NS191

Batteries & Battery Chargers in Major Substations

February 2010

SUMMARY

Network Standard NS191 details 110 V battery and battery charger systems within new Major Substations consisting of Sub-transmission and Zone Substations.

ISSUE

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Network Standard
NS191
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1 SCOPE

This guideline applies to all 110 V battery and battery charger systems within new Major Substations consisting of Sub-transmission and Zone Substations.

2 REFERENCE DOCUMENTS

Batteries and battery chargers shall be installed in accordance with:

- AS 3011 – Electrical installations – Secondary batteries installed in buildings,
- AS 2676 - Installation and maintenance of batteries in buildings,
- AS 4044 – Battery chargers for stationary batteries.
- IEEE 1184-2006 IEEE Guide for Uninterruptible Power Supply Systems.
- IEEE 485-1997 revised 2003: Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications
- IEEE 1115-2000 revised 2005: Recommended Practice for Sizing Nickel-Cadmium Batteries for Stationary Applications
- IEEE 1189-1996: Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications
- Ausgrid Network Engineering Guideline NEG SM 04.7– Substation Battery Size, Type & Black-start Strategy

3 BATTERIES & BATTERY CHARGERS

3.1 General Design Principals

3.1.1 Performance Criteria

Battery and battery charger systems must be designed for the purpose intended and to meet the requirements of all applicable standards.

The primary role of the substation battery system is to provide a source of energy that is independent of the primary ac supply, so that in the event of the loss of the primary supply the substation control systems that require energy to operate can still do so safely.

The battery is required to supply the DC electrical requirements of the substation, including SCADA, control, protection indication, communications and circuit breaker switching operations when there is no output from the battery charger. This may be due to a loss of AC supply to the substation or a fault in the battery charger. Under these conditions the battery shall supply the DC loads for a minimum period of 5 hours after which time the battery should then be able to supply trip-close-trip operations of a HV circuit breaker which would typically restore supply to the battery

charger. The 5 hour capacity allows for ageing and a given minimum cell voltage under load at the end of discharge. There will be nominally no remaining capacity on the battery at the end of the 5 hour period if subjected to the given duty cycle at the end of its service life.

The absolute minimum requirement is that the battery has sufficient energy to allow the substation to be made safe on loss of ac supply. A secondary requirement is to provide high capacity support to the battery charger for operating high current transient loads that are beyond the charger's capability.

3.1.2 Design Philosophy

Batteries shall have a minimum capacity that is sufficient to supply the duty cycle requirements specified in Section 3.2.1.1.

The number of batteries provided, and the physical & electrical separation of these, shall be in accordance with Section 3.2.1.2.

Where a 50 V DC supply is required for substation communications systems, this shall be supplied from the 110V DC battery via a 50V DC-DC converter.

Substation battery systems are one of the essential elements affecting Ausgrid's ability to assist in the restoration of normal power system operation from a black system condition in accordance with the National Electricity Rules. For this reason Ausgrid's procedures require the conservation of stored energy systems, including battery supplies, in the event of a black system condition. This may include the switching off of certain DC loads, and restrictions on the use of other loads, for the duration of any black system condition. In such situations, the provision of alternative means (such as generators) to supply substation auxiliary supply systems is also considered. Refer Ausgrid Control Room Advice No. 461.

3.2 Design Criteria

3.2.1 Batteries

3.2.1.1 Battery Type & Configuration

All new batteries shall consist of valve regulated gel cell lead acid cells.

The battery cells shall be suitable for mounting on their sides.

The configuration and nominal capacity of the batteries shall be derived as follows: from a fully charged state the batteries must be capable of meeting both Duty A and Duty B as shown in the table below:

Battery Type	**Zone Substation** **(solenoid operated CBs)**		**Sub Transmission Substations** **(solenoid operated CBs)**		**Zone Substations (spring operated CBs)**	
Load Duty	Duty A	Duty B	Duty A	Duty B	Duty A	Duty B
Nominal capacity	*200 Ah		*160 Ah		*200 Ah	
Discharge Current	20 A	20 A	15 A	15 A	25 A	25 A
Discharge Time	5 hr	2 hr	5 hr	2 hr	5 hr	2 hr
Followed immediately by:						
Discharge Current	150 A	240 A	150 A	240 A	35 A	45 A
Discharge Time	10 sec	10 sec	10 sec	10 sec	10 sec	10 sec
End terminal voltage not less than:	100 V	100 V	100 V	100 V	100 V	100 V
Battery ageing factor	20%	20%	20%	20%	20%	20%
50V supply via:	dc-dc converter		dc-dc converter		dc-dc converter	
Temperature operating range	+5^{o}C to 45°C		+5^{o}C to 45°C		+5^{o}C to 45°C	
Service life required	>7 years		>7 years		>7 years	
Accommodation	Cabinet		Cabinet		Cabinet	
Chemistry	VRLA		VRLA		VRLA	
Cells in series	56		56		56	
Float voltage (manufacturer specific)	124.9 V (2.23 V / cell typical)		124.9 V (2.23 V / cell typical)		124.9 V (2.23 V / cell typical)	
Boost voltage (max) (manufacturer specific)	135.0 V (2.41 V cell typical)		135.0 V (2.41 V cell typical)		135.0 V (2.41 V cell typical)	

* These are nominal capacities only - actual battery capacities are dependant on discharge rates, final battery voltages and the type of loads to be supplied.

3.2.1.2 Number of Batteries

Substations with duplicated protection systems shall have dual (2) battery systems – one for each protection system.

Substations that do not have remote back-up protection systems shall also have dual battery systems. Substations without duplicated protection systems, and which have remote back-up protection, shall have a single (1) battery system.

Where dual battery systems are provided the batteries and associated chargers, including all associated wiring, shall be kept physically and electrically isolated to ensure that potential problems with one system do not affect the other. Each battery shall have a separate dedicated charger.

'A' and 'B' protection systems shall be supplied by different batteries and the overall substation DC load shall be distributed as evenly as possible between the two batteries, for example 'A' protection and SCADA supplied by battery 1, 'B' protection, local control, protection, indication and communications, etc supplied by battery 2.

3.2.1.3 Cell Casing

Cell casings shall be clear or translucent material fitted with safety (anti-explosion) vents.

3.2.1.4 Connections

All bolts, nuts, fasteners and electrical connections shall be of material that is resistant to corrosion.

3.2.1.5 Battery Charging

Battery charging is to be strictly to the manufacturer's specification with no unapproved changes to the regime.

Individual cell monitoring shall be installed, with alarms via SCADA for charging voltages and currents outside preset norms.

Charging is to be via a low ripple, UPS style switch mode charger with temperature compensation facility.

"iButton" temperature sensors are to be installed:

- on the centre cell of the centre row to monitor temperature of the cell likely to be the warmest.
- additional iButtons are to be installed on the end cell of the top and bottom row to monitor the coolest cells.

3.2.2 Battery Chargers

3.2.2.1 Type

Battery chargers shall be low ripple, UPS style switch mode charger with temperature compensation facility.

Battery chargers shall comply with the Type 2 requirements of AS 4044 – Battery chargers for stationary batteries, (i.e. the charger is to be suitable for providing supply to a load with or without a battery connected in parallel) and are to be a suitable for wall and floor mounting.

Battery chargers are to be single-phase connected to facilitate connection of petrol-driven generator sets in situations of loss of ac supply (such as under "black start" conditions or other loss of ac supply).

3.2.2.2 Location

Battery charger units shall be located within the Substation Control Room, as close as practicable to the relevant battery.

3.2.2.3 AC Supply

For substations where two battery systems are provided, AC supply to each battery charger shall be taken from a different auxiliary AC distribution switchboard.

3.2.2.4 Features

Battery chargers are to have an AC input circuit breaker, battery monitor relay, DC output fuses or circuit breakers and output voltage indicator. The charger is to be operated in accordance with the battery manufacturer's recommendations.

3.2.3 DC Supply Circuits

The standard 110V DC distribution switchboards to be used shall be Ausgrid type 12 boards, as detailed in the following Ausgrid drawings:

Description	Drawing No.
Substations 110V DC Board Type 12A Schematic	191062
Substations 110V DC Board Type 12B Schematic	191063
Substations 110V DC Supplies Distribution Board Type 12A Wiring Diagram	191064
Substations 110V DC Supplies Distribution Board Type 121B Wiring Diagram	191065
Substations 110V DC Board Type 12A General Arrangement	191060
Substations 110V DC Board Type 12B General Arrangement	191061
Substations 110V DC Board Type 12 Busbar Details	191066

110V DC supply cabling shall be sized to prevent voltage drop problems, particularly for long cable runs.

3.2.4 Accommodation

3.2.4.1 Battery Cabinets

For all new major substations:

- Batteries are to be accommodated in a cabinet within the substation control room – separate battery rooms are not required.
- Battery cells are to be mounted on their sides within the cabinet
- Cells are to be mounted in accordance with the manufacturer's recommendations regarding separation between cells to allow air-flow for cooling and for easier access for removal if necessary.
- Cabinet to be designed to facilitate front access to the batteries, with sufficient space in front of the cabinet for lifting and carrying gear for handling individual cells.
- Cabinet to be treated against electrolyte spill (electrolyte is gel and limited quantity, so spread under cell rupture is limited).
- Where multiple battery groups are provided, the batteries shall be located with sufficient separation to enable maintenance or similar activities on one battery to not adversely affect operation of the other.
- Air flow and rate of change of air to be in accordance with Australian Standards for stationary batteries.
- Air flow for cooling under normal conditions (in at bottom, out at top) and for hydrogen emission under fault conditions.

For existing substations where batteries are accommodated in a separate dedicated battery room(s), the batteries may remain accommodated in these rooms.

Battery stands and cell arrangements shall be in accordance with AS 2676 and AS 3011.

Safety signs, in accordance with AS 2676, shall be permanently displayed in appropriate prominent positions.

3.2.4.2 Ventilation

The battery room or enclosure shall be ventilated, in accordance with the requirements of AS 2676, to keep the average concentration of hydrogen gas within the limits specified in AS 3011.

The preferred method to be used is natural ventilation, wherever practicable.

Also refer to Network Engineering Guideline NRS 185 and NS186.

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