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| Assets Planning and Delivery Group  Engineering |

DESIGN STANDARD DS 26-17

Type Specifications – Electrical

Type Specification for Large Low Voltage Switchboards

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| version 2  revision 3 |
| January 2024 |

FOREWORD

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

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

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

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

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

**Head of Engineering**

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REVISION STATUS

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

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Type Specifications – Electrical

Type Specification for Large Low Voltage Switchboards

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# GENERAL

## Scope

This Specification covers the requirements for the design, construction, workshop testing, delivery, on site assembly, mechanical installation and site testing and commissioning of a Large Low Voltage switchboard.

The switchboard nominal operating voltage shall be 415 Volts, 440 Volts or 690 Volts, as specified in the Annexure.

This Specification is limited to a switchboard supplied by a transformer rated at not more than 2000 kVA at 415 Volts or 3150kVA at 690 Volts.

This Specification is limited to a switchboard controlling 415 Volt motors rated up to 450 kW, 440 Volt motors rated up to 500 kW, or 690 Volt motors rated in the range 450 kW to 800 kW.

The Specification shall be read in conjunction with the accompanying Annexure and the Principal’s drawings listed therein.

## Referenced Type Specifications

In addition to the requirements of this Specification, the switchboard shall be constructed in accordance with the requirements of the following Water Corporation’s Type Specifications:

1. DS26-09 Type Specification for L.V. Switchboards - General Requirements
2. DS26-32 Type Specification for Main Circuit L.V. Surge Diverters
3. DS26-21 Type Specification for Current Transformers and Sensors

## Site

The location of and access to the site for the installation of the Large Low Voltage switchboard shall be as shown in the Annexure.

The switchboard shall be designed and constructed so that manual controls are located on the front of the switchboard and are easily accessible.

## Standards

In addition to the Australian Standards specified in the Water Corporation’s Type Specification for LV Switchboards - General Requirements, the following Australian Standards are referred to in this Specification.

AS/NZS ISO 9001 Quality Management Systems - Requirements

AS 60099.4 Surge arresters - Metal-oxide surge arresters without gaps for a.c. systems

AS 1319 Safety signs for the occupational environment

AS 2124 General conditions of contract.

AS 61869.2 Instrument transformers - Additional requirements for current transformers

IEC 60269-4 Low voltage fuses - Supplementary requirements for fuse links for the protection of semiconductor devices

AS 60529 Degrees of protection provided by enclosures (IP code)

AS/NZS 60947.1 Low voltage switchgear and controlgear - General rules

AS/NZS 60947.2 Low voltage switchgear and controlgear - Circuit breakers

IEC 61439-1 Low-voltage switchgear and controlgear assemblies - Part 1: General rules

IEC 61439-2 Low-voltage switchgear and controlgear assemblies - Part 2: Power switchgear and controlgear assemblies

IEC 61643-11 Low Voltage surge protective devices - Surge protective devices connected to Low Voltage power systems- Requirements and test methods

IEC 61643-12 Low Voltage surge protective devices - Surge protective devices connected to Low voltage power systems- Selection and application principles

IEC 61000-4 Electromagnetic compatibility (EMC) - testing and measurement techniques

IEC 61439-0 Low voltage switchgear and controlgear assemblies - Guidance to specifying assemblies

IEC 61439-1 Low voltage switchgear and controlgear assemblies - General rules

IEC 61439-2 Low voltage switchgear and controlgear assemblies - Power switchgear and controlgear assemblies

IEC 61641 Enclosed low-voltage switchgear and control gear assemblies – Guidance for testing under conditions of arcing due to internal fault

IEC 61643-11 Low-voltage surge protective devices - Part 11: Surge protective devices connected to low-voltage power systems - Requirements and tests

IEC 62208 Empty enclosures for low-voltage switchgear and controlgear assemblies - General requirements

The switchboard shall comply with the requirements of IEC 61439-1 and IEC 61439-2, except where specified otherwise in this Specification. In the case of any conflict between the requirements of IEC 61439-1/2 and this Specification, the requirements of this Specification shall take precedence.

## Quality Assurance

The switchboard shall be manufactured under a Quality System certified by an Accredited Authority in accordance with AS/NZS ISO 9001 or an approved equivalent.

## Supervising Engineer

For work being carried out under a formal contract utilising General Conditions of Contract AS 2124, Supervising Engineer shall mean the Contracts Superintendent.

In all other instances, Supervising Engineer shall mean the engineer who approved the relevant drawings or an engineer authorised to act on his/her behalf.

## Principal’s Drawings

### General

The switchboard shall be constructed strictly in accordance with the Principal’s drawings and with this Specification. The arrangement of the primary circuit and the type and rating of equipment shall be as shown on the Principal’s drawings and shall not be modified unless by written variation from the Supervising Engineer.

In the event of a discrepancy between the Principal’s drawings and this Specification, the matter shall be referred to the Supervising Engineer for resolution.

### Electrical Single Line Diagram

As required by IEC61439-1 the Principal’s drawings shall include an electrical single line diagram for the switchboard defining the incoming and outgoing circuit arrangements, loads, external conductors, incoming supply fault level and other selected interface characteristics.

### Generic Circuit Diagrams

The Principal’s drawings shall include the following generic drawings:

(a) main power circuit diagrams

(b) main power circuit material lists

(c) control and metering circuit diagrams

(d) switchboard arrangement drawing

(e) interlocking diagram

## Work by the Principal

The work to be performed by the Principal shall be as detailed in the Annexure.

## Information to be Provided by the Contractor

The Contractor shall provide the following documentation in respect to the switchboard within the listed number of days after receipt of the Principal’s order.

(a) General Arrangement Drawings 28 days

(b) Electric Wiring and Schematic Drawings 28 days

(c) Manufacture and Delivery Schedule 14 days

(d) Specification Data Sheets 35 days

(e) Inspection and Test Plan 35 days

(f) Test Certificates Within 14 days after delivery

(g) Operating and Maintenance Manual Within 14 days after delivery

## Contractor’s Drawings

### General

1. All drawings provided by the Contractor shall be in accordance with the latest issue of the Water Corporation Design Standard DS24 – Electrical Drafting
2. All drawings shall be prepared in AutoCAD format, Release 2018 or later software
3. Drawings shall be prepared on the “Electrical” A1 metric drawing sheet and title block provided in the Water Corporation eXternal (WCX) package (available for download) in accordance with the Water Corporations Design Standard DS80
4. The drawings shall provide within the title block, the details to identify the drawing, including but not limited to its title, plan number, revision status, date of issue, Corporate project number, contractor’s name and reference number (if applicable)
5. Drawings detail shall include, but not limited to, the general arrangement, panel layout, power and control circuit diagrams and equipment specifications, as required
6. The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings

### Content of Contractor’s Drawings

The Contractor shall provide the Principal with the following drawings:

(a) Project specific main circuit diagrams based on the generic main circuit diagrams provided in the Contract documents

(b) Project specific main circuit equipment lists based on equipment performance specifications shown on the generic main circuit equipment lists provided in the Contract documents

(c) Project specific control and metering circuit diagrams based on the generic control and metering circuit diagrams provided in the Contract documents

(d) Project specific control and metering circuit equipment lists based on equipment performance specifications shown on the generic control and metering circuit equipment lists provided in the Contract documents

(e) Switchboard arrangement drawings

(f) Interlocking diagrams (if applicable)

The Contractor shall prepare new project specific main circuit, control and metering circuit diagrams in accordance with the specified generic drawings, but with additional detail, including wire and terminal numbers, equipment make and model numbers and equipment ratings.

The Contractor shall not alter the Principal’s drawings for this purpose.

The Contractor’s project specific control circuit diagrams shall be approved by the Project Electrical Engineer prior to the associated work being implemented.

### Marked Up Principal’s Drawings

Except for minor variations approved in writing by the Supervising Engineer, the work shall be constructed strictly in accordance with the Principal’s drawings. Any approved variations to the Principal’s drawings shall be marked up in red on an electronic copy of the drawings and submitted to the Supervising Engineer for course to the Principal’s Engineering Business Unit.

### Ownership

Drawings provided by the Contractor to the Principal under the Contract shall become the intellectual property of the Principal.

### Statement of Design Verification

The Contractor’s project specific main circuit diagrams and switchboard arrangement diagrams shall include the following note:

“For safety reasons, design verification for this switchboard has been by certified verification tests. No alterations to the main circuit equipment, the main circuit enclosures or the switchboard structure are permitted without the written permission of … (insert the Contractor’s name)”

# SERVICE CONDITIONS

## General

The switchboard shall have voltage and frequency ratings as specified in the Annexure. (Usually the switchboard rated operational voltage specified will be 415 Volts, but on special occasions may be specified at 440 Volts or 690 Volts. Usually the switchboard rated frequency will be 50 Hz)

## Impulse Overvoltage Category

(a) Except as specified hereunder, switchboards shall be rated for category IV impulse overvoltages, i.e. 415 Volt switchboards shall have a 1.2/50 µs impulse voltage rating of 6 kV, and 690 Volt switchboards shall have a 1.2/50 µs impulse voltage rating of 8 kV.

(b) Electronic soft starters and variable speed controllers, shall have impulse overvoltage rating not less than 4 kV.

(c) Electronic instrumentation equipment shall be provided with secondary impulse over voltage protection as specified clause 3.2 hereunder and shall have an over voltage rating not less than the voltage protection level (Up) provided.

## Power Frequency Withstand Voltage

(a) All switchboard Low Voltage measuring instruments shall have a continual phase to neutral over voltage rating of not less than 264 Volts and, in accordance with IEC 61439-1 clause 10.9.1, shall be completely disconnected during switchboard power-frequency withstand voltage testing.

(b) Except as above, the switchboard shall have a power-frequency withstand voltage ratings in accordance with IEC 61439-1 clause 10.9.2, as follows:

(i) All switchboard main circuit electrical equipment, including electronic soft starters and variable speed controllers, shall have a power-frequency withstand voltage rating not less than 1890 Volts.

(ii) All switchboard Low Voltage auxiliary equipment except measuring instruments shall have a power-frequency withstand voltage rating not less than 1890 Volts.

(iii) All switchboard Extra Low Voltage auxiliary equipment except measuring instruments shall have a power-frequency withstand voltage rating not less than 500 Volts.

## Full Load and Fault Current Levels

(a) The required prospective short circuit fault current level of the switchboard shall be the sum of the switchboard incoming supply fault current level and the installation maximum driven motor prospective fault current contribution.

(b) The switchboard incoming Low Voltage supply fault current level will depend on the switchboard voltage, the incoming High Voltage prospective fault current level and the impedance of the transformer(s), and shall be as shown in the Annexure.

(c) The driven motor prospective fault current contribution will depend on the motor voltage and the full load speed reactance of the driven motors, and shall be as shown in the Annexure.

(d) Generally, switchboards in accordance with this Specification will be connected directly to matched incoming transformer(s) with a maximum motor load approaching the rating of the transformer(s).

(e) Where this Specification is being used for the purposes of a generic proposal rather than for a specific project, the incoming LV supply prospective short circuit level shall be assumed to be 17 times the switchboards rated full load current, and the switchboard required minimum short circuit fault current rating shall be assumed to be 22 times the switchboard’s rated full load current.

(f) The switchboard main busbar full load current rating shall be as specified in the Annexure.

## Prospective Fault Current in Neutral Conductor

The prospective fault current level in the neutral shall be taken to be 60% of phase prospective fault current level as defined para. 2.4 above.

## Prospective Fault Current in the Protective Circuit

Unless specified otherwise on the Principal’s drawings, the switchboard shall be provided with an incoming circuit breaker as a short circuit protection device (SCPD).

The prospective fault current level in the protective circuit (i.e., in the main bus bars) shall be determined by prospective fault current level at the incoming terminals of the switchboard as determined by Section 2.4 above and the impedance of the incoming circuit breaker. (IEC/TR 61439-0 Clause 6.4 refers).

## Location

1. The switchboard will be located indoors in a large well-ventilated room and will be protected from direct solar radiation
2. Access to the switchboard will be restricted to authorised personnel only
3. The clearance behind the switchboard will be not less than 600 mm

## Full Load Current Temperature Rise

1. The ambient air conditions around the switchboard shall be as defined in Type Specification DS 26-9 for the type of location specified above.
2. The switchboard full load current rating shall be as specified in the Annexure.
3. At switchboard full load current, the rise in ambient temperature within switchboard compartments shall be in accordance with the requirement of Type Specification DS26-9 for the type of location specified above.
4. At switchboard full load current, the rise in busbar temperature shall be in accordance with the requirements of Type Specification DS26-9 for the type of location specified above.

## Ambient Air Relative Humidity

Unless specified otherwise in the Annexure, the switchboard shall be rated for operation in a location having an air maximum relative humidity of 50% at +40ᵒC and of 90% at +20ᵒC.

## Degree of Pollution

For the purpose of determining the switchboard minimum degree of protection required, in the absence of locally generated pollution, separate switchrooms may be considered to provide an environment with a Pollution Degree 2 (AS 60947.1 Clause 7.3.1.2), provided that the switchroom is located not less than 100 meters from the seashore and not less than 1 kilometer from breaking surf. All other environments shall be considered to have a Pollution Degree 3 or 4 as specified in the Annexure.

## Atmospheric Corrosion Severity

The switchboard shall be rated for operation in an environment having a corrosion severity level A in accordance with IEC 61439-1.

## Altitude

The switchboard shall be suitable for operation at an altitude of < 2000 metres.

## EMC Environment

The switchboard shall be suitable for operation in an industrial EMC Environment type A as defined in IEC 61439-1.

# IEC 61439.1 DESIGN VERIFICATION

## General Requirements

1. IEC 61439-1 specifies the following methods of switchboard design verification:

(i) verification testing,

(ii) verification comparison with tested worst case reference design,

(iii) verification assessment, i.e. confirmation of the correct application of calculations and safety rules, including use of safety margins

1. Switchboard design verification shall be carried out generally in accordance with IEC 61439-1 Annex D, and as specified hereunder, and as further specified in the Addendum to this specification
2. Notwithstanding the provisions to contrary at IEC 61439-1 clause 10.1, if the switchboard is manufactured under licence from the original designer, design verification shall be carried out by the licensee
3. Notwithstanding the provisions to contrary at IEC 61439-1 clause 10.1, if the switchboard is manufactured in a factory remote from the original designer, design verification shall be carried out at the place of switchboard manufacture
4. The degree of external protection provided by switchboards shall be verified by submitting a representative sub-assembly for independent testing and certification, and by carrying out a verification assessment on the completed switchboard as part of routine testing to ensure that any external modifications have not resulted in any deterioration of the degree of protection
5. The full load temperature rise may be verified for the particular switchboard(s) by test in accordance with IEC 61439-1 clause 10.10.2.3.5

Alternatively, the full load temperature rise for the particular switchboard(s) shall be verified by comparison with a worst case reference design, as hereunder:

1. the reference design main busbars shall have been tested separately in accordance with IEC 61439-1 clause 10.10.2.3.7 (a)
2. the reference design distribution busbars shall have been tested separately in accordance with IEC 61439-1 clause 10.10.2.3.7 (b)

all outgoing feeder functional units to be installed in the particular switchboard shall have been tested separately in accordance with IEC 61439-1 clause 10.10.2.3.7(c)

1. except as per sub-clause (v) hereunder, all outgoing motor starter modules to be installed in a particular switchboard shall have been tested separately in accordance with IEC 61439-1 clause 10.10.2.3.7(c)
2. the temperature rise of outgoing motor starter modules fitted with short circuit protection devices rated not greater than 630 amps may be verified by the verification comparison method in accordance with the general principles described in IEC 61439-1 clause 10.10.3.5, on the basis of comparison with the tested power loss capability of outgoing feeders housed in the same modules, provided that the temperature rises of individual devices within each starter module do not exceed individual device maximum ratings and provided that the internal design of the motor starter units complies with the requirements listed IEC 61439-1 Clause 10.10.4.2.1 sub-clauses (a) to (f) inclusive, Other requirements of IEC 61439-1 sub-clause 10.10.4 shall not apply
3. the specified temperature rise current ratings of the main busbars and the distribution busbars in a particular switchboard shall be determined by the design comparison method
4. on the basis of the specified diversity factor(s) and the maximum ratings of the outgoing functional modules to be fitted in the particular switchboard, it shall be verified by calculation that, for the proposed switchboard arrangement, the currents in the main busbars and the distribution busbars do not exceed the ratings as calculated above
5. Generally, switchboards specified in accordance with this specification will not contain significant quantities of electronic equipment so that electromagnetic compatibility (EMC) testing in accordance with IEC 61439-1 clause 10.12 will not be required usually

In the unlikely event that the switchboard is required to house significant quantities of electronic equipment, EMC verification tests carried out by electronic equipment manufacturer may be used for design verification by the assessment method.

1. Verification of the mechanical impact switchboard characteristic shall not be required.
2. Copies of test certificates and calculations verifying the design of the particular switchboard to be provided under the Contract shall be provided by the Contractor to the Supervising Engineer for review. Construction of the switchboard shall not commence until the Supervising Engineer has issued written approval of such test certificates and calculations.

Such documentation shall comply with the following:

(i) if any aspects of the switchboard design are to be verified by the design testing method, a complete set of copies of the associated test certificates shall be provided

(ii) if any aspects of the switchboard design are to be verified by the design comparison method, copies of all associated calculations shall be provided and such calculations shall be accompanied with a complete set of copies of the test certificates verifying the associated reference switchboard design

(iii) if any aspects of the switchboard design are to be verified by the design assessment method, copies of all associated calculations and references shall be provided Test Certificates Required

## Verification testing of Completed Switchboard

(a) IEC 61439-1/2 specified design verification testing of the following switchboard characteristics shall be carried out on the completed switchboard as part of routine testing as per clause 16.2:

(i) internal forms of separation and associated internal IP ratings as per AS 61439.2 and Section 5.5 of this Specification

(ii) external IP rating as per clause 3.1(f) above and as per IEC 61439-1 clause 10.3

(iii) clearances and creepage distances as per IEC 61439-1 clause 10.4

(iv) electrical continuity between exposed conductive parts and the protective circuit as per IEC 61439-1 clause 10.5.2

(v) incorporation of switching devices and components as per IEC 61439-1 clause 10.6

(vi) internal electrical circuits and connections as per IEC 61439-1 clause 10.7

(vii) terminals for external conductors as per IEC 61439-1 clause 10.8

(viii) power frequency withstand voltage as per IEC 61439-1 clause 10.9.2

(ix) impulse withstand voltage as per IEC 61439-1 clause 10.9.3 (not required if this test has been carried out successfully on a switchboard of the same power circuit design.)

(x) mechanical operation as per IEC 61439-1 clause 11.8

(b) Design verifications by either the verification comparison method or the verification assessment method shall be subject to formal item by item review by an independent reviewer approved by the Principal and engaged by the Contractor. The independent reviewer shall submit the initial review report direct to the Contractor who shall take any appropriate corrective actions necessary. At the same time the Contractor shall submit a copy of the initial review report to the Supervising Engineer together with details of the corrective actions proposed. Once corrective actions have been completed, the independent reviewer shall review the design again and shall submit a certificate to the Contractor verifying the design. Then the Contractor shall submit this certificate to the Supervising Engineer. All costs incurred in this process shall be to the Contractor’s account

(c) If impulse withstand testing is required in accordance with the above such tests shall be carried out with phase and neutral connections to electronic switchgear, electronic instrumentation equipment and surge diverters isolated

(d) Power frequency withstand testing shall be carried out with phase and neutral connections to electronic instrumentation equipment and surge diverters isolated (i.e., as per IEC 61439-1 clause 10.9.1)

# ARCING FAULT PROTECTION CATEGORIES

## IEC 61641 Arc Protection Categories

(a) The switchboard shall be designed to provide “personal protection” in the event of an internal arcing fault. Such personal protection shall be provided by inherent mechanical design of the switchboard in accordance with IEC 61641 Class A

(b) If so specified in the Annexure as being required, “assembly protection” shall be provided by the inherent mechanical design of the switchboard in accordance with IEC 61641minimumClass B. Assembly protection shall be such that damage from a particular arc shall be limited to switchboard compartment in which the arc occurred

## IEC 61641 Design Verification

### Verification Method

(a) In respect to arcing fault protection, the switchboard design shall be subjected to design verification by testing or by the verification comparison method as further specified in the Addendum to this Specification

(b) The above tests shall be carried out with any arc detection equipment fitted being disabled

### Arc Ignition Protected Zones

(a) If the switchboard design includes arc ignition protected zones as defined in IEC 61641, the design in respect to such zones shall be verified by testing in accordance with IEC 61641

(b) Withdrawable circuit breakers in arc ignition protected zones shall be deemed to satisfy the degree of protection (IP) requirements specified in IEC 61641 provided such requirements are met only in both the fully racked out and the fully racked in conditions

(c) All withdrawable circuit breakers in IEC 61641 Arcing Class I switchboards used as incoming supply main circuit breakers or busbar coupler circuit breakers shall be provided with remote racking facilities operated at Extra Low Voltage

All withdrawable outgoing feeder circuit breakers installed in IEC 61641 Arcing Class I switchboards shall be fitted with the above remote racking facilities, or shall be fitted with the following label in lieu of the label specified clause 15.7

**Withdrawable Circuit Breaker**

**Do not rack in with main busbars under voltage**

### Test Prospective Fault Current Levels

Arcing fault tests shall be carried out at a prospective fault current level Icpmin (IEC 61439-1) not less than the value specified in Section 2.4 above for a switchboard having the full load rating specified in the Annexure

### Test Fault Durations

(a) For arcing fault tests applied to the line side of the incoming circuit breaker at a prospective fault current level (Icpmin), the test power supply shall be maintained for not less than 300 milliseconds and not more than 500 milliseconds

(b) For arcing fault tests applied to the line side of the incoming circuit breaker at a prospective fault current level (Icpmax) greater than the value specified in para. 2.4 for a switchboard having the full load rating specified in the Annexure, the test fault duration may be reduced to 100 milliseconds provided the ratio Icpmax to Icpmin is greater than 1.73

(c) For arcing fault tests applied on the load side of the incoming circuit breaker, the test incoming power supply shall be maintained for at least 200 milliseconds after tripping of the associated circuit breaker

### Test Ignition Points.

(a) In accordance with IEC 61641 clause 8.6.2, test arc fault testing is not required in arc ignition protected zones as defined IEC 61641 clause A.2.

(b) Except as per para. (a) above and para. (c) hereunder, test ignition points shall be located at:

(i) the point of switchboard connection to the incoming supply

(ii) the supply side of the incoming circuit breaker

(iii) the load side of the incoming circuit breaker

(iv) along the main busbar

(v) along the distribution busbar

(vi) the supply side of outgoing functional units, unless the supply side of the protective device in the functional unit is fully insulated

(vii) the load side of outgoing functional units not tested on the line side, except where protected by fault current limiting devices which limit the peak cut off current to less than 17 kA

(c) All of the above arc ignition points shall be used in arcing fault tests, except in instances where it can be shown that the omission of the use of a particular arc ignition test point will not render the test less onerous, having due regard to arc propagation characteristics and the nature of the switchboard construction, as further specified in the Addendum to this Specification

### Arcing Fault Test Reports

Verification arcing fault tests on sample switchboard sections shall be carried out by an independent testing authority and the Contractor shall submit the associated test reports and test certificates to the Superintendent for approval.

The Contractor shall carry out arcing fault protection design verification by the verification comparison method and shall prepare a report describing the associated calculations and comparisons made.

The Contractor shall submit this report to the Superintendent.

## Assembly Protection by Arc Detection

### General

In addition to the arc fault protection provided by the inherent mechanical design of the switchboard and specified in Section 4.1 above, further arc fault protection shall be provided by the provision of arc detection equipment.

Such arc detection equipment shall consist of optical arc detectors located at specified locations, optical cables connecting these detectors to an arc monitor relay, and an incoming current sensing unit which prevents operation of the system unless the switchboard incoming peak current exceeds the switchboard maximum short term peak current demand and a battery back-up system (including charger) with 8 hours support.

The current sensing unit shall be connected to 1 Amp (remote CTs) or 5 Amp (local CTs) secondary current transformers located at the Low Voltage terminal box of the associated main incoming supply transformer (remote) or on the line side of the incoming circuit breaker within the switchboard (local), as specified in the Annexure. These current transformers shall be supplied by the Contractor.

### Location of Arc Detectors

Arc fault detectors shall be located so as to be able to locate arc faults occurring:

1. at the point of switchboard connection to the incoming supply
2. in the incoming circuit breaker compartment
3. along the main busbar, unless this is fully insulated
4. along the distribution busbar, unless this is fully insulated
5. in outgoing circuit breaker compartments
6. in motor starter compartments, except where protected by HRC fuses which limit the peak cut off current to less than 17 kA and the line side of which is fully insulated

### Auxiliary Circuit Outputs

(a) The arc monitor relay shall be equipped with two solid state (triac) outputs to enable tripping each High Voltage circuit breaker protecting transformers supplying Low Voltage load current to the switchboard

The time delay between arc detection and closure of solid-state trip outputs shall be not more than 2 milliseconds

(b) In addition, the arc monitor shall be equipped with a high speed relay normally open contact outputs to enable tripping of switchboard main Low Voltage circuit breakers

The time delay between arc detection and relay contact closure shall be not more than 10 milliseconds

(c) The arc monitor unit shall be equipped with two change-over output contacts, one to indicate that the arc fault monitor relay is energized and one to indicate an arc fault trip

### Arc Detection System Electromagnetic Compatibility

The arc detection system shall comply with the electromagnetic compatibility (EMC) requirements for equipment to be installed in a severe industrial environment, or in switchgear with mixed signal and power cables, as specified in IEC 61000-4.

### Design Verification of Arc Detection System

Verification tests on a sample arc detection system shall been carried out by the supplier of the system and the Contractor shall submit to the Superintendent for approval either, the associated test report or, a relevant test certificate from an independent testing authority against a recognised standard

# CONSTRUCTION

## General

1. Except where specified otherwise in this Specification, the switchboard shall be designed and constructed in accordance with IEC 61439-1 and IEC 61641
2. Lighting and general purpose distribution panels, whether equipped with fuses or circuit breakers, shall not be incorporated into the switchboard
3. All switchboard control circuits shall be protected by appropriately rated HRC fuses rather than circuit breakers
4. All switchboard compartment doors shall be provided with interlocks to prevent the door being opened without the associated isolator being open
5. Except compartments providing a degree of protection of IP2X with the associated isolator closed, all switchboard compartments shall be provided with interlocks to prevent the associated isolator being closed with the door open, i.e. without the use of tools
6. All switchboard compartments housing withdrawable equipment shall be such that, with such equipment withdrawn and the compartment door closed, the external degree of protection specified Section 5.8 hereunder is maintained
7. The ratio of cross-sectional area of neutral conductors to associated phase conductors shall 100 % for conductors < 16 mm2, and 50% for conductors > 16 mm2

## Circuit Breakers

1. The main incoming supply circuit breaker, any bus tie circuit breakers and outgoing feeder circuit breakers shall be withdrawable units
2. All withdrawable circuit breakers shall be provided with shutters to provide a degree of protection of not less than IP20 within the circuit breaker compartment when the circuit breaker is withdrawn
3. All withdrawable circuit breakers shall be interlocked to prevent withdrawal or insertion unless the circuit breaker is open
4. Withdrawable circuit breaker modules shall be arranged such that it is possible to rack the circuit breaker in and out with the module door closed
5. All circuit breakers shall have a rated service short circuit breaking capacity (Icu) in accordance with AS 60947.2 of not less than the prospective fault current (Icp) as specified Section 2.4 above for a switchboard designed for connection to a transformer of the size specified in the Annexure
6. All circuit breakers rated < 630 Amps and controlling circuits external to the switchboard shall be fault current limiting type
7. All circuit breakers rated > 630 Amps shall be withdrawable

## Motor Control Modules

1. Motor control modules shall be either withdrawable or demountable as specified in the Annexure
2. Compartments housing withdrawable motor control modules shall provide a degree of protection not less than IP2X with the module withdrawn and the compartment door open
3. A degree of protection of not less than IP3X shall be provided within each demountable motor control module with the compartment isolator open. This degree of protection may be provided by suitable barriers or by insulation
4. Motor control modules rated at either 415 Volts or 440 Volts, shall include line contactors and shall be suitable for direct on line motor starting, for control of motors with separately mounted secondary resistance starters, or for control of variable speed drives with separately mounted variable speed controllers, as shown on the Principal’s drawings
5. Motor control modules rated at 690 Volts shall include line contactors and shall be suitable for controlling motors via separately mounted variable speed controllers
6. Each motor control module shall be provided with an isolator, either a circuit breaker, or an isolating switch rated to interrupt motor locked rotor current
7. Short circuit protection for each motor control modules housing a DOL starter shall be by either HRC fuses or by a fault current limiting circuit breaker, as specified on the Principal’s drawings
8. Short circuit protection for each motor control module housing a reduced voltage starter shall be by a fault current limiting circuit breaker as specified on the Principal’s drawings

The term reduced voltage starter shall be taken to mean an auto transformer starter

1. Short circuit protection for each motor control module housing an electronic soft starter shall be by a fault current limiting circuit breaker. Additional protection of the electronic switches shall be provided by matched semi- conductor fuses in accordance with IEC 60269-4 and with the Principal’s Drawings
2. Short circuit protection for each motor control module housing a variable speed controller shall be by matched semi-conductor fuses in accordance with IEC 60269-4, as specified on the Principal’s drawings

## Auxiliary Equipment Modules

1. For the purposes of this Specification, auxiliary equipment modules shall be defined as switchboard modules containing electrical equipment other than withdrawable circuit breakers and the equipment included in motor control modules
2. Auxiliary equipment modules shall be either withdrawable or demountable as specified in the Annexure
3. Compartments housing withdrawable auxiliary equipment modules shall provide a degree of protection not less than IP2X with the module withdrawn and the compartment door open
4. Each auxiliary equipment module shall be provided with an isolator, either a circuit breaker, or an isolating switch rated to interrupt module full load current
5. Short circuit protection shall be provided by HRC fuses in each auxiliary equipment module with a full load rated current < 200 Amps
6. Short circuit protection shall be provided by a fault current limiting circuit breaker in each auxiliary equipment module with a full load rated current >200 Amps
7. If module short circuit protection is provided by fuses, these shall be connected on the line side of the associated isolating switch
8. A degree of protection of not less than IP3X shall be provided within each auxiliary equipment module with its isolator open. This degree of protection may be provided by suitable barriers or by insulation

## Type of Enclosure

1. The switchboard shall be an A.C. metal enclosed switchboards of the multiple cubicle type in accordance with IEC 61439-1clause 3.3.5
2. The form of separation within the switchboard incoming cubicle shall be Form 4a or Form 4b.
3. If the form of separation within the switchboard incoming cubicle is Form 4a, all conductors and terminals on the line side of the incoming circuit breaker shall be provided with a degree of protection of IP2X between phases and between phase and earth, by either insulation or insulated barriers

The insulation used shall be in accordance with the requirements of AS/NZS 61439.1 clause 8.4.2.2, except that powder coating insulation shall not be permitted

1. If the form of separation within the switchboard incoming cubicle is Form 4b and the switchboard is specified in the Annexure to be suitable for connection to a Low Voltage supply direct from Supply Authority Low Voltage mains (including direct from a Supply Authority transformer), all conductors on the line side of the incoming circuit breaker shall be provided with a degree of protection of IP2X between phases and between phase and earth, by either insulation or by insulated barriers

The insulation used shall be in accordance with the requirements of AS/NZS 61439.1 clause 8.4.2.2, except that powder coating insulation shall not be permitted

1. Removal of panels or insulated barriers to gain access to the load side terminals of the incoming circuit breaker or other load side conductors shall not reduce the degree of protection provided to terminals or conductors on the line side of the circuit breaker
2. Apart for the incoming cubicle, the form of separation of input and output functional units and associated terminals within the switchboard shall meet, either the requirements of either Form 4a or Form 4b as defined in Figure AA.3 of IEC 61439-2, or the requirements of Form 4bi as defined in Figure ZB4 (D) of AS/NZS 61439.2

## Cable Entry

Cable entry into the switchboard shall be top or bottom entry as specified in the Annexure.

## Extension Facility

If so, specified in the Annexure, provision shall be made for the extension to the switchboard with a minimum of shut down time but not necessarily with the switchboard under voltage.

## External Degree of Protection

1. If the switchboard is specified in the Annexure to be installed in an environment having a Pollution Degree rating of not more than 2 in accordance with IEC 61439-1, the switchboard shall have an overall degree of protection rating of not less than IP31 ventilated
2. If the switchboard is specified in the Annexure to be installed in an environment having a Pollution Degree rating of more than 2 in accordance with IEC 61439-1, the switchboard shall have an overall degree of protection rating of not less than IP53

## Use Floor Surfaces to Provide Required Degree of Protection

The type of switchboard mounting shall be shown on the principal’s drawings.

The switchboard will be mounted on smooth concrete floor over cable ducts. If the design of the switchboard is such that it relies on the floor surfaces to be part of the enclosure providing the required degree of protection, the Contractor shall provide all necessary materials and instructions to enable the Principal to take the measures necessary to achieve the required degree of protection.

## Protection Against Internal Faults

The design and construction of the switchboard shall incorporate features to minimize the likelihood of internal faults particularly in the following locations:

* 1. cable termination compartments
  2. disconnectors, switches and earthing switches
  3. bolted connections and contacts
  4. instrument transformers
  5. circuit breakers

## Circuit Switching Interlocks

The switchboard shall incorporate the switching interlocks shown on the Principal’s Drawings.

## Surge Diverters

1. Surge diverters shall be in accordance with IEC 61643
2. Main circuit surge diverters shall be IEC 61643-11 Class I surge diverters and shall be in accordance with the requirements specified in Type Specification DS26-32
3. Main circuit surge diverters shall be installed on the load side of the switchboard main circuit breaker
4. Main circuit surge diverters which are entirely voltage limiting type and do not contain voltage switching components and shall have a short circuit current rating not less than the site incoming L.V. supply prospective fault current level specified in the Annexure.
5. Main circuit surge diverters which contain voltage switching components shall have a short circuit current rating not less than the switchboard prospective fault current rating specified in the Annexure
6. If necessary two sets of main circuit surge diverters and associated backup fuses may be used to achieve the required short circuit rating
7. Instrumentation protection surge diverters shall have the following characteristics:
8. Nominal voltage (Un): 240 Volt
9. Nominal current (In): > 3 Amp
10. Rated voltage (Uc): > 275 Volt
11. Rated protection level (Up): < 700 Volt
12. Maximum operating temperature: > 70 ᵒC
13. Required back up fuse rating: 2 Amp

*(For this application the Weidmuller SD275X would be typical surge diverter - as recommended for protection of PLCs etc)*

## Current Transformers

All current transformers shall be in accordance with the requirements of AS 61869.2 and the rating data shown on the Principal’s drawings. Protection current transformers shall be epoxy encapsulated. Measurement current transformers shall be either epoxy encapsulated or PVC encased.

## Metering Instruments & Protection Relays

Metering instruments and protection relays shall be in accordance with the specifications and rating data shown on the Principal’s drawings.

Suitable test links shall be provided on all protection secondary circuits so as to allow testing by secondary injection.

## Auxiliary Contacts

Contacts shall close to indicate the indicated state.

Auxiliary contacts shall be brought out to terminals in the control circuit module associated with the particular item of main circuit switchgear.

Auxiliary contacts shall be rated at not less than 240 Volt, 2 Amp inductive.

# RATED DIVERSITY FACTOR

The switchboards shall have a rated diversity factor of 1.0.

# RATED OPERATIONAL VOLTAGE

The switchboard rated operational voltage in accordance with IEC 61439-1 shall be shown in the Annexure.

# RATED INSULATION VOLTAGE

The switchboard rated insulation voltage in accordance with IEC 61439-1 shall be not less than 110% of the switchboard rated operational voltage or 750 Volt, whichever is the lesser.

# CREEPAGE DISTANCES

The switchboard shall be rated for operation with an internal micro-environment having an atmospheric pollution level not less than degree 3 in accordance with IEC 61439-1. Wherever practical, switchboard components shall be provided which are rated for operation in a micro-environment having an atmospheric pollution level of degree 4 in accordance with IEC 61439-1.

Creepage distances across insulator surfaces between bare air-insulated conductors in Low Voltage switchboards shall be not less than the values shown in Table 2 of IEC 61439-1.

# RATED IMPULSE WITHSTAND VOLTAGE

Switchboard main circuits shall have a rated impulse withstand voltage of not less than 6kV. Switchboard control and auxiliary circuits shall have a rated impulse withstand voltage of not less than 4 kV.

# RATED SHORT TIME CURRENT

The switchboard rated short time withstand current (Icw) as specified IEC 61439-1 shall be not less than the prospective fault current (Icp) as specified by Section 2.4 above for a switchboard designed for connection to a transformer of the size specified in the Annexure, for a period of 300 milliseconds.

# ACCESS FOR SERVICING AND MAINTENANCE

## General

1. The switchboard shall be designed and constructed so as to facilitate access by authorised personnel to switchboard equipment for servicing
2. In accordance with IEC 61439-1 clause 8.4.6.2.2 the switchboard shall provide safe access with the switchboard under voltage for the adjusting and setting of protection relays and the replacement of indicating lamps, without compromising switchboard arcing fault containment

## Access to Miscellaneous Compartments

Except as specified Section 5 above, access to switchboard compartments shall be protected by:

1. bolted panels
2. hinged panels secured with a locking system keyed in accordance with the requirements of Section 3.3 of Type Specification DS26-9
3. hinged panels with tool operated fixings on the unhinged side

Hinged panels with tool operated fixings shall not be permitted to provide access to equipment compartments unless interlocking is provided such that the panel cannot be opened unless the compartment isolating device is open.

## Access to Cable Connections

1. All outgoing cable zones shall be provided with front access.
2. In respect to clauses 8.4.6.2.2 and 8.4.6.2.3 of IEC 61439-1, the design of the switchboard shall be such that the connection and disconnection of outgoing cables may be performed by competent authorised persons with the switchboard under voltage. Consequently, the design of the switchboard shall incorporate protective measures as outlined in clause 8.4.6.2.3. of IEC 61439-1.

## Access to Busbar Joints

1. Access to busbar joints and main circuit equipment connections may be via the removal of bolted panels as necessary but shall not necessitate other dissembling of the switchboard enclosure or dismantling of switchboard equipment. Such access shall not necessitate shifting the switchboard itself or shifting its associated external cabling
2. The switchboard arrangement shall not be of the “back to back” type of design
3. Preferably access to main circuit equipment connections and busbar joints should be via back panels. Such switchboards shall be mounted with a rear clearance of not less than 600 mm as indicated in the Annexure. Hinged rear panels shall not be permitted unless a clearance of not less than 600 mm can be maintained with the rear panels open

# INTERFACES TO FIELD EQUIPMENT

Circuit interfaces between motor control module circuits and the associated control programmable logic controller and other field mounted control or protection devices shall be either at Extra Low Voltage or shall be an industry standard field bus link such a Modbus, Profibus or Devicenet, as specified in the Annexure

# POWER MONITOR

If so specified in the Annexure, the switchboard shall be fitted with an incoming power monitor. Such power monitors shall be capable of measuring and transmitting to the control programmable logic controller, voltage, current, power, energy, power factor and harmonic voltage & current distortion.

# LABELLING

## General

Each module of the switchboard and each item of equipment, including terminals and terminal rails, shall be clearly labelled. The inscription on the label shall correspond with the designation given on the drawings. The labels shall include Danger and Warning labels to AS 1319.

Colours shall be permanent and free from fading. Unless otherwise approved all designation labels shall be engraved with black lettering on a white background. “Warning” labels shall have black lettering and a yellow background. The minimum lettering height shall be 3mm.

Rating plates shall be fitted to each item of equipment and shall provide the information specified in the relevant standard to which the item of equipment has been manufactured.

## Design Verified Switchboard

The following label shall be mounted in a prominent position on the front of the switchboard:

Switchboard Design Verified by Manufacturer

Not to be Altered in Any Way Except by the Manufacturer

Manufactured by (insert manufacturer’s name)

## Isolation Labelling

Labelling shall be fitted to the switchboard which describes clearly the safe isolation procedures for the main circuit sections of the switchboard and explains all of the interlocking involved.

## Control Circuit Labelling

The control power feeds into each switchboard compartment shall be labelled with a warning label at the control power feeder isolating devices within the compartment.

## Demountable Modules

The following label shall be fitted to all demountable modules

**Demountable Module**

**Do not install or remove with supply to switchboard under voltage**

## Withdrawable Modules

The following label shall be fitted to all switchboard withdrawable modules:

**Withdrawable Module**

**Do not install or remove with supply to switchboard under voltage**

## Withdrawable Circuit Breakers

The following label shall be fitted to all switchboard withdrawable circuit breakers except those in Arcing Class I switchboards (clause 4.2.2 refers):

**Withdrawable Circuit Breaker**

**Do not rack in with compartment door open**

## Special Labels

As well as the other labelling specified above, the labels numbers 1, 3 and 4 in the following schedule shall be fitted on the front of switchboard cubicles controlling main circuit motors. In addition, label number 2 shall be fitted on switchboard cubicles controlling slip ring motors.

|  |  |  |
| --- | --- | --- |
| **Label** | **Letter Height** | **Schedule** |
| 1 | 6  3  3  3  3  3  3 | **CAUTION**  THIS PUMP MAY BE OPERATED IN THE “EMERGENCY” MODE UNDER “LOCAL” CONTROL HOWEVER UNDER THAT CONDITION THE PUMP UNIT OPERATES WITHOUT HYDRAULIC PROTECTION OR SECONDARY CIRCUIT PROTECTION |
|  |  |  |
| 2 | 6  3  3 | **CAUTION**  THIS MOTOR CIRCUIT BREAKER DOES NOT ISOLATE THE CONTROL CIRCUIT |
|  |  |  |
| 3 | 6  3  3  3  3 | **TO RESET CONTROL AFTER FAULT**  1. TURN THE “CONTROL SELECTOR SWITCH” TO OFF  2. RESET THE “PROTECTION RELAY”  3. PRESS THE “UNIT LOCAL RESET” BUTTON |
|  |  |  |
| 4 | 6  3  3  3  3  3 | **CAUTION**  THE MOTOR ANTI-CONDENSATION HEATER IS “ON” WHEN THE MOTOR IS “OFF”. TO ISOLATE THE MOTOR ANTI-CONDENSATION HEATER TURN THE MOTOR ANTI-CONDENSATION HEATER CIRCUIT BREAKER OFF AND TAG. |

# ROUTINE VERIFICATION TESTS

## General

(a) The Contractor shall subject the switchboard to routine verification tests at the manufacturer’s works

(b) All routine verification tests shall be carried out in the presence of, and to the satisfaction of, the Supervising Engineer or his/her authorised representative

## Scope of Tests

Routine verification test shall include the following:

1. IEC 61439-1/2 design verification tests on the completed switchboard as per clause 3.2 of this Specification
2. tests to verify the accuracy of all instrumentation
3. tests of the resistance of the main circuit in order to verify the absence of any poor joints in main circuit conductors
4. operational tests on the arc detection system using flashlights
5. protection relay tests as detailed hereunder.

## Protection Relay Tests

1. The Contractor shall submit a routine verification testing certificate to verify the correct operation of protective devices as detailed hereunder
2. Standalone current transformer connected protection devices to IEC 60255 shall be tested by secondary injection at not less than six points spread evenly over the complete operating range of the device specified settings. In addition, each such protective device shall be tested at one appropriate current level by primary injection
3. The incoming circuit breaker shall be provided with a test function and, if necessary, a separate test instrument. The Contractor shall verify the correct operation of the circuit breaker protection using this test function

## Routine Verification Certificates

The Contractor shall provide the Supervising Engineer with two copies of routine test reports detailing the tests carried out and the results obtained so that the Supervising Engineer can certify that the testing has been completed successfully. The Contractor shall retain one copy of the certified routine test reports with the other copy being for the Principal’s records.

# DESIGN VERIFICATION COSTS

The Contractor shall subject the switchboard to design verification and routine tests as specified in this Specification with the cost of all design verification and routine testing to be to the Contractor’s account.

# DELIVERY AND INSTALLATION

1. The Contractor shall deliver the switchboard to the site and shall unload and unpack it at site

The Contractor shall inspect the unpacked switchboard and shall ensure that the switchboard is undamaged

Any onsite assembly necessary shall be carried out by, or under direct supervision of, the switchboard manufacturer

1. The Contractor shall give the Principal seven (7) days’ notice of when the switchboard will be ready for installation
2. The Contractor shall install the switchboard in its permanent position in the switch room ready for connection by others
3. If the incoming cable is to be connected as specified in Section 5.5 (d) above, the Contractor shall provide the Principal with written instructions for issue to the electrical installer detailing how the incoming cable connections shall be made, so as not to compromise the specified degree of protection on the line side of the incoming circuit breaker

# ON-SITE TESTING

1. Before the Contractor makes the switchboard available to the Principal for connection to the electrical system, the Contractor shall carry out an insulation resistance test
2. In addition, if the switchboard has been delivered to the site, the Contractor shall carry out any additional tests necessary to verify correct reassembly of the switchboard
3. Before the switchboard is energised, if the incoming cable is to be connected as specified in Section 5.5 (d) above, the Contractor shall provide independent verification that the specified degree of protection on the line side of the incoming circuit breaker has not been compromised by the incoming cable connections

# AS CONSTRUCTED INFORMATION

The Contractor shall provide as-constructed information on all drawings detailing all changes and modifications made during the construction and installation phases of the project.

The contractor shall submit drawings in both AutoCAD and PDF formats in accordance with the Drawing Submission Process. Adequate contrast within the PDF image shall be maintained between drawing content and background to ensure the clarity and quality of the drawings.

# MANUALS

The Contractor shall supply three (3) copies of comprehensive instruction manuals, written in English and covering the complete operation and maintenance requirements of all equipment supplied under the Contract.

The manuals shall be printed on high grade A4 size paper and shall be bound in a high grade A4 size loose leaf binder.

Information included in the manual shall include:

(a) operating instructions

(b) safety instructions and warnings

(c) maintenance instructions and schedules

(d) recommended spare parts and special tool list

(e) as-constructed drawings, and

(f) test reports and test certificates

**Addendum to Specification**

**for**

**Large Low Voltage Switchboard**

**1. IEC 61439 Design Verification**

* 1. Design verification of the project switchboard design in respect to short circuit strength of the protective circuit in the main incoming circuit breaker cubicle, the main busbar chamber, the distribution busbar chamber and in outgoing units with short circuit protective devices having an I2t let through of greater than 6\*106 Amp2 sec. shall be by testing in accordance with IEC 61439-1 Clause 10.11.5, or by comparison with a reference design in accordance with IEC 61439-1 Clause 10.11.4 utilising the check list specified in Table 13
  2. Similarly design verification of the project switchboard design in respect to short circuit strength of the three phase circuit in the main incoming circuit breaker cubicle, the main busbar chamber, the distribution busbar chamber and in outgoing units with short circuit protective devices having an I2t let through of greater than 6\*106 amp2 sec. shall be by testing in accordance with IEC 61439-1 Clause 10.11.5, or by comparison with a reference design in accordance with IEC 61439-1 Clause 10.11.4 utilising the check list specified in Table 13
  3. Design verification shall not be required of the short circuit strength of the protective circuit and the three-phase circuit in outgoing units with short circuit protective devices having an I2t let through less than 3\*105 Amp2sec
  4. Except as above, the design verification of the project switchboard design in respect to the requirements of IEC 61439 may be by testing, or may be by comparison with a reference design provided that the project switchboard enclosure(s) are the same as used in the reference switchboard design

**2. IEC 61641 Design Verification**

1. Design verification of the IEC 61641 arcing fault performance of the project main incoming circuit breaker cubicle shall be by testing
2. A design which incorporates insulation providing a degree of protection of IP4X or IP3XD on the line side of the short circuit protection device in each outgoing functional unit module shall be preferred. In such cases arcing fault tests with the arc initiated at the line side terminals of the associated short circuit protective device shall not be required
3. Design verification of the IEC 61641 arcing fault performance of project switchboard outgoing functional unit modules incorporating a degree of protection of IP4X or IP3XD on the line side of the module short circuit protection device may be by testing, or may be by comparison with a reference design provided that:
4. the project switchboard enclosures are the same as used in the reference switchboard design, and
5. the values of I2t let through of the relevant short circuit protective device(s) in the project switchboard are not greater than those in the reference switchboard design
6. Except as above, design verification of the project switchboard IEC 61641 arcing fault performance of the project switchboard may be by testing, or may be by comparison with a reference design, provided that:
7. the project switchboard enclosures are the same as used in the reference switchboard design,
8. the short circuit protective devices are the same make, type and arrangement as used in the reference design, and
9. the values of I2t let through of the relevant short circuit protective device(s) in the project switchboard are not greater than those in the reference switchboard design
10. If tests results confirm that a test arc initiated at the line side terminals of the main incoming cubicle has jumped across the main circuit breaker terminals onto the circuit breaker load side busbars, there shall be no need to carry out an additional arcing fault test initiated at the load side of the main circuit breaker
11. If test results confirm that a test arc on the load side of the main circuit breaker travels onto the main busbars and terminates at the final main busbar arc fault barrier, there shall be no need to carry out an additional arcing fault test initiated on the main busbars
12. The distribution busbar system must be arcing fault tested. Consequently, an arc shall be initiated at the top of the distribution busbars unless tests confirm that an arc initiated at the input terminals of an outgoing unit connected to the distribution busbars has caused an arcing fault on the distribution busbars

In such cases provided that there is evidence that the arc travelled to the end of the distribution busbars and there caused significant damage, there shall be no need to conduct a separate arcing fault test with the arc initiated directly on the distribution busbars

1. If a successful arcing fault test is carried out in an outgoing unit with the arc initiated at the input terminals, there shall be no need to carry out additional arcing fault tests on the outgoing unit with the arc initiated at the output terminals

**Annexure to Specification**

**for**

**Large Low Voltage Switchboard**

**Project:**

…………………………………………………………………………………………………….

**Switchboard Title:**

…………………………………………………………………………………………………….

**Type of Access to Site:**

…………………………………………………………………………………………………….

**Work by the Principal:**

The following work will be undertaken by the Principal:

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

…………………………………………………………………………………………………….

**Service Conditions:**

Located in a Separate Switchroom (yes or no)

Switchboard located >100 m from sea shore (yes or no)

Switchboard located > 1 km from breaking surf (yes or no)

Pollution Degree (as per clause 2.9)

Maximum 24-hour average air temperature oC

Maximum relative humidity at above temperature %

Clearance behind switchboard (not less than 600 mm):

Connection Direct to Supply Authority LV Mains (yes or no)

Rated Operational Voltage: Volts

Rated Operational Frequency: Hz

Full Load Current Rating Amps

Incoming LV Supply Prospective Fault Current kA

Driven Motor Prospective Fault Current Contribution kA

Switchboard Required Fault Current Rating kA

Auxiliary Circuits Voltage Rating Volts

Auxiliary Circuits Voltage AC or DC

**Annexure to Specification**

**for**

**Large Low Voltage Switchboard**

**Cable Entries**

Type of Incoming Cable Entry (top or bottom entry) ………………………………………………………………..

Type of Outgoing Cable Entry (top or bottom entry) ………………………………………………………………..

Generic **Single Line Diagram,** detailing all main circuit equipment and the type, ratings and

arrangement thereof, shown on drawing number(s) ………………………………………………………………

……………………………………………………………………………………………………………………….

**Generic Incoming Cubicle 3 Phase Power Diagrams** shown on drawing(s)…………………………………..

……………………………………………………………………………………………………………………….

**Generic Outgoing Cubicle 3 Phase Power Diagrams** shown on drawings ……………………………………...

……………………………………………………………………………………………………………………….

**Generic Incoming Cubicle Control Diagrams** (including details of all auxiliary contacts required), shown on drawing(s) ……………………………………………………………………………………………………………………………………………………………………………………………………………………………………………………

**Generic Outgoing Cubicle Control Diagrams** (including details of all auxiliary contacts required), shown on drawing(s)…………………………………………………………………………………………………………….

…………………………………………………………………………………………………………………………

**Sundry 3 Phase Power Diagrams**, shown on drawing(s) ………………………………………………………….

…………………………………………………………………………………………………………………………

**Sundry Schematic Diagrams** (including details of all auxiliary contact required), shown on drawing(s)

…………………………………………………………………………………………………………………………

**Switching Interlock Diagram** (detailing all interlocks), shown on drawing number(s)

…………………………………………………………………………………………………………………………

**Annexure to Specification**

**for**

**Large Low Voltage Switchboard**

**Motor Control Modules**

Fully withdrawable or Dismountable ………………………………………………………………………………..

**Auxiliary Equipment Modules**

Fully Withdrawable or Dismountable ……………………………………………………………………………….

**Type of Protection Relay and Circuit Breaker Shunt Trip Power Supply**

shown on drawing number(s) ………………………………………………………………………………………..

**Type and Rating of Main Circuit Fuses**

shown on drawing number(s) ………………………………………………………………………………………..

**Type and Rating of Main Circuit Breakers**

shown on drawing number(s) ………………………………………………………………………………………..

**Current Transformer Ratings** shown on drawing number(s) …………………………………………………….

**Type and Ratings of Instruments and Protection Relays**

shown on drawing number(s) ……………………………………………………………………………………….

**Auxiliary Contacts required**

* on main circuit breakers …………………………………………………………………………….
* on main circuit isolators …………………………………………………………………………….
* on motor line contactors……………………………………………………………………………

**Incoming Power Monitor** (required or not required) ……………………………………………………………….

**Type of Field Equipment Interface** (hard wired or field bus type) …………………………………………………

If hard wired, required voltage………………………………………………………………………………………... If field bus, required type (Modbus, Profibus or Devicenet) ………………………………………………………...

| **Type Specification for Large Low Voltage Switchboard**  **Tender Technical Response Schedule** | | | | | |
| --- | --- | --- | --- | --- | --- |
| **Clause No.** | **Subject** | **Noted** | **Compliance** | | **Comments** |
|  |  |  | **Yes** | **No** |  |
| **1** | **General** |  |  |  |  |
| 1.1 | Scope |  |  |  | Switchboard rated Volts = |
|  |  |  |  |  | Switchboard rated Amps = |
|  |  |  |  |  | Max. motor starter kW = |
|  |  |  |  |  | Min. motor starter kW = |
| 1.2 | Referenced Type Specifications |  |  |  |  |
| 1.3 | Site |  |  |  |  |
| 1.4 | Standards |  |  |  |  |
| 1.5 | Quality Assurance |  |  |  |  |
| 1.6 | Supervising Engineer |  |  |  |  |
| 1.7 | Principal’s Drawings |  |  |  | *Any proposed deviations from that specified* |
| 1.7.1 | General |  |  |  | *Equipment ratings to be detailed separately* |
| 1.7.2 | Electrical Single Line Diagram |  |  |  |  |
| 1.7.3 | Generic Circuit Diagrams |  |  |  |  |
| 1.8 | Work by Principal |  |  |  |  |
| 1.9 | Information to be Provided |  |  |  |  |
| 1.10 | Contractor’s Drawings |  |  |  |  |
| 1.10.1 | General |  |  |  |  |
| 1.10.2 | Content of Contractor’s Drawings |  |  |  |  |
| 1.10.3 | Marked Up Principal’s Drawings |  |  |  |  |
| 1.10.4 | Ownership |  |  |  |  |
| 1.10.5 | Statement of Design Verification |  |  |  |  |
| **2** | **Service Conditions** |  |  |  |  |
| 2.1 | General |  |  |  |  |
| 2.2 | Impulse Overvoltage Category |  |  |  |  |
| 2.3 | Power Frequency Withstand Voltage |  |  |  |  |
| 2.4 | Full Load and Fault Current Levels |  |  |  |  |
|  | Main Circuit Fault Level |  |  |  | rated fault level = kA |
|  | Incoming Circuit Breaker |  |  |  | rated FLC = Amps |
|  | Busbars Full Load Current |  |  |  | DS 26-9 clause 10.3 refers |
|  | Main Busbar FLC |  |  |  | rated FLCX = Amps |
|  | Dropper Busbars FLC |  |  |  | rated FLC = Amps |
| 2.5 | Prospective Fault Current in Neutral Conductor |  |  |  |  |
| 2.6 | Prospective Fault Currents in Protective Circuit |  |  |  |  |
| 2.7 | Location |  |  |  |  |
| 2.8 | Ambient Temperature |  |  |  |  |
|  | Switchboard Ambients |  |  |  | DS 26-9 clause 3.4 refers |
|  |  |  |  |  | External ᵒC = |
|  |  |  |  |  | Internal ᵒC = |
|  | Thermal derating of equipment |  |  |  | DS 26-9 clause 3.4 refers |
|  |  |  |  |  | Switchgear rated ᵒC = |
|  |  |  |  |  | Switchgear derating % = |
|  |  |  |  |  | Electronic equipment rated ᵒC = |
|  |  |  |  |  | Electronic equipment derating % = |
| 2.9 | Ambient Air Relative Humidity |  |  |  |  |
| 2.10 | Degree of Pollution |  |  |  |  |
| 2.11 | Atmospheric Corrosion Severity |  |  |  |  |
| 2.12 | Altitude |  |  |  |  |
| 2.13 | EMC Environment |  |  |  |  |
| 3 | IEC61439-1 Design Verification |  |  |  |  |
| 3.1 | General Requirements |  |  |  | Attach any project specific design test certificates |
|  |  |  |  |  | Any design aspects to be verified by design comparison? (yes or no) |
|  |  |  |  |  | Attach any relevant reference design test certificates |
| 3.2 | IEC 61439-1/2 Tests on Completed Switchboard |  |  |  |  |
| 4 | Arcing Fault Protection Design |  |  |  |  |
| 4.1 | IEC61641-1 Arc Protection Categories |  |  |  |  |
| 4.2 | IEC61641-1 Design Verification |  |  |  |  |
| 4.2.1 | Verification Method |  |  |  |  |
| 4.2.2 | Test Prospective Fault Current Levels |  |  |  |  |
| 4.2.3 | Test Fault Durations |  |  |  |  |
| 4.2.4 | Arc Ignition Protected Zones |  |  |  |  |
| 4.2.5 | Test Ignition Points |  |  |  |  |
|  | at incoming supply terminals |  |  |  |  |
|  | at line side of incoming ACB |  |  |  |  |
|  | at load side of incoming ACB |  |  |  |  |
|  | at main busbars |  |  |  |  |
|  | at distribution busbars |  |  |  |  |
|  | at line side of functional units |  |  |  |  |
|  | at load side of functional units |  |  |  |  |
| 4.2.6 | Arcing Fault Test Reports |  |  |  |  |
| 4.3 | Assembly Protection by Arc Detection |  |  |  |  |
| 4.3.1 | General |  |  |  |  |
| 4.3.2 | Location of Arc Detectors |  |  |  |  |
| 4.3.3 | Auxiliary Circuit Outputs |  |  |  |  |
| 4.3.4 | Arc Detection System EMC |  |  |  |  |
| 4.3.5 | Design Verification of Arc Detection System |  |  |  |  |
| 5 | Construction |  |  |  |  |
| 5.1 | General |  |  |  |  |
| 5.2 | Circuit Breakers |  |  |  |  |
| 5.3 | Motor Control Modules |  |  |  |  |
| 5.4 | Auxiliary Equipment Modules |  |  |  |  |
| 5.5 | Type of Enclosure |  |  |  | Attach power single line diagram overlaid |
|  | As per sub-clause 5.5 (a) |  |  |  | with compartment boundaries |
|  | As per sub-clause 5.5 (b) |  |  |  |  |
|  | As per sub-clause 5.5 (c) |  |  |  |  |
|  | As per sub-clause 5.5 (d) |  |  |  |  |
|  | As per sub-clause 5.5 (e) |  |  |  |  |
| 5.6 | Cable Entry |  |  |  |  |
| 5.7 | Extension Facility |  |  |  |  |
| 5.8 | Degree of Protection |  |  |  | IP Rating = |
| 5.9 | Use of Floor Surfaces |  |  |  |  |
| 5.10 | Protection Against Internal Faults |  |  |  |  |
| 5.11 | Circuit Switching Interlocks |  |  |  |  |
| 5.12 | Surge Diverters |  |  |  |  |
| 5.13 | Current Transformers |  |  |  |  |
| 5.14 | Metering Instruments & Protection Relays |  |  |  |  |
| 5.15 | Auxiliary Contacts |  |  |  |  |
| 5.16 | Type 2 Coordination |  |  |  |  |
| 6 | Rated Diversity Factor |  |  |  |  |
| 7 | Rated Operational Voltage |  |  |  | Rated Operational Volts = |
| 8 | Rated Insulation Voltage |  |  |  | Rated Insulation Volts = |
| 9 | Creepage Distance |  |  |  | Minimum Creepage mm = |
| 10 | Rated Impulse Withstand Voltage |  |  |  | Main Circuits Impulse Withstand kV = |
| 11 | Rated Short Time Current |  |  |  | Main Circuits Short Time Amps = |
| 12 | Access |  |  |  |  |
| 12.1 | General |  |  |  |  |
| 12.2 | Access to Miscellaneous Compartments |  |  |  |  |
| 12.3 | Access to Cable Connections |  |  |  |  |
| 12.4 | Access to Busbar Joints |  |  |  |  |
| 13 | Interfaces to Field Equipment |  |  |  |  |
| 14 | Power Monitor |  |  |  |  |
| 15 | Labelling |  |  |  |  |
| 15.1 | General |  |  |  |  |
| 15.2 | Design Verified Switchboard |  |  |  |  |
| 15.3 | Isolation Labelling |  |  |  |  |
| 15.4 | Control Circuit Labelling |  |  |  |  |
| 15.5 | Demountable Modules |  |  |  |  |
| 15.6 | Withdrawable Modules |  |  |  |  |
| 15.7 | Withdrawable Circuit Breakers |  |  |  |  |
| 15.8 | Special Labels |  |  |  |  |
| 16 | Routine Verification Tests |  |  |  |  |
| 16.1 | General |  |  |  |  |
| 16.2 | Scope of Tests |  |  |  |  |
| 16.3 | Special Protection Relay Tests |  |  |  |  |
| 16.4 | Routine Verification Certificates |  |  |  |  |
| 17 | Design Verification Costs |  |  |  |  |
| 18 | Delivery and Installation |  |  |  |  |
| 19 | On Site Testing |  |  |  |  |
| 20 | As Constructed Information |  |  |  |  |
| 21 | Manuals |  |  |  |  |
|  | Overall Switchboard Dimensions |  |  |  | Length m = |
|  |  |  |  |  | Width m = |
|  |  |  |  |  | Height m = |
|  |  |  |  |  | Weight kg = |
|  | Addendum |  |  |  |  |
|  |  |  |  |  |  |

END OF DOCUMENT