RESEARCH FOUNDATION

RESEARCH FOR THE NFPA MISSION

PROJECT SUMMARY

Firefighter Safety in Battery Energy Storage System Fires

1 November 2017

Background: With recent advances in battery technologies and renewable energy, lithium-ion batteries have become one of the leading solutions for large-scale energy storage. The types of catastrophic failures that can occur in all battery systems are amplified by the size and scale of energy storage systems (ESS). The hazards are dependent on the design of the ESS, characteristics of the compartments containing the ESS, and levels of fire protection systems in the structure. Lithium-ion battery energy storage systems (Li-BESS) potentially pose unique hazards to the fire service. It is only through understanding the interaction of the ESS and the building fire protection systems can one assure that the firefighters responding to fires involving such systems and their firefighting tactics are safe. This project aims to reduce the risk to firefighters responding to emergencies involving Li-BESS by improving fire service knowledge of Li-BESS fires and the associated hazards.

Research Goal: The overall project goals are to establish a scientific basis for the fire service to develop Standard Operating Guidelines (SOGs) for Li-BESS emergencies and disseminate the research findings to the fire service. Deliverables from this project will provide practical resources for the fire service to address these emerging issues.

Implementation and Schedule: This research project is by The University of Texas at Austin (UT-Austin) with collaborative support from multiple partners including: Underwriters Laboratory (UL); Energy Storage Safety Products International (ESSPI); and the Fire Protection Research Foundation (FPRF). Funding for this project is through a two-year DHS/FEMA Assistance to Fire Fighter (AFG) Fire Grant with a targeted project completion date of September 2019. The Principal Investigator for this project is Dr. O.A. (DK) Ezekoye (dezekoye@mail.utexas.edu) and senior technical contributor is Dr. Kevin Marr (kevin.c.marr@utexas.edu) both from UT-Austin. Additional technical contributors are: Dr. Judith Jerrvarajan (Judy.Jeevarajan@ul.com) from UL and Ron Butler (esspiron@gmail.com) from ESSPI.

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Project Tasks: This project will be completed through five main tasks:

Task 1: Evaluate Li-BESS fire scenarios. A literature review and survey will conducted to collect and analyze background information, evaluate Li-BESS fire scenarios and identify technical gaps that may prevent effective risk assessments for firefighter safety.

Task 2: Small and medium-scale testing. Testing will be conducted to characterize thermal failure and fire behavior of Li-ion cells and small modules. Key properties such as heat release rate, species concentration of gas released, volume of gas released and rate of gas released will be measured. Tests to characterize cell-to-cell propagation of thermal runaway in small modules will also be conducted. Deliverable of this task is to provide input data for extrapolation to large-scale and modeling that can be simulated in the Li-BESS simulator and training prop for fire service tactics.

Task 3: Large-scale testing. Battery failures and fires will be characterized by conducting large scale experiments on Li-BESS modules. Methods to extrapolate results to full scale Li-BESS through computational modeling and simulations will be developed. Deliverable of this task is validation data set for extrapolation and modeling from task 2. Initial tests (free burn) with additional tests (TBD) exploring fire fighting tactical considerations.

Task 4: Li-BESS Simulator and Testing (LSAT). A test apparatus to simulate Li-BESS failures will be developed and used to simulate Li-BESS fire scenarios in field studies. Field studies will be conducted with fire service partners and data will used by the fire service to evaluate firefighting tactics. This first iteration device can be used as a training prop for introductory and ongoing training as part of a fire service curriculum, and used for Standard Operating Guidelines (SOGs). A spec will be provided to allow the training prop to be replicated.

Task 5: Dissemination & Outreach. A final written report from this project will be freely available for download from the Research Foundation website. Additional project deliverables (e.g. training prop specifications) will be disseminated into the scientific and fire services communities. Presentations will be submitted to key stakeholder meetings.