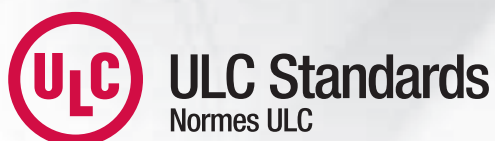


**NATIONAL STANDARD
OF CANADA**

**CAN/ULC-S2580:2013-AM1
(Including Amendment 1)**

**STANDARD ON BATTERIES FOR USE IN ELECTRIC
VEHICLES**

Prepared and Published by:



Approved by:



Standards Council of Canada
Conseil canadien des normes



ANSI/UL 2580:2013
Documents
AVA Document Sharing Hub

Underwriters Laboratories of Canada (ULC) was established in 1920 by letters patent issued by the Canadian Government. It maintains and operates laboratories and certification services for the examination, testing and certification of appliances, equipment, materials, constructions and systems to determine their relation to life, fire and property hazards as well providing inspection services.

Underwriters Laboratories of Canada is accredited by the Standards Council of Canada as a Certification Organization, a Testing Organization, and an Inspection Body under the National Standards System of Canada.

ULC Standards develops and publishes standards and other related publications for building construction, security and burglar protection, environmental safety, electrical equipment, fire protection equipment, gas and oil equipment, thermal insulation products, materials and systems, energy use in the built environment and electrical utility safety.

ULC Standards is a not-for-profit organization and is accredited by the Standards Council of Canada as a Standards Development Organization.

National Standards of Canada developed by ULC Standards conform to the criteria and procedures established by the Standards Council of Canada. Such standards are prepared using the consensus principle by individuals who provide a balanced representation of interests relevant to the subject area on a national basis.

ULC is represented across Canada as well as many countries worldwide. For further information on ULC services, please contact:

Customer Service: 1-866-937-3852

National Standard of Canada

A National Standard of Canada is a standard developed by an SCC-accredited Standards Development Organization (SDO), and approved by the Standards Council of Canada (SCC), in accordance with SCC's: *Requirements and Guidance-Accreditation for Standards Development Organizations*, and *Requirements and Guidance-Approval of National Standards of Canada Designation*.

More information on National Standard requirements can be found at www.scc.ca. An SCC-approved standard reflects the consensus of a number of experts whose collective interests provide, to the greatest practicable extent, a balance of representation of affected stakeholders. National Standards of Canada are intended to make a significant and timely contribution to the Canadian interest.

SCC is a Crown corporation within the portfolio of Industry Canada. With the goal of enhancing Canada's economic competitiveness and social well-being, SCC leads and facilitates the development and use of national and international standards. SCC also coordinates Canadian participation in standards development, and identifies strategies to advance Canadian standardization efforts. Accreditation services are provided by SCC to various customers, including product certifiers, testing laboratories, and standards development organizations. A list of SCC programs and accredited bodies is publicly available at www.scc.ca.

Users should always obtain the latest edition of a National Standard of Canada from the standards development organization responsible for its publication, as these documents are subject to periodic review.

CORPORATE HEADQUARTERS

Underwriters Laboratories of Canada
7 Underwriters Road
Toronto, Ontario M1R 3A9
Telephone: (416) 757-3611
Fax: (416) 757-9540

REGIONAL OFFICES

PACIFIC OFFICE

13775 Commerce Parkway, Suite 130
Richmond, British Columbia V6V 2V4
Telephone: (604) 214-9555
Fax: (604) 214-9550

EASTERN OFFICE

6505, Rte Transcanadienne, Suite 330
St-Laurent, Québec H4T 1S3
Telephone: (514) 363-5941
Fax: (514) 363-7014

For further information on ULC standards, please contact:

ULC STANDARDS

171 Nepean Street, Suite 400
Ottawa, Ontario K2P 0B4
Telephone: (613) 755-2729
Fax: (613) 231-5977
E-mail: customerservice@ulc.ca
Web site: www.ulc.ca

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.

Copies of this National Standard of Canada may be ordered from ULC Standards.

CETTE NORME NATIONALE DU CANADA EST DISPONIBLE EN VERSIONS FRANÇAISE ET ANGLAISE

Prepared by:



**ULC Standards
CAN/ULC-S2580
First Edition**



**Underwriters Laboratories Inc.
ANSI/UL 2580
Second Edition**

Batteries for Use In Electric Vehicles

December 16, 2013

(Title Page Reprinted: June 17, 2016)



ANSI/UL 2580-2016

Approved by



**Standards Council of Canada
Conseil canadien des normes**



Documents
Document Sharing Hub

Commitment for Amendments

This Standard is issued jointly by Underwriters Laboratories Inc. (UL) and ULC Standards. Amendments to this Standard will be made only after processing according to the Standards writing procedures by UL and ULC Standards.

UL and ULC Standards are separate and independent entities and each is solely responsible for its operations and business activities. The UL trade names and trademarks depicted in this document are the sole property of Underwriters Laboratories Inc. The ULC Standards trade names and trademarks depicted in this document are the sole property of ULC Standards.

ISSN 0317-526X Copyright © 2016 ULC Standards

All rights reserved.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, whatsoever without the prior permission of the publisher.

In Canada, written comments are to be sent to ULC Standards, 400 – 171 Nepean Street, Ottawa, Ontario K2P 0B4. Proposals should be submitted on a Standards Revision Request Form available from ULC Standards.

Copyright © 2016 Underwriters Laboratories Inc.

UL's Standards for Safety are copyrighted by UL. Neither a printed nor electronic copy of a Standard should be altered in any way. All of UL's Standards and all copyrights, ownerships, and rights regarding those Standards shall remain the sole and exclusive property of UL.

This ANSI/UL Standard for Safety consists of the Second Edition.

The most recent designation of ANSI/UL 2580 as an American National Standard (ANSI) occurred on June 17, 2016. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at <http://csds.ul.com>.

To purchase UL Standards, visit Comm 2000 at http://www.comm-2000.com/help/how_to_order.aspx or call toll-free 1-888-853-3503.

ULC Preamble

International Classification for Standards (ICS): 29.220; 43.120

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

Attention is drawn to the possibility that some of the elements of this Canadian standard may be the subject of patents rights. ULC Standards shall not be held responsible for identifying any or all such patents rights.

This Standard is intended to be used for conformity assessment.

The First Edition of this ULC Standard was based on, and superseded, the First Edition of Subject 2580. The First Edition has been amended.

The review and action to revise or reaffirm this Standard will not exceed 5 years from the date of publication, unless the Standard is identified as fitting within a stabilized category, whereby the review will commence within the appropriate time frame set out by ULC Standards.

TECHNICAL COMMITTEE ON BATTERIES FOR ELECTRIC VEHICLES

Name	Affiliation	Region	Category
A. Archambault	Bathium Canada Inc	Canada	Producer
S. Arimori	SABIC Innovative Plastics	Japan	User
P. Arora	DuPont	USA	General Interest
C. Bender	Tennant Company	USA	User
W. Choi	LG Chemical	Korea	Producer
T. De Lucia	A123Systems	USA	Producer
W. Densham III	O2Micro Battery	USA	User
Y. Ding	US Army —Ground Vehicle Power & Mobility	USA	Regulator
D. Doughty	Battery Safety Consulting Inc.	USA	General Interest
L. Dunn	Nacco Materials Handling Group	USA	User
J. Haruhara	Polyplastics Co., Ltd.	Japan	User
R. Hoemsen	Red River College	Canada	General Interest
H. Kamath	EPRI	USA	General Interest
R. Lankin	Accelerated Systems Inc.	Canada	User
A. Masias	Ford Motor Company	USA	User
N. Meyer	Transport Canada	Canada	Regulator
J. Pereira	E-One Moli Energy	Canada	Producer
J. Pinon	Hybrid Design Services, Inc.	USA	General Interest
G. Ressler	General Motors Co.	USA	Producer
E. Shen	Tesla Motors, Inc.	USA	Producer
G. Shih	Automotive Research Testing Center	Taiwan	General Interest
A. Spataru	Adept Group Inc.	USA	General Interest
M. G. Theivanayagam	The Dow Chemical Co	USA	General Interest
J. Thompson	Nissan Technical Center	USA	Producer
A. Wong	ATL	USA	Producer
D. Wu	Consultant	Taiwan	General Interest

Table (Continued)

Name	Affiliation	Region	Category
G. Wu	BYD Com Ltd	China	Producer
R. Byczek	Intertek	USA	Associate (Non-Voting)
R. deMesa	California Energy Commission	California	Associate (Non-Voting)
L. Florence	UL LLC	USA	Associate (Non-Voting)
M. Greiner	MGA Research Group	USA	Associate (Non-Voting)
P. Gorney	US Dept. of Transportation	USA	Associate (Non-Voting)
J. Leber	SGS	USA	Associate (Non-Voting)
D. Lowry	US Army Research Laboratory	USA	Associate (Non-Voting)
C. Michot	INERIS	France	Associate (Non-Voting)
G. Rech	CETECOM ICT Services GmbH	Germany	Associate (Non-Voting)
S. Ryu	TUV Rheinland	Korea	Associate (Non-Voting)
M. Ramlochan (Project Manager)	ULC Standards	Canada	Non-Voting
M. Van Heirseele (Project Manager)	Underwriters Laboratories Inc.	USA	Non-Voting

This list represents the membership at the time the Committee balloted on the final text of this edition. Since that time, changes in the membership may have occurred.

AMENDMENT NOTICE

ULC STANDARDS

Batteries for Use In Electric Vehicles	CAN/ULC-2580:2013-AM1
AMENDMENT 1	DATE OF AMENDMENT: JUNE 17, 2016

The following amendments are being incorporated into (CAN/ULC-2580:2013):

1. Correction of IEC Standard number.
2. Revision of samples numbers for cell testing in 16.2 and 16.3.
3. Clarification of the Overcharge Test and revision of the Isolation Test and External Fire Exposure Test.

NOTICE

PLEASE NOTE THAT THIS STANDARD INCLUDES AMENDMENT(S). THE CURRENT EDITION OF THIS STANDARD IS NOT VALID UNLESS USED TOGETHER WITH THE AMENDMENT(S).

IT IS POSSIBLE, HOWEVER, THAT CERTAIN CODES WILL REFER TO THE SUPERSEDED EDITION OF THIS STANDARD, WITHOUT THE AMENDMENT(S). IN THOSE INSTANCES, THE COMPILATION OF THIS DOCUMENT ALLOWS FOR REFERENCE TO BE MADE TO THE STANDARD PRIOR TO THE INCLUSION OF THE AMENDMENT(S).

No Text on This Page

Document ID: 123456789

IEC Standards

IEC 62660-2

Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing

B1.2 The test conditions of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2, Section 4 are to be applied for the test program outlined in Section B2 below.

B1.3 The capacity of the cells shall be determined as outlined in 5.2 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.1.1 The cell shall be subjected to the vibration test as outlined in 6.1.1 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.2.1 The cell shall be subjected to the mechanical shock test as outlined in 6.1.2 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 60662-2.

B2.3.1 The cell shall be charged in accordance with the manufacturer's specifications as outlined in 5.1 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2, and then subjected to a drop test as outlined in B2.3.2.

B2.4.1 The cell shall be subjected to the crush test as outlined in 6.1.3 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.5.1 The cell shall be subjected to the high temperature endurance test as outlined in 6.2.1 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.6.1 The cell shall be subjected to the temperature cycling test as outlined in 6.2.2.1.1 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.7.1 The cell shall be subjected to the external short circuit test as outlined in 6.3.1 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

B2.8.1 The cell shall be subjected to the overcharge test as outlined in 6.3.2 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

Exception: This test is not required if it can be determined that overcharge is reliably prevented by a control system meeting the requirements of 13.4 and cell state of charge is monitored at the cell level in the end use vehicle system.

B2.9.1 The cell shall be subjected to the forced discharge test as outlined in 6.3.3 of the Standard for Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing, IEC 62660-2.

Exception: This test is not required if it can be determined that overdischarge is reliably prevented by a control system meeting the requirements of 13.4 that prevents overdischarge of cells and that monitors at the cell level in the end use vehicle system.

16.2 Lithium ion cells shall comply with the requirements for secondary lithium cells in the Standard for Lithium Batteries, UL 1642 per Table 5 with modifications as outlined in Exception No. 1 – 6 below.

Exception No. 1: The overall dimensions of the projectile test aluminum test screen may be increased from those outlined in the Standard for Lithium Batteries, UL 1642 to accommodate large cells intended for EV applications but the flat panels of the test screen shall not exceed a distance of 305 mm (12 in) from the cell in any direction.

Exception No. 2: The overall external resistance for the short circuit test shall be less than or equal to 20 mΩ.

Exception No. 3: The crush test shall be a bar crush test rather than a flat plate crush using a bar with a 15-cm (5.9-in) diameter. The force is to be applied until one of the following occurs first:

- a) A voltage (OCV) drop of one-third of the original cell voltage occurs; or*
- b) A deformation of 15% or more (in the direction of the crush) of initial cell dimension occurs; or*
- c) A force of 1000 times the weight of cell is reached.*

Exception No. 4: For cells whose weight is greater than 500 g (1.1 lbs), the maximum temperature of the heating test shall be held for 30 min rather than 10 min.

Exception No. 5: The requirements outlined in Annex B may be used instead of the Standard for Lithium Batteries, UL 1642 for lithium ion cells and Exception No. 1 – 3 above.

Exception No. 6: The sample numbers for cell testing are to be reduced from 5 samples per test to 2 samples per test.

16.3 Nickel based cells shall comply with the cell requirements in the Standard for Household and Commercial Batteries, UL 2054 per Table 6 with modifications as outlined in Exception No. 1 – 6 below.

Exception No. 1: The overall dimensions of the projectile test aluminum test screen may be increased from those outlined in the Standard for Household and Commercial Batteries, UL 2054 to accommodate large cells intended for EV applications but the flat panels of the test screen shall not exceed a distance of 305 mm (12 in) from the cell in any direction.

Exception No. 2: The overall external resistance for the short circuit test shall be less than or equal to 20 mΩ.

Exception No. 3: The crush test shall be a bar crush test rather than a flat plate crush using a bar with a 15-cm (5.9-in) diameter. The force is to be applied until one of the following occurs first:

- a) A voltage (OCV) drop of one-third of the original cell voltage occurs; or
- b) A deformation of 15% or more (in the direction of the crush) of initial cell dimension occurs; or
- c) A force of 1000 times the weight of cell is reached.

Exception No. 4: For cells whose weight is greater than 500 g (1.1 lbs), the maximum temperature of the heating test shall be held for 30 min rather than 10 min.

Exception No. 5: The sample numbers for cell testing are to be reduced from 5 samples per test to 2 samples per test.

Exception No. 6: Nickel based cells that are sealed and formed as part of a monobloc battery, need only comply with the test requirements of this standard as part of the assembled battery/module.

**Table 5 – Cell Tests from UL 1642
(See 16.2)**

UL 1642 test	UL 1642 reference
Short-Circuit Test	Section 10
Abnormal Charging Test	11.7 – 11.10
Crush Test	Section 13
Impact Test	Section 14
Shock Test	Section 15
Vibration Test	Section 16
Heating Test	Section 17
Temperature Cycling Test	Section 18
Low Pressure (Altitude Simulation) Test	Section 19
Projectile Test	Section 20

**Table 6 – Cell Tests from UL 2054
(See 16.3)**

UL 2054 test	UL 2054 reference
Short-Circuit Test	9.1 – 9.6
Abnormal Charging Test	10.7 – 10.9
Crush Test	Section 14
Impact Test	Section 15
Shock Test	Section 16
Vibration Test	Section 17
Projectile Test	Section 22
Heating Test	Section 23
Temperature Cycling Test	Section 24

25.3 The test is to continue until ultimate results occur. Ultimate results are considered to have occurred when one of the following occurs:

- a) The sample charging is terminated by the protective circuitry whether it is due to voltage or temperature controls. The DUT is monitored per 18.5 and 20.2; or

b) Where an automatic interrupt function fails to operate, or no such function for the charging is provided and the DUT is charged to 110% of its rated charge capacity or a manufacturer-specified limit. (reaching 110% of the rated charge capacity or the manufacturer-specified charging limit would be considered as a failure of the overcharge evaluation); or

c) EESA failure occurs as evidenced by explosion, fire.

31.2.1 As an exception to the method outlined in the Standard for Electrically Propelled Road Vehicles – Safety Specifications – Part 1: On-Board Rechargeable Energy Storage System (RESS), ISO 6469-1, an insulation resistance test using a dc voltage applied to the circuit under test may be conducted. For this method, the insulation resistance is to be measured using a megohmmeter after application of a dc voltage for 1 min that is higher than the circuit under test. (i.e. at least have the working voltage of the high voltage dc bus or circuit under test if higher).

31.5 For both (a) and (b) of 31.2 and 31.2.1, the isolation resistance divided by the maximum working voltage of the circuit under test, shall be at least 100 Ω/V for dc and 500 Ω/V for ac or for circuits containing both ac and dc parts.

CONTENTS

Preface	15
A INTRODUCTION	16
1 Scope	16
2 Components	16
3 Units of Measurement	16
4 Undated References	17
5 Reference Publications	17
6 Glossary	20
B CONSTRUCTION	25
7 Non-Metallic Materials	25
8 Metallic Parts Resistance to Corrosion	26
9 Enclosures	26
10 Wiring and Terminals	27
11 Spacings and Separation of Circuits	28
12 Insulation Levels and Protective Grounding	29
13 System Safety Analysis	30
14 Protective Circuits	31
15 Cooling/Thermal Management Systems	32
16 Cells (Battery and Electrochemical Capacitor)	32
17 Manufacturing and Production Line Testing and Production Quality	34
C PERFORMANCE	34
18 General	34
19 Determination of Potential for Fire Hazard	35
20 Important Test Considerations	35
21 Single Fault Conditions	36
22 Test Results	36
23 Determination of Toxic Emissions	37
24 Tolerances	37
D ELECTRICAL TESTS	38
25 Overcharge Test	38
26 Short Circuit Test	39
27 Overdischarge Protection Test	40
28 Temperature Test	40
29 Imbalanced Charging Test	41
30 Dielectric Voltage Withstand Test	42
31 Isolation Resistance Test	42
32 Continuity Test	43
33 Failure of Cooling/Thermal Stability System Test	43
E MECHANICAL TESTS	44
34 Rotation Test	44
35 Vibration Endurance Test	45
36 Shock Test	46
37 Drop Test	47
38 Crush Test	48
F ENVIRONMENTAL TESTS	48
39 Thermal Cycling	48
40 Salt Spray Test	49
41 Immersion Test	50
42 External Fire Exposure Test	50

43 Internal Fire Exposure Test	51
G MARKING	52
44 Markings	52
H INSTRUCTIONS	53
45 Instructions	53
46 TABLES	53
47 FIGURES	56

ANNEX A (NORMATIVE)

A1 Component Standards	A1
------------------------------	----

ANNEX B (NORMATIVE) Alternative Test program for Lithium ion Cells

B1 General	B1
B2 Tests	B1
B2.1 Vibration Test	B1
B2.2 Shock Test	B1
B2.3 Drop Test	B2
B2.4 Crush Test	B2
B2.5 Heating Test	B2
B2.6 Temperature Cycling Test	B2
B2.7 External Short Circuit Test	B3
B2.8 Overcharge Test	B3
B2.9 Forced Discharge Test	B3
B2.10 Projectile Test	B3
B3 Results Criteria	B4

ANNEX C (NORMATIVE) Electrochemical Potentials

Preface

This is the common UL and ULC Standard for Batteries for Use In Electric Vehicles. It is the First edition of CAN/ULC-S2580 and the Second edition of ANSI/UL 2580.

This Joint Standard was prepared by Underwriters Laboratories Inc., ULC Standards, and the Technical Committee on Batteries for Use in Electric Vehicles (EVs). The standard was formally approved by the UL/ULC Technical Committee on Batteries for Use in Electric Vehicles (EVs). The efforts and support of the Technical Committee are gratefully acknowledged.

Only metric SI units of measurement are used in this Standard. If a value for measurement is followed by a value in other units in parentheses, the second value may be approximate. The first stated value is the requirement.

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.

Annex A, Annex B, and Annex C are identified as normative, as such, form mandatory parts of this Standard.

Note: *Although the intended primary application of this Standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.*

Level of Harmonization

This Standard is published as an identical standard between UL and ULC Standards. An identical standard is a standard that is the same in technical content except for conflicts in Codes and Governmental Regulations. Presentation shall be word for word except for editorial changes.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard shall be based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision shall be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

A INTRODUCTION

1 Scope

1.1 These requirements cover electrical energy storage assemblies such as battery packs and combination battery pack-electrochemical capacitor assemblies and the subassembly/modules that make up these assemblies for use in electric-powered vehicles as defined in this standard.

1.2 This standard evaluates the electrical energy storage assembly's ability to safely withstand simulated abuse conditions and prevents any exposure of persons to hazards as a result of the abuse. This standard evaluates the electric energy storage assembly and modules based upon the manufacturer's specified charge and discharge parameters at specified temperatures. It does not evaluate the assembly's interaction with other control systems within the vehicle.

1.3 This standard does not evaluate the performance or reliability of these devices.

1.4 This standard does not include requirements for the evaluation of batteries for light electric vehicles such as electrical assist bicycles, wheel chairs, electric scooters and similar devices as defined in the Standard for Batteries for Use In Light Electric Vehicle (LEV) Applications, UL 2271 / CAN/ULC-S2271.

2 Components

2.1 Except as indicated in 2.2, a component of a product covered by this Standard shall comply with the requirements for that component. See Annex A for a list of Standards covering components generally used in the products covered by this Standard. A component shall comply with the Standards of CSA or UL Standards as appropriate for the country where the product is to be used.

2.2 A component is not required to comply with a specific requirement that:

- a) Involves a feature or characteristic not required in the application of the component in the product covered by this standard; or
- b) Is superseded by a requirement in this standard.

3 Units of Measurement

3.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information. The values given in SI (metric) units shall be normative.

4 Undated References

4.1 Any undated reference to a code or standard appearing in the requirements of this standard shall be interpreted as referring to the latest edition of that code or standard.

5 Reference Publications

5.1 Throughout this standard, the CSA and ULC standard references apply to products intended for use in Canada, while the UL standard references apply to products intended for use in the United States. Combined references are commonly separated by a slash ("/").

5.2 The following standards are referenced in this standard, and portions of these referenced standards as identified in this standard may be essential for compliance.

UL Standards

UL 50E

Enclosures for Electrical Equipment, Environmental Considerations

UL 94

Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 746B

Polymeric Materials – Long Term Property Evaluations

UL 746C

Polymeric Materials – Use in Electrical Equipment Evaluations

UL 810A

Electrochemical Capacitors

UL 840

Insulation Coordination Including Clearances and Creepage Distances For Electrical Equipment

UL 1642

Lithium Batteries

UL 1973

Batteries for Use in Light Electric Rail (LER) Applications and Stationary Applications

UL 1989

Standby Batteries

UL 2054

Household and Commercial Batteries

UL 2251

Plugs, Receptacles and Couplers for Electric Vehicles

UL 60950-1

Information Technology Equipment Safety – Part 1: General Requirements

ULC Standards

CAN/ULC-S2271

*Batteries for Use in Light Electric Vehicles (LEV) Applications***ASTM Standards**

ASTM D4490

Standard Practice for Measuring the Concentration of Toxic Gases or Vapors Using Detector Tubes

ASTM D4599

*Standard Practice for Measuring the Concentration of Toxic Gases or Vapors Using Length-of-Stain Dosimeters***Canada Motor Vehicle Safety Standards (CMVSS)**

Document No. 305

*Motor Vehicle Safety Regulations (C.R.C., c. 1038) Electrolyte Spillage and Electrical Shock Protection (Standard 305)***CSA Group Standards**

CAN/CSA-C22.2 No. 0.17

Evaluation of Properties of Polymeric Materials

CSA-C22.2 No. 0.2

Insulation Coordination

CAN/CSA-C22.2 No. 94.2

Enclosures for Electrical Equipment, Environmental Considerations

CAN/CSA-C22.2 No. 60950-1

*Information Technology Equipment Safety – Part 1: General Requirements***Federal Motor Vehicle Safety Standards**

FMVSS 49 CFR 571 305

*Electric-Powered Vehicles: Electrolyte Spillage and Electrical Shock Protection***IEC Standards**

IEC 60068-2-27

Environmental Testing – Part 2-27: Tests – Test Ea and Guidance: Shock

IEC 60068-2-30

Environmental Testing – Part 2-30: Tests – Test Db: Damp Heat, Cyclic (12 h + 12 h Cycle)

IEC 60068-2-52

Environmental Testing – Part 2: Tests – Test Kb: Salt Mist, Cyclic (Sodium Chloride Solution)

IEC 60417

Graphical Symbols for Use on Equipment

IEC 60662-2

Secondary lithium-Ion Cells for the Propulsion of Electric Road Vehicles – Part 2: Reliability and Abuse Testing

IEC 60812

Analysis Techniques for System Reliability – Procedure for Failure Mode and Effects Analysis (FMEA)

IEC 61025

Fault Tree Analysis (FTA)

IEC 61508-1

Functional Safety of Electrical/Electronic/Programmable Electronic Safety-Related Systems Part 1: General Requirements

ISO Standards

ISO No. 7010

Graphical Symbols – Safety Colours and Safety Signs – Registered Safety Signs

ISO 6469-1

Electrically Propelled Road Vehicles – Safety Specifications – Part 1: On-Board Rechargeable Energy Storage System (RESS)

ISO 26262-2

Road Vehicles – Functional Safety Part 2: Management of Functional Safety

NEMA Standards

NEMA 60529

Degrees of Protection Provided by Enclosures (IP Code)

National Institute for Occupational Safety and Health (NIOSH) Standards

NIOSH Manual of Analytic Methods

NFPA Standards

NFPA 70

National Electrical Code

Occupational Safety and Health Administration (OSHA) Standards

OSHA Evaluation Guidelines for Air Sampling Methods Utilizing Spectroscopic Analysis

SAE Standards

SAE ARP4761

Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment

SAE J1718

Measurement of Hydrogen Gas Emission From Battery-Powered Cars and Light Trucks during Battery Charging

SAE J1739

Potential Failure Mode and Effects Analysis in Design (Design FMEA), Potential Failure Mode and Effects Analysis in Manufacturing and Assembly Processes (Process FMEA)

SAE J2380

Vibration Testing of Electric Vehicle Batteries

SAE J2464

Electric and Hybrid Electric Vehicle Rechargeable Energy Storage System (RESS) Safety and Abuse Testing

US Department of Defense (DOD) Standards**MIL-STD-1629A**

Procedures for Performing a Failure Mode, Effects, and Criticality Analysis

6 Glossary

6.1 BATTERY PACK – Batteries that are ready for use in a electric powered vehicle, contained in a protective enclosure, with protective devices, with a battery management system, and monitoring circuitry, with or without cooling systems. See Figure 1.

6.2 CAPACITOR PACK – Electrochemical capacitors that are ready for use in a electric powered vehicle, contained in a protective enclosure, with or without protective devices, cooling systems, and monitoring circuitry. See Figure 2.

6.3 CAPACITY, RATED (C_n) – The total number of ampere-hours that can be withdrawn from a fully charged battery at a specific discharge rate to a specific end-of-discharge voltage (EODV) at a specified temperature as declared by the manufacturer.

6.4 CASING – The container that directly encloses and confines the electrolyte and electrodes of a cell or electrochemical capacitor.

6.5 CELL – The basic functional electrochemical unit (sometimes referred to as a battery) containing an electrode assembly, electrolyte, separators, container, and terminals. It is a source of electrical energy by direct conversion of chemical energy.

6.6 CHARGING – The application of electric current to battery or capacitor terminals, which results in a Faradic reaction that takes place within the battery that leads to stored electro-chemical energy or in the case of the capacitor, due to electrical charge being stored without a chemical reaction taking place. For electric vehicle applications, charging of the electric energy storage assembly can occur through one or more of the following methods:

- a) Regenerative braking which utilizes energy from regenerative brakes.
- b) Off board charging which utilizes an ac to dc charger, a dc charger, or an inductive charger external to the vehicle.
- c) On board charging which utilizes a charger on the vehicle to convert the ac mains supply to dc for charging. Charge energy can be provided external to vehicle or by an on board generator (termed Extended Range EV).

6.7 CHARGING, CONSTANT CURRENT (CC) – Charging mode where current is held constant while charging voltage is allowed to vary within defined parameters.

6.8 CHARGING, CONSTANT VOLTAGE (CV) – Charging mode where voltage is held constant while charging current is allowed to vary within defined parameters.

6.9 DUT – Device under test.

6.10 ELECTRIC ENERGY STORAGE ASSEMBLY (EESA) – A battery pack, electrochemical capacitor pack or combination battery/electrochemical capacitor pack that provides electric energy for electric vehicle motive power. This assembly can include the cooling and ventilation systems and battery management systems. See Figure 1.

6.11 ELECTRIC POWERED VEHICLE – An on-road or off-road vehicle that uses electricity from batteries or other electric energy storage assemblies as a source of energy for motive power. Electric powered vehicles cover, but are not limited to, road passenger vehicles and heavy duty off road vehicles such as industrial trucks.

6.12 ELECTROCHEMICAL CAPACITOR – An electric energy storage device where electrical charge is typically stored as a result of non-Faradaic reactions at the electrodes. (A subset of electrochemical capacitors referred to as an "asymmetric" type have non-Faradaic reactions at one electrode and Faradaic reactions at the other electrode.) The unique porous surface of the electrodes increases the surface area for holding charge resulting in much larger capacitance and energy density. Electrochemical capacitors differ from common electrolytic capacitors in that they employ a liquid rather than a solid dielectric with charge occurring at the liquid-solid interface of the electrodes when a potential is applied. Some other common names for an electrochemical capacitor are "double layer capacitor", "ultra capacitor", "electrochemical double layer capacitor" and "super capacitor".

6.13 ENCLOSURE – The protective outer cover of the electric energy storage assembly that provides mechanical protection to the assembly's contents.

6.14 END-OF-DISCHARGE VOLTAGE (EODV) (Cell) – The voltage, under a specified load, of the cell at the end of discharge. The EODV may be specified by the manufacturer, as in the case of a voltage-terminated discharge typical for lithium ion chemistries.

6.15 EODV MONITORING (Cell) – EODV monitoring is typically provided at the pack/electric energy storage assembly level by the battery management system.

6.16 EXPLOSION – A violent release of energy that produces projectiles or a pressure wave from the DUT and results in DUT contents being forcibly expelled through a rupture in the enclosure or casing.

6.17 FIRE – The sustained combustion of the DUT's contents as evidenced by flame, heat and charring or other damage of materials.

6.18 FULLY CHARGED – An electric energy storage assembly, pack, module or cell which has been charged to its full state of charge (SOC) as specified by the manufacturer.

6.19 FULLY DISCHARGED – An electric energy storage assembly, pack, module or cell, which has been discharged to its end-of-discharge voltage (EODV) as specified by the manufacturer.

6.20 HAZARDOUS ENERGY – Available power level of 240 VA or more, having a duration of 60 s or more, or a stored energy level of 20 J or more, at a voltage of 2 V or more.