Eskom		Proconics

Title: **Eskom BESS Project at Paleisheuwel Sub-Station**

Technology Selection for EMPr Input

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Table of Content

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1 Introduction

Eskom has obtained an Environmental Authorisation in terms of Section 24 of the National Environmental Management Act 107 of 1998 (NEMA) for activities listed in the Environmental Impact Assessment (EIA) Regulations, 2014, promulgated in terms of Section 24(5) of NEMA (GN 982, as amended). The Environmental Authorisation is legally binding and must be implemented during the construction of the Battery Energy Storage System (BESS). The Environmental Management Program (EMPr) and construction layout submitted as part of the EIA process was not approved and requires revision once the BESS technology type(s) have been decided. The environmental risks of the approved BESS technology type(s) shall be assessed, and the management actions incorporated into the revised EMPr and construction layout. The final documents shall be submitted to the Competent Authority for approval prior to commencement of construction is permitted.

This document provides the technology details to enable the process described above.

2 Overview

The energy storage system shall have a capacity of 45MWh. The key components of the system shall be:

1. Initially 11 off battery containers. This will be augmented over time to maintain the total useable capacity of 45MWh over the 20 years lifespan of the project. The final state will have 15 battery containers. The battery containers shall include:
    a. Batteries
    b. Battery Management Systems (BMS)
    c. Cooling systems
    d. Fire extinguishing systems
2. 6 off Power Conversion System (PCS) containers. These shall include:
    a. Bi-directional inverters
    b. Dry-type transformers
    c. Medium voltage (MV) switchgear

3. 1 off control containers. This container will include various control system cabinets to control the battery system.

3 Battery Container Technology

3.1 Overview

The battery containers shall be standard 40-foot marine containers and shall include several components as can be seen in the figure below.

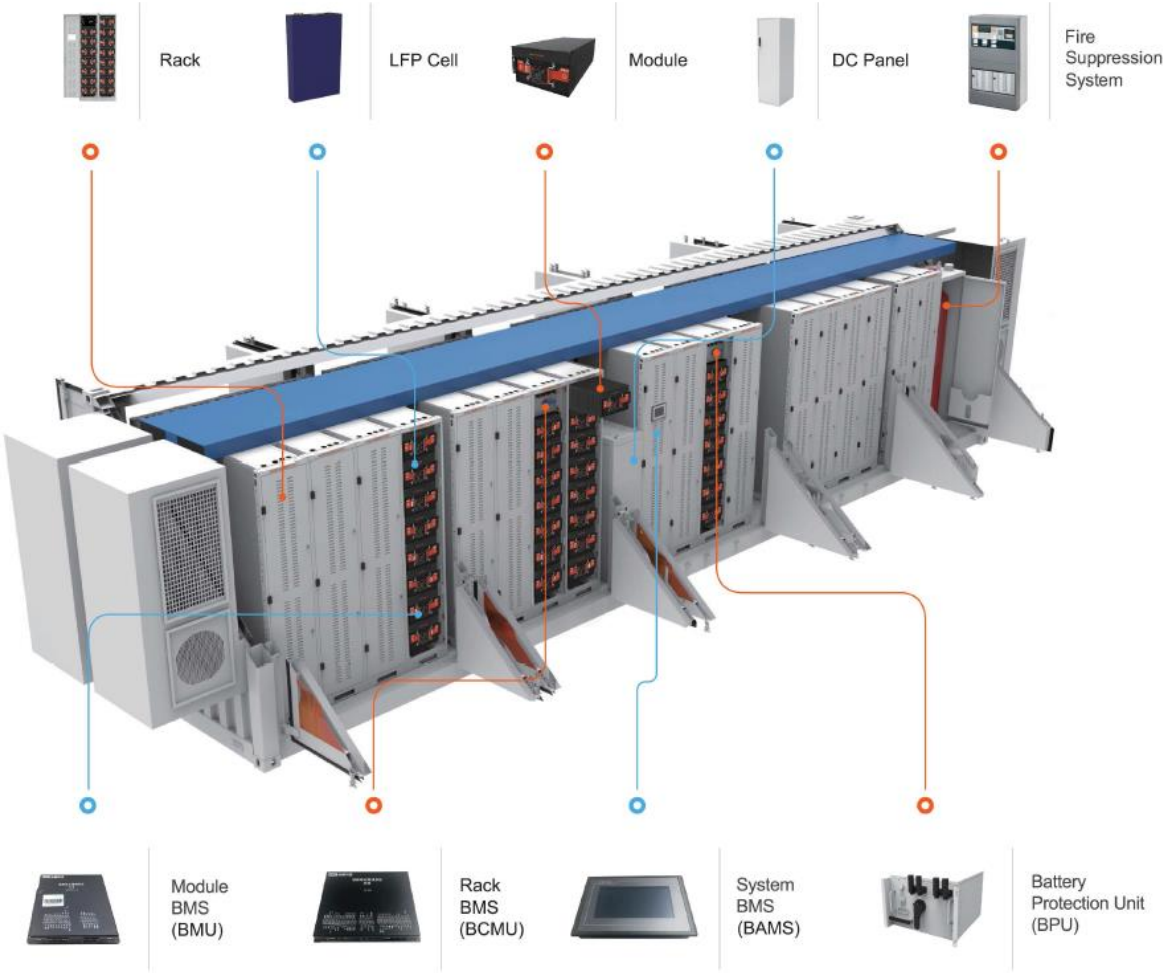


Figure 1: Overview of the Battery Containers

The batteries are built up as follows:

1. The smallest unit is a battery cell.
2. 48 cells are combined to form a battery module.
3. 15 modules are combined to form a battery rack.
4. 18 racks are installed in one container.

The outer paint of the container is a light grey (colour code: RAL7035).

3.2 Batteries

3.2.1 Chemistry

The solution adopts 125Ah lithium iron phosphate battery technology. A Material Safety Data Sheet (MSDS) for the cells can be found in Appendix A.

Lithium Ion batteries are hermetically sealed and designed to withstand temperatures and pressures encountered during normal use. Under normal conditions of use, there is no physical danger of ignition, explosion or chemical danger of hazardous materials leakage. The materials contained in this battery may only represent a hazard if the integrity of the battery is compromised or if the battery is mechanically, thermally or electrically abused. Because these batteries are stored in sturdy racks within weather and movement resistant containers, physical exertions and extreme temperature variations are a very low/ insignificant probability of occurrence. This method of storage of multiple battery cells also reduces the probability of multiple batteries becoming damaged or leaking.

3.2.2 Construction and Containment Methods for Electrolyte

Lithium Ion batteries are hermetically sealed and designed to withstand temperatures and pressures encountered during normal use. Under normal conditions of use, there is no physical danger of ignition, explosion or chemical danger of hazardous materials leakage. The materials contained in this battery may only represent a hazard if the integrity of the battery is compromised or if the battery is mechanically, thermally or electrically abused.

The battery cells are sealed and packaged by a metal case, and the explosion relief valve on the cell is only opened when the battery is thermally out of control; the battery pack and battery rack are packaged by a separate metal case, and the bottom of the case is completely sealed to prevent electrolyte leakage; each the battery racks have separate cabinets and are not in direct contact with each other.

3.2.3 Transportation

IMDG:

The transportation of Lithium Ion Batteries is regulated by the International Maritime Dangerous Goods (IMDG) 4.1.4. These regulations classify these types of batteries as dangerous goods. Refer to IMDG Code Packaging Instructions P903 for more details pertaining to the transportation of Lithium Ion Batteries. Additional requirements, or relief from some requirements, may be found in special provisions 188 and 230.

Shipping information as follows:

Proper Shipping Name: Lithium Ion Battery UN Identification: UN3480 Hazard Class: 9 Packaging Group: II Packing Instructions: P903 Label/Placard: Miscellaneous

The contractor will ensure to use accredited hazardous goods transportation companies to ensure safe transportation of hazardous materials. Equipment will be properly packaged in line with regulations to facilitate safe handling, transportation, and placement. Route planning and obtaining of all relevant permits from local authorities, will be in place prior to delivery of equipment's to site. Prior to installation, batteries containers will be inspected for damage to packaging. In instances where batteries are found to be faulty and unfunctional, arrangements will be made with the appointed hazardous service provider for collection and disposal at a licensed landfill site. The maximum period for storage of any hazardous waste onsite will be less than 90 days as guided by the National Environmental Management: Waste Act, 2008 (Act No.59 of 2008).

Relevant safety measures and signage will be in place when containers are delivered to site. Vehicles transporting battery storage containers will be suitably marked noting the hazardous nature of their load. All large construction vehicles will be suitably marked to be visible to other road users and pedestrians. Appropriate road signage will be installed, in accordance with the South African Traffic Safety Manual, providing flagmen, barriers etc. at the various access points when necessary.

3.2.4 Disposal

Should disposal be required, it is recommended to discharge a battery of its remaining power and storing it within a temporary used battery storage facility on the site. This facility needs to be sheltered, be kept under lock and key, have a bund around and an impermeable floor surface. Used batteries must then be removed within 90 days and transported to a registered battery recycling facility where components and liquids of the battery are salvaged. The salvaged components need to be recycled. Battery recycling is handled by a third-party company. The maximum period for storage of any hazardous waste onsite will be less than 90 days as guided by the National Environmental Management: Waste Act, 2008 (Act No.59 of 2008), and the client Environmental Specification. The contractor will ensure that company removing waste is registered and permitted to remove hazardous waste. Safe disposal certificates are to be acquired after removal to ensure that the waste was taken to an approved facility. All personnel involved in the removal must wear the appropriate PPE.

3.2.5 Monitoring

When the electrolyte in the cell leaks, it will trigger the insulation monitoring system of BMS, BMS will send the information to the upper management system, the system will give an alarm and cut off the faulty part. As described in 3.2.2 the bottom of the bottom of the case (in which the cells are installed) is completely sealed to prevent electrolyte leakage out of the case.

3.3 Fire Extinguishing Medium

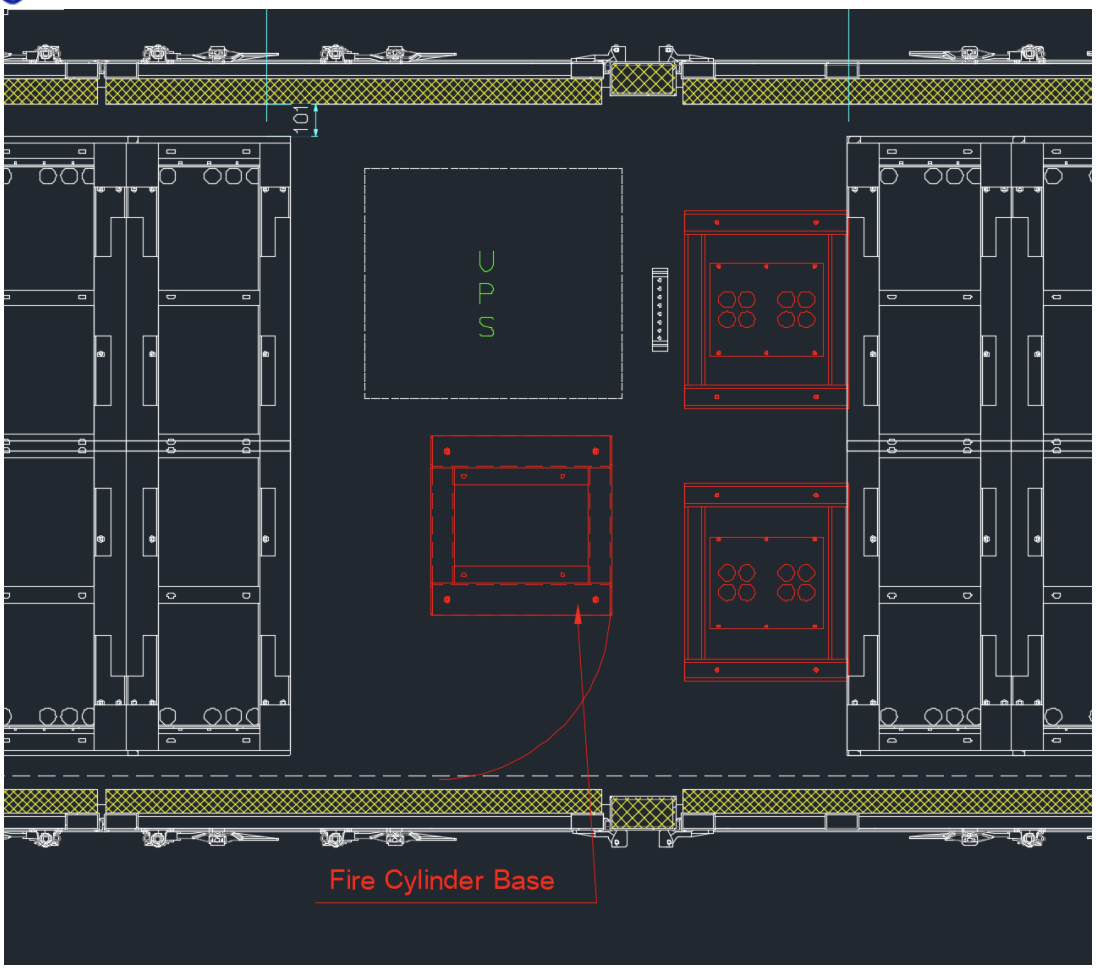
3.3.1 Chemistry

The system shall employ a perfluorinated hexanone fire extinguishing system. Perfluorohexanone is a clear, colorless, odorless liquid charged with nitrogen and stored in high-pressure cylinders as part of a fire extinguishing system. As an efficient and clean gas fire extinguishing agent, perfluorohexanone has been accepted, recognized and widely used by the international fire protection industry. It has the characteristics of low fire extinguishing concentration, high fire extinguishing efficiency, high safety factor, non-conductivity and no residue. Perfluorohexanone is suitable for fire places that cannot be put out by other fire extinguishing agents and cannot have secondary pollution after extinguishing. The perfluorohexanone fire extinguishing agent is safe and non-toxic, and it is safe for the human body when used. Perfluorohexanone is a liquid at room temperature, and can be safely stored and transported (including shipping) in a wide temperature range using ordinary containers under normal pressure.

The advantages of perfluorohexanone fire extinguishing agent are environmental protection performance – its potential value of global greenhouse effect is very low, whilst its ozone depletion potential value is insignificant. When released to atmosphere, it has a lifespan of 5 days. Perfluorohexanone provides a long-term and durable replacement for environmental impacting gases like hydrofluorocarbons, halons and perfluorinated compounds.

3.3.2 Storage

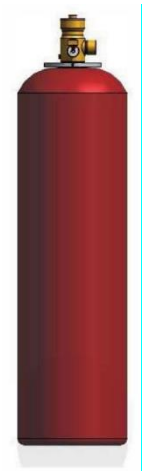
Cabinet semi-fixed fire extinguishing system equipment is adopted to implement total submerged fire extinguishing.



In the middle part of the battery container, we specially set a fixed base for the fire cylinder to prevent the fire cylinder from being displaced during transportation.

3.3.3 Disposal

The extinguishing agent storage vessel consists of steel container (seamless or welded) fitted with a valve and an internal siphon tube, factory filled with the relevant agent.



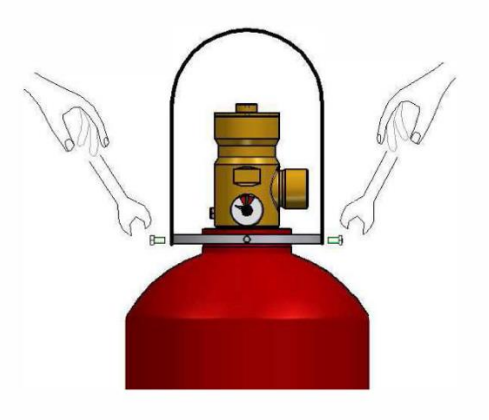
Cylinder bridle

They are used for the protection of the valve during its transport and handling, all the cylinders have a bridle with the corresponding protective cap. In this way accidents during its transport or handling are avoided.

Protective caps

It consists in a safety and protection device in case of hit of the cylinder.

For the protection of the valve during its transport and handling, all the cylinders have a protective cap. In this way accidents during its transport or handling are avoided.



3.4 Air Conditioning System

The final design of the system is still being finalized, but the refrigerant used will be in accordance with the Montreal Protocol.

4 PCS Containers

4.1 Description

The PCS containers shall be standard 40-foot marine containers as shown in the figure below.

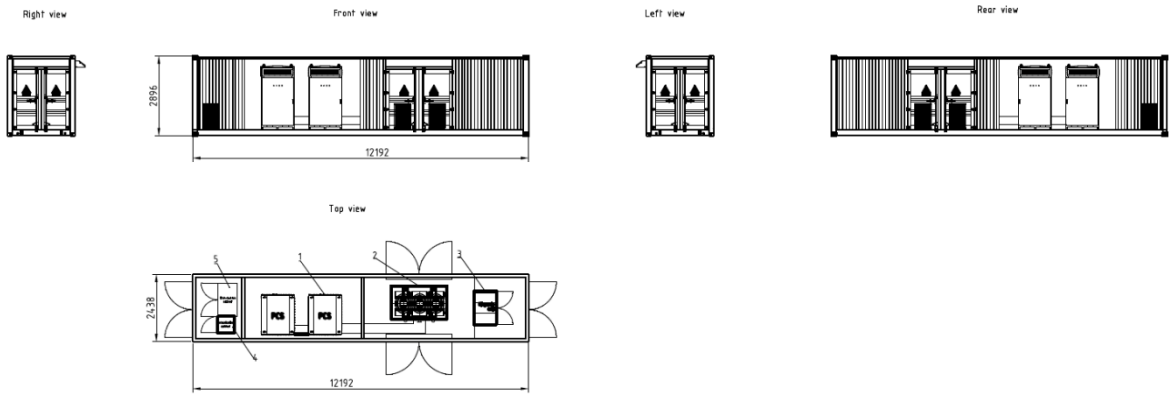


Figure 2: Overview of PCS Containers

The key technologies are:

1. The inverters – these are power electronics.
2. The transformers. Dry type transformers have been selected. Dry type transformers use no oil, so pose no environmental concerns. This type of transformer uses resin encapsulation instead. An example is show in the figure below.

Figure 3: Example of a dry type transformer

3. Medium voltage switchgear (ring main units). The switchgear shall use Sulphur hexafluoride (SF6) as the insulation medium. SF6 is a non-hazardous gas with excellent electrical insulation properties. It has no ecotoxic potential, and does not deplete ozone. However, SF6 is a greenhouse gas, but is widely used in electrical distribution networks globally, including Eskom's grid. Though alternative technologies are being developed they are not yet common place. The SF6 is stored in a permanently sealed tank just above atmospheric pressure. A pressure gauge is used to monitor any leakage. The average leakage across the industry is less than 0.1% per year. When the switchgear is disposed off it must be done by a registered SF6 handling company.

5 Foundations

Pad and pedestal foundations will be used for all the containers:

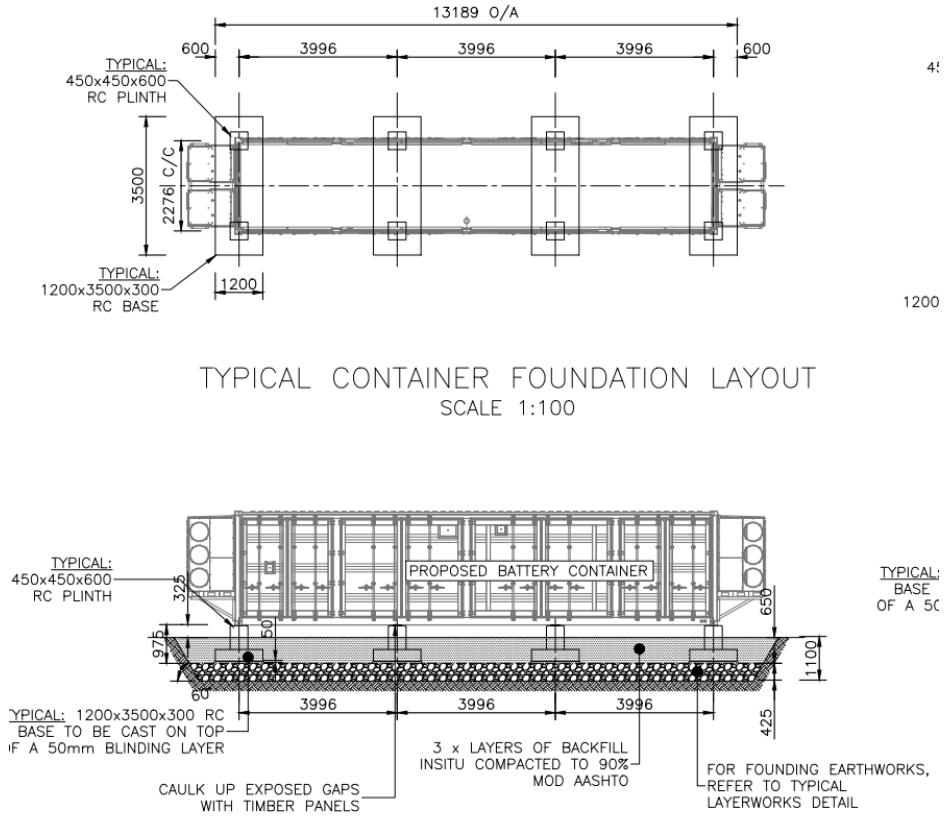


Figure 4: Pad and Pedestal Type Foundations

The pads will be precast in the laydown area with the rebar for the pedestal installed. The precast pads will then be moved into the final position and the pedestal will be cast. After construction the pre-casting area will be rehabilitated.

General note:

All hazardous waste on site will be temporary stored, the once-off storage of waste for a period not exceeding 90 days as guided by the National Environmental Management Act, 2008 (Act 59 of 200), and the client Environmental Specification. No recycling of lithium-ion batteries will take place on site, any faulty and damaged components emanating from the lithium-ion batteries will be handled, stored, and disposed as hazardous waste.

Appendix A: Material Safety Data Sheet (MSDS)

Section 6: Accidental Release Measures:

All waste and any components from the lithium-ion batteries will be handled, stored, and disposed of as hazardous waste at a licensed landfill site. No incineration of waste or burning of waste will take place on site.

Waste Disposal Method: All components from lithium-ion batteries to be handled, stored and disposed off as hazardous waste to a licensed landfill site.

Section 7: Handling and Storage:

All hazardous waste to be generated during the construction phase of Skaapvlei will be disposed of at Vissershok Landfill site.

Section 12: Ecological Information:

The BESS Containers are to be installed/built onto pads and pedestal foundation's as per Figure 4, which is an impervious surface for containment, should there any potential for leaks or spillage. Storage area to be bunded with an appropriate volume capacity to protect from environmental contamination should accidental leakages occur.

Section 13: Disposal Considerations:

Any component emanating from the Lithium-ion batteries, faulty and malfunctioning will be handled, stored and disposed of as hazardous waste at a licensed landfill site. No secondary facility is planned for site.

Section 15: Regulatory Information:

National Environmental Management Act: Waste Act. 2008 (Act No. 59 of 2008).

National Road Traffic: Act 93 of 1996.