Sydney WATER

Technical Specification - Protection

Table of Contents

Figures

Revision details

Version No.	Clause	Description of revision
1.0	All	General revision
2.0	All	General revision
3.0	All	General revision
4.0	All	Format update, changing 'must', 'should' and 'may' to must where relevant to Sydney Water, 'approved' replaced with 'accepted', minor editorial changes elsewhere.
5.0	All	Added protection relay and protection study requirements

Introduction

This Specification covers HV and LV protection requirements for the design, supply and installation within power distribution networks for Sydney Water assets.

Sydney Water makes no warranties, express or implied, that compliance with the contents of this Specification must be sufficient to ensure safe systems or work or operation.

It is the user's sole responsibility to ensure that the copy of the Specification is the current version as in use by Sydney Water.

Sydney Water accepts no liability whatsoever in relation to the use of this Specification by any party, and Sydney Water excludes any liability which arises in any manner by the use of this Specification.

For the purpose of this Specification "Sydney Water" is the nominated person or organisation that has written authority to act on Sydney Water's behalf.

This document is uncontrolled once printed or downloaded.

Copyright

Acronyms

Acronym	Definition
AC	Alternating current
ACB	Air Circuit Breaker
ANSI	American National Standard Institute
CB	Circuit Breaker
CT	Current Transformer
DB	Distribution Board
DC	Direct current
DT	Definite Time
FVC	Fused Vacuum Circuit Breaker
HMI	Human Machine Interface
H2	2nd Harmonic
HV	Exceeding low voltage
IDMT	Inverse definite minimum time (protection)
IEC	International Electrotechnical Commission (Standard)
Ik"	IEC60909 Initial Symmetrical Fault Current
LV	Exceeding Extra-low voltage, but not exceeding 1000 V a.c. or 1500 V d.c.
MCC	Motor control centre
MCCB	Moulded Case Circuit Breaker
SC	Short Circuit
SCA	Switchgear and control gear assembly
SCADA	Supervisory control and data acquisition
SEF	Sensitive Earth Fault
SLD	Single Line Diagram
SLG	Single Line to Ground
STD	Short Time Delay
STPU	Short Time Pick Up
TCC	Time Current Curve
Z%	Transformer Impedance Percentage

General Terms & Definitions

Term	Definition
Arcing Fault Current	A fault current flowing through an electrical arc plasma. Also referred to as arc fault current or arc current
Backup Protection	Should primary protection fail to operate, backup protection is the next protection relay and circuit breaker combination to detect and clear an electrical fault. For an arcing fault occurring on a switchboard's main incomer, this is typically the first upstream feeder protection
Bolted Fault Current	A fault current flowing where there is close to zero resistance or impedance in the fault path
Distribution Board	General power distribution boards (typically up to 250A) are defined as single compartment electrical boards with MCB (miniature circuit breaker) outgoing circuits.
Maximum Utility Fault Current	Information supplied by the utility for a network system configuration, resulting in the highest fault current supplied to the site
Minimum Utility Fault Current	Information supplied by the utility for a network system configuration, resulting in the least fault current supplied to the site
Transformer Frequent Damage Curve	More than 5 through-faults that occur in the transformer's lifetime
Transformer Infrequent Damage Curve	Less than 5 through-faults that occur in the transformer's lifetime
Voltage factor "C"	Factor used in the determination of the equivalent source voltage

1. General

1.1 Introduction

This Specification defines the minimum technical requirements for the design and delivery of protection systems. This Specification is to be read in conjunction with the Sydney Water Technical Specification – Arc Flash and other reference documents in Section2.

1.2 Scope

This Specification applies to HV and LV power distribution networks. The Specification is intended to provide the basic level of protection required for an electrical system, highlight areas that require additional mitigation and provide protection report requirements covering each item.

This specification is intended to provide minimum protection system requirement for Sydney Water power reticulation system, including protection relay technical requirements, protection discrimination, and protection report requirements.

1.3 Use of document

This Specification is not to be used as the sole source for protection requirements. A network power distribution application or protection scheme may have certain peculiarities that this Specification will not cover. Each protection scheme and the protection elements required must be assessed individually for suitability. This Specification does not take precedence over Australian Standards, Utility Network Standards, Service Installation Rules of NSW, other Sydney Water specifications or specific site requirements. Where a conflict exists between any of the above references, a clarification request with a recommendation on which criteria to use must be presented to Sydney Water for acceptance.

2. References

2.1 Sydney Water technical specifications and standards

Sydney Water	CPDMS0022 Technical Specification – Electrical
Sydney Water	D0002263 Technical Specification – Arc Flash
Sydney Water	Interim IEC 61850 design requirements
Sydney Water	D0000833 Engineering Competency Standard

2.2 Australian standards

AS/NZS 3000	Electrical Installations – 'Wiring Rules'
AS/NZS 3008.1.1	Electrical Installations – Selection of cables – Cables for alternating voltages up to and including 0.6/1 kV
AS/NZS 2067	Substations and High Voltage Installations
AS/NZS 3851	The calculation of short-circuit currents in three phase A.C. systems

AS/NZS 62271 series	High-voltage switchgear and control gear - A.C. metal-enclosed switchgear and control gear for rated voltages above 1kV
AS/NZS 61439 series	Low-voltage switchgear and control gear assemblies

3. General requirements

3.1 Protection philosophy

The prime objective of the electrical protection system is to reliably:

- Identify system faults and automatically initiate action to isolate the affected equipment or section of electrical network whilst minimising disruption to the unaffected (healthy) part of the system.
- Prevent, or minimise, equipment damage by quick identification of fault conditions and rapid disconnection of faulty equipment or section of electrical installation.
- Maintain the plant availability by successfully isolating the faulty section with minimal disruption and returning the system to normal, while at the same time avoiding nuisance trips.
- Provide redundancy, if a single protection device or circuit fails there must be an independent secondary method (back-up) for fault identification and isolation.
- Provide positive operation for the full range of anticipated system fault levels.
- Provide stable operation for short time overloads (within the safe limit of equipment) and normal system transients, such as motor starting currents, transformer magnetising inrush currents, switching surges etc.
- Provide selectivity when a fault occurs. The protection system is required to trip only those CBs whose operation is required to isolate the fault.
- Provide sensitivity when a fault occurs. The protection system is required to operate the appropriate devices before any damage occurs to unaffected equipment and not operate under normal conditions.

3.2 Qualification and competency requirements

Sydney Water's minimum qualifications and experience as per the Engineering Competency Standard are applicable for protection system design.

3.3 Utility fault current contribution

The utility fault current contribution must be confirmed with the utility at the point of connection detailing the below information:

- Maximum three phase and single line to ground initial symmetrical fault level (or equivalent impedance)
- Minimum three phase and single line to ground initial symmetrical fault level (or equivalent impedance)
- X/R ratio of the supply network impedance, for both the maximum and minimum fault level cases

3.4 Utility protection settings

The utility protection device details must be confirmed with the utility detailing the below information:

- Location of protection device (substation number etc, panel number, protection device number)
- Protection device model and settings.

3.5 Fault current scenarios

Maximum and minimum fault current scenarios are required in determining protection equipment rating and protection operating times.

Minimum fault current – minimum utility impedance and minimum ‘C’ Factor with no generation onsite or motor contributions.

Maximum fault current – maximum utility impedance and maximum ‘C’ Factor.

3.6 Voltage factors

- Ik” Fault currents are to be calculated using the following voltage “C” factors:

  < 1000V minimum fault current 0.94 and maximum fault current 1.06

  > 1000V minimum fault current 0.9 and maximum fault current 1.1

Note: If the utility only provides one fault level, then separate maximum and minimum scenarios are to be extrapolated using the C Factor 1.1 for maximum and 0.9 C Factor for minimum fault current calculation.

3.7 Arc flash protection requirement

Arc flash incident energy can be greatly reduced by selecting appropriate protection devices and protection settings. The target arc flash hazard category must be as low as reasonably practicable and not above Cat.2 (8 Cal/cm^2). Setting optimisation is achieved by reducing the protection settings as much as possible, while maintaining time and current coordination between protection devices and still avoiding risk of nuisance tripping. Refer to the Sydney Water Technical Specification – Arc Flash for details.

Arc flash detection schemes must be installed for new HV switchboards and all LV switchboards that are directly supplied by Sydney Water transformers (pad mounted and/or kiosk type). To achieve this function, LV switchboard incomers must be equipped with protection relay (in compliance with Section 5 of this Specification) to deliver the arc flash protection scheme (as well as any other LV protection functionality if required). This protection relay must be installed to inter-trip the associated upstream HV protection and seamlessly integrated into the communication network of its associated upstream HV switchboard. This integration facilitates remote control and monitoring as governed by the communication philosophy and interface to be adopted.

Where arc flash protection scheme is employed, both current detection and light detection must be used to trigger the tripping signal.

3.8 Primary, back up and duplicate protection

Any fault in the system is required to be effectively seen and cleared by a minimum of two independent protection devices.

Where duplicate protection schemes are required the backup protection must be completely separate from the main protection scheme. Typically this includes two independent CTs, VTs, trip supplies and trip circuitry and necessitate the main and backup protection to operate on different relay make/model.

3.9 Busbar protection

Where busbar protection is employed, the supply circuit for the bus relays and multi-trip unit must be separated to ensure isolation of individual circuit must not affect the bus tripping function.

3.10 Software requirements

SKM Power*Tool for Windows (PTW) modelling software package is preferred to create and/or update power system models. With prior approval, an equivalent software may be used if data is compatible and easily imported into PTW with generation of consistent results.

The use of PTW provides:

- Consistency of approach and output
- Accurate modelling
- Common basis for the future electrical installation modifications/assessment.

3.11 TCC Curves

Curves displayed on the TCC are to end at the min Ik” symmetrical fault current. Transformer inrush current is to be displayed. Each curve is to display the appropriate data block attribute, is illustrated in Figure 1.

Equipment loads are to be summed together for normal operations (PTW function: load adder) with the largest equipment starting current curve (this is to show normal lumped loads and the largest equipment starting characteristic on a single curve).

3.12 TCC Damage curves

Transformer infrequent, transformer frequent and cable and other equipment damage curves are to show that the protection device will operate before any point of the damage curve is reached.

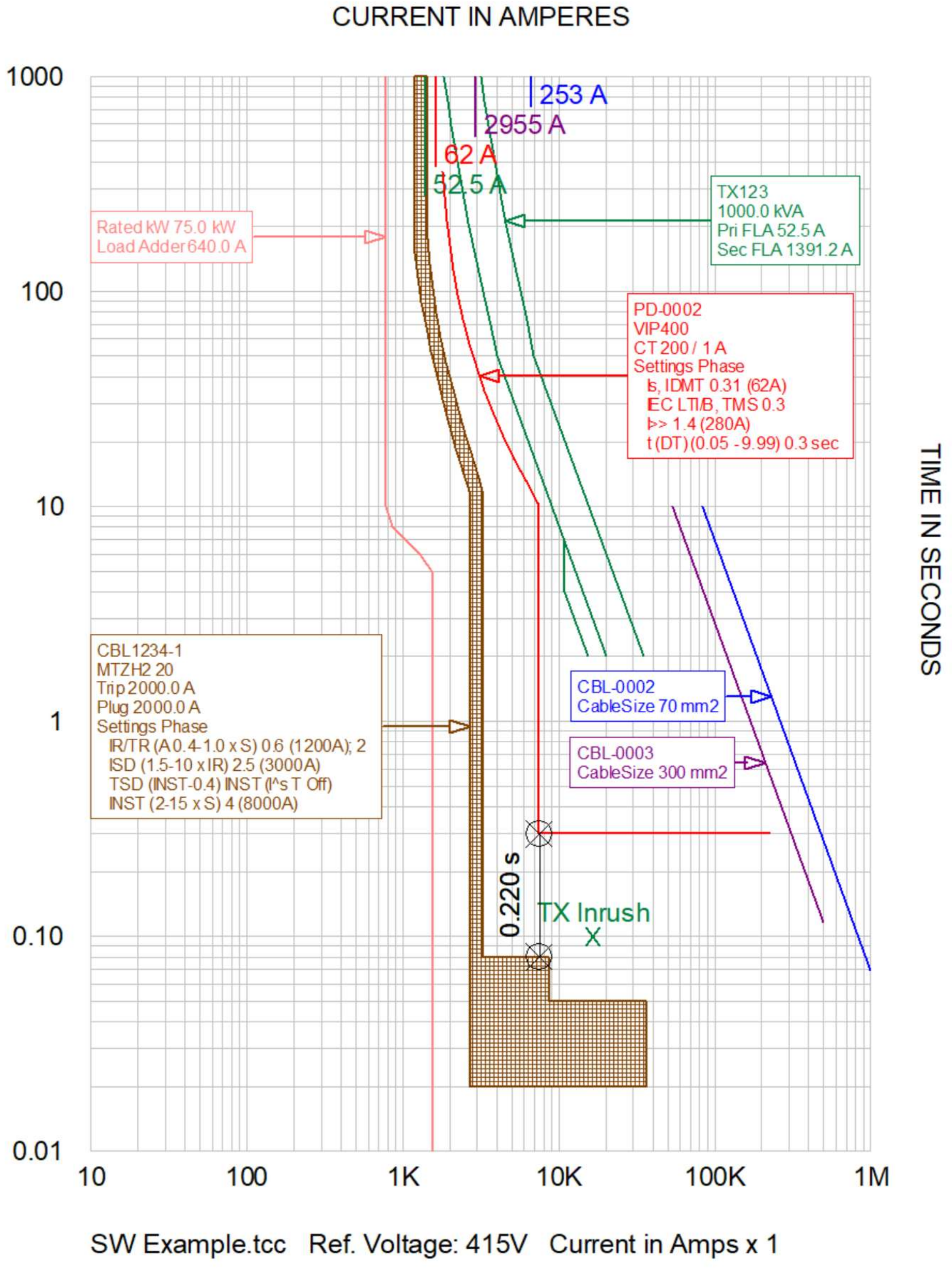

Figure 1. Example TCC curve

4. Protection relay technical requirements

The design of the protection system is required to use the basic protection elements with the minimum required elements to satisfy the protection philosophy. If those minimum elements do not provide the protection required, then additional protection elements/schemes must be used.

For requirements of LV circuit breakers (ACB's, MCCB switchboard incomers and MCCB outgoing power distribution feeders), refer to Sydney Water Technical Specification - Electrical. ACBs are to be provided for incomer breakers 800A and above.

The requirements for integrated LV circuit breaker protection/trip unit as part of ACB or MCCB is not covered in this specification.

4.1 General

Protection relays must be microprocessor based and suitable for operation within the integrated control system where they have the ability to communicate on a digital communication link with a programmable logic controller or a distributed control system.

Protection relays must offer control, protection, metering and data acquisition capabilities relating to the particular application. The relays must also be equipped with fault and alarm event memory, and self-supervision. The following is the minimum metering and status information that must be available from the protection relay.

a) Root mean square (RMS) phase current

b) Phase-to-Phase, and phase-to-neutral voltages

c) Active and reactive power

d) Active and reactive energy

e) The protection relays must be equipped with digital communications with capabilities for the transmission of metering and status information and receiving control commands in accordance with IEC 61850.

f) Local controls, status and metering information must be provided for display and control purposes via a graphical interface included with the protection relay. Protection relays must be dust proof and flush mounted in the front doors or panels of the assemblies installed.

The relays must be capable of withstanding the output current of the associated current transformers corresponding to a primary current equal to the specified short time withstand current and time of the assembly.

Digital relays must be supplied for all applications. Electromechanical relays and analogue solid-state relays will not be accepted.

Digital protection relays must comply with all relevant parts of the IEC 60255 series of standards and all relevant standards referenced therein.

The protection relay must be able to directly receive the voltage and current as analogue inputs.

4.2 Standardisation

Equipment must be designed with standard parts and components readily available within Australia. Parts and components must be standardised as much as possible. All replaceable and consumable equipment must be standard supply equipment. The use of "one off" special designs is not permitted.

4.3 Proprietary items

Nomination of a proprietary item by Sydney Water does not imply preference or exclusivity for the item identified.

Alternatives that are equivalent to the nominated items can be submitted to Sydney Water for acceptance. The submission must include appropriate technical information, samples, calculations and the reasons for the proposed substitution, as appropriate.

4.4 Mechanical requirements

Protection relays must be mounted in the doors of the respective LV compartments as per the OEM requirements.

Protection relays must be housed in robust enclosures of a design to:

a) Achieve mechanical robustness in accordance with IEC 60255-21-1, -2 and -3

b) Achieve climatic withstand in accordance with IEC 60068-2

c) Maintain the Ik" and IP ratings of the switchboard enclosure.

d) Provide means for easy withdrawal and re-insertion of relays for inspection and maintenance.

e) Protect keypads and adjustment devices while ensuring that all settings are visible from the front with all covers in place

f) Provide operation and alarm indicators, clearly visible from the front and capable of being manually reset with all covers in place.

Relays must be suitable for back connection. All connections must be clearly identified for wiring purposes. The types of terminals for the connection of energising quantities, auxiliary supplies, tripping circuits, etc, will be subject to approval by Sydney Water. All screw connections must use ring lugs.

Mounting of protection relays in a standalone arrangement (i.e. separate from the switchgear panel) is considered an exception, and approval by Sydney Water is required for this arrangement.

4.5 Human machine interfaces (HMIs)

Each protection device must include metering functions and an integral HMI (liquid crystal display and keypad) which allows an operator to view status, enter control commands, review and acknowledge alarms/trips, view measured values, enter and review setup parameters. The relay must be selected with the largest available integral HMI option.

Separate, hand reset operation indicators must be provided for all Inverse Definite Minimum Time Lag (IDMTL) and instantaneous protection elements.

4.6 Electrical ratings

Tripping and closing contacts must be rated to suit the requirements of the CB/FVC trip and close coils for all steady state and transient load conditions.

Alarm and indication contacts must be rated for duty level II B as defined in IEC 60255.

All relays for new installations must be suitable for one amp (1A) current transformer (CT) secondaries.

4.7 Relay operating voltages

HV protection relays for new installations are to have an operating voltage of 48VDC.

Renewal of existing HV protection relays can use the existing operating voltage from 32VDC to 110VDC.

Separate DC circuits for protection trip and circuit breaker closing circuits are to be provided.

4.7.1 LV protection relay operating voltages

New or renewal of existing LV protection relays are to have an operating voltage of 24VDC (or 48VDC if sourced from the upstream HV protection DC system).

4.8 Protection performance requirements

The selection of relay products and functionalities must be based on the agreed and approved protection study report.

The effective range, the minimum and maximum pickup currents, the resetting current, the time current characteristic and the overshoot time must correspond with the normal inverse definite minimum time lag (IDMTL) Class E7.5 characteristics as defined in IEC 60255.

The time multiplier setting range must be approximately 0.05 to 1.0, adjustable either continuously or in 0.05 maximum steps.

The typical setting range should be as follows:

Elements	Details
phase fault IDMTL	50% to 200% of the rated current, adjustable either continuously or in 25% maximum steps.
earth fault IDMTL	10% to 40% of the rated current, adjustable either continuously or in 5% maximum steps.
phase fault instantaneous	2 to 10 times rated current, adjustable either continuously or in steps no larger than 0.5 times rated current, plus infinity.
earth fault instantaneous	1 to 4 times rated current, adjustable either continuously or in steps no larger than 0.5 times rated current, plus infinity.

All relays must incorporate a high set instantaneous element as an integral part of each phase fault or earth fault or earth fault measuring unit.

The design of instantaneous elements must be such that they may be made inoperative (i.e. infinity setting) without being disconnected from the relay.

Auxiliary tripping elements (if used) must operate in less than 20 milliseconds with the energising quantity at rated value and must operate positively with the energising quantity at 70% of rated value.

The design of the earth protection circuit must be such that nuisance tripping on energisation does not occur. Where necessary, stabilising resistors must be fitted.

Relays must be capable of continuous service at twice setting current (any setting) and must withstand 20 times rated current for three seconds.

Relays must be capable of providing very-inverse and extremely-inverse time characteristics by simple setting or using a purpose-built switch mechanism mounted on the front of the relay.

Each relay must provide no less than two electrically separate contacts for tripping duty, rated at set out elsewhere in this Specification.

Where busbar differential protection is specified, it must be low impedance current measurement type utilising a central relay. An additional tripping relay c/w latching, and flag must be used to trip the circuit breakers in the protected zone.

All transformer feeder protection relays must be capable of providing H2 restraint or inrush blocking.

The protection relays must be capable of implementing a blocking scheme. Blocking scheme must only be considered when the contractor has written approval from Sydney Water.

The protection relays must achieve appropriated time-based discrimination system, the discrimination interval should comprise following elements:

- Circuit breaker interrupting time
- Relay timing error
- Allowance for CT ratio error (%)
- Upstream protection device overshot time
- A safety margin which must be no less than 20% of the overall discrimination interval

Sydney Water requires the Contractors to submit detail calculations of the time-based discrimination system.

Where appropriate relay time based discrimination system cannot be achieved, effective alternative protection could be accepted subject to Sydney Water prior approval.

All protection relays must have event recording capabilities.

4.9 Communication interfaces

The protections relays must be connected to the PLC/SCADA/HMI/IICATS system via hardwired communications interface. HV protection communication's network is to be via a dedicated network i.e. not to be shared with SCADA, security systems, etc.

It is acceptable to use an approved communication protocol converter to interface to the PLC/SCADA/HMI/IICATS subject to written approval from Sydney Water.

The interfaces must provide a means of:

a) Remote monitoring of digital parameters (DIs for status, etc)

b) Remote monitoring of analogue parameters (AI’s for voltage, current, power, etc).

Unless specifically approved otherwise, all I/O for each tier of switchgear must be sent/received to the PLC /SCADA/HMI system via the protection relay communications interface.

The protocol and architecture of the communications interfaces for the protection relays must be subject to specific approval by Sydney Water.

Refer to Sydney Water guideline “Interim IEC 61850 design requirements” for further details.

4.10 IEC61850 – Zone selective interlocking

Zone selective interlocking uses blocking signals which are sent between downstream and upstream protection devices, allowing protection to trip quickly without a protection grading trade off.

Adopting the IEC61850 Communication protocol standard for interlocking schemes can be used when equipment does not discriminate with other protection devices subject to prior consultation with Sydney Water.

4.11 Programming interfaces

The protection, control and communications functions of the protection relay must be able to be setup and parameterised by means of a laptop/notebook computer interface as well as manually via the local HMI.

Access to the protection, control and communications parameterisation and setup functions must be password protected for both the computer interface and manual HMI. Passwords and configuration files of all associated system must be clearly documented and provided to Sydney Water upon commissioning of the system or purchasing of the equipment.

5. Protection of power system elements

Below are the minimum requirements for protection of major power system elements.

5.1 Feeders (cable & overhead)

- Inverse time, definite time and instantaneous overcurrent protection elements (ANSI 50/51)
- Inverse time, definite time and instantaneous earth fault elements (ANSI 50N/51N)
- Sensitive earth-fault element connected to a toroid CT (for feeders with overhead sections (ANSI 50SEF)
- Directional protection for overcurrent and earth-fault where required or complex sites (ANSI 67)
- Differential protection for overcurrent and earth-fault where required or complex sites (ANSI 87F)

5.2 Transformers

- Inverse time, definite time and instantaneous overcurrent protection elements (ANSI 50/51)
- Inverse time, definite time and instantaneous earth fault elements (ANSI 50N/51N)
- Sensitive earth-fault element connected to a toroid CT (for feeders with overhead sections (ANSI 50SEF)
- Thermal overload, winding and oil over temperature (ANSI 26, 49)
- Over pressure detection (ANSI 63)
- Differential protection (ANSI 87T) when ANSI 50/51 is ineffective for protection of the transformer.

5.3 HV generators less than 2MVA

- Voltage restrained overcurrent (ANSI 51)
- Negative sequence overcurrent (ANSI 46)
- Reverse Power (ANSI 32)
- Loss of field (ANSI 40)
- Stator earth-fault (ANSI 64)
- Under & over-voltage (ANSI 27/59)
- Under & over-frequency (ANSI 81)
- Utility requirements for embedded generators

5.4 HV generators 2MVA or greater

As above, with additional:

- Generator differential protection (ANSI 87G) when (ANSI 50/51) is not sufficient for protection
- Utility requirements for embedded generators

5.5 HV motors less than 1MW

- Inverse time, definite time and instantaneous overcurrent elements (ANSI 50/51)
- Inverse time, definite time and instantaneous earth fault elements (ANSI 50N/51N)
- Overload & over-temperature protection through thermal modelling (ANSI 49)
- Stall protection (ANSI 51R)
- Number of starts control
- Negative sequence overcurrent (ANSI 46)
- Stator earth-fault (ANSI 64)
- Under & over-voltage (ANSI 27/59)
- Under & over-frequency (ANSI 81)

5.6 HV motors 1MW or greater

As above, with additional:

- Motor differential protection (ANSI 87M) when ANSI 50/51 is not sufficient for protection

5.7 Embedded generation – generator, solar PV

- Instantaneous and overcurrent protection (ANSI 50/51)
- Under voltage (ANSI 27), under frequency (ANSI 81), neutral and earth protection to be assessed for each case
- Utility requirements for embedded generators and solar PV

Note: for co-gen units consult Sydney Water REG team for additional requirements.

5.8 Bus zones

- Integrated circuit-breaker monitoring and CB Fail scheme (ANSI 50BF)
- Communication network to allow CB fail scheme to operate over IEC61850 network

5.9 Unit protection (differential protection)

Unit protection can be used where multiple grading layers results in unacceptable protection discrimination.

Types of unit protection schemes can be:

- Bus-zone differential protection
- Feeder differential protection
- Transformer differential protection.

5.10 Fault current limiting fuses

If current limiting fuses are chosen to reduce fault current, additional labelling stating fuse type and ratings are required on the switchboard to clearly designate the use of current limiting fuses. The design will need to show all calculations to ensure the fault limiting fuses are carrying out their intended use. The design is to be submitted to Sydney Water for prior approval before implementation.

5.11 Motor starters

For protection requirements of LV motors and LV motor starters, refer to Sydney Water Technical Specification - Electrical.

Motor starters are to incorporate type 2 coordination protection.

6. Protection discrimination requirements

6.1 Discrimination requirements

Typical discrimination requirements to be met are detailed below:

- HV-HV IDMT electromechanical relay time grading is ≥ 400ms
- HV-HV IDMT & DT electronic relay time grading is ≥ 200ms, applicable to within Sydney Water electrical network. Grading requirements with utility protection to be coordinated with the supply authority.
- LV-LV protection as per AS/NZS3000 and Service and Installation Rules of NSW.

7. Testing requirements

7.1 Routine (factory) testing

Perform routine (factory) tests on each protection relay prior to shipment to site. Such tests must include all routine tests listed within:

IEC 60255 series Measuring relays and protection equipment.

Routine (factory) tests must include:

a) Functional testing of all protection circuits via secondary injection
b) Secondary injection testing must be carried out at a minimum of three current settings to verify correct operation of protection relays
c) Insulation resistance/dielectric withstand/insulation resistance
d) A comprehensive Factory Test Report must be submitted to Sydney Water for approval within five working days of completion of the tests for that protection relay or prior to shipment (whichever is the earlier). The Factory Test Report must include as a minimum:
e) Results of all tests
f) Copies of any test oscillograms, graphs, printouts, etc
g) Copies of all routine test certificates (from place of manufacture) for digital protection relays
h) Copies of manufacturing inspection and test documentation and records, follower cards, etc

i) Statement confirming compliance with the specified requirements

j) Unless agreed otherwise by Sydney Water, all defects arising prior to or during the factory tests must be rectified to the satisfaction of Sydney Water prior to the respective equipment being shipped to site.

7.2 Site testing

After assembly at site, the Contractor must perform detailed site tests to verify that each protection relay fully complete and ready for energising. The Contractor must complete a copy of their Pre-Commissioning Checks, for each protection relay incorporated within the switchboard.

Such site tests must comply with the applicable requirements of:

IEC 60255 series Measuring Relays and protection equipment.

As a minimum, the following tests must be performed:

a) Detailed mechanical inspection

b) Detailed electrical inspection (including termination of inter-tier wiring)

c) Check of setup parameters for all protection relays

d) Functional testing of all protection circuits via secondary injection (including tripping function of the entire tripping chain)

e) Note – secondary injection testing must be carried out at a minimum of three current settings to verify correct operation of protection relays

f) Functional testing of all metering circuits

g) Testing of protection relay to ensure settings are retained with the loss of power to the relay for duration of 2 hrs

h) Inspection of all loose-supplied equipment

i) Review of assembly inspection and test documentation and records

j) Review of assembly defect lists / punch lists.

Representatives from Sydney Water must be given the opportunity and 10 working days' notice to witness the site tests.

The results of all site tests must be available for review during the tests.

A comprehensive Site Test report must be submitted to Sydney Water for approval within five working days of completion of the tests (or on handover, whichever is the earlier). The Site Test Report must include:

a) Results of all tests

b) Copies of any test oscillograms, graphs, printouts, etc

c) Copies of site defect lists

d) Copy of the completed Site Inspection and Test Plan (ITP)

e) Statement confirming compliance with all specified and legislated requirements.

8. Protection report

The protection report must detail the below information as a minimum. Modelling data block attributes are detailed in the Sydney Water Technical Specification - Arc Flash.

Note: a protection report need not be provided for small power standalone LV systems, unless at least one of the below conditions is met:

a) Maximum prospective fault level is above 10kA; or

b) The rating of the supply incomer protection device is 400A or higher; or

c) The rating of the supply incomer circuit breaker is 100A, or 160A, or 250A rated current with an instantaneous (magnetic release) trip setting above 8x nominal CB rated current.

8.1 Protection Philosophy

The protection philosophy and functional description must be provided describing how the overall protection is to operate for the site. This must include protection trip matrix and logic diagrams.

8.2 Utility Information

- Date when the utility supplied the maximum and minimum fault currents.
- Maximum 3-phase fault level, X/R ratio and impedances
- Maximum 1-line-ground fault level, X/R ratio and impedances
- Minimum 3-phase fault level, X/R ratio and impedances
- Minimum 1-line-ground fault level, X/R ratio and impedances

8.3 Report scenarios

- Maximum and minimum fault current scenarios
- All operating scenarios including motors running whilst another motor is starting

8.4 Time current curves (TCC)

Each TCC will detail the required items below:

- Upstream and downstream protection device
- Transformer frequent and Infrequent damage curve
- Cable damage curve
- Transformer inrush
- HV & LV protection setting and curves
- Motor starting curve
- Curves end at Ik” 3 phase / 1 phase fault current
- Fault current line with text block
- Current and time grading margin indicators
- SLD showing line and load side of the protection device where the protection device is fed from and equipment protected

8.5 Single line diagram (SLD)

A minimum of two PTW SLD are required, one detailing maximum fault level and the other detailing minimum fault level

- Maximum & Minimum I"pp 3 phase and SLG fault currents
- Incident energy
- Bus Voltage
- HV and LV Protection details including CT ratio
- Transformer Pri & Sec voltage, Nominal kVA, Z%, Tap setting
- Cable size, length, type and number in parallel
- Worst case arc incident energy (refer to Technical Specification – Arc Flash for detailed information)
- 37kW > Motor size, diversity
- Generator size
- Bus tie normal operating position Open/Closed

8.6 Equipment and protection details

Equipment/protection model numbers, sizes, ratings, lengths and settings are to be detailed in a table.

8.7 Assumptions

All assumption are to be listed in a table in the report.

9. Documentation

All documentation listed in this section must be submitted with the protection report.

- Single Line Diagrams (Colour A4/A3 PDF).
- Assumptions in a single table (A4 PDF and Excel Doc).
- Recommendations in a single table (A4 PDF and Excel Doc).
- Protection Report Presentation (PDF).
- Testing documentation and relay software setting file.
- All calculations where applicable including CT calcs.
- Protection setting details for all devices.

Ownership

Ownership

Role	Title
Group	Asset Lifecycle – Engineering and Technical Support
Owner	Engineering Manager
Author	Technical Director – Electrical Engineering
BMIS Number	DOC0014

Change history

Version No.	Prepared by	Date	Approved by	Issue date
1	Robert Lau / Andrew Manganas / Paul Zhou	05/12/2014	Norbert Schaeper	05/12/2014
2	Robert Lau / Andrew Manganas / Paul Zhou	21/9/2016	Norbert Schaeper	21/9/2016
3	Robert Lau / Paul Zhou	15/09/2018	Ken Wiggins	15/09/2018
4	Paul Zhou	20/02/2020	Steve-Keevil Jones	20/02/2020
5	Paul Zhou/ Hedi Mahdavi Aghdam	31/01/2024	Norbert Schaeper	31/01/2024