Assets Planning and Delivery Group
Engineering

DESIGN STANDARD DS 28

Water and Wastewater Treatment Plants - Electrical

VERSION 1
REVISION 8

JULY 2021

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 WA OSH Regulations 1996 (Division 12, Construction Industry – consultation on hazards and safety management) to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

https://www.slp.wa.gov.au/legislation/statutes.nsf/law_s4665.html

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

Head of Engineering

DISCLAIMER

Water Corporation accepts no liability for any loss or damage that arises from anything in the Standards/Specifications including any loss or damage that may arise due to the errors and omissions of any person. Any person or entity which relies upon the Standards/Specifications from the Water Corporation website does so that their own risk and without any right of recourse to the Water Corporation, including, but not limited to, using the Standards/Specification for works other than for or on behalf of the Water Corporation.

The Water Corporation shall not be responsible, nor liable, to any person or entity for any loss or damage suffered as a consequence of the unlawful use of, or reference to, the Standards/Specifications, including but not limited to the use of any part of the Standards/Specification without first obtaining prior express written permission from the CEO of the Water Corporation.

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. It is important to note that the latest revisions including additions, deletions and changes to this version of the standard are also identified by the use of a vertical line in the left hand margin, adjacent to the revised section.

REVISION STATUS						
SECT.	VER./ REV.	DATE	PAGES REVISED	REVISION DESCRIPTION (Section, Clause, Sub-Clause)	RVWD.	APRV.
1	0/0	23.05.05	All	New Version	CW	AAK
1	1/3	30.08.11	14-15	1.1, 1.3, 1.4, 1.6, 1.7 revised	NHJ	AAK
1	1/4	30.06.12		1.4 revised ((EXAMPLE))	NHJ	SE
1	1/7	10.01.18		1.4, 1.5, 1.8 revised	NHJ	MSP
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2	1/6	31.05.17	20, 21	2.4.4 removed, 2.5.2 revised	NHJ	MSP
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3	1/0	30.06.06	24	3.3.5 revised	NHJ	AAK
3	1/2	02.06.09	23	3.4.2 revised	NHJ	AAK
3	1/3	30.08.11	28, 34	3.6.4, 3.9.2	NHJ	AAK
3	1/5	30.07.13	34	3.9.2 revised	NHJ	MH
3	1/7	10.01.17		3.3.1, 3.3.2, 3.3.5,3.6.4 revised 3.3.5 new 3.10 new (previously 3.3.5)	NHJ	MSP
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4	1/7	10.01.17		4.3 new	NHJ	MSP
5	0/0	23.05.05	All	New Version	CW	AAK
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5	1/8	05.07.21	1	5.3 added	EG	NHJ
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6	1/1	30.04.07	37	6.1,6.2 revised	NHJ	AAK
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10	0/0	23.05.05	All	New Version	CW	AAK
10	1/1	30.04.07	39	10.1,10.3,10.4 included	NHJ	AAK
10	1/2	02.06.09	39, 40	10.2, 10.3, 10.9 revised	NHJ	AAK
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10	1/7	10.01.18		10.2, 10.3, 10.4 revised 10.9, 10.10 new	NHJ	MSP
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11	1/3	30.08.11	46	11.3, 11.5 revised	NHJ	AAK
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13	0/0	23.05.05	All	New Version	CW	AAK
13	1/2	02.06.09	43	13.1, 13.2, 13.3 revised	NHJ	AAK
13	1/5	30.07.13	49	13.5 revised	NHJ	MH
14	0/0	23.05.05	All	New Version	CW	AAK
14	1/3	30.08.11	51	14.3 revised	NHJ	AAK
14	1/7	10.01.18		14.4 revised	NHJ	MSP
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16	0/0	23.05.05	All	New Version	CW	AAK
16	1/6	31.05.17	56 - 59	New	NHJ	MSP
16	1/7	10.01.18		16.1.4 revised 16.3 new	NHJ	MSP
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17	1/6	31.05.17	60 - 61	New	NHJ	MSP
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App 1	**1/7**	**10.01.18**		**2.2.1.1, 3.2.2, 3.3.2, 4.1.1, 4.3, 5.5, 6.4.2, 6.6, 7.2.1, 7.2.2, 7.3.1, 7.3.2, 7.4.2, 7.4.3, 7.5.1, 7.5.2, 8.1.2, 8.1.3, 8.3, 8.4, 8.5, 8.6 revised**	**NHJ**	**MSP**
App 1	**1/8**	**05.07.21**		**Deleted all except clause 1.** **Note added.**		

DESIGN STANDARD DS 28
Water and Wastewater Treatment Plants - Electrical

CONTENTS

1 INTRODUCTION

1.1 Purpose

The Water Corporation has adopted a policy of out sourcing most of the electrical engineering and electrical detail design associated with the procurement of its assets. The resulting assets need to be in accordance with the Corporation's operational needs and standard practices. This design standard (i.e. Electrical Design Standard DS28) sets out design standards and engineering practice which shall be followed in respect to the design and specification of electrical parts of major and minor treatment works being acquired by the Corporation. This design manual does not address all of the issues which will need to be addressed by the Designer in respect to a particular treatment works.

It is the Water Corporation's objective that its assets will be designed so that these have a minimum long term cost and are convenient to operate and maintain. In respect to matters not covered specifically in this manual, the Designer shall aim his/her designs and specifications at achieving this objective.

This design standard is intended for the guidance of electrical system designers. It is not intended as a type specification for equipment or installation work and shall not be quoted in specifications (including drawings) for the purpose of purchasing electrical equipment or electrical installations except as part of the prime specification for a major design and construct contract.

1.2 Scope

This design standard covers in detail aspects of electrical design which are particular to water and wastewater treatment plants. It provides cross references to other Corporation design standards in respect to those electrical design aspects which are common to both treatment plants and pump stations.

1.3 Use of Type Specifications and Corporation Standard Designs

The Type Specifications in the DS26 series cover many of the items of equipment commonly used in Treatment Plants. The Designer shall use the DS26 Type Specifications for the purchase of equipment where applicable. Where an applicable Type Specification does not exist, the Designer shall prepare an appropriate specification based on this design standard (i.e. Electrical Design Standard DS28).

The Corporation has prepared standard circuit designs and standard PLC logic designs and these are included in Corporation drawing sets FS00 and FS01. The Designer shall make use of these standard designs wherever practical.

1.4 References

Reference should be made also to the following associated design standards:

DS 20	Design Process for Electrical Works
DS 21	Major Pump Stations - Electrical
DS 22	Ancillary Plant and Minor Pump Stations - Electrical
DS 23	Pipeline AC Interference and Substation Earthing
DS 24	Electrical Drafting
DS 25	Electronic Instrumentation
DS 26	Type Specifications – Electrical

DS 29	Arc Flash Hazard Assessment of Switchgear Assemblies
FS00	Water Corporation Electrical Standard Drawings FS00 Series
MN01	Water Corporation Electrical Standard Drawings - Small Pump Stations - MN01 planset Series
HA-ST-02	EEHA Hazardous Area Classification Manual
HA-ST-03	EEHA Selection and Installation Manual
HA-ST-04	EEHA Competency Manual

1.5 Definitions

Asset Manager:	the Corporation officer responsible for the operation of the asset being acquired
Corporation:	the Water Corporation (of Western Australia)
Designer:	the consulting engineer carrying out the electrical design
Design Manager:	the Corporation officer appointed to manage the project design process
Network Operator:	the supply authority controlling the operation of the electrical supply network
Small Treatment Plants:	site having an installed duty transformer capacity rated at ≤ 315 kVA
Medium Treatment Plants:	site having an installed duty transformer capacity rated at > 315 kVA and ≤ 2 MVA
Major Treatment Plants:	site having an installed duty transformer capacity rated at > 2 MVA
Senior Principal Engineer:	Senior Principal Engineer, Electrical Engineering, Electrical Standards Section, Engineering Branch, Water Corporation

1.6 Standards

(a) Electrical installations shall be designed in accordance with the latest edition of AS 3000 and except where specified otherwise in this design standard, treatment plant electrical design shall be carried out in accordance with the latest edition of all other relevant Australian Standards. In the absence of relevant Australian Standards, relevant international, other national, or industry standards shall be followed.

(b) Except where a concession is obtained from Energy Safety, electrical design shall be in accordance with the W.A. Electrical Requirements Manual (WAER) produced by the Energy Safety Division (EnergySafety) of the Department of Consumer & Employment Protection.

(c) Except where a concession is obtained from the Supply Authority, the electrical design of all installations to be connected to the Supply Authority system shall be designed in accordance with their requirements. Such requirements include the Western Australian Distribution Connection Manual and the Technical Rules for the South West Interconnected Network published by Western Power.

(d) All electrical equipment which incorporates electronic switching or electronic measuring circuits shall be specified to be in accordance with the European standards IEC 61000-6-4 and IEC 61000.6.2 for Electromagnetic Emissions and Immunity respectively. In addition all such equipment shall be specified to have been approved by the Australian Communications Authority in respect to Electromagnetic Compatibility.

(e) Electrical installations shall be designed in accordance with the requirements of the Water Corporation's HA-ST-03: EEHA Selection and Installation Manual.

1.7 Electrical Safety

Electrical installations shall be designed to facilitate the safe operation and maintenance of electrical plant.

In respect to High Voltage equipment, mechanically and/or key interlocked isolating switches, earthing switches and access doors shall be employed wherever practical so as to prevent access to live conductors. In instances where interlocking is not practical, High Voltage isolating and earthing switches and access doors shall be fitted with the Water Corporation's EL1 series locks.

In respect to Low Voltage equipment, mechanically and/or key interlocked isolating switches and access doors shall be employed so as to prevent access to live conductors wherever it is practical and economical to do so. Where the latter is not the case, doors providing access to live conductors shall be fitted with the Water Corporation's EL2 equivalent series locks (Bilock).

All electrical equipment shall be adequately rated for the electrical fault level at the site so as to prevent injury to personnel in the event of a major electrical fault.

1.8 Mandatory Requirements

In general the requirements of this standard are mandatory. If there are special circumstances which would justify deviation from this standard, the matter shall be referred to the Senior Principal Engineer for his consideration. No deviation from the requirements of this standard shall be made without the written approval of the Senior Principal Engineer.

It is a requirement of the Corporation that the following QA systems be applied by electrical equipment manufacturers and electrical installers.

1.9 Quality Assurance

Suppliers of major electrical equipment (such as transformers, motors, variable speed controllers, switchgear, switchboards, instrumentation system) shall supply only equipment from a manufacturer who has in place a Quality Management System certified by an accredited third party to AS/NZS 9001:2000, or an approved equivalent.

1.10 Installers

Installers of major electrical equipment (such as transformers, motors, variable speed controllers, switchgear, switchboards, instrumentation system) shall have in place a Quality Management System certified by an accredited third party to AS/NZS 9001:2000 (excluding clause 7.3 Design & Development), or an approved equivalent.

1.11 Acceptance Tests

In tender documents in which acceptance tests are specified, the cost of providing works tests (including associated test certificates) and site tests (including associated test certificates) shall be shown as separate items in the Bill of Quantities so that it can be verified that sufficient funds have been allowed to carry out such testing and it is clear that works tests and site tests are separable and critical deliverables.

2 BASIS OF DESIGN

2.1 General

The design of the treatment plant shall be carried out in accordance with:

(a) The Corporation's Design Process for Electrical Works (DS20),

(b) This Design Standard (DS28), and

(c) The Corporation's design brief.

The Corporation's Design Standards set out the general standards and practices to be followed for all projects. However in the course of design of a particular treatment plant design data are accumulated, decisions are made and guidelines are developed which are specific to that treatment plant and which are not necessarily covered in detail in the Design Standards.

Such decisions shall be recorded, reviewed and incorporated into the project design management system as described hereunder.

2.2 Basis of Design Document

As an initial task the Designer shall develop a Basis of Design Document which shall record the design information which is specific to the particular treatment plant and shall keep this document up to date as a reference document for reviewers, detail design staff and designers from other disciplines. The Basis of Design Document shall form the basis for the preparation of the Concept Design Report and the Engineering Summary Report required under Corporation's Design Process for Electrical Works (DS20).

Since the electrical, instrumentation and control engineering design associated with treatment plants must proceed to some extent in conjunction with the process design, it is recognised that not all information may be available and not all design decisions may have been made at this early stage.

Consequently, in order to maintain adequate control of the design, it is important that the Designer maintain the Basis of Design as a living document for the duration of the design as specified above.

The Basis of Design Document shall be submitted to the Design Manager for approval at the first draft stage and following each major revision.

For major projects the electrical, control and instrumentation Basis of Design may form part of an overall project Basis of Design document.

The Basis of Design Document shall include the following items:

(a) A brief outline of the scope of work,

(b) Specific definitions and abbreviations,

(c) Specific details of site conditions, including environmental conditions, isokeraunic level and details of any specific constraints,

(d) Details of power supply to the site (source, voltage, fault levels, etc,) and estimates of power demand,

(e) Decisions regarding locations and types of transformers, cabling, switchgear, switchboards, earthing systems, types and voltages of motors and variable speed controllers,

(f) Process control system architecture and hardware, data communication methods and field instrument types,

(g) Decisions regarding classification of hazardous areas and types of hazardous area equipment to be used (in accordance with the requirements of HA-ST-02: EEHA Hazardous Area Classification Manual and HA-ST-03: EEHA Selection and Installation Manual),

(h) Decisions regarding lighting, paging, communication, fire and security systems,

(i) Details of any departures or exemptions from the Corporation's Design Standards that have been approved by the Senior Principal Engineer and

(j) Decisions arising from discussions with operators, maintenance staff and other stakeholders.

2.3 Environmental Conditions

The electrical engineering design shall be based on green field site environmental conditions determined as follows:

(a) Maximum ambient temperature - the maximum monthly average daily maximum outside temperature for the site as published by the Commonwealth Bureau of Meteorology,

(b) Maximum humidity - the maximum monthly average index of humidity for the site as published by the Commonwealth Bureau of Meteorology,

(c) Isokeraunic Level - as shown for the site on the Average Thunder Day Map published by the Commonwealth Bureau of Meteorology,

(d) Corrosion Environment - the ISO environmental corrosion category for the site as defined in AS/NZS 2312,

(e) Airborne dust pollution level - severe, moderate, or low as determined for the site bearing in mind proposed operations and future developments,

(f) Altitude - site mean height above sea level.

Except for air conditioned spaces, the environmental conditions at the various locations around the treatment plant will be more severe than the values determined above and shall be estimated on the basis of the above values depending on the particular location.

In wastewater treatment plants particular attention shall be paid to equipment to be located in areas in which traces of hydrogen sulphide (H_2S) gas may be present.

Within buildings, sun loading and heat losses from energy conversion equipment (including switchgear) will raise the local temperature above outside shade ambient temperature. In such cases ventilation or air conditioning shall be provided to ensure that internal room temperatures do not exceed 45°C.

Air filtering may be required to reduce to acceptable values the levels of airborne contaminants including poisonous and/or corrosive gases. If such is the case, filters shall be arranged to facilitate convenient maintenance.

2.4 P&ID's and Equipment Lists

The Designer's first task shall be to review the initial conceptual P&ID and in conjunction with the process, chemical and mechanical designers to develop and expand the P&ID details. From these the Designer, in conjunction with the mechanical designer, shall prepare the following lists on which the electrical engineering design shall be based. As a minimum the lists shall include the details in sections 2.4.1 to 2.4.4 below. Additional information shall be included as necessary to ensure that the equipment selected is appropriate to the specific process requirements and environmental conditions.

2.4.1 Mechanical Equipment List

Preparation of the mechanical equipment list is primarily the responsibility of the mechanical Designer. However the electrical Designer shall ensure that the list contains at least the following information and that equipment is correctly numbered in accordance with this Design Standard:

(a) Plant area

(b) Unique equipment number

(c) Equipment name and description

(d) Date and revision details

And for electrically-driven equipment:

(e) Supply voltage .

(f) Rated load (kW)

(g) Actual load (kW)

(h) Duty (continuous, intermittent, standby)

(i) Starter type, and whether fixed or variable speed

2.4.2 Valve List

Preparation of the valve list is the responsibility of the hydraulic, process or mechanical designer. However the electrical Designer shall ensure that the list contains at least the following information and that equipment is correctly numbered in accordance with this Design Standard:

(a) Plant area

(b) Unique valve number

(c) Valve name and description

(d) Fluid

(e) Valve size and type

(f) Actuator details (if applicable)

(g) Position transmitter and position switch details (if applicable)

(h) Date and revision details

2.4.3 Electrical Equipment List

The Designer shall develop the electrical equipment list from the mechanical equipment and valve lists, with the addition of non-mechanical equipment such as lighting and small power, UPS's, transformers, switchboards, distribution boards and the like. The list shall contain at least the following information:

(a) Plant area

(b) Unique equipment number

(c) Equipment name and description

(d) Supply voltage and no. of phases

(e) Rated load (kW)

(f) Actual load (kW)

(g) Duty (continuous, intermittent, standby)

(h) Starter type (if applicable)

(i) Number of PLC inputs and outputs required

(j) Switchboard from which supplied

The designer shall use the electrical load list as a basis for estimating loads and maximum demands for each switchboard and for the treatment plant as a whole. (This can be done conveniently by creating the electrical load list as a database or spreadsheet with automatic calculation of load subtotals and totals, taking power factor into account.)

2.4.4 Maintenance of Lists

The Designer shall ensure that all lists are kept up to date throughout the project up to completion of commissioning. This requires implementation of strict project controls and close liaison between designers of all disciplines; serious problems may arise if uncontrolled changes are allowed to occur.

On a major project maintenance of lists may be a significant task

2.5 Equipment Numbering Systems

2.5.1 Mechanical and Electrical Equipment Numbering

Mechanical and electrical equipment numbers shall be allocated according to Section 4 of the Corporation's "DS80 WCX Manual". The general format for equipment numbers is CC{C} aannn, where:

(a) CC{C}, the equipment type code, represents two or three letters selected from Section 4 of the DS80 WCX Manual which identify the type of equipment;

(b) aa represents the two-digit process area number from Section 4 of the DS80 WCX Manual;

(c) nnn is a sequential 3-digit equipment number. For new plants the equipment numbers should start from 001 in each process area.

For example, "PU 15002" might be the second raw water pump in area 15 (raw water pump station). "BS 22001" might be the first bar screen at the inlet works of a wastewater treatment plant.

As a general rule each sequential 3-digit equipment number shall be used only once within each process area; for example the number "CP 15002" shall not be used for an air compressor in a raw water pump station if one of the raw water pumps has already been numbered "PU 15002 ".

The exceptions to this rule are:

(i) Motors shall be numbered as for their driven equipment. For example, "MV 15002" is the variable-speed motor associated with raw water pump "PU 15002".

(ii) Variable speed controllers and local control stations shall be numbered as for their associated motors.

Where there is more than one motor associated with an item of equipment (such as a blower drive motor with an electrically-driven lube oil pump), the ancillary motors shall be identified with the suffix A, B, C etc. For example MF 42004A could be the drive for a lube oil pump associated with blower motor MF 42004.

2.5.2 Existing Treatment Plants

Guidelines for work on existing treatment plants are given in section 17.

3 ELECTRICITY SUPPLY

3.1 Energy Supply Agreement

For major treatment plants, the Corporation may wish to consider purchase of energy from an electrical power supplier other than the local Network Operator. Negotiations in this respect will be carried out by the Corporation itself. However to assist the Corporation in this regard, the Designer shall carry out preliminary assessments of:

(a) Expected maximum demand power requirements stage by stage,

(b) Expected load versus time of day profile including an assessment of any power export from embedded generation, and

(c) Date by which power supply is expected to be required.

3.2 Connection to Electrical Supply Network

3.2.1 Incoming Supply Arrangements

(a) Electrical supply from a Network operator's network directly to treatment plant installations having a maximum power demand of not greater than 315 kVA may be taken at Low Voltage with the Network Operator metering being at Low Voltage and the associated transformers and primary side High Voltage switchgear being Network Operator owned.

(b) Electrical supply from a Network Operator's network direct to treatment plant installations having a maximum power demand of greater than 315 kVA shall be taken at High Voltage with the Network Operator metering being at High Voltage and the associated transformers and primary side High Voltage switchgear being Corporation owned.

Sole use transformers owned by the Network Operator shall not be used if the treatment plant maximum power demand is greater than 315 kVA.

In country areas where the supply to the treatment plant site is via High Voltage overhead lines, the Network Operator metering unit may be aerial type external to the treatment plant site depending on Network Operator preference. Otherwise the Corporation's main High Voltage switchboard shall incorporate the Network operator's metering unit and one or two Network operator isolating switches, the latter depending on whether one or two Network Operator incoming cables are to be provided.

The Corporations main incoming High Voltage switchboard shall be of the indoor type located in a separate dust free switch room or in a proprietary weatherproof and dust free kiosk enclosure.

3.2.2 Initial Connection Enquiries

Early in the design process following an agreement for the supply of electrical energy the Designer shall reach an understanding with the Network Operator as to the likely conditions of connection to the electrical supply network. Initial information to be provided to the Network Operator shall include;

(a) Expected maximum demand power requirements,

(b) Expected load versus time of day profile including an assessment of any power export from embedded generation,

(c) Whether sole use transformer is required (only if supply ≤ 315 kVA),

(d) Required supply voltage,

(e) Maximum motor size

(f) Types of drives,

(g) Size and type of any expected embedded generation, and

(h) Date by which power supply is expected to be required.

3.2.3 Information Required Initially from Network Operator

In making the initial submission to the Network Operator, the Designer shall request the following information:

(a) The minimum and maximum fault levels at the site,

(b) The minimum and maximum source impedances at the site,

(c) Any required variations from the Network Operator's published Specific Requirements (including power factor requirements),

(d) Any required special protection requirements,

(e) Details of the available tariff options,

(f) The location and type of Network Operator's metering unit,

(g) The date connection could be made to the electrical supply network,

(h) The cost of connection.

3.3 Incoming High Voltage Electricity Supply

3.3.1 Point of Attachment

Generally for major treatment plants the incoming supply to the site will be at 22 kV or 33 kV and thus higher than can be used directly for drives within the treatment plant. Often a major treatment plant will have load spread over a relatively large area so that it will be desirable to distribute power over the site at the supply voltage. In such cases it will be necessary to use step down transformer substations at various locations within the treatment plant complex. Nevertheless the Corporation's point of attachment to the incoming electrical supply distribution network will be at the location where the supply enters the site and the High Voltage distribution system on the load side of that point will be the Corporation's responsibility.

3.3.2 Metering and Incoming Isolators

(a) The Network Operator's metering will be at the incoming supply voltage and may consist of either an external pole mounted metering unit (i.e. potential and current transformers) or may be an internally mounted metering unit. If an internally mounted metering unit is to be used, the

Network Operator's metering unit and line side isolating switch shall be mounted integral with the primary supply voltage switchboard.

(b) For critical or major treatment plants two feeders from the incoming electrical supply distribution network should be obtained if this is possible. If two feeders are provided, each feeder shall be connected to the switchboard via separate Network Operator controlled isolators connected in parallel to the line side of the Network Operator's metering unit. If a second incoming feeder is not available initially space shall be provided for the addition of a second incoming isolator on the line side of the Network Operator's metering unit.

(c) Metering data shall be fed into the Plant Control System (PCS). As a minimum, the following data shall be provided:

- Instantaneous power consumption
- Instantaneous kVA
- Tariff

3.3.3 Surge Protection

(a) Suitably rated surge diverters shall be installed so as to provide overvoltage protection to the incoming High Voltage switchboard.

(b) If there is only a single main circuit breaker, the above surge diverters shall be installed directly onto the High Voltage bus bars on the line side of the main circuit breaker.

(c) If there are multiple main circuit breakers, the above surge diverters shall be installed onto the load side of the main switchfuse controlling the local auxiliary supply transformer

3.3.4 Incoming Feeder Ratings

(a) It is an additional specific requirement of Western Power that no single High Voltage main switchboard connected to the Western Power normal High Voltage distribution network be rated greater than 4 MVA.

(b) Consequently within a particular treatment plant with a total electrical load > 4 MVA, ≤ 8 MVA, the loads will have to be distributed across two incoming main switchboards.

(c) Both such switchboards are required to have two incoming isolators on the line side of the switchboard metering unit. Western Power will provide a separate feeder to each switchboard and reserve the right to parallel the two switchboards using a Western Power cable inter connecting the second incoming isolator on each switchboard. However, paralleling of the two switchboards within the Corporation's distribution system is not permitted.

3.3.5 Point of Common Coupling

The point on the network where Corporation assets associated with a connection point are connected to primary network assets that are shared with other Users. For Corporation assets this is usually the line side of the Corporation’s incoming High Voltage equipment.

3.4 High Voltage Distribution

3.4.1 General

(a) All of the Corporation's High Voltage distribution on the treatment plant site shall be underground cable type and High Voltage switchgear shall be indoor type suitably enclosed.

The use of overhead line mounted recloser switchgear shall not be permitted, neither shall the use of air insulated and/or air break switchgear be permitted within the treatment plant High Voltage distribution system,

(b) The High Voltage distribution system may be of the radial or the open ring main type. If the open ring main type of distribution is used, interlocking shall be provided to prevent closure of the ring main.

If an open ring main system is used in conjunction with two incoming High Voltage switchboards, operational procedures shall be put in place to ensure that ring main switching does not result in the load on either switchboard exceeding 4 MVA.

(c) All High Voltage main switchboards shall be located in separate purpose built switchrooms (or for smaller treatment plants in weatherproof kiosks) close to the point of attachment to the incoming electrical supply distribution network.

(d) Transformer substations shall be located near the associated electrical loads and shall consist of primary voltage switchgear, transformer(s) and earthing system, all suitably enclosed separately from enclosures for associated secondary voltage switchgear and treatment plant equipment.

(e) The treatment plant electrical supply configuration shall be such that the Low Voltage prospective fault current levels do not exceed 50 kA.

3.4.2 Protection Equipment

(a) High Voltage distribution cable systems within a treatment plants shall be protected by circuit breakers and associated protection relays. Definite Minimum Inverse Time Delay overcurrent and earth fault protection shall be provided as a minimum.

If the High Voltage distribution system is of the open ring main type, directional overcurrent and earth fault protection shall be provided so as to provide adequate protection grading regardless of the location of the open point.

(b) If the treatment plant includes embedded generation equipment, additional protection equipment shall be provided as detailed in para. 3.7 hereunder.

3.4.3 Tripping Releases and Power Supplies

(a) High Voltage circuit breakers supplying transformers rated >1250 kVA shall be equipped with D.C shunt trip releases and D.C. under voltage releases.

All protective devices on circuit breakers supplying transformers rated > 1250 kVA shall trip the circuit breaker utilising either the D.C. shunt trip release or the primary current sensor powered release (if the latter is fitted also).

(b) High Voltage circuit breakers supplying transformers rated ≤ 1250 kVA shall be equipped either with D.C shunt trip releases and D.C. under voltage releases, or shall be supplied with primary current sensor powered releases and A.C. shunt trip releases.

Overcurrent and earth fault protection relays on circuit breakers supplying transformers rated ≤ 1250 kVA shall trip the circuit breaker utilising either the D.C. shunt trip release or the primary current sensor powered release (if the latter is fitted). Other protective devices shall be connected to such circuit breakers so as to trip the circuit breaker via the associated D.C. shunt trip release or A.C. shunt trip release, whichever is fitted.

(c) High Voltage switch fuses supplying transformers rated ≤ 500 kVA may be fitted with an A.C. shunt trip release only for the purpose of tripping the switchfuse in the event of a transformer over temperature fault or for operational reasons.

(d) AC shunt trip releases fitted to High Voltage circuit breakers (or high Voltage switch fuse units) supplying transformers shall be powered from the secondary side of the transformer fed by the particular High Voltage circuit breaker (or High Voltage switch fuse unit).

3.4.4 Voltage Surge Protection

The design of the insulation coordination for the complete High Voltage system shall be in accordance with Section 12 of Design Standard DS21. Suitably rated surge diverters shall be fitted to the primary winding terminals of all transformers connected directly to the High Voltage distribution system. The Designer shall ensure that the rating of these surge diverters and the length of the associated feeder cables are such that the above surge diverters will provide adequate surge protection for the associated High Voltage switchboard. If this cannot be achieved, suitably rated surge diverters shall be provided connected directly to the associated High Voltage switchboard busbars.

3.5 Substations

3.5.1 Dual Transformers

Dual transformers shall be provided in substations supplying Low Voltage power to critical areas of the treatment plant.

3.5.2 Switchgear Enclosures

High Voltage distribution system switchgear shall be housed in outdoor kiosk enclosures or in separate switchrooms located within treatment plant buildings.

Where the substation consists of more than one transformer or where the transformer rating exceeds 1250 kVA, the High Voltage switchgear shall be located in a separate switchroom.

Switchgear kiosk enclosures shall comply with the requirements of Section 3 of Design Standard DS21.

3.5.3 Transformer Enclosures

Transformers rated ≤ 1250 kVA may be housed in outdoor kiosk enclosures in accordance with the requirements of Section 7 of Design Standard DS21. Otherwise oil filled transformers shall be located outdoors in fenced enclosures and dry type transformers shall be housed in separate well ventilated transformer rooms located within treatment plant buildings.

3.5.4 Clearances

The clearances to be maintained between oil filled transformers and buildings and between each other shall comply with the requirements of Section 3 of Design Standard DS21.

3.5.5 Connections to Transformers

Connections to transformers shall comply with the requirements of Section 3 of Design Standard DS21.

3.5.6 Transformer Ratings

Transformer ratings shall comply with the requirements of Section 3 of Design Standard DS21.

3.5.7 Transformer Feeders

Transformer High Voltage and Low Voltage feeders shall comply with the requirements of Section 3 of Design Standard DS21.

3.6 Low Voltage Distribution

3.6.1 General

It may be necessary to provide Low Voltage distribution between various adjacent sections of the treatment plant, sometimes to provide an alternative source of supply. If the latter is the case, interlocking shall be provided to prevent voltage being back fed into the High Voltage distribution system.

3.6.2 Sectionalising Switchboards

In critical areas of the treatment plant consideration shall be given to sectionalising the main Low Voltage switchboard in each area. The decision as to whether or not to sectionalise such switchboards shall be in accordance with Sections of DS21.

3.6.3 Protection

All circuits within the Low Voltage distribution system shall be provided with short circuit protection by means of fault current limiting circuit breakers fitted with mains current operated over current and earth fault releases.

3.6.4 Neutral and Earth Connections

The Low Voltage star point of each transformer shall be connected directly to earth. All earth bars within a particular switchboard shall be connected directly to the switchboard's main earth bar.

3.7 Embedded Generation

3.7.1 Use of Earthing Transformer

If the treatment plant includes embedded generation which is required to transmit power over the internal High Voltage distribution system when the treatment plant site is disconnected from the incoming electrical supply distribution network, an earthing transformer shall be provided so as to earth the internal High Voltage distribution system during such times.

The circuit breaker controlling the earthing transformer shall be closed automatically whenever the main incoming supply circuit breaker or its associated isolating switches are open. The circuit breaker controlling the earthing transformer shall be opened automatically once the main incoming supply circuit breaker and its associated isolating switches are closed.

3.7.2 Selection of Earthing Transformers

Earthing transformers shall be of the interconnected star (i.e. zig-zag) type. The kVA rating of a three phase earthing transformer shall be defined as the product of the line to neutral voltage (kV) and the neutral to earth current (amps).

Earthing transformers shall be designed to have a zero sequence impedance of 100%, i.e. if the transformer is supplied from an otherwise unearthed three phase supply, a solid earth fault on one line shall result in the circulation of the earthing transformers rated neutral to earth current.

The one minute kVA rating of an earthing transformer shall be not less than the 30% of the combined three phase kVA rating of all embedded generator step up transformers feeding into the associated treatment plant High Voltage distribution system.

3.7.3 Synchronising with the Incoming Supply

Embedded generators shall be connected to the incoming mains supply via automatic synchronising equipment.

3.7.4 Point of Connection of Embedded Generators and Earthing Transformer

Wherever practical the point of connection of embedded generators and their associated earthing transformer to the High Voltage distribution system shall be at the site main switchboard so as to make the interlocking, between the circuit breakers controlling these items and the main circuit breaker, as direct as possible.

3.7.5 Harmonic Circulating Currents

Embedded generation is often required to supply a significant local load which must be able to be supplied from the incoming supply if the local embedded generators are shut down.

If the generators are Low Voltage, these will be required to be connected in parallel with the Low Voltage side of a delta/star step down transformer. In such circumstances it is necessary that the neutrals be connected in parallel.

The preferred two thirds pitch wound generators produce negligible triplen harmonic voltages. However, this design results in generators which have very low zero sequence impedance, so that these machines will allow significant triplen harmonic currents to flow if these are connected in parallel with other machines which produce significant triplen voltages.

A delta/star transformer will produce significant triplen harmonic voltages (which will be zero sequence).

For example a typical standard delta/star 2000 kVA 22/0.415 kV transformer operating at 108 % of nominal voltage will cause a circulating current of approximately 140 amps if connected in parallel with a two thirds pitch wound generator.

If the generator was rated at 400 kVA (i.e. 560 amps), the above circulating current would be 25% of full load current. This current would be shared between the three phases so that at fundamental full load current, the resulting r.m.s. current overload would be less than 0.5%. So from an overload point of view, provided the generator star point connection is rated for full load current, the above circulating current would not cause a problem.

However, the third harmonic circulating current appears as an earth fault current to generator earth fault protection. Since it is normal to set generator earth fault protection to 10%, in the above example it would be desirable to reduce the third harmonic current circulating through the generator to 3%. In the above example a 0.04 ohm series resistor connected between the generator winding star point and the connections to neutral and earth bus bars would achieve this result.

Use of a low loss design transformer will reduce the third harmonic current significantly.

The Westinghouse Electrical Transmission and Distribution Reference Book is a useful reference in regard to the above matters.

The approximate value of the third harmonic circulating current can be calculated as follows:

$I_{o3} = I_{e3}*X_{p3} / (R_n + 0.33*X_{t3}*j+3* |X_{g0}| *j)$ = third harmonic circulating current, amps where: $I_e = I_r * F_e$ = excitation current at 108% of Vt, amps

$I_r = Q_t/(3^{0.5} * V_t)$

= transformer rated current, amps

Q_t = transformer rating, kVA

V_t = transformer secondary voltage rating, kV (= 0.415 kV)

F_e = 50 Hz excitation current, per unit of I_r

$I_{e3} = I_e * F_3$

= 3rd harmonic content of I_e, amps

F_3 = 3rd harmonic content of excitation current, per unit of I_e

$X_{p3} = X_{t3} * F_z$

= transformer primary winding 3rd harmonic impedance, ohms

$X_{t3} = |Z_t| * |X_t| * j * 150/50$

= transformer total 3rd harmonic impedance, ohms

$|Z_t| = V_t^2 * 1000/Q_t$

= transformer base 50 Hz impedance, ohms

F_z = ratio of transformer primary winding impedance to total impedance

$|X_t|$ = transformer 50 Hz impedance, per unit of $|Z_t|$

R_n = neutral resistor, ohms

$|X_{g0}|$ = generator 50 Hz zero sequence impedance , ohms

If the embedded generators are High Voltage, these should not exhibit significant circulating current provided two thirds pitch machines are used.

3.7.6 Fault Levels

The provision of embedded generators will increase significantly the fault level within the treatment plant's electrical system and the Designer shall carry out calculations so as to ensure that equipment specified fault ratings are adequate. Because the zero sequence impedance of two thirds pitch alternators is very low, the increase in earth fault level can be particularly significant.

3.7.7 Generator Specifications

(a) The generating set engine shall be sized to the mechanical load demand and the generator set alternator shall be sized to the electrical load demand.

(b) Engines on generating sets supplying loads with significant proportions of non-linear load shall be fitted with electronic governors.

(c) The sub transient reactance of any alternator supplying a non-linear load shall be not more than 0.05 per unit assuming the non-linear load kVA as the per unit values base kVA.

(d) Alternators fitted to embedded generating sets shall comply with the requirements of DS26-27 - Type Specification for Alternators Fitted to Embedded Generating Sets.

3.7.8 Generator Protection

Embedded generators shall be provided with the following protection by relays separate from the generator set management system :

(a) Phase overcurrent,

(b) Restricted earth fault (or differential protection),

(c) Neutral overcurrent (only if the generator neutral connection is rated less than generator full load rated phase current),

(d) Reverse power,

(e) Loss of excitation,

(f) Pole slip,

(g) Over voltage,

(h) Under frequency,

(i) Synchronism check

(j) Negative sequence over current (only for alternators rated > 1000kVA)

3.7.9 Loss of Incoming Mains Protection

It is important that the loss of incoming mains supply causes the treatment plant main circuit breaker to open before the relevant Network Operator's circuit breaker recloses, so as to prevent the incoming supply returning on to unsynchronised embedded generation. Consequently the following protection equipment shall be provided on the treatment plant main circuit breaker as well as that specified para. 3.3 above:

(a) Voltage vector shift,

(b) Rate of change of frequency,

(c) Neutral displacement,

(d) Directional earth fault (monitoring the incoming supply),

(e) Directional overcurrent (monitoring the incoming supply)

(f) Under frequency,

(g) Under voltage,

(h) Reverse power (if power export is prohibited),

(i) Over frequency (if power export is permitted),

(j) Over voltage (if power export is permitted),

(k) Synchronism check.

3.7.10 Generator Circuit Breakers

Circuit breakers controlling generators shall be of the fully withdrawable type and shall have an operational durability rating of 10,000 open and close operations without current in the main circuit.

3.7.11 Network Operator's Special Requirements

Depending on the location of the treatment plant, the Network Operator may have special requirements in respect to the operation and protection of embedded generators, which the Designer shall ascertain and take into account in the preparation of the design.

3.7.12 Use of Uninterruptible Power Supplies

Critical instrumentation shall be supported by small local uninterruptible power supplies (UPS's) rather than use of smaller numbers of a larger UPS's.

UPS's shall be arranged so that back feeding onto associated mains supply cables is prevented.

Small local UPS's shall be purchased in accordance with the requirements of either Type Specification DS26-30 or DS26-31 as appropriate.

3.8 Treatment Plant Wide Harmonic Analysis

Converters including those associated with variable speed drives give rise to harmonic currents in the supply lines and hence cause harmonic distortion of the supply voltage. Network Operators impose limits on the levels of harmonic currents which may be drawn by any one consumer from the electrical supply network and on the resulting level of voltage harmonic distortion at the point of common coupling to the network. The Designer shall ensure that the design is such that these limits are not exceeded. In this respect the Designer shall refer to section 4 of Corporation Design Standard DS21.

Using manufacturer's harmonic current spectrum values for each particular converter, the Designer shall calculate harmonic current and harmonic distortion values for the whole plant by:

(a) first calculating total values of each individual harmonic current using the second summation law as defined in AS /NZS 61000-3-6 para. 6.2,

(b) then calculating harmonic impedance values using the worst case impedance curve method as defined in AS /NZS 61000-3-6 Appendix G, and

(c) then calculating harmonic voltage distortion values using the above values.

In respect to any alternators involved in these calculations, care shall be taken to use manufacturer’s values of sub transient reactances wherever possible. However for preliminary calculations in the absence of a known alternator make and model, a sub transient reactance value of 13 % can be assumed.

3.9 Power Factor Correction

3.9.1 General

WA Electrical requirements require that the power factor which an electrical installation presents at the point of attachment to the incoming electrical supply distribution network shall be not less than 0.8 lagging at the time of peak load and shall not at any time become leading. Western Power reserve the right, in some particular cases, to require the power factor at the time of peak load to be not less than 0.95.

Power factor correction within treatment plants will be achieved usually by the use of capacitor banks, but in some instances may be achieved by use of the embedded generation alternator control.

The requirement for power factor correction can be reduced by specifying equipment with relatively high power factors. In this respect the use of variable speed drives is beneficial because variable speed controllers of the type complying with the Corporation's type specification have an inherently high power factor.

However, the increasing use of variable speed drives within treatment plants means that the effects of harmonic currents will need to be taken into account if capacitor banks are proposed for power factor correction purposes, thus increasing significantly both the complexity of the design and the cost of the installation.

In order to minimise the need for power factor correction, electrical equipment shall be selected so as to minimise within practical limits reactive current demand.

Power factor correction shall be applied only if necessary to meet statutory or Network Operator requirements.

If capacitor power factor correction is required, it shall be applied centrally (i.e. near the point of attachment), rather than at individual loads.

3.9.2 Calculation of Required Capacitive kVAR

The fundamental relationships between capacitance and capacitive kVAR are as follows:

(a) for single phase connection:

$Q_c = \omega * C * V^2 * 10^{-3}$

$Q_c = I_c * V$

(b) for three phase star connection:

$Q_c = \omega * C * V^2 * 10^{-3}$

$Q_c = 3^{0.5} * I_c * V$

(c) for three phase delta connection:

$Q_c = 3 * \omega * C * V^2 * 10^{-3}$

$Q_c = 3^{0.5} * I_c * V$

where Q_c = total reactive power, kVAR

$\omega = 2 * \pi * f$

f = frequency, Hz

C = capacitance, μF per phase

V = line voltage, kV

I_c = line current, amps

Real and reactive power vector relationships for an uncompensated low power factor load are shown in Fig. 3.1 where:

S = load, kVA

P = load power, kW

Q = load lagging reactive power, kVAR

$\cos \varphi_1$ = P/S = load power factor

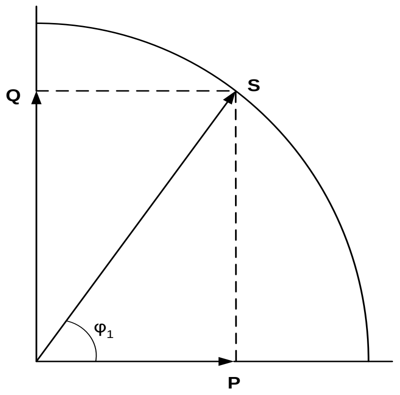
The effect of power factor correction is shown in Fig. 3.2 where:

Q_c = P * ($\tan \varphi_1 - \tan \varphi_2$)

= capacitor bank leading reactive power, kVAR

S_1 = corrected load, kVA

$\cos \varphi_2 = P/S_1$ = corrected power factor



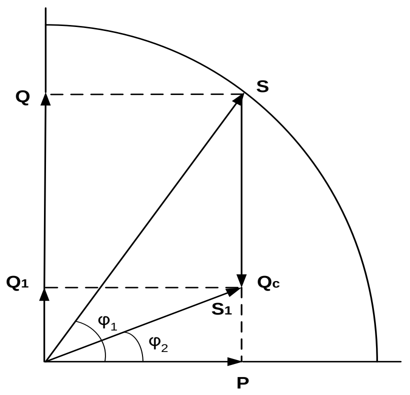


Fig 3.1

Uncompensated Load

Fig 3.2

Compensated Load

3.9.3 Effect of Converters

Power factor correction capacitors shall be installed with series reactors chosen so that the tuned frequency (f0) of the reactor and capacitor circuit falls well below 250 Hz, where:

$f_0 = \omega^{-1} * (L_c * C)^{-0.5}$

= tuned frequency , Hz

$\omega = 2 * \pi * f$

f = frequency = 50 Hz

L_c = inductance of series reactor, henries

C = capacitance, farads

The circuit design shall be checked to ensure that it does not resonate at any of the other harmonic frequencies as follows:

$n = (S_k/Q_c)^{0.5}$

where n = order of the harmonic in question

S_k = short circuit level including reactance of the series reactor, kVA

Q_c = capacitor bank leading reactive power, kVAR

The value of n shall not be equal or close to the order of the harmonics which occur in the supply, usually 5, 7, 11, 13.

In some cases it will be necessary to install the capacitor bank as a filter in a manner similar to that indicated in Fig. 3.3.

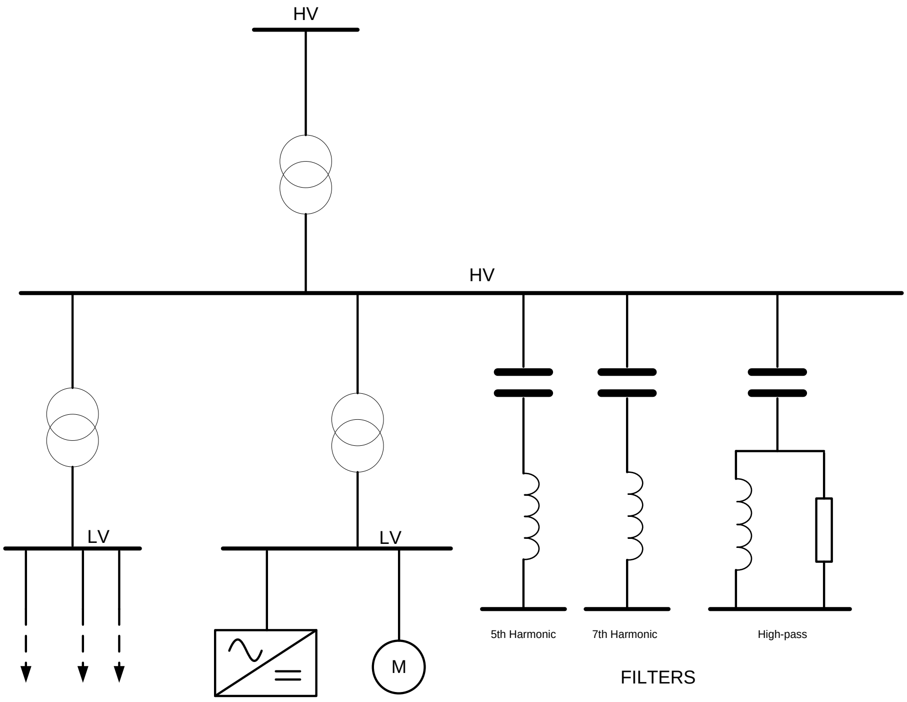


Fig. 3.3

3.9.4 Switching of Capacitors

As can be seen from Fig. 3.2, if the treatment plant load is reduced significantly and the capacity of the capacitor bank is not reduced, the power factor of the load as seen by the incoming electrical supply distribution network could become leading. As this is not permitted, some switching of capacitors may be required.

Switching of capacitors will cause a step change in treatment plant system voltage which shall be limited to less than 2% and the switching period shall be not less than 2 hours.

The voltage change brought about by capacitor switching can be calculated as follows:

$\Delta V = 100 * Q_C / S_s$

where ΔV = voltage change, %

Q_c = capacitor bank leading reactive power, kVAR

S_s = system short circuit level at the point of connection of the capacitor bank RC circuit, kVA

Switching on capacitors causes switching current transients which can be calculated as follows and protection equipment shall be rated to allow for these short term transient currents:

$I_s = I_c * 2^{0.5} * (S_k / Q_c)^{0.5}$

where Is = surge current peak, amps

I_c = switched capacitors rated current, amps

S_k = short circuit level including reactance of the series reactor, kVA

Q_c = capacitor bank leading reactive power, kVAR

3.9.5 Switching Apparatus and Protection

All apparatus and cables in capacitor circuits shall be rated not less than 140% of capacitor nominal current rating in order to allow for overvoltages and harmonic currents.

All switchgear used for capacitor switching shall be rated for that duty.

Capacitor banks shall be fitted with both overload and short circuit protection.

Capacitor banks connected in parallel shall be provided with separate overload and short circuit protection.

High Voltage capacitor banks connected parallel shall be protected as shown in Fig 3.4.

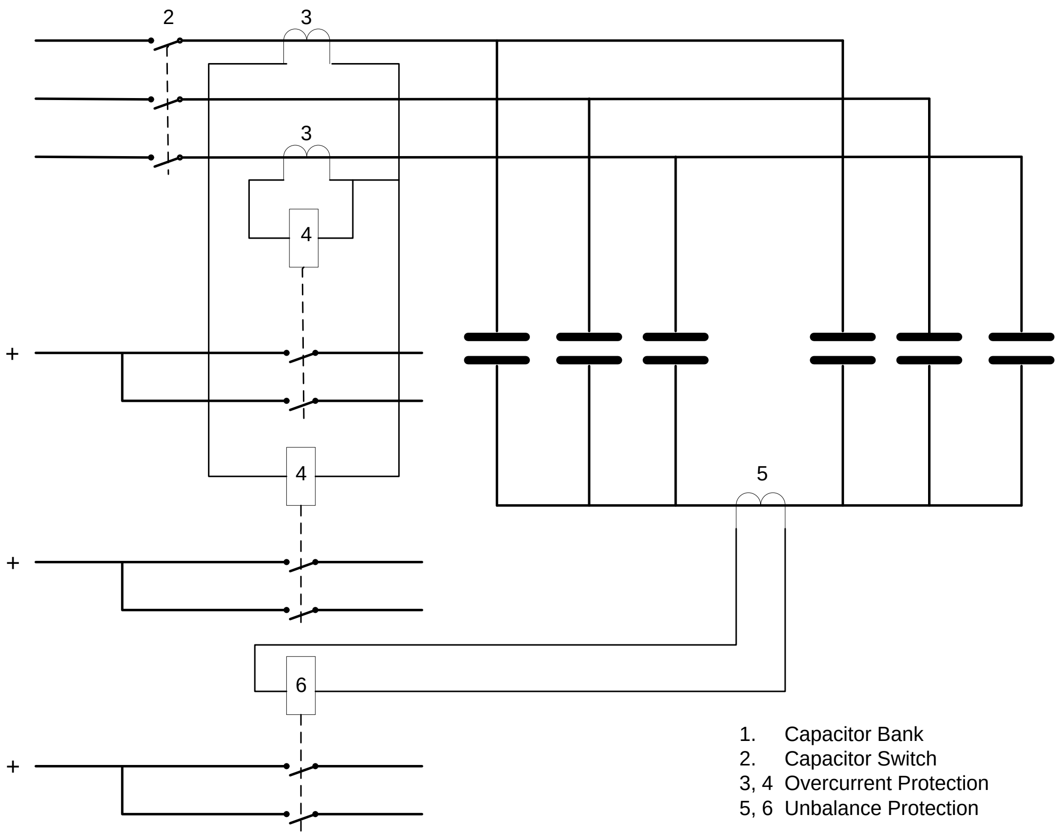


Fig 3.4

3.10 Power Supply Quality Monitoring

(a) Power supply quality measuring equipment shall be installed on each main incoming supply for all treatment plant sites. The measuring equipment shall provide data as listed in the following table, with the specific requirements dependent on the size of the treatment plant.

Data Required	**Small ≤ 315kVA**	**Medium >315kVA, ≤2MVA**	**Major (>2MVA)**
Current each Phase	✓	✓	✓
Voltages Phase to Neutral	✓	✓	✓
Voltages Phase-to-Phase		✓	✓
Real Power	✓	✓	✓
Reactive Power	✓	✓	✓
Power Factor		✓	✓
Frequency	✓	✓	✓
Total Voltage Harmonic Distortion (%)	✓	✓	✓
Total Current Harmonic Distortion (%)	✓	✓	✓
Individual Harmonic Currents (A)		✓	✓
Event Recordings		*	✓
Disturbance Recordings		*	✓

* The Designer shall determine requirements in consultation with representatives of the Region/ Alliance that will be responsible for operating the asset.

Note 1: All instantaneous signals (i.e. not event and disturbance recordings) shall be displayed on ViewX and stored in PI.

(b) As the Supply Authority will not permit customer access to its metering current and voltage transformers for the purpose of power quality monitoring by the customer, a separate High Voltage metering unit shall be installed to provide the primary signals to the power quality monitoring equipment.

(c) Consideration shall be made as to whether signals from the Supply Authority's meters, via Modbus, could be utilised in lieu of the separate HV metering unit for HV sites and quality metering equipment for LV sites.

Note 2: Bores associated with water treatment plants shall align their power quality requirements with this table.

4 MOTOR STARTERS AND CONTROLLERS

4.1 Motor Starters and Controllers Rated > 150 kW

The design of electrical drives rated >150 kW shall be in accordance with the requirements of Section 4 of Design Standard DS21.

4.2 Motor Starters and Controllers Rated ≤ 150 kW

The design of electrical drives rated ≤ 150 kW shall be in accordance with the requirements of Sections 3 and 7 of Design Standard DS22.

4.3 Power Monitoring

All motor starters and controllers for drives rated > 30kW shall be fitted with power measuring equipment monitoring current per phase, voltages phase to neutral, real power, reactive power and, for variable speed drives, frequency.

Note: All power monitoring signals shall be displayed on ViewX and stored in PI.

5 MOTOR ISOLATION AND EMERGENCY STOP

5.1 Motor Isolation for Motors Rated ≤ 11kW

Motors rated ≤ 11 kW shall be provided with a pad lockable isolating switch located close to the motor so that the motor can be isolated for maintenance purposes.

The isolating switch shall be 3 pole with an early break late make auxiliary contact which shall be connected in series with the coil of the associated line contactor. The main circuit contacts of the isolator shall be rated not less than motor full load current at Utilisation Category AC-23 to AS 3947.

Motors rated ≤ 11 kW shall be provided with a pad lockable latched emergency stop push button (red, mushroom type) located close to the motor so that the motor can be isolated in an emergency. The stop push button shall be connected in series with the associated line contactor.

5.2 Motor Isolation for Motors Rated > 11 kW

Motors rated > 11 kW shall be provided with a pad lockable latched emergency stop push button (red, mushroom type) located close to the motor so that the motor can be isolated in an emergency. The stop push button shall be connected in series with the associated line contactor.

Motor isolation facilities for maintenance purposes shall be provided at the switchboard.

5.3 Local Stop/Start Control

Local stop/start control stations shall be located adjacent to each motor unless determined otherwise by the Asset Manager.

6 MOTOR SPECIFICATIONS AND TENDER ANALYSIS

6.1 Specifications for Motors Rated >150 kW

The specifications for motors rated >150 kW shall be in accordance with the requirements of Section 5 of Design Standard DS21.

6.2 Specifications for Motors Rated ≤ 150 kW

The specifications for motors rated ≤ 150 kW shall be in accordance with the requirements of Section 4 of Design Standard DS22.

6.3 Motor Tender Analysis

Tender analysis for motors of all ratings shall be done in accordance with the requirements of Section 6 of Design Standard DS21.

7 MOTOR PROTECTION

7.1 Motor Protection for Motors Rated > 150 kW

The protection for motors rated > 150 kW shall be designed and specified in accordance with Sections 9.7 and 9.8 of Design Standard DS21.

7.2 Motor Protection for Motors Rated ≤ 150 kW

The protection for motors rated ≤ 150 kW shall be designed and specified in accordance with Sections 8.5 to 8.8 inclusive of Design Standard DS22.

8 TRANSFORMER SPECIFICATIONS AND TENDER ANALYSIS

8.1 Transformer Specifications

The specifications for power transformers of all ratings shall be in accordance with the requirements of Section 7 of Design Standard DS21.

8.2 Transformer Tender Analysis

Tender analysis for power transformers of all ratings shall be done in accordance with the requirements of Section 8 of Design Standard DS21.

9 TRANSFORMER PROTECTION

The protection for transformers shall be designed and specified in accordance with Section 7 of Design Standard DS21.

10 SWITCHBOARDS

10.1 High Voltage Switchboards

High Voltage switchboards shall be designed and specified in accordance with the requirements of Section 9 of Design Standard DS21.

10.2 Low Voltage Switchboards Rated > 440 amps

Low Voltage switchboards rated >440 amps shall be designed and specified in accordance with Section 9 of Design Standard DS21 and the Type Specification DS26-17.

10.3 Low Voltage Switchboards Rated ≤ 440 amps

Low Voltage switchboards rated ≤ 440 amps shall be designed and specified in accordance with Section 8 of Design Standard DS22.

In addition, if such switchboards are of the motor control centre type, these shall be specified in accordance with Design Standard DS 26-17.

10.4 L.V. Switchboard Form of Internal Separation

Low Voltage switchboards rated ≤ 440 amps shall have a minimum form of separation in accordance with Section 8 of Design Standard DS22.

Low Voltage switchboards rated > 440 amps shall have a minimum form of separation in accordance with Section 9 of Design Standard DS21.

10.5 Sectionalising Motor Control Switchboards

The advantages and disadvantages of sectionalising motor control switchboards are discussed at Section 3.5 of Design Standard DS21.

10.6 Motor Control Switchboard Incoming Feeder Isolators

Incoming feeder isolators on motor control switchboards shall comply with the requirements specified in Section 3.6 of Design Standard DS21.

10.7 Switchboard Isolation, Earthing and Interlocking

Switchboard isolation, earthing and Interlocking facilities shall comply with the requirements specified at Section 3.7 of Design Standard DS21.

10.8 Switchboard Control

Motor control centre switchboards shall form part of the treatment plant overall Plant Control System as defined in the Appendix.

Each motor control centre switchboard shall be provided with a switchboard controlling system housed in a separate Plant Area Control Cubicle and connected to the treatment plant overall control system as defined in the Appendix.

10.9 Power Monitoring

All high voltage switchboards and all low voltage switchboards rated ≥ 220A shall be fitted with incoming power measuring equipment monitoring current per phase, voltages phase to neutral, real power, reactive power, total voltage harmonic distortion and total current harmonic distortion.

For low voltage switchboards rated < 220A, the Designer shall determine requirements for power monitoring in consultation with representatives of the Region/Alliance that will be responsible for operating the asset. Consideration shall be given to the Region's/Alliance's potential requirement for monitoring of individual circuits or groups of circuits in proprietary distribution boards.

Note: All power monitoring signals shall be displayed on ViewX and stored in PI.

10.10 Vendor Equipment Packages

The term "Vendor Equipment Package" covers equipment that, while it may be more or less of a standard design, is manufactured or assembled to order. The Designer, as specifier, will generally have at least some control over the type of equipment and performance requirements provided. Examples of vendor equipment packages include filters, chlorinators, chemical batching and dosing plants, aeration blowers, gas flares, modular package plants and the like.

Power equipment shall comply with the performance requirements of the Corporation's Design Standards listed in section 1 of this standard. Furthermore, switchboard requirements for vendor equipment shall comply with the requirements of DS20 section 3.11. Switchboards supplying loads greater than 50 amps load demand shall comply with the requirements of clause 10 of this standard.

11 ELECTRICAL EARTHING AND BONDING

11.1 Major Earthing Connections

Major earthing connections shall be designed and specified in accordance with Section 11 of Design Standard DS 21 with the proviso that the meaning of the term "pump station" in the figures shall be taken to include all individual sections of the treatment plant which are supplied by a separate transformer. The earthing and bonding of cathodically protected pipelines shall be as shown in Section 11 of Design Standard DS 21.

The design of the earthing connections to the general mass of earth shall be such that, under the worst case climatic conditions and without reliance on connection to the Supply Authority earth system, the touch and step voltages do not exceed the limits determined by the application of AS2067 and Design Standard DS23.

11.2 Interconnection of Power and Light Current Earthing Systems

Within each switchboard earth bars separate from the power system protective earth bar shall be provided for instrumentation/communication systems and for intrinsically safe systems (if these light current systems exist within the particular switchboard). Generally all such earth bars shall be bonded together and connected to the main earth system. However if special conditions exist requiring a separate instrumentation/communication earthing system, the instrumentation/ communication system shall be connected to the main power protective earth system via transient earth clamps with a rated DC 100 V /sec spark over voltage of 150 V +/- 20% and a 1 kV /µsec surge spark over voltage of <800 volts.

11.3 Site Wide Earthing Interconnection

All transformer earthing systems within a treatment plant having a High Voltage distribution system shall be bonded together using 35 mm^2 (minimum) copper conductor PVC insulated cable (green with yellow stripe).

11.4 Earth Bonding of Pipework and Structures

Metal pipework and structural metal shall be earthed generally as described in Section 11 of Design Standard DS21.

11.5 Lightning Protection of Buildings and Structures

The Designer shall carry out a lightning risk assessment in accordance with AS/NZS 1768:2007 in order to determine what level of lightning protection should be provided to the building or structure.

The Designer shall incorporate equipment into the electrical design such that the level lightning damage risk in each risk category will be less than the associated acceptable risk level as specified in AS/NZS 1768:2007.

In respect to the damage category 4 – economic loss, the acceptable risk level shall be 0.001.

12 POWER CABLES

12.1 Cable Types

Power and control cables shall be specified in accordance with the Section 13 of Design Standard DS21.

High Voltage distribution cables shall be as specified for incoming cables to transformers in Section 13 of Design Standard DS21.

Low Voltage cables running between switchboards shall be PVC or XLPE insulated, PVC sheathed and shall be nylon sheathed, PVC sheathed overall if run underground.

Cables not covered by the above shall be the type best suited for the particular purpose in accordance with industry best practice.

Cables traversing or installed within hazardous areas shall be specified in accordance with HA-ST-03: EEHA Selection and Installation Manual.

12.2 Cable Ratings

Power cable continuous, intermittent and fault ratings shall be calculated in accordance with the Section 13 of Design Standard DS21 and cable systems designed accordingly.

13 CABLE INSTALLATION METHODS

13.1 High Voltage Distribution Cables

High Voltage distribution system cables running between various sections of the treatment plant:

(a) Shall have a fault rating in accordance with WA Electrical Requirements,

(b) Shall be rated in accordance with the manufacturer's recommendations and, if run underground, with the measured thermal resistivity of the backfill soil type,

(c) Shall be laid in trefoil formation,

(d) Shall be protected from rodent and termite damage,

(d) Shall be protected from mechanical damage including vibration damage,

(e) Shall be buried directly, protected by polymeric cable cover strip in accordance with AS3000;

- Run in enclosed cable ducts on cable ladders separate from cable ladders carrying other cables, or
- Run within buildings on cable ladders separate from cable ladders carrying other cables.

In respect to item (b) above, in the absence of soil resistivity measurements, it can be taken that well drained sand has a thermal resistivity of 2.5°C.m/W and that bricklayers' sand has a thermal resistivity of 1.2°C.m/W. The routes of all buried High Voltage cables shall be marked with approved above ground markers.

13.2 High Voltage Drive Cables

High Voltage cables associated directly with drives:

(a) Shall be run either in non-metallic conduits, or on cable ladders of either stainless steel if run in chemical dosing or mixing areas or of aluminium if run in general areas,

(b) Shall be protected from sun, rodent and termite damage,

(c) Shall be protected from mechanical damage including vibration damage, and

(d) Shall be laid with cores clamped in trefoil formation where run on cable ladders.

13.3 Low Voltage Distribution Cables

Low Voltage distribution system cables running between switchboards in various sections of the treatment plant:

(a) Shall be run in non-metallic conduits if run underground,

(b) Shall be run on shaded stainless steel cable ladder if run above ground in chemical dosing or mixing areas,

(c) Shall be run on shaded aluminium cable ladder if run above ground in general areas,

(d) Shall be protected from rodent and termite damage,

(e) Shall be laid in trefoil formation where run on cable ladders if single core, and

(f) Shall be rated in accordance with the measured thermal resistivity of the backfill soil type.

(g) Shall when traversing or installed within hazardous areas be in accordance with HA-ST-03: EEHA Selection and Installation Manual.

In respect to item (e) above, in the absence of soil resistivity measurements, it can be taken that well drained sand has a thermal resistivity of 2.5°C.m/W and that bricklayers' sand has a thermal resistivity of 1.2°C.m/W.

13.4 Other Cables

Cables other than distribution cables and High Voltage drive cables shall be installed in the manner best suited for the particular purpose in accordance with industry best practice.

13.5 Cable Trays and Ladders

There is no current restriction in the use of non-metallic (e.g. PVC) based cable tray/ladder systems provided that the non-metallic based system is fit for purpose appropriate to the project and environmental conditions under consideration. Hence, whether non-metallic based cable trays systems are used at a site will be determined by the designer of the particular project.

Such non-metallic tray/ladder systems shall be non-flammable, UV stabilised suitable for outdoor use, minimum service temperature performance of -20 to 60 degrees Celsius and verification tested by a third party to IEC (BS EN) 61537.

Benefits to consider are:

- Increased electrical safety due to double insulation.
- No requirement for tray/ladder earthing
- Reduced installation costs. (No earthing cables, snap-on accessories, lack of sharp edges, ease of handling).
- Reduced maintenance costs (no corrosion and no earthing system to maintain).

14 BUILDING SERVICES

14.1 Internal Lighting

Lighting within treatment plant buildings shall be designed in accordance with AS/NZS 1680.

The lighting levels and other characteristics shall be designed so as to conform to the recommendations given in AS/NZS 1680.2.4 Table E1 Item 43 for Petroleum, Chemical and Petrochemical Works.

14.2 Emergency Lighting

Emergency lighting shall be provided to illuminate hazards and to enable safe movement within buildings in the event of power failure. Emergency lighting shall also be provided for illumination of rotating plant, chemical storage and handling areas, switchrooms and control rooms.

Illuminated exit signs shall be provided in accordance with the Building Code of Australia only in areas that are likely to be occupied on a regular basis, such as administration buildings, control rooms, offices, workshops and laboratories.

Emergency lighting shall conform to AS/NZS 2293.1, "Emergency evacuation lighting for buildings" and shall be designed for an in-service duration of 90 minutes minimum following power failure, with an initial duration as required by AS/NZS 2293.1. Manually-initiated discharge testing facilities shall be provided as required by AS/NZS 2293.1.

14.3 Exterior Lighting

Illumination shall be provided for process areas, valve and meter pits, substations, walkways, roadways, doorways and general access areas within the treatment plant boundaries. Special attention shall be paid to illumination of trip and fall hazards, open tanks, trenches, pits and the like.

Outdoor substations shall be provided with sufficient illumination for safety of access and equipment operation.

Exterior lighting within treatment plants shall be designed in accordance with the AS/NZS 1158.3.1 categories as follows;

(a)	Entrance roads and internal roadways -	category P4
(b)	Areas that require night time maintenance operations -	category P6
(c)	General plant areas -	category P8
(d)	Steps and stairways, ramps, footbridges, and other areas which contain trip or fall hazards -	category P9
(e)	Footpaths and walkways-	category P3

If practical, exterior lighting shall utilise high pressure sodium lamps due to their availability, high efficiency and long life,

Wherever practical, exterior luminaires shall be mounted on walls or structures. The number of lighting poles within the treatment plant shall be minimised, so that as few obstructions as possible are presented to vehicle movements. All lighting poles greater than 3 metres in height shall incorporate a means to lower and raise the column for lamp maintenance without the need for specialised equipment.

The possibility of damage to external luminaires by acts of vandalism shall be minimised by selection of appropriate luminaire types or fitting with guards.

All exterior doorway lighting on each building shall be controlled by a switch located on the outside of the building adjacent to the main personnel access door.

Exterior lighting shall be designed for minimal environmental impact and to contain light within the site boundaries.

14.4 Control of Exterior Lighting

Roadway lighting shall be controlled by an automatic daylight switch with a manual override.

Other exterior lighting shall be controlled by an automatic daylight switch with provision for manual override by means of an ‘Off/Auto/On’ switch. For small to medium treatment plants, lighting control shall be located in the administration building or main control room. For major plants, consideration shall be given to individual lighting control of each plant area from a central location.

For safety reasons, automatic switch on of exterior lights when vehicles approach the front gate, may be required for smaller country plants. The Designer shall check with the Corporation whether this will be a requirement of the project.

14.5 General Purpose Power Socket Outlets

Ideally, single phase general purpose switched socket outlets should be located in buildings and outdoor areas such that any working area of the treatment plant can be reached with a 30 m extension cord. However due to the widespread use of portable generators for operation and maintenance activities it may not be necessary to provide single phase general purpose switched socket outlets in every area,

In addition to single phase general purpose switched socket outlets provided for plant operation and maintenance duties, single phase general purpose switched socket outlets shall be provided in all buildings as follows:

(a) At least two double outlets in each office,

(b) At least four double outlets in each amenities area,

(c) Two double outlets located at each workstation, and

(d) At least one double outlet located at each High Voltage switchboard, motor control centre switchboard and at each control cubicle,

A three phase 20 amp 5 pin general purpose switched socket outlet shall be installed in each switchroom. In addition, such three phase outlets shall be provided within buildings and in outdoor areas where required to facilitate the operation cleaning and maintenance of the plant,

All general purpose switched socket outlets shall be provided with Residual Current Detection protection and labelled as “RCD PROTECTED” at each outlet.

14.6 Air Conditioning

Generally all electrical equipment should be rated for operation in the on-site atmospheric conditions. However, in some instances it may be necessary to take measures to ensure that the equipment operating environment is modified so as to match the rating of the class of equipment which is available economically. Generally it is not practical to modify the atmospheric environment within the whole of a treatment plant building. However following locations shall be investigated to determine if some form of air conditioning is required:

(a) Control rooms,

(b) Switchrooms,

(c) Rooms containing power transformers , and

(d) Rooms containing large variable speed controllers,

If the above rooms are located in areas of wastewater treatment plants subject to H_2S gas pollution, activated carbon filters shall be provided at associated air conditioning system air intakes.

Electrical equipment cabinets located in areas of wastewater treatment plants subject to H_2S gas pollution which are not air conditioned shall be pressurised with clean filtered air.

For rooms housing large variable speed controllers and/or power transformers the most common type of air conditioning required is mechanical ventilation which takes cooling air from an area which is free of chemical pollution and dust, and discharges the exhaust air well away from the intake. Such air conditioning shall be sized so that the heat losses from the equipment in the room do not raise the room temperature by more than 5°C with the equipment operating at full load

In rooms housing large variable speed controllers the arrangement shall be in accordance with one of the arrangements shown Fig. 14.1, Fig. 14,2 and Fig. 14.3. However in locations where chemical and dust free cooling air is not available, refrigerated cooling as shown in Fig. 14.4 shall be used and shall be sized so that the heat losses from the equipment in the room do not raise the room temperature by more than 5°C, with the equipment operating at full load.

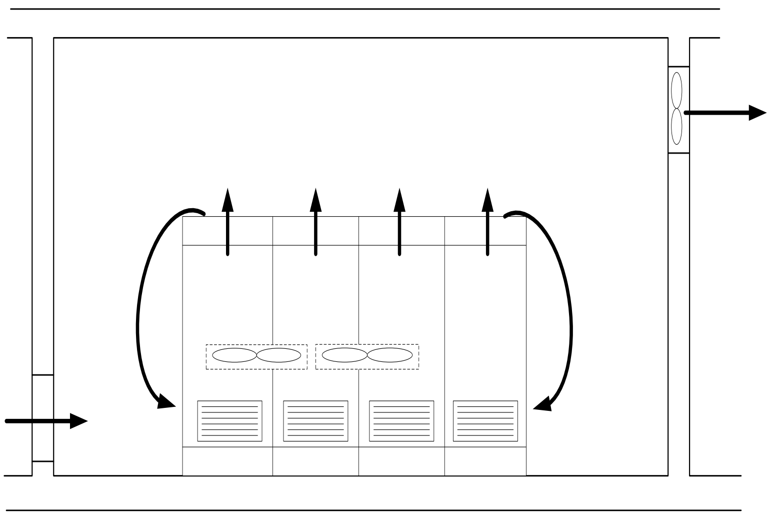


Fig 14.1

Simple Room Ventilation System

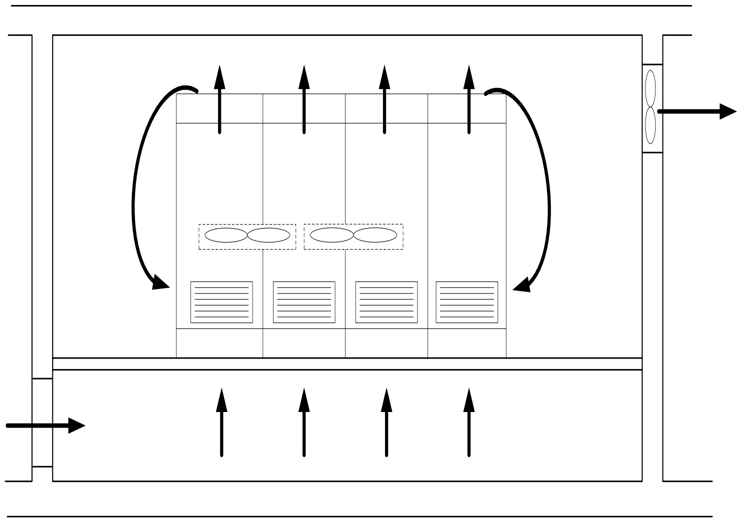


Fig 14.2

Simple Room Ventilation System with Air Inlet through false floor

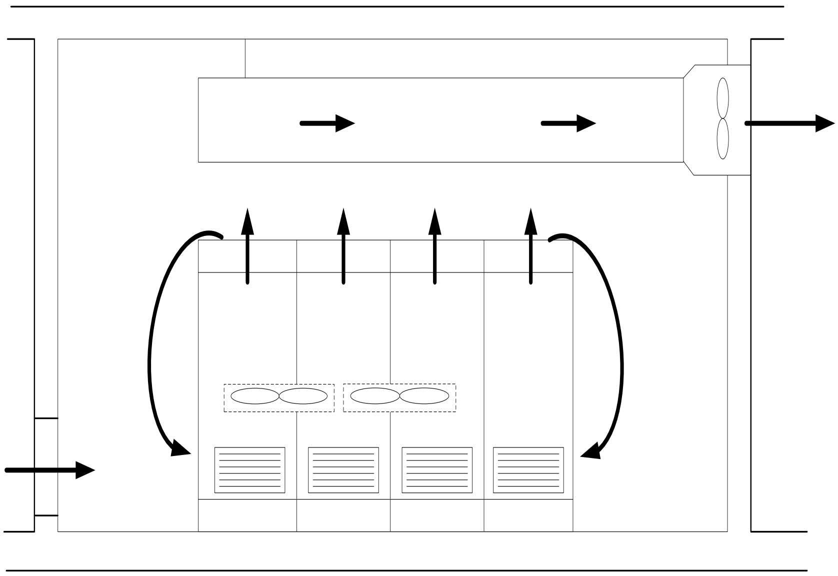


Fig 14.3

Room Ventilation with Air Extraction System

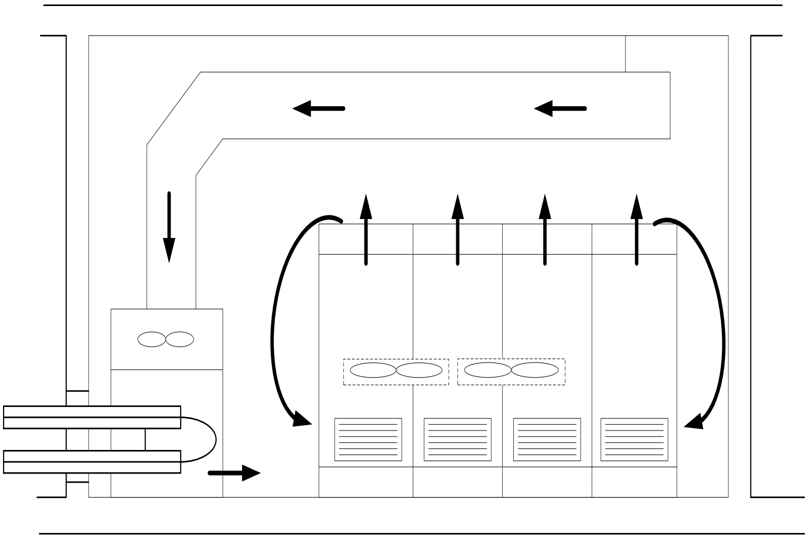


Fig 14.4

Room Ventilation System with Internal Cooling

Some variable speed controllers are provided with facilities which allow an exhaust duct of limited length to be connected directly to the controller with the air flow being powered solely by the cooling air fan within the controller. However the use of a supplementary cooling air duct exhaust fan may not permitted.

If the cooling system shown at Fig. 14.2 is used, the cooling air inlet gratings in the false floor shall be located directly adjacent to the cooling air inlets into the variable speed controller cabinets.

The required cooling air flow rate for the cooling systems shown at Fig. 14.1 and 14.2 can be calculated as follows:

$F_a = k * P_1 * e^{0.1251} * h * T_k / [(T_r - T_k)*T_0]$

Where;

F_a = required air flow, m^3/h

k = 2770

P_1 = controller losses, kW

T_r = allowable room temperature, °K

T_k = inlet air temperature, °K

T_0 = reference temperature = 273 °K

h = altitude mean sea level, km

However, because of the relatively high inlet air temperatures in Western Australia, it will generally be advantageous to extract the warm air from above the variable speed controller as indicated in Fig. 14.3, For systems shown in Fig. 14,3 and Fig. 14.4, the air extraction ducts should not be flanged onto the variable speed controller cabinets because generally the controller air flow rate will much higher than the required room air flow rate.

The required cooling air flow rate for the cooling systems shown at Fig. 14.3 and 14.4 can be calculated as follows:

$F_a = k * P_1 /[(T_r - T_k) + k * P_1 *F_C^{-1}]$

Where;

F_a = required air flow, m^3/h

k = 2770

P_1= controller losses, kW

T_r = allowable room temperature, °K

T_k = inlet air temperature, °K

F_c = controller required air flow, m^3/h

Room cooling air fans shall be equipped with variable speed drives and proportional/integral controllers, so as to minimise fan speed consistent with keeping the room temperature within acceptable limits, and hence to minimise dust collection and acoustic noise.

Room temperature shall be monitored as part of the treatment plant automatic control system.

14.7 Acoustic Noise Control

The overall design of a treatment plant must comply with the acoustic noise limits imposed by environmental legislation. In locations where plant acoustic noise is likely to be a problem, low acoustic noise electrical equipment shall be specified wherever practical, so as to minimise the building costs associated with acoustic noise control.

15 VALVE ACTUATORS

Valve actuators shall be designed and specified in accordance with Section 12 of Design Standard DS22 and Type Specification DS26.41.

16 MISCELLANEOUS PLANT SERVICES

16.1 Lighting

16.1.1 Interior Lighting

Interior lighting for buildings within treatment plants shall be designed in accordance with Australian standard AS/NZS 1680, "Interior lighting". Lighting levels shall be in accordance with the relevant AS/NZS 1680 recommendations referred to in the following table.

Room or area type	Applicable Australian standards reference	Item in table	Comments
Indoor process or mechanical plant (pump rooms, process equipment etc.)	AS 1680.2.4 Table E1	43: Petroleum, chemical and petrochemical works	
Pipe and cable galleries	AS 1680.2.4 Table E1	15: Electricity generating stations	As for walkways and cable tunnels
Indoor substations, transformer rooms, switchrooms etc.	AS 1680.2.4 Table E1	15: Electricity generating stations	
Plant administration buildings and offices	AS 1680.2.1 Table E1	(As applicable)	
Control rooms	AS 1680.2.1 Table E1	10: Control and monitoring rooms	

For process areas, plant rooms, galleries, switchrooms and the like appropriately protected industrial 36W fluorescent luminaires shall be used as light sources. Luminaires shall be mounted on suitable trunking wherever practical. Alternatively, high bay luminaires may be used if the design of the building allows and if adequate provision is made to enable safe maintenance of the luminaires.

Lighting of rooms containing rotating machinery shall be evenly distributed over a 3 phase circuit switched by a contactor to avoid possible stroboscopic effects.

Where necessary additional lighting shall be provided so that the interiors of switchboard cubicles, control panels and the like are adequately illuminated when open for maintenance. Supplementary lighting shall be installed inside cubicles where necessary. Care shall be taken to ensure that pushbuttons, switches, instruments and the like are well lit and are free of shadows.

For administration buildings, offices, control rooms and the like 36W fluorescent luminaires shall be used as light sources. Luminaires shall be recessed where possible and shall be functionally and aesthetically appropriate to the area in which they are to be installed.

16.1.2 Emergency Lighting

Emergency lighting shall be provided to illuminate hazards and to enable safe movement within buildings in the event of power failure. Emergency lighting shall also be provided for illumination of rotating plant, chemical storage and handling areas, switchrooms and control rooms.

Illuminated exit signs shall be provided in accordance with the Building Code of Australia only in areas that are likely to be occupied on a regular basis, such as administration buildings, control rooms, offices, workshops and laboratories.

Emergency lighting shall conform to AS/NZS 2293.1, "Emergency evacuation lighting for buildings" and shall be designed for an in-service duration of 90 minutes minimum following power failure, with an initial duration as required by AS/NZS 2293.1. Manually initiated discharge testing facilities shall be provided as required by AS/NZS 2293.1.

16.1.3 Exterior Lighting

Illumination shall be provided for process areas, valve and meter pits, substations, walkways, roadways, doorways and general access areas within the treatment plant boundaries. Special attention shall be paid to illumination of trip and fall hazards, open tanks, trenches, pits and the like.

Outdoor substations shall be provided with sufficient illumination for safety of access and equipment operation.

Lighting of treatment plant areas shall be designed to conform to the following categories of AS/NZS 1158.0 and AS/NZS 1158.3.1, "Road lighting":

(a) Entrance roads and internal roadways: category P4.

(b) Areas that may require night-time maintenance operations: category P6.

(c) General plant areas: category P8.

(d) Steps and stairways, ramps, footbridges, and other areas containing trip or fall hazards: category P9

(e) Walkways and footpaths: category P4.

If practical, exterior lighting shall utilise high pressure sodium lamps due to their availability, high efficiency and long life.

Wherever practical, exterior luminaires shall be mounted on walls or structures. The number of lighting poles within the treatment plant shall be minimised, so that as few obstructions as possible are presented to vehicle movements. All lighting poles greater than 3 metres in height shall incorporate a means to lower and raise the column for lamp maintenance without the need for specialised equipment.

The possibility of damage to external luminaires by acts of vandalism shall be minimised by selection of appropriate luminaire types or fitting with guards.

All exterior doorway lighting on each building shall be controlled by a switch located on the outside of the building adjacent to the main personnel access door.

Exterior lighting shall be designed for minimal environmental impact and to contain light within the site boundaries.

16.1.4 Lighting Control

Roadway lighting shall be controlled by an automatic daylight switch with a manual override.

Exterior lighting shall be controlled by an automatic daylight switch with provision for manual override by means of an OFF/AUTO/ON switch. For small to medium treatment plants lighting control shall be located in the administration building or main control room. For major plants consideration shall be given to individual lighting control of each plant area from a central location.

Control of individual lighting by motion sensors with automatic daylight cut-out and manual override shall also be provided where appropriate.

16.2 Power Outlets

General purpose outlet requirements are referenced in section 14.5.

Critical equipment within a plant (chlorinators, instruments etc) may be adversely affected by operation of RCDs connected to these final subcircuits. Such disruption to plant operations is costly and restricts efficient performance of the installation. In accordance with the requirements of AS3000:2018 (clause 2.6.3.2.3.3, exception 3) all socket outlets on final subcircuits installed for connection of specific items of critical equipment do not require RCD protection.

16.3 Fire and Gas Detection and Alarm System

16.3.1 General

A fire and gas detection and alarm system shall be provided for all but very small (e.g. package) treatment plants. The system shall cover the following areas:

(a) Administration and amenities buildings;

(b) Control rooms and associated equipment rooms;

(c) Switchrooms and substations;

(d) Plant rooms;

(e) Gas handling, processing and storage areas.

Where the plant includes special facilities such as maintenance workshops and laboratories a risk assessment shall be carried out to identify any fire or chemical hazards, assess the likely consequences of fire or chemical release and determine the most appropriate form of detection and/or protection. The assessment shall take into account the risks posed by any flammable or hazardous materials likely to be stored on the site.

Automatic sprinkler or gas flooding systems shall not be provided unless there are particular risks that justify their use.

16.3.2 Design

Detectors shall be suitable for the areas in which they are to be installed. In particular, detectors to be installed in wastewater treatment plants shall be resistant to attack from low concentrations of hydrogen sulfide.

Fire detection and alarm systems shall be designed in accordance with AS 1670, “Fire detection, warning, control and intercom systems” and the Building Code of Australia. Detectors, manual call points and indicators shall comply with the AS 1603 series of standards.

The main fire panel shall be located in the administration or amenities building and shall be connected to the PCS, the alarm dialler system (if provided) and the local Fire Brigade. It shall include routine testing facilities as required by the standards and codes.

For major plants sub-indicator panels shall be provided in local plant areas where appropriate.

Alarm zones shall be allocated in accordance with AS 1670, commensurate with the size and layout of the plant.

The system shall provide local visual and audible alarm indication. The audible alarm shall be interfaced to the voice paging system if provided. If appropriate, interlocks shall be provided to disconnect power to specific areas or to shut down process equipment.

16.3.3 Equipment

Smoke detectors shall be provided in all switchrooms and control rooms. Thermal detectors may be used in offices and indoor process areas and shall be used in areas which are subject to smoke, fumes or dust during normal plant operation.

Depending on the nature of the risk the Designer may need to consider the use of other types of detector such as UV flame detectors or aspirated smoke detection systems.

A manual call point shall be provided in a prominent position at the entrance to the administration or amenities building. For major plants additional call points shall be located around the plant in suitable locations.

Visual and audible alarms shall be provided on the exterior of key buildings.

Areas where toxic or flammable gases (e.g. chlorine, digester gas) are handled, processed or stored shall be provided with suitable gas alarms linked to the main fire panel.

17 WORK ON EXISTING TREATMENT PLANTS

17.1 General

The design of additions and upgrades to existing treatment plants shall follow the same general principles as for new plants. However the Designer needs to be aware of a number of issues that are likely to arise when working on existing plants.

17.1.1 Site Survey

Before commencing work on additions to or upgrades of an existing treatment plant the Designer shall:

(a) Obtain copies of all available drawings and documentation for the plant from the Design Manager;

(b) Carry out a site survey of the areas affected by the new works in order to confirm the completeness and accuracy of existing documentation and to determine the condition of the existing installation.

Any issues arising from the site survey which may affect the scope or design of the new works shall be reported to the Design Manager.

It is strongly recommended that the Designer meets with plant operations and maintenance personnel on a regular basis during the design phase to brief them on the proposed works and to provide an opportunity for discussion and feedback. Such meetings shall be coordinated through the Design Manager and any proposed or requested design changes arising from them shall be referred to the Design Manager for approval.

17.1.2 Standards and Regulations

All new work shall conform to current Corporation, Australian and international standards and to current statutory regulations.

Some of the standards and regulations to which existing plants, particularly older plants, have been designed may have been superseded. In many cases this may be of little consequence. However the Designer will sometimes encounter compatibility or safety issues when interfacing with equipment or facilities built to superseded standards. This is particularly so when designing additions and upgrades to older plants that have been subject to several previous upgrades. In such cases the Designer shall identify the issues and propose solutions for consideration by the Senior Principal Engineer.

17.1.3 Safety and Environmental Issues

The conformance of existing facilities affected by the new works to current statutory requirements shall be checked. The Designer shall refer any non-conformances, particularly those which relate to safety or the environment, to the Senior Principal Engineer with recommendations for resolving them.

If the Designer becomes aware of any safety or environmental issues relating to existing plant or equipment, even though the plant or equipment may not be directly affected by the new works, the issues shall be referred in writing to the Senior Principal Engineer.

Such issues may include:

(a) Plant or equipment that does not meet current safety or environmental regulations;

(b) Existence of hazardous materials (e.g. asbestos) on the site;

(c) Plant or equipment in poor or unsafe condition.

17.1.4 Numbering

Numbering of equipment and instruments for the new works shall be in accordance with this standard and Section 4 of the Corporation's "DS80 WCX CAD STANDARD Manual".

Before allocating any new numbers, the Designer shall check if any blocks of numbers have been reserved in the existing scheme for future additions. If any such blocks exist they shall be allocated first. For instance if the plant includes three equipment items of a particular type and a fourth item is to be installed, numbering for the new item may already have been allocated by a previous designer.

Where numbering has not already been allocated, numbering of new equipment and instruments shall continue existing sequences. For example if the last number used in an existing area is 1534, the new equipment numbering could start from 1540. (It is recommended that a gap be left between the old and new numbers.)

Numbering in some older plants may have been carried out to older standards not compatible with the current practice specified in the DS80 WCX CAD STANDARD Manual. Generally it is not feasible to renumber existing equipment and instruments to conform to current practice, so a compromise system must be adopted. Such cases shall be referred to the Design Manager.

Above all, numbering of new equipment and instruments shall follow a logical method which is consistent as far as possible with existing practices at the plant.

17.2 Electrical Equipment and Cabling

The Senior Principal Engineer may require that existing electrical equipment and cabling affected by the new works be upgraded or replaced if it has insufficient capacity for the additional loads, does not conform to current Corporation standards, is in poor condition or is nearing the end of its useful life.

17.3 Hazardous Areas

The Designer shall carry out a full review of existing hazardous area classifications for those areas affected by the new works. Existing areas shall be reclassified where necessary when the hazardous areas created by the new works overlap existing plant, or the new works are within an area that is already classified as a hazardous area.

Re-classification shall be undertaken in accordance with HA-ST-02: EEHA Classification Manual with the existing site hazardous classification report updated.

When the new works affects the hazardous area classification of existing plant areas, the Designer shall review existing electrical equipment in those areas to ensure they are suitable for the new classification.

If the Designer becomes aware of any hazardous area non-conformance issues relating to existing plant or equipment not affected by the new works, the issues shall be referred in writing to the Senior Principal Engineer.

The existing Hazardous Area Verification Dossier shall be kept up to date at all times by the addition of new material from the new works as components and systems are designed, installed and commissioned and brought on line.

APPENDIX 1 – CONTROL, INSTRUMENTATION AND SCADA SYSTEMS

1 HYDRAULIC SURGE VESSELS

Hydraulic surge vessels to be installed at pump stations within treatment plants shall be designed and specified in accordance with Appendix A1 of Design Standard DS22.

Note: *The standard design practice for the Operational Technology (OT) component of treatment plants is now covered under DS45-06 Treatment Plant Design.*

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