4.0 FIRE TESTING REVIEW

Full-scale fire testing provides a basis for the evaluation of thermal runaway fire propagation and the effectiveness of the fire protection strategy in mitigating potential harmful conditions arising from a thermal runaway event.

4.1 UL9540A TESTING

The CEN BESS system has been subject to testing utilizing the methods of UL 9540A at the cell, module, unit and installation levels. The UL 9540A test results are summarized below. Refer to the UL 9540A Cell, Module and Unit level test reports for detailed information. Full UL 9540A test reports are provided for review in Appendix F.

- **Cell Level Testing** – Cell level testing indicates that [redacted] of gas may be released per cell when thermal runaway occurs. Testing indicates that the gas is primarily composed of [redacted] with a LFL of [redacted] at ambient temperature. Refer to the *UL 9540A Cell Level Report* for detailed gas composition data. The average cell surface temperature at thermal runaway was [redacted]. The cell vent gas fundamental burning velocity, S_u, was determined to be [redacted] with a maximum pressure, P_{max}, of [redacted].

- **Module Level Testing** – Module level testing demonstrated that thermal runaway initiation of a single cell is capable of propagation throughout a majority of the cells within the module. The testing resulted in flaming combustion, flying debris, explosive discharge of gas and sparks or electrical arcs. A peak heat release rate (HRR) of [redacted] was achieved during testing.

- **Unit Level Testing** – Unit level testing did not result in propagation of a thermal runaway event from the failure of a single cell. External flaming combustion was observed with a peak HRR of [redacted]. Release of flammable gas with an associated explosion was not observed. The maximum enclosure wall surface temperature observed was [redacted].

- **Installation Level Testing** – The installation level test is intended to collect information regarding the performance of the ESS's fire protection features. The installation level test included the operation of the direct injection clean agent cooling system. The installation level test did not result in propagation of a thermal runaway event from the failure of a single cell. No flaming or flying debris was observed outside of the enclosure. The maximum enclosure wall surface temperature observed was [redacted].

4.2 BESPOKE FIRE AND DEFLAGRATION TESTING

Bespoke Fire and Deflagration testing was conducted for this project. Test results are being processed and updates will be provided in the final version of the HMA report. The results will be evaluated and compared to local ambient conditions.

5.0 FIRE SAFETY ANALYSIS

This fire safety analysis is intended to provide a record of the decision-making process in determining the fire prevention, fire protection and explosion prevention measures for the identified hazards associated with the CEN BESS enclosure.