Equipment Strategy DC Power Supplies, Quality Procedures and Documentation – Strategy

Table of contents

1. Introduction

1.1 Purpose

Equipment Strategy documents express Powerlink's vision for equipment technologies, to provide both Powerlink and suppliers with consistent planning and project management platforms for the life of the equipment strategy. The documents express Powerlink's vision in terms of the equipment performance requirements. It is not a detailed technical specification.

The equipment strategy for DC Power Systems has been developed with input from relevant teams in Powerlink.

1.2 Scope

This document covers DC power systems including rectifiers, battery banks, monitoring systems and any other components required to enable continuous DC supply for secondary systems and telecommunication devices in transmission substations, switchyards and telecommunication sites.

It is envisaged that the Equipment Strategy for DC supply systems will have a life of five (5) years with a significant review in the third (3rd) year to enable inclusion of technologies which have matured and show merit. The technology development in this area is very fast and therefore more frequent reviews are warranted.

1.3 References

Document code	Document title
NER	National Electricity Rules

1.4 Defined terms

Terms	Definition
VRLA	Valve Regulated Lead Acid Battery
SAP	Software package used for computerised maintenance management system and asset register
SMR	Switch Mode Rectifier

1.5 Monitoring and compliance

This equipment strategy will guide development of the technical specification. The success is monitored through regulatory information notice, annual reporting and SAP records review of installed equipment.

The success of this strategy is measured by monitoring life cycle costs associated with this equipment as well as availability and service history.

The minimum records required are:

- Technical specification
- Tender evaluation report
- Period contract
- Purchase orders
- SAP equipment records
- Operation and Manufacturer Manual

- Nameplate details

1.6 Risk management

The risks considered in the development of this strategy are:

- **Safety Risk** – risk associated with the malfunction of protection systems resulting in the prolonged or lack of protection operation exposing personnel and the public to fault conditions – this can result in serious injuries and fatalities due to electrocution. In addition, there are safety risks associated with potential fire risk and hazardous chemicals.
- **Network Operations Risk** – risk related to the lack of visibility and control of the equipment status leading ultimately to significant network outages and their impact on customers and stakeholders.
- **Environmental Risk** – related to presence of hazardous chemicals and their responsible handling and disposal.
- **Financial and Contractual Risk** – risk associated with the inability to make warranty claims, request access to adequate technical support and spares, increased maintenance costs, additional capital and operational costs.

2. Strategy

2.1 Projected use of Equipment

Powerlink's communications, automation and protection systems are critical to the safe operation of the high voltage network and must continue to run in the absence of power supply. The NER contains requirement for these systems to be duplicated.

The majority of these devices require DC supply and therefore there is a need for rectifiers to provide their power supply. Traditionally Powerlink has achieved this requirement for continuous functionality of these devices by using duplicated DC supply systems consisting of a battery charger (used as rectifier and battery charger when AC supply is present) and storage batteries for back up supply, when AC supply is lost.

In addition these DC supply systems provide supply for control devices and circuit breaker motors to ensure that faults in the network can not only be detected but can also be isolated even if AC supply to a substation/switchyard is not present.

Two DC supply systems have the capability to be connected via a manually operated DC switch, so that both battery banks and both protection and control systems and circuit breaker motors can be supplied via each of the rectifiers.

All DC supplies are required to supply the total site DC standing load for 10 hours duration and then contain sufficient energy to trip all circuit breakers at the site should the requirement arise. If there is only one functional rectifier, the requirement to trip all circuit breakers after 10 hours does not need to be met.

Battery based DC supplies are installed indoor typically in demountable buildings (although sometimes in block or brick built buildings), communications facilities, and sometimes in stand-alone control houses to provide power to protection, automation and control equipment. Regardless of the building type, the rooms in which batteries are installed are air conditioned to achieve the maximum life expectancy from the battery cells.

2.2 Technology traditionally used by Powerlink

DC supply systems are used with battery banks operated at 125V and 48V. These duplicated systems are capable of being connected via a manually operated DC switch, so that both battery banks and both protection and control systems and circuit breaker motors can be supplied via each of the rectifiers.

Systems are capable of supplying the total site DC standing load for 10 hours duration and then contain sufficient energy to trip all circuit breakers at the site should the requirement arise.

High quality VRLA sealed battery systems are used with an expected service life of 15 years, combined with switched mode chargers. SMR chargers are used due to their efficiency to filter any super-imposed AC voltage called "ripple" and due to their modular design. In addition, mid battery bank voltage monitoring system is utilised, although there are still some installations with individual cell voltage monitoring system.

All these components are sourced from a single supplier to avoid any potential equipment incompatibilities and easier access to spares and technical support.

Due to the requirement for in situ replacement the physical layout of DC systems is very important.

2.3 Technologies available now

Many alternative energy storage methods exist, with several chemical and non-chemical energy storage techniques now available. These are mostly used for very high power applications and while all of them have been used in practical systems, there has been a slow take up of these technologies across various industries.

Based on Powerlink's investigations and market analysis, none of these alternatives to VRLA batteries demonstrate any real commercial or technical benefits.

In addition, there are two main types of technology used in chargers, typically mutually exclusive:

- "Phase control" which operates at 50Hz so that all filtering to eliminate ripple must be done at 100Hz which required large and heavy filtering components to meet the VRLA battery manufacturer's requirements. Typically the first generations of phase controlled chargers were large, noisy, hot and not built in replaceable modules.
- Switch Mode Rectifiers (SMR) utilising high voltage semi-conductor switches which is capable of operating at minimum supersonic and sometimes much higher frequencies and therefore eliminating issues related to low frequencies (50 to 100Hz).

Alternative DC supply systems may consist of other devices presently not utilised by Powerlink which could be adopted if they demonstrate benefit in terms of whole of life cost.

2.4 Preferred Equipment Strategy Elements

The elements of DC supply system equipment strategy are:

- Duplicated DC power systems including the following main features:
  - Safe operation, availability and reliability to meet network requirements.
  - Low lifecycle cost.
  - Two DC supply systems having the capability to be connected via a manually operated DC switch, so that both battery banks and both protection and control systems and circuit breaker motors can be supplied via each of the rectifiers.
  - All DC supplies are required to supply the total site DC standing load for 10 hours duration and then contain sufficient energy to trip all circuit breakers at the site should the requirement arise.
  - If there is only one functional rectifier, the requirement to trip all circuit breakers after 10 hours does not need to be met.
  - Mid battery bank voltage monitoring is required.
  - Expected service life of minimum 15 years for batteries and battery voltage monitoring system and longer where possible for chargers.
  - Batteries to be installed in racks and all other components in the suitable cubicles.
  - Battery chargers and voltage monitoring systems to be matched to batteries in order to achieve their expected service life of minimum 15 years.
  - Modular battery chargers consisting of at least two modules so that, in case of one module failing or being removed, the remaining module/s shall be capable of carrying the static load (excluding load experienced when tripping circuit breakers).
  - DC supply system components, batteries, rectifiers, monitoring items are required to be replaceable either as complete systems or as individual items.
  - Spares for all parts of the system, including batteries have to be readily available for the life of this strategy plus 10 years.
  - Battery banks to be designed to allow for cells to be individually replaced. Where failures of greater than 10% occur, complete banks will be replaced.
  - Suitable for installation indoor in air-conditioned rooms that may have temperature variations up to a maximum of 10°C.
  - Timely local service and spare parts support during the complete life of the equipment.
  - The supplier to provide tools to interpret and analyse data available in any on-line monitoring facilities, particularly with respect to predicting failure and end of life.
  - Require minimal visual inspections and minimal intrusive maintenance.
  - The layout of components is such to ensure full redundancy of the two systems.
  - Typical battery bank voltages required are 110V and 48V for telecommunication devices,.

- o DC systems shall be capable to be used with DC/DC voltage converters to enable use of common battery bank for 110V (or 125V) and 48V.

2.5 Concurrent Investigations:

While VRLA battery cells and integrated chargers are well entrenched, new technologies in energy storage and generation are under development. During the life of this Equipment Strategy efforts will be made to monitor this development and ensure that the next strategy aligns practical technologies. Any future technologies should ideally:

- Be capable of delivering DC power instantly.
- Not have moving parts.
- Contain maintenance free batteries with long service lives.
- Able to be remotely condition monitored for imminent failure with sufficient lead time to take corrective action.