JOINT CANADA-UNITED STATES
NATIONAL STANDARD

ANSI/CAN/UL 9540A:2025

STANDARD FOR SAFETY

Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

Approved American National Standard

ANSI/UL 9540A-2025

SCC FOREWORD

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UL Standard for Safety for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems, ANSI/CAN/UL 9540A

Fifth Edition, Dated March 12, 2025

Summary of Topics

This Fifth Edition of ANSI/CAN/UL 9450A, Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems dated March 12, 2025, includes the following changes in requirements:

– Revised FTIR measurements to be optional and added hydrogen measurements at Unit Level Test: 8.2.14, 8.2.15, 9.2.23, 9.2.24, and 10.3.13.

– Clarified sample rest times after conditioning and charging: 7.2.2, 8.1.2, and 9.1.9.

– Corrected standard reference in 9.1.12: 3.2.

– Replaced reference to UL 1685 with UL 2556: 3.2 and 10.2.2.

– Revised Residential Unit Level Testing to remove the usage of the NFPA 286 test room and replaced with test wall: 9.1.2, Figure 9.3, 9.2.6, 9.4.2, 9.4.3, 9.5.1, 9.5.2, and 10.3.3.

– Added option for continuous thermal ramp until thermal runaway: 7.3.1.5.

– Added NFPA 855 for applicable codes: 1.2 and 3.2

– Clarified charging method for cells: 7.2.1 and 7.2.4

– Revised location of thermocouples during cell testing and thermal ramp option: 7.3.1.2, 7.3.1.7 – 7.3.1.10.

– Clarified report if using a battery system as the BESS unit for testing: 7.7.1.

– Clarified establishing cell to cell propagation in the test method in 8.2: 8.2.3 – 8.2.7.

– Revised Module Level Performance Criteria: 8.5.1.

– Revised requirements to allow the use of Gardon heat flux gauge, revised sampling rate for heat flux and wall temperature, and added floor mounted residential system exceptions: 6.3, 6.4, 9.2.15, 9.2.17 – 9.2.20, 10.3.5, 10.3.6, 10.3.8 – 10.3.10.

– Revised egress path heat flux measurements for non-residential outdoor wall mount systems: 9.5.1 and 9.5.5.

– Removed noncombustible construction exception and clarified outdoor flame exception: 4.16, 9.1.1, 9.1.6, 9.2.19, 9.3.2, 9.6.1 – 9.6.5, 9.7.1, and Table 9.1.

– Added test method for lead acid and nickel cadmium batteries: 3.2, 7.3.1.4, 7.3.3.1 – 7.3.3.8, 7.6.1, 7.6.2, Table 7.1, 7.7.3, and 7.10.1 – 7.10.4.

– Revised flow battery requirements: 5.4.3, 7.1.1, 7.1.2, Section 7.3.2, 7.7.2, 7.9.1, 9.9.1 – 9.9.4, 9.10.1, and 9.11.1.

– Removed statement about installation in residential dwelling units.

– Added test procedure for high temperature batteries: 7.1.3, 7.3.4.1 – 7.3.4.4, 7.4.1, 7.7.4, 7.11.1, 8.3.1 – 8.3.5, 8.4.2, 8.6.1, 9.1.3, 9.1.4, 10.2.3, 10.2.4, Figure 10.3, 10.9.1 – 10.9.10, 10.10.1, 10.11.1 – 10.11.3

– Added deflagration considerations to Annex A: A3.3.1.

– Clarified residential and non-residential use definition, revised test set-ups for the module and unit level testing, added to the module, unit, and installation level test reports: 8.4.1, 9.5.2, 9.7.3, 10.4.1, and 10.7.1.

– Clarified wording for cell, module and unit failure methodologies: 7.3.1.2, 8.2.8, 8.2.14, 9.1.2, and 9.1.8.

– Added a definition for "thermal runaway propagation" and revised the "thermal runaway" definition: 4.16 and 4.19

– Revised the module surface temperature measurement range: 9.7.3, Table 9.1, and 10.5.2.

– Revised requirements to align with the code on "Residential Use": 1.2, 3.2, 4.15, 4.17, 10.1.1, 10.1.2, and A2.3.2.

– Revised Unit Level Indoor and Outdoor Tests: 4.2, 9.1.1, 9.1.2, Figure 9.2, Figure 9.3, 9.1.9, 9.2.1, 9.2.5, 9.2.6, 9.2.22, 9.2.25, 9.3.1, 9.5.1, 9.5.2, 9.7.3, Table 9.1, 10.3.12, 10.5.6, A2.5.2.2, and A2.5.3.2.

– Revised Installation Level Tests: 10.5.7 and A3.3.1

The new and revised requirements are substantially in accordance with Proposal(s) on this subject dated September 29, 2023, June 28, 2024, October 4, 2024, and December 20, 2024.

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MARCH 12, 2025

ANSI/CAN/UL 9540A:2025

Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems

First Edition – November, 2017
Second Edition – January, 2018
Third Edition – June, 2018
Fourth Edition – November, 2019

Fifth Edition

March 12, 2025

This ANSI/CAN/UL Safety Standard consists of the Fifth Edition.

The most recent designation of ANSI/UL 9540A as an American National Standard (ANSI) occurred on March 12, 2025. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page, Preface or SCC Foreword.

This Standard has been designated as a National Standard of Canada (NSC) on March 12, 2025.

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Preface

This is the Fifth Edition of the ANSI/CAN/UL 9540A, Standard for Test Method for Evaluating Thermal Runaway Fire Propagation in Battery Energy Storage Systems.

ULSE is accredited by the American National Standards Institute (ANSI) and the Standards Council of Canada (SCC) as a Standards Development Organization (SDO).

This Standard has been developed in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization.

This ANSI/CAN/UL 9540A Standard is under continuous maintenance, whereby each revision is approved in compliance with the requirements of ANSI and SCC for accreditation of a Standards Development Organization. In the event that no revisions are issued for a period of four years from the date of publication, action to revise, reaffirm, or withdraw the standard shall be initiated.

Annexes A and B, identified as Informative, is for information purposes only.

In Canada, there are two official languages, English and French. All safety warnings must be in French and English. Attention is drawn to the possibility that some Canadian authorities may require additional markings and/or installation instructions to be in both official languages.

This Fifth Edition joint American National Standard and National Standard of Canada is based on, and now supersedes, the Fourth Edition of UL 9540A.

Comments or proposals for revisions on any part of the Standard may be submitted at any time. Proposals should be submitted via a Proposal Request in the Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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This Edition of the Standard has been formally approved by the Technical Committee (TC) on Energy Storage Systems and Equipment, TC 9540.

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This Standard is intended to be used for conformity assessment.

The intended primary application of this Standard is stated in its scope. It is important to note that it remains the responsibility of the user of the standard to judge its suitability for this particular application.

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INTRODUCTION

1 Scope

1.1 The test methodology in this Standard determines the capability of a battery technology to undergo thermal runaway and then evaluates the fire and explosion hazard characteristics of those battery energy storage systems that have demonstrated a capability to undergo thermal runaway.

1.2 The data generated will be used to support the manufacturer's installation instructions with regards to separation between individual battery energy storage systems and determine the fire and explosion protection required for an installation of a battery energy storage system intended for installation, operation and maintenance in accordance with:

a) The Standard for the Installation of Stationary Energy Storage Systems, NFPA 855;

b) The National Electrical Code, NFPA 70;

c) The Fire Code, NFPA 1;

d) The Standard for Energy Storage Systems and Equipment, UL 9540;

e) The Canadian Electrical Code, Part I, Safety Standard for Electrical Installations, CSA C22.1;

f) The General Requirements – Canadian Electrical Code, Part II, CSA C22.2 No. 0;

g) The National Electrical Safety Code, IEEE C2;

h) The International Fire Code, ICC IFC;

i) The International Residential Code, ICC IRC; and

j) Other codes affecting energy storage systems.

1.3 Fire protection requirements not related to battery energy storage system equipment are covered by appropriate installation codes.

1.4 See Figure 1.1 for a schematic of the test sequence in this Standard. See Annex A which explains:

a) The purpose of the tests included in this Standard;

b) Explanation of individual tests; and

c) Interpretation and application of the results.