SUPDET 2018 Energy Storage Systems (ESS) Design Challenge – Koffel Associates, Inc.

We first addressed this design challenge by considering suppression options. There is currently limited scientific data concerning fire suppression for ESS. Fires can start within ESS cells or external equipment. We wanted to select a suppression system that could respond to the fire in the incipient stages, similar to what is done for an electrical or data center fire. This resulted in our first gap analysis in how similar are electrical and data center fires to ESS fires, which are more thoroughly researched. Another gap analysis is how fires that start within cells develop.

We selected a hybrid suppression using both nitrogen and water droplets, similar to the Victaulic Vortex systems. This system suppresses fire by both cooling and oxygen displacement. The Victaulic Vortex system also not does pressurize the room, does not require room integrity that a clean agent system would, and allows for continuously ventilation. We also choose to provide two 15 gpm quick-response, fusible link sprinklers over each rack. This flow rate was established as each racks was 15 sq ft and NFPA research indicates a suppression rate of 1 gpm per sq ft (100 gpm over 100 sq ft).

For detection, we would provide an air sampling-type smoke detection system for fast detection to activate the hybrid suppression systems. We would also use high temperature switches within the ESS control equipment for activation of water. We would provide an automatic battery disconnect emergency stop upon sprinkler activation and also provide a manual battery disconnect. For notification, we would evacuate the fire floor and two floors above.

To handle liquid runoff, we would construct a 2 ft berm around the room. A 2 ft berm in a 625 sq ft room creates a volume of 1,250 ft^3 or 9,350 gallons. Based on 100 gpm, or one handheld hoseline, this berm provides about 1.5 hours of water containment. The berm also helps with manual suppression. For long-duration events, submerging batteries after they burned is effective at cooling the batteries and neutralizing the thermal threat. Thus, any cells could be submerged in the water created by the berm. The racks could themselves could be on raised floors or on 2 ft high stands directly on the floor, though this would create limited accessibility for egress. The concrete berm would also prevent the spread of stranded energy, which is the energy trapped within each cell.

ESS fires are similar to plastic fires of comparable mass (NFPA Research), but the degree of high hazards such fires constitute are still unknown. We would use any dedicated HVAC units going into automatic 100% exhaust upon sprinkler activation. We would also provide a manual button for 100% building exhaust with a dedicated exhaust duct and isolation damper bypasses.

We would enclose our room with a 2-hour fire barrier. A minimum 3 feet separation between racks is recommended, which would be provided. As an option, we would also consider sub-dividing the room or provide fire curtains between racks. Our second gap analysis would be to further consider how fires spread between racks.

Except for the hybrid suppression system, our design concept is feasible.