ZOE ENERGY STORAGE

FIRE SAFETY TECHNICAL SPECIFICATION

For ZOE battery energy storage system (ZOE BESS)

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Time：2024.03.06

Energy for Life

1. INTRODUCTION

ZOE Battery Energy Storage Systems (BESS), as a type of energy storage device, carries certain fire risks. This document aims to provide technical guidance and specifications on relevant features and measures of fire safety in ZOE BESS, hence to prevent and control fires to ensure the safety of personnel and the integrity of equipment.

2. FIRE RISK ASSESSMENT

1) Battery

Battery could cause fire by varies reasons, include:

a. Thermal runaway due to overcharging;
b. Thermal runaway due to short circuiting;
c. Thermal runaway due to external heat source;
d. Explosion due to deflation during charging and discharging;
e. Thermal runaway due to aging, defects, damages and others;

2) Other components of BESS

There are other components than battery cells in the BESS that could cause fire, e.g. the power conversion system (PCS), as all the electrical powers run through it, but it is much less likely to happen compared with battery cells.

3. EQUIPMENT LAYOUT AND FIRE SEPERATION

Installation condition and working environment of BESS largely affect the fire safety, requirements of these are as follow:

a. The working environment of BESS should be free from corrosive, explosive, and insulation-destructive gases or conductive dust, and should be kept away from heat sources;
b. The gap between adjacent BESSs should be ≥30mm, and the gap between back-to-back BESSs should be ≥600mm;
c. Do not install BESS near heating equipment;
d. Do not expose BESS to flammable or corrosive chemicals or vapours;
e. Do not immerse BESS or its components in water or other liquids;

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f. Do not insert foreign objects into any part of BESS;

4. BATTERY MANAGEMENT

Typically, battery in BESS is structured such that 12 or 13 battery cells assemble into battery modules, 4 battery modules assemble into battery packs, and 4 to 8 battery packs further assemble into a cluster. A BESS usually consist of only one battery cluster and multiple BESS are usually connected in parallel.

1) Voltage management

Voltages of each battery cell, pack and cluster are monitored in real-time. Warnings would be triggered and sent to management platform by energy management unit (EMU) if any of the voltages deviate from the expected value. These warnings include:

a. Overvoltage and undervoltage of cells (3-level warning);
b. Overvoltage and undervoltage of packs (3-level warning);
c. Overvoltage and undervoltage of clusters (3-level warning);
d. Voltage difference across cells (3-level warning);
e. Voltage difference across packs (3-level warning);
f. Voltage difference across clusters (3-level warning);

Once any of these warnings is triggered, the corresponding cluster would be disconnected to prevent further runaway.

2) Current management

Currents of each cluster during charging and discharging are limited to avoid overcurrent and corresponding over/undervoltage. Warnings would be triggered and sent to management platform by energy management unit (EMU) if any of the currents exceeds the limits. These warnings include:

a. Exceeded current during charging (3-level warning);
b. Exceeded current during discharging (3-level warning);

Once any of these warnings is triggered, the corresponding cluster would be disconnected to prevent further runaway.

3) Temperature management

Temperatures of approximately every two battery cells are monitored in real-time. Warnings would be triggered and sent to management platform by energy management unit (EMU) if any of the temperatures deviate from the expected value. These warnings include:

a. High and low temperature during charging (3-level warning);
b. High and low temperature during discharging (3-level warning);
c. Temperature difference across battery cells within a cluster (3-level warning);

Once any of these temperatures is too high, the corresponding measures would be taken. These measures are as follow:

a. Power of the cooling and heating system would be increased;
b. Power of charging and discharging would be reduced if the temperature exceeds a certain threshold value;
c. Charging and discharging would be fully stopped if the temperature exceeds a certain threshold value;

4) Insulation resistance management

Resistance between positive and negative to earth of the high voltage control box (in and out of the power of the battery) are monitored in real-time. Warnings would be triggered and sent to management platform by energy management unit (EMU) if any of the resistance falls below the expected value. These warning include:

a. Resistance between positive to earth too low;
b. Resistance between negative to earth too low;

These warnings indicate that certain faults have already occurred, and certain inspections and maintenance should be carried out to prevent further incidents that may lead to a fire.

5) Liquid cooling and heating system

ZOE BESS uses a liquid cooling and heating system to control the temperature of battery, temperature of the liquid is monitored in real-time. Corresponding measures related to the temperature of liquid are as follow:

a. Power of charging and discharging would be reduced if the temperature exceeds a certain threshold value;
b. Charging and discharging would be fully stopped if the temperature exceeds a certain threshold value;

6) Pressure relief valve

Each battery pack is equipped with a pressure relief valve to prevent explosions due to overpressure in the event of deflation. The valve relief pressure from both sides, parameters of the valve are:

a. The valve opens and external gas enters when the external pressure difference is 4 ± 1 kPa;
b. The valve opens and internal gas exits when the internal pressure difference is 1 ± 0.5 kPa;

5. BUILT IN FIRE DETECTION AND SUPPRESSION

1) Smoke alarm and temperature alarm

ZOE BESS is equipped with a smoke detector and a temperature sensor that can send alarms to the fire protection unit, which controls the activation of the aerosol.
The fire protection unit activates the aerosol when it receives both alarms from smoke detector and temperature sensor. The triggering condition for smoke detector and temperature sensor to send alarms are:

a. Smoke concentration reaches 3.0 + 1.0 - 1.98 %/ft;
b. Temperature reaches 135°F (57°C);

2) Aerosol suppression

ZOE BESS uses aerosol as fire suppression. Dispersed fine aerosol particles quickly fill the entire area inside the BESS and rapidly absorb heat from fire, suppressing flame spread. Parameters of the aerosol are as follow:

a. Dosage: 300 ± 6g;
b. Effective spraying time: 15 ± 5s;
c. Number of uses: single use;

3) Flame-retardant material

The interior sides of the BESS are covered with a layer of flame-retardant material, the Basotect from BASF. It is a material with excellent flame retardance, relevant properties include:

a. long-term resistance to high temperature;
b. is a thermoset;
c. when comes into contact with flames, it simply chars and produces only small amount of smoke, no afterglow;

6. EMERGENCY RESPONSE

Upon receiving an alarm from any of the smoke detector or temperature sensor, please contact the company's after-sales personnel immediately, do not attempt to open or operate the BESS in any way.
If the BESS is visibly on fire, please disconnect the AC power at the distribution cabinet immediately, evacuate the crowd, and call the fire emergency.

7. REGULAR MAINTENANCE AND INSPECTIONS

To ensure all the safety measures of the BESS can function properly and maximise the fire safety, please follow the maintenance and inspection measures. Instructions are as below:

a. Clean the cabinet of BESS with a soft, lint-free cloth;
b. Do not use cleaning solvents on the cabinet of the BESS. If necessary, only use a damp cloth dampened with neutral soap and water;
c. Keep the sides of the BESS free from leaves and other debris to maintain optimal airflow if installed outdoor;
d. If there is liquid leak from the liquid cooling and heating system, shut down the BESS and contact after-sales personnel;
e. If there is a low liquid level condition, contact after-sales personnel for refilling;
f. Lights of smoke detector and temperature sensor (on the interior side of the door) should flash once every few seconds, this indicates normal operation;
g. The aerosol should be replaced every 15 years if not used;
h. Regularly inspect the inlet and outlet vents;
i. Regularly inspect the electrical earthing condition;

Please refer to user manual for specific inspection cycles and procedures.

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MAR. 06. 2024

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