ANSI/CAN/UL 2056:2025

JOINT CANADA-UNITED STATES
NATIONAL STANDARD

STANDARD FOR SAFETY

Power Banks

ANSI/UL 2056-2025

SCC FOREWORD

National Standard of Canada

A National Standard of Canada is a standard developed by a Standards Council of Canada (SCC) accredited Standards Development Organization, in compliance with requirements and guidance set out by SCC. More information on National Standards of Canada can be found at www.scc.ca.

SCC is a Crown corporation within the portfolio of Innovation, Science and Economic Development (ISED) 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.

UL Standard for Safety for Power Banks, ANSI/CAN/UL 2056

First Edition, Dated October 22, 2024

Summary of Topics

This revision of ANSI/CAN/UL 2056 dated February 18, 2025 includes changes to the enclosure requirements: 4.3 and 6.1.4.

Text that has been changed in any manner or impacted by ULSE's electronic publishing system is marked with a vertical line in the margin.

The revised requirements are substantially in accordance with Proposal(s) on this subject dated November 29, 2024

No Text on This Page

ANSI/UL 2056-2025

OCTOBER 22, 2024
(Title Page Reprinted: February 18, 2025)

ANSI/CAN/UL 2056:2025

Standard for Power Banks

First Edition

October 22, 2024

This ANSI/CAN/UL Safety Standard consists of the First Edition including revisions through February 18, 2025.

The most recent designation of ANSI/UL 2056 as an American National Standard (ANSI) occurred on February 18, 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 February 18, 2025.

No Text on This Page

CONTENTS

MARKINGS

INSTRUCTIONS

Preface

This is the First Edition of ANSI/CAN/UL 2056, Standard for Power Banks.

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 2056 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.

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.

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.

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

This Edition of the Standard has been formally approved by the Technical Committee (TC) on Power Banks, TC 2056.

This list represents the TC 2056 membership when the final text in this Standard was balloted. Since that time, changes in the membership may have occurred.

TC 2056 Membership

Name	Representing	Interest Category	Region
Akhlasi, Kamran	Health Canada	Government	Ontario, Canada
Aman, Simon	Stanley Black & Decker	Producer	USA
Bolton, David	Air Canada	Commercial/Industrial User	Quebec, Canada
Brenner, Rick	Products Safety Advisors	Supply Chain	USA
Bullock, Nathaniel	Geiger	Supply Chain	USA
Byczek, Rich	Intertek	Testing and Standards Org.	USA
Chen, Yanqi	Kunshan Ntek Testing Technology	Testing and Standards Org.	China
Furukawa, Akio	TDK Corporation	Supply Chain	Japan
Holmdahl, Bryan	Amazon	Producer	USA
Huang, Leo	APCB Electronics (Kunshan) Co Ltd	Supply Chain	China

TC 2056 Membership Continued on Next Page

TC 2056 Membership Continued

Name	Representing	Interest Category	Region
Jordan, Diana Pappas	UL Standards & Engagement	TC Chair – Non-Voting	USA
Kadiwala, Jay	US Consumer Product Safety Commission	Non-Voting	USA
Liang, Alex	UL Solutions	Testing and Standards Org.	Taiwan
Murray, Nickolas	Consumer Association of Canada	Consumer	New Brunswick, Canada
Ogard, John	United Airlines	Commercial/Industrial User	USA
Rahardi, Susanto	Balai Besar Bahan dan Barang Teknik (B4T) (Representing BSN)	International Delegate	Indonesia
Savage, Michael	Marion County, FL	Authorities Having Jurisdication	USA
Sudler, Samuel	SEA Ltd	General Interest	USA
VanHeirseele, Megan	UL Standards & Engagement	TC Project Manager – Non-Voting	USA
Wunderlich, Heather	Staples Promotional Products	Supply Chain	USA
Zhang, Guanghui	Vertiv	Commercial/Industrial User	China

International Classification for Standards (ICS): 29.220.10; 29.220.20; 29.220.30

For information on ULSE Standards, visit https://www.shopulstandards.com, call toll free 1-888-853-3503 or email us at ClientService@shopULStandards.com.

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.

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

INTRODUCTION

1 Scope

1.1 These requirements cover power banks, sometimes also known as portable USB chargers or portable back-up battery power, which are standalone devices that incorporate primary or secondary batteries for mobile powering of low voltage electronic devices.

1.2 These requirements cover products with the following power characteristics:

a) Input:

1) Supplied by isolated dc power source rated maximum 60 Vdc; or

2) Supplied by ac mains power source, through direct plug-in construction.

b) Output: Provides dc output(s) rated maximum 60 Vdc; and

c) The watt-hour rating of the power bank does not exceed 100 Wh.

1.3 These requirements are intended to reduce the risk of fire or explosion of power banks.

1.4 These requirements also cover products with integral photovoltaic cells as a power source.

1.5 These requirements do not cover products under the scope of the Standard for Portable Power Packs, UL 2743.

2 Units of Measurement

2.1 Values stated without parentheses are the requirement. Values in parentheses are explanatory or approximate information.

3 Components

3.1 A component of a product covered by this Standard shall:

a) Comply with the requirements for that component as specified in this Standard;

b) Be used in accordance with its rating(s) established for the intended conditions of use; and

c) Be used within its established use limitations or conditions of acceptability.

3.2 A component of a product covered by this Standard is not required to comply with a specific component requirement that:

a) Involves a feature or characteristic not required in the application of the component in the product;

b) Is superseded by a requirement in this Standard; or

c) Is separately evaluated when forming part of another component, provided the component is used within its established ratings and limitations.

3.3 A component shall be used in accordance with its rating established for the intended conditions of use.

3.4 Specific components are incomplete in construction features or restricted in performance capabilities. Such components are intended for use only under limited conditions, such as certain temperatures not exceeding specified limits, and shall be used only under those specific conditions.

3.5 A component that is also intended to perform other functions such as overcurrent protection, ground-fault circuit-interruption, surge suppression, any other similar functions, or any combination thereof, shall comply additionally with the requirements of the applicable standard(s) that cover devices that provide those functions.

3.6 This Standard deals with the covered components used in accordance with CSA C22.2 No. 0.

4 Referenced Publications

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.

4.2 Power banks covered by this Standard shall comply with the referenced codes and standards noted in this Section as appropriate for the country where the power bank is to be used. When the power bank is intended for use in more than one country, the product shall comply with the codes and standards for all countries where it is intended to be used. Standards that are harmonized with each other are separated by a slash (/).

4.3 The following publications are referenced in this Standard.

CSA C22.2 No. 0, *General Requirements – Canadian Electrical Code, Part II*

CSA C22.2 No. 0.15, *Adhesive Labels*

CSA C22.2 No. 0.17, *Evaluation of Properties of Polymeric Materials*

CSA C22.2 No. 65, *Wire Connectors*

CSA C22.2 No. 153, *Electrical Quick-Connect Terminals*

CSA C22.2 No. 158, *Terminal Blocks*

CSA C22.2 No. 182.3, *Special Use Attachment Plugs, Receptacles and Connectors*

CSA C22.2 No. 188, *Splicing Wire Connectors*

CSA C22.2 E60730-1, *Automatic Electric Controls – Part 1: General Requirements*

CSA C22.2 No. 60691, *Thermal-Links – Requirements and Application Guide*

CSA C22.2 No. 62133-1, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications – Part 1: Nickel Systems*

CSA C22.2 No. 62133-2, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications – Part 2: Lithium Systems*

CSA C22.2 No. 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

IEC 60695-2-11, *Fire Hazard Testing – Part 2-11: Glowing/Hot-Wire Based Test Methods – Glow-Wire Flammability Test Method for End Products (GWEPT)*

IEC 60695-2-12, *Fire Hazard Testing – Part 2-12: Glowing/Hot-Wire Based Test Methods – Glow-Wire Flammability Index (GWFI) Test Method for Materials*

IEC 61951-2, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Secondary Sealed Cells and Batteries for Portable Applications – Part 2: Nickel-Metal Hydride*

IEC 61960-3, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Secondary Lithium Cells and Batteries for Portable Applications – Part 3: Prismatic and Cylindrical Lithium Secondary Cells, and Batteries Made from Them*

UL 248-14, *Low-Voltage Fuses – Part 14, Supplemental Fuses*

UL 310, *Electrical Quick-Connect Terminals*

UL 486A-486B, *Wire Connectors*

UL 486C, *Splicing Wire Connectors*

UL 486E, *Equipment Wiring Terminals for Use with Aluminum and/or Copper Conductors*

UL 746C, *Polymeric Materials – Use in Electrical Equipment Evaluations*

UL 796, *Printed Wiring Boards*

UL 969, *Marking and Labeling Systems*

UL 1434, *Thermistor-Type Devices*

UL 1642, *Lithium Batteries*

UL 1977, *Component Connectors for Use in Data, Signal, Control and Power Applications*

UL 2738, *Induction Power Transmitters and Receivers for use with Low Energy Products*

UL 60691, *Thermal-Links – Requirements and Application Guide*

UL 60730-1, *Automatic Electrical Controls – Part 1: General Requirements*

UL 62133-1, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications – Part 1: Nickel Systems*

UL 62133-2, *Secondary Cells and Batteries Containing Alkaline or Other Non-Acid Electrolytes – Safety Requirements for Portable Sealed Secondary Cells, and for Batteries Made From Them, for Use in Portable Applications – Part 2: Lithium Systems*

UL 62368-1, *Audio/Video, Information and Communication Technology Equipment – Part 1: Safety Requirements*

5 Glossary

5.1 For the purpose of these requirements the following definitions apply.

5.2 BATTERY – General term for a single cell or a group of cells connected together either in a series and/or parallel configuration. May be ready for use or may be an installed component. May be a primary battery or secondary battery. See 5.4 and 5.5.

5.3 BATTERY, BUILT-IN – A single cell, or group of cells connected together either in a series and/or parallel configuration, accompanied by protecting circuit, to be installed in the power bank.

NOTE: The term “battery(ies)” refers to single or multicell batteries.

5.4 BATTERY, PRIMARY – A battery which can only be discharged once. It is not designed to be rechargeable and must be protected from a charging current.

5.5 BATTERY, SECONDARY – A battery that is intended to be discharged and recharged many times in accordance with the manufacturer’s specifications.

5.6 BATTERY PROTECTION CIRCUIT, or BATTERY MANAGEMENT SYSTEM (BMS) – Electronic system associated with a battery which has functions to control current in case of overcharge, overcurrent, overdischarge, and overheating and which monitors and/or manages the battery's state, calculates secondary data, reports that data and/or controls its environment to influence the battery's safety, performance and/or service life.

5.7 C_5 AMP RATE – The current, in amperes, that a cell or battery can be discharged at for 5 h to the voltage cutoff point specified by the manufacturer.

5.8 CAPACITY, RATED – The capacity, in ampere-hours, of a cell or battery determined under specified load, temperature and voltage conditions and declared by the manufacturer.

5.9 CASING – The outer rigid can or flexible pouch of an individual cell that contains the internal components of that cell.

5.10 CELL – The basic functional electrochemical unit containing an assembly of electrodes, electrolyte, container, terminals, and usually separators, that is a source of electrical energy by direct conversion of chemical energy.

5.11 CELL OPERATING REGION – The conditions during charging and discharging in which the cell operates within its voltage and current and temperature range as specified by the cell manufacturer.

5.12 CHEESECLOTH – Bleached cotton cloth of approximately 40 g/m^2 (1.18 oz/yd^2).

5.13 COMPONENT, CURRENT-LIMITING – Any component employed to limit current during abnormal conditions. Current-limiting components include resistors, fuses, or PTC thermistor type devices.

5.14 COMPONENT, TEMPERATURE-LIMITING – Any component used to limit temperature during abnormal conditions. Temperature-Limiting Components include thermal protectors and thermal cutoffs.

5.15 CURRENT, ABNORMAL CHARGING – Also called overcharge current for secondary cells; maximum rated charging current to a cell or battery under fault condition.

5.16 DIRECT PLUG-IN CONSTRUCTION – A construction which employs a blade assembly on the enclosure for connection to the ac mains circuit.

5.17 DISCHARGE, FORCED – Subsequent discharge of one fully discharged cell in each parallel string by connecting in series with cells of the same kind so as to drive the cell into polarity reversal.

5.18 DISCHARGED, FULLY – A condition of battery energy potential representing depletion to its end-of-discharge voltage as specified by the manufacturer.

5.19 ENCLOSURE – The outer housing of a power bank that provides mechanical protection and a level of fire protection for internal cells and components of the power bank.

5.20 END-OF-DISCHARGE VOLTAGE – Specified voltage of a battery at which the battery discharge is terminated.

5.21 EXPLOSION – A condition that occurs when a cell container or power bank enclosure violently opens and major components are forcibly expelled.

5.22 MAXIMUM CHARGING CURRENT – The maximum charging current in the cell operating region, which is specified by the cell manufacturer.

5.23 MAXIMUM CONTINUOUS DISCHARGE CURRENT – The specified highest current that can be delivered continuously by a cell or battery under normal load conditions that permits repeated cycles.

5.24 PORTABLE – Easy to be moved or carried by hand.

5.25 POWER BANK - Also known as portable USB chargers or portable back-up battery power. A standalone, portable power supply with built-in lithium or nickel battery and dc/dc converter circuitry for mobile use of powering electronic devices through USB or similar universal interfaces.

5.26 PROTECTIVE DEVICES – Any device such as a field effect transistor (FET), fuse, diode or current limiter which stops the current flow, blocks the current flow in one direction or limits the current flow in an electrical circuit.

5.27 SHORT CIRCUIT – A direct connection between positive and negative terminals of a cell or power bank that provides a virtual zero resistance path for current flow.

5.28 SMALL PART – The part with a size of less than 1750 mm^3 (0.107 in^3); or a mass of the material that is capable of being ignited or burned of less than 4 g (0.141 oz).

5.29 TISSUE PAPER – Tissue between 12 g/m^2 (8.108 lb) and 30 g/m^2 (20.27 lb).

5.30 UPPER LIMIT CHARGING VOLTAGE – Highest charging voltage in the cell operating region, which is specified by the cell manufacturer.

5.31 VENTING or VENT(S) – A condition that occurs when the cell releases excessive internal pressure in a manner intended by design to preclude rupture, explosion or self-ignition.

5.32 VOLTAGE, ABNORMAL CHARGING – Maximum specified charger output voltage applied to a cell or battery under fault condition.

CONSTRUCTION

6 General

6.1 Casing and enclosure

6.1.1 The enclosure of a power bank shall have the strength and rigidity required to resist the reasonably foreseeable abuses, that it is exposed to during its reasonably foreseeable use, in order to reduce the risk of fire or injury to persons.

6.1.2 The enclosure of a power bank shall be rigid enough to prevent flexing that would result in damage to the cells or internal protective components. A tool providing the mechanical advantage of a plier, hacksaw, or similar tool, shall be the minimum mechanical capability required to open the power bank enclosure.

6.1.3 For a power bank with a plastic outer enclosure, the outer enclosure shall be designed such that it is not capable of being opened using simple tools, such as a screwdriver. The enclosure shall be ultrasonically welded, or permanently secured by equivalent means. Adhesives complying with the adhesive requirements of UL 746C or CSA C22.2 No. 0.17, single use or tamper-proof screws are considered equivalent means.

6.1.4 All outer enclosure material of the power bank shall be classed as V-1 or less flammable (e.g. V-0, 5VB, 5VA) in the minimum part thickness in accordance with UL 94 or CSA C22.2 No. 0.17 and with a glow wire flammability index (GWFI) of 750 ºC (1382 ºF) or higher in the minimum part thickness is accordance with IEC 60695-2-12. Enclosure material without suitable GWFI but passing the glow-wire test at 750 ºC (1382 ºF) according to IEC 60695-2-11 is acceptable as an alternative.

Exception: Materials are not required to be classed as V-1 or less flammable when they comply with the Enclosure Flammability – 20 mm (3/4 inch) Flame test described in UL 746C or CSA C22.2 No. 0.17.

6.1.5 Nonmetallic materials used for internal parts within the overall enclosure shall be rated V-2 minimum (e.g. V-2, V-1, V-0, 5VB, 5VA).

6.1.6 Small parts, and gaskets, that are not located near live parts, and are located in a manner such that they cannot propagate flame from one area to another within the equipment, are not required to have a specific flame rating.

6.1.7 No openings in power bank enclosures shall be permitted to prevent damage to cells, connections, and internal circuitry and shorting of electrical spacings within the pack.

Exception: Openings for power input/output and pressure venting are permitted. Enclosure openings are permitted to be located over cells that comply with the rigid casing requirements of 6.1.2 or over protective circuitry and connections where damage or shorting from debris entering the enclosure shall not result in a hazard.

6.2 Cells

6.2.1 The lithium cell of a power bank shall comply with either UL 1642 or UL 62133-2 / CSA C22.2 No. 62133-2.

6.2.2 The nickel cell of a power bank shall comply with either UL 2054 or UL 62133-1 / CSA C22.2 No. 62133-1.

6.2.3 For other chemistry of cell types, the cell shall comply with the related safety standard requirements.

6.3 Wiring and terminals

6.3.1 Wiring shall be insulated and acceptable for the purpose, when considered with respect to temperature, current, and voltage to which the wiring is likely to be subjected within the power bank.

6.3.2 All wiring connections shall be mechanically secured and shall provide electrical contact without strain on connections and terminals. Wiring shall be secured and routed away from sharp edges or other parts that may compromise wiring insulation.

6.3.3 Wiring splices and twist connectors shall not be permitted for power banks.

6.3.4 All electrical connections, such as splicing wire connectors, quick-connect terminals, terminal connectors, multi-pin and other forms of wire connectors, shall comply with the following standards:

a) UL 310 / CSA C22.2 No. 153;

b) UL 486A-486B / CSA C22.2 No. 65;

c) UL 486C / CSA C22.2 No. 188;

d) UL 486E or CSA C22.2 No. 158 or CSA C22.2 No. 65;

e) UL 1977 or CSA C22.2 No. 182.3.

Exception: This requirement is not applicable to the following types of connections:

a) Brazed or welded connections;

b) Soldered connections on printed circuit boards; or

c) Connections on small components that are mounted on printed circuit boards located in a low-voltage circuit.

6.4 External power bank connectors

6.4.1 An external power bank connector shall be constructed to prevent inadvertent short circuiting of its terminals. Examples of methods to prevent inadvertent short-circuiting include recessing the terminals, providing circuitry that prevents inadvertent short circuiting, providing covers over the terminals, use of keyed connectors, and the like.

6.4.2 Insulating material for external power bank connectors, outside the enclosure, shall have a V-2 minimum flame rating. External connectors forming part of the fire enclosure shall be V-1 minimum.

6.5 Printed wiring boards

6.5.1 Printed wiring boards with or without mounting circuit components shall be rated V-1 minimum and comply with UL 796.

6.6 Lithium ion systems only

6.6.1 The voltage and temperature of each cell or each cellblock consisting of parallel-connected plural cells shall not exceed the upper limit charging voltage and temperature specified by the cell manufacturer.

6.6.2 For the power bank consisting of a single cell or a single cellblock, it shall be confirmed that the charging voltage and temperature of the cell does not exceed the upper limit charging voltage and temperature specified by the cell manufacturer.

6.6.3 For the power bank consisting of series-connected plural single cells or series-connected plural cellblocks, it shall be confirmed that the voltages and temperatures of any one of the single cells or single cellblocks do not exceed the upper limit charging voltage and temperature, specified by the cell manufacturer, by monitoring the voltage and temperature of every single cell or the single cellblocks.

6.6.4 Compliance for 6.6.1 – 6.6.3 can be achieved through analysis of the battery protection circuit or if unable to determine through analysis, then through monitoring values during the test of Sections 14 and 16.

6.7 Direct plug-in construction

6.7.1 For power banks with direct plug-in construction, the following shall be met:

a) The power bank and its built-in ac/dc power supply shall comply with the applicable requirements of UL 62368-1 / CSA C22.2 No. 62368-1.

b) A barrier shall be provided between the built-in ac/dc power supply and built-in battery pack. The barrier shall comply with the requirements of electrical insulation and fire enclosure of UL 62368-1 / CSA C22.2 No. 62368-1.

c) When the power bank is charged by an ac power source, the power bank shall not discharge.

6.8 Wireless charging and discharging function

6.8.1 The power bank that provides wireless charging or wireless discharging functions shall comply with the applicable requirements of UL 2738 or similar.

PERFORMANCE

7 General

7.1 Power banks are to be tested as described in Sections 12 – 26. The Forced-Discharge Test, Section 15, is applicable only to power banks with cells in multicell series applications.

7.2 Power banks or their cells shall not explode or catch fire as a result of the tests in this Standard. For the Steady Uniform Force Test, Section 22, and the Drop Impact Test, Section 25, the samples shall also not separate. For the Steady Uniform Force Test, Section 22, Flexing Force Test, Section 23, Mold Stress Relief Test, Section 24, and the Drop Impact Test, Section 25, the samples shall also not vent or leak. For these tests, unacceptable leakage is deemed to have occurred when the resulting mass loss exceeds 0.1 %.

7.3 Each output port shall be an ES1 energy source in accordance with UL 62368-1 / CSA C22.2 No. 62368-1.

7.4 Unless indicated otherwise, the power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

8 Protective Devices

8.1 When a current-limiting component or temperature-limiting component that has been evaluated for the purpose (i.e. a positive temperature coefficient device complying with the tests specified in UL 1434 and UL 60730-1 or CSA C22.2 E60730-1, the Annex for Requirements for Thermistor Elements and Controls Using Thermistors, Annex J) activates as designed, testing shall be resumed as follows:

a) A resettable device that operates during the test – The test is to be continued allowing the device to cycle during the test;

b) A non-resettable device or resettable device that operates during the test but does not reset – The test is to be repeated with the battery pack connected to the maximum load that does not cause the protective device to trip; and

c) A current-limiting or temperature-limiting device that has not been evaluated for the purpose is to be shorted from the circuit prior to testing.

9 Samples

9.1 Unless otherwise indicated, power banks in the fully charged state are to be used for the tests. The test program and number of samples to be used in each test is shown in Table 9.1.

Table 9.1
Testing required for power banks

Test	Section	Number of fully charged packs
Electrical Tests		
Short-Circuit of Output Port Test	12	
at room temp.		5 (unsealed)
at 55 °C (131 °F)		5 (unsealed)
Abnormal Charging of the Battery Test	13	5 (unsealed)
Abusive Overcharge of the Battery Test	14	5 (unsealed)
Forced-Discharge of the Cells[a] Test	15	5 (unsealed)
Temperature Test and BMS Verification	16	2 (unsealed)
Power Input Test	17	1 (complete)
Overload of Output Ports Test	18	1 (unsealed)
Flammability of Photovoltaic Cells Test	19	1 (complete)
Capacity Verification Test	20	1 (complete)
Enclosure Tests		
Steady Uniform Force Test	22	3 (complete)
Flexing Force Test	23	2 (complete)
Mold Stress Relief Test	24	3 (complete)
Drop Impact Test	25	3 (complete)
Casing and Enclosure[b]	6.1.4	3 (+3, if necessary) unsealed enclosures
Miscellaneous Tests		
Label Permanence Test	26	1 (complete)

Table 9.1 Continued on Next Page

Table 9.1 Continued

Test	Section	Number of fully charged packs
NOTE – Unsealed refers to power banks which do not use securement such as adhesive and/or ultrasonic welding to seal the top and bottom enclosures in order to facilitate access to the inside of the power bank. Complete refers to a whole sample of the power bank representative of production.		
[a] Forced Discharge test is conducted only for multi-cell series configurations. [b] Enclosure materials classified as V-1 or less flammable (e.g. V-0, 5VB, 5VA) in the minimum part thickness do not require enclosure flammability tests.		

9.2 All power banks shall be fully charged in accordance with the manufacturer's specifications prior to testing except for the samples to be subjected to the Abnormal Charging and Abusive Overcharge Tests, which shall be discharged to the manufacturer specified end-of-discharge voltage using the manufacturer specified current prior to testing.

10 Important Test Considerations

10.1 As some power banks explode in the tests, it is important that personnel be protected from the flying fragments, explosive force, sudden release of heat, chemical burns, and noise results from such explosions. The test area is to be well ventilated to protect personnel from possible harmful fumes or gases.

10.2 The temperatures on the surface of the cell casings shall be monitored during the tests described in Sections 12, 13, 14, 15, 16 and 18. All personnel involved in the testing of power banks are to be instructed never to approach a sample until the surface temperature returns to ambient temperature.

11 Temperature Measurements

11.1 Temperatures are to be measured by thermocouples consisting of wires not larger than 0.21 mm^2 (24 AWG) and not smaller than 0.05 mm^2 (30 AWG) and a potentiometer-type instrument.

11.2 The temperature measurements on the power bank are to be made with the measuring junction of the thermocouple held tightly against the outer enclosure of the power bank.

ELECTRICAL TESTS

12 Short-Circuit of Output Port Test

12.1 Each fully charged test sample power bank, in turn, is to be short-circuited by connecting the positive and negative output port terminals of the power bank with a circuit load having a resistance load of 80 ±20 mΩ. The temperature of the internal cell casing is to be monitored during the test. The power bank is to discharge until a fire or explosion is obtained, or until it is completely discharged and/or the cell case temperature has returned to ±5 °C (±9 °F) of ambient temperature.

12.2 Tests are to be conducted at ambient temperatures of 20 ±5 °C (68 ±9 °F) and at 55 ±5 °C (131 ±9 °F). The power banks are to reach equilibrium at 20 ±5 °C (68 ±9 °F) or 55 ±5 °C (131 ±9 °F), as applicable, before the terminals output are connected.

12.3 Power bank constructions are to be subjected to a single fault across any protective device in the load circuit of the power bank under test. When protective devices actuate during the test, the test shall be repeated with the power bank connected to the maximum load that does not cause the protective devices to open. See 5.26.

Exception: A positive temperature coefficient device which complies with the tests specified in UL 1434, CSA C22.2 E60730-1 or UL 60730-1, or other protective devices determined to be reliable, may remain in the circuit without being faulted. See 5.26. Other standards that may apply are UL 248-14 / CSA C22.2 No. 248.14 and UL 60691 or CSA C22.2 No. 60691.

12.4 One of the five test sample power banks, tested at ambient temperature of 20 ±5 °C (68 ±9 °F) shall be evaluated with the following additional conditions in place. The output terminals are to be subjected to a resistive circuit load and shall have a maximum total resistance of 20 mΩ. The test is to be conducted on a tissue paper covered soft wood surface and the sample power bank and bare conductor are to be covered with a single layer of cheesecloth.

12.5 For power banks which enable their output(s) while the input power is applied, one of the test sample power banks apply the process as in 12.4 with the following additional conditions in place. The input terminals are to be subjected to the maximum charging rate and the output terminals are to be subjected to a resistive circuit load shall have a maximum total resistance of 20 mΩ at the same time. The test is to be conducted on a tissue paper covered soft wood surface and the sample power bank and bare conductor are to be covered with a single layer of cheesecloth.

12.6 For lithium chemistries, one of the test sample power banks, tested at ambient temperature of 20 ±5 °C (68 ±9 °F) shall be evaluated with the following additional conditions in place. The built-in battery is to be discharged at an initial current of 1.2 times of the maximum continuous discharge current of the built-in battery. No need to apply the single fault condition on the built-in battery's BMS. The temperature of the cell casing and the discharge current of the cell shall be monitored. The discharge is to continue until the cell or battery explodes, vents, or BMS operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient. The test is to be conducted at the output point of the protecting circuit that accompanies the built-in battery. This means output converter circuitry of the power bank is to be bypassed to result in the evaluation of the protective circuitry for the battery.

12.7 For all samples tested, the samples shall not vent, explode, or catch fire and the tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing. The temperature of the cell casings shall not exceed 75 ±1 °C (167 ±2 °F) for lithium chemistries. For power bank samples tested in accordance with 12.4, there shall be no charring or burning of the cheesecloth or tissue paper. Charring is defined as a blackening of the cheesecloth caused by combustion. Discoloration of the cheesecloth caused by smoke is acceptable. For the sample tested by 12.6, the cell's discharge current shall be no greater than its maximum continuous discharge current of the operation region.

13 Abnormal Charging of the Battery Test

13.1 The power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F). A thermocouple is to be attached to the cells of each test sample power bank. Each power bank shall be discharged at a constant current of 0.2C/1 h, to a manufacturer specified end-of-discharge voltage of the built-in battery.

13.2 For lithium chemistries, one of the above five test samples in 13.1 shall be evaluated with the following additional conditions. The input voltage converter circuitry of the power bank is to be bypassed to result in evaluation of the lower limit discharge voltage protective circuitry for the built-in battery. The built-in battery is to be discharged at a constant current of 0.2C/1 h, to 10 % deeper than the manufacturer specified end-of-discharge voltage. No need to apply the single fault condition on the battery BMS. The temperature of the cell casing and the voltage of the cell shall be monitored. The discharge is to continue until the cell or battery explodes, vents, or BMS operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient.

13.3 Each test sample power bank is to be subjected to the following abnormal charging conditions, in sequential order.

a) The test is to be conducted at the input point of the protecting circuit that accompanies the built-in battery. This means input voltage converter circuitry of the power bank is to be bypassed to result in evaluation of the protective circuitry for the battery.

b) The built-in battery is to be initially charged at the input point (a) using a constant current charging mode with an abnormal charging current limit of three times the built-in battery's maximum current specified by the manufacturer until the maximum specified abnormal charging voltage is reached. At that point, the built-in battery is to be charged with a constant maximum specified abnormal charging voltage of the built-in battery and an abnormal charging current limit of three times the battery maximum current. Charging duration is the time required to reach the manufacturer's specified end-of-charge conditions (voltage and current) plus seven additional hours. The temperature on the cell casing shall be monitored. A re-settable protective device such as a PTC that actuates during the test shall be allowed to reset and the test shall be resumed, cycling as often as necessary, but no less than 10 times, to complete the test. Automatic reset devices are allowed to cycle during the test. When an overcurrent protective device operates during the test, the test is repeated with the same charging time, but with the battery connected to the maximum source that does not cause the protective devices to operate.

NOTE: The current of three times the maximum current I_c calculation is based on the maximum current of built-in battery, not the maximum current of power bank.

c) The charge condition in accordance with (b) shall be conducted with each single component fault that is likely to occur in the battery protection circuit and which would result in overcharging of the built-in battery.

Exception: A protective device determined to be reliable may remain in the circuit without being faulted. See 8.1 and 5.26.

13.4 For lithium chemistries, one of the test samples in 13.3 shall be evaluated with the following additional conditions in place. The built-in battery is to be initially charged at the input point in 13.3(a) using a constant current charging mode with an abnormal charging current of 20 % greater than the built-in battery's maximum current, specified by the manufacturer until the built-in battery's maximum specified charging voltage is reached. No need to apply the single fault condition on the battery BMS. The temperature of the cell casing and the charging current for the built-in battery shall be monitored. The test is to continue until the cell or battery explodes, vents, or BMS operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient.

13.5 During the test, the temperature of the cell casings shall not exceed 90 ±1 °C (194 ±2 °F) for lithium chemistries.

13.6 The samples shall not vent, explode, or catch fire. For power bank samples, tests shall not result in chemical leaks caused by cracking, rupturing or bursting of the cell casing. For the sample tested in accordance with 13.2, the voltage of the cell shall not be lower than its end-of-discharge voltage of the operation region. For the sample tested in accordance with 13.4, the charging current of the cell shall not exceed its maximum charging current of the operation region.

14 Abusive Overcharge of the Battery Test

14.1 The power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

14.2 The tests are to be conducted at the input point of the protecting circuit that accompanies the built-in battery. This means input voltage converter circuitry of the power bank is to be bypassed to evaluate the protection circuit for the built-in battery.

14.3 The built-in batteries are to be subjected to a constant charging current at the input point of 14.2 at 10 times the C_5 amp rate, using a supply voltage sufficient to maintain the 10 times C_5 amp rate throughout the duration of the test. During the test, the temperature is to be measured on the internal cell casing of each sample. The test is to continue until the cell or battery explodes, vents, or a single operation protective device operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient. If a PTC or other re-settable protection device operates during the test, it is to be reset a minimum of 10 times during the test. An automatic reset device is allowed to cycle during the test.

14.4 The charge condition in accordance with 14.2 shall be conducted with each single component fault that is likely to occur in the battery protection circuit and which would result in overcharging of the built-in battery.

Exception: Protective devices determined to be reliable, may remain in the circuit without being faulted.

14.5 For lithium chemistries, one of the above test samples in 14.3 shall be evaluated with the following additional conditions in place. The built-in battery is to be subjected to a constant charging maximum current Ic, specified by the manufacturer at the input point of 14.2 with a supply voltage 1.1 times the upper limit charging voltage for single cell/cell block batteries or 1.1 times the upper limit charging voltage per cell for series connected multi-cell batteries. No need to apply the single fault condition on BMS. The temperature on the cell casing and the charging voltage for the cell/cell block shall be monitored. The test is to continue until the cell or battery explodes, vents, or BMS operates, and the temperature of the internal cell casing reaches steady state conditions or returns to ambient.

14.6 At least one of the five samples shall be subjected to the test outlined in 14.3 and 14.4 with a constant current charge 5 times the C_5 amp rate (e.g. at the C rate) with a supply voltage sufficient to maintain that rate throughout the duration of the test.

14.7 During the test, the temperature of the cell casings shall not exceed 90 ±1 °C (194 ±2 °F) for lithium chemistries.

14.8 The samples shall not explode or catch fire. For the sample tested by 14.5, the charging voltage of the cell shall not exceed its upper limit charging voltage of the operation region.

15 Forced-Discharge of the Cells Test

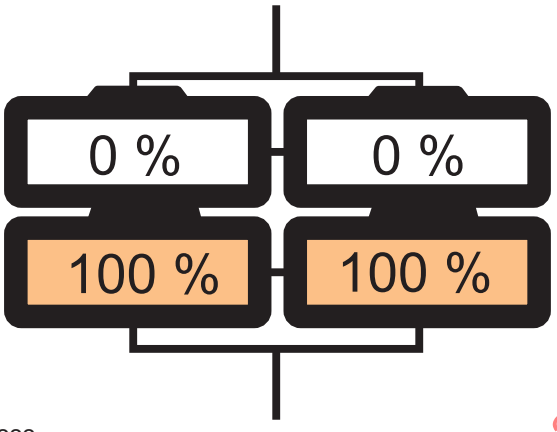
15.1 This test is intended for power banks with cells in multicell series applications cells that are to be used in multicell applications. The power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

15.2 For multi-cell series configurations without parallel strings a fully discharged cell is to be force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells to be connected in series with the discharged cell is to equal the total number of cells in the pack less one.

15.3 For multi-cell series configurations with parallel strings, a fully discharged parallel string is to be force-discharged by connecting it in series with fully charged cells of the same kind. The number of fully charged cells to be connected in series with the discharged parallel string is to equal the total number of cells in the pack less the number of cells in the discharged parallel string. See Figure 15.1.

Figure 15.1

Example of Discharged Parallel String



su5222

15.4 Each of the five power banks shall be prepared as described in 15.2 or 15.3, as applicable.

15.5 Once the fully discharged cells (or string of cells) are connected in series with the specified number of fully charged cells, the resultant battery is to be short circuited.

15.6 The positive and negative terminals of the sample are to be connected with a copper wire with a resistance load of 80 ±20 mΩ. The power bank is to discharge until a fire or explosion is obtained, or until it has reached a completely discharged state and the cell case temperature has returned to ±10 °C (±18 °F) of ambient temperature.

15.7 During the tests, power banks supplied with protective devices shall be subjected to a single component fault using any single fault condition which is likely to occur in the discharge circuit and which would result in excessive discharge of the battery.

Exception: A positive temperature coefficient device which complies with the applicable tests specified in UL 1434 and UL 60730-1 or CSA C22.2 E60730-1, or other protective devices determined to be reliable, may remain in the circuit without being faulted. Other standards that may apply are UL 248-14 / CSA C22.2 No. 248.14 and UL 60691 or CSA C22.2 No. 60691.

15.8 The samples shall not explode or catch fire.

16 Temperature Test and BMS Verification

16.1 A power bank shall be subjected to a normal temperature test under both input (charging) and output (discharging) conditions. As a result of this testing, temperatures on temperature sensitive components shall not exceed the limits outlined in Table 16.1 and Table 16.2.

Table 16.1
Normal Temperature Limits – Component

Part	Maximum temperature (T_{max}) °C (°F)
Synthetic rubber or PVC insulation of internal and external wiring	
– without temperature marking	75 (167)
– with temperature marking	The temperature marking
Components, insulation, and thermoplastic materials	a
Cell casing	b

[a] Temperatures measured on components and materials shall not exceed the maximum temperature rating for that component or material including internal cells.

[b] The cell casing temperature shall not exceed the manufacturer's recommended maximum temperature and shall not exceed the maximum temperature of 75 °C (167 °F).

Table 16.2
Normal Temperature Limits – Surface

Accessible surfaces	Maximum temperature (T_{max})	
	Metal °C (°F)	Plastic[a] °C (°F)
Accessible parts held continuously during normal use	55 (131)	75 (167)
Accessible surfaces held or touched for short periods only	60 (140)	75 (167)
Accessible surfaces which may be touched	70 (158)	75 (167)

[a] Temperatures measured on accessible plastic enclosure surfaces shall not exceed the temperature ratings of the materials.

16.2 For the output loading temperature test, a fully charged power bank shall be subjected to a constant resistive loading across the output ports of the power bank, at the maximum rated current of the output ports. Temperatures and cell voltages are monitored until thermal stabilization or until the built-in battery is at its rated end-of-discharge voltage, whichever comes first.

16.3 For the input loading temperature test, a fully discharged power bank shall be subjected to charging at maximum current as specified by the manufacturer. Temperatures and cell voltages are monitored until thermal stabilization or until the built-in battery is at its fully charged state, whichever comes first.

16.4 Temperatures are considered to be stabilized when three successive readings taken at intervals of 10 % of the previously elapsed duration of the test, but not less than 15 min, indicate no further increase.

16.5 Protective devices within the pack shall not operate during the test.

16.6 Temperatures are monitored on surfaces of components using thermocouples. Thermocouples are to consist of 0.05 mm^2 (30 AWG) wires. Larger size wires may be used, but they shall not exceed 0.21 mm^2 (24 AWG) and shall not be large enough to result in a heat sink condition on the part under test.

16.7 During the normal temperature test, temperature measurement *T* shall not exceed:

$$T_{max} + T_{amb} - T_{ma}$$

Where:

T is the temperature of the given part measured under the prescribed test.

T_{max} is the maximum temperature specified for compliance with the test.

T_{amb} is the ambient temperature during the test.

T_{ma} is the maximum ambient temperature permitted by the manufacturer's specification, or 25 °C (77 °F), whichever is greater.

During the test T_{amb} should not exceed T_{ma} unless agreed by all parties involved.

16.8 During the normal temperature test, cell voltages shall not be below the end-of-discharge voltage of the operation region in the output loading temperature test, and the cell voltages shall not exceed the upper limit charging voltage of the operation region in the input loading temperature test.

17 Power Input Test

17.1 The current input to a power bank shall not exceed 110 % of the marked input current rating of the power bank, when the power bank is operated under the conditions of maximum normal load.

17.2 Maximum normal load shall consist of the maximum power draw while the power bank is operating in all possible modes including the battery at different states of charge. This may include charging the built-in battery, output ports unloaded or loaded at the rated maximum normal load and the operation of auxiliary functions such as flashlight, speaker, etc. Any load that can be operated at the same time shall be considered in order to obtain the maximum normal load.

18 Overload of Output Ports Test

18.1 Each power output pin of output port shall be overloaded in accordance with 18.2 – 18.5.

18.2 In accordance with manufacturer's specifications, fully charge the built-in battery of power bank.

18.3 The power bank is covered with one layer of cheesecloth and placed on a softwood board covered with one layer of tissue paper.

18.4 Each power output pin of output port shall then be loaded to draw the maximum power, for 1 h or the maximum duration of operation permitted by the battery pack, whichever is less. For power banks which enable their output(s) while the input power is applied, the input terminals are to be subjected to the maximum charging rate at the same time during this test.

18.5 During the test, the samples shall not vent, explode, or catch fire. After this test, the cheesecloth and tissue paper shall remain intact (e.g. no discoloration or minor charring). The cell casing temperature shall not exceed the manufacturer's recommended maximum temperature.

19 Flammability of Photovoltaic Cells Test

19.1 This test shall be conducted if the power bank is provided with integral photovoltaic cells as a power source.

19.2 In accordance with manufacturer's specifications, fully charge the built-in battery of the power bank.

19.3 The power bank is covered with one layer of cheesecloth and placed on a softwood board covered with one layer of tissue paper.

19.4 The power bank is subjected to single component fault that is likely to occur and which would result in flammability issue of the photovoltaic cells, such as back-feed of battery power, and is kept in this state for 1 h.

19.5 During this test, the battery shall not vent, explode, or catch fire. After this test, the cheesecloth and tissue paper shall remain intact (e.g. no discoloration or minor charring).

20 Capacity Verification Test

20.1 The marked electrical capacity of power bank, measured at the power output pin of output port, shall comply with IEC 61960-3, Clause 7.3.1, Discharge Performance at 20 °C (Rated Capacity) for lithium cell power bank or IEC 61951-2, Clause 7.3.2.3, Discharge performance for batteries at rated capacity (20 °C) for nickel cell power bank, and the modified test method in 20.2.

20.2 The power bank is discharged at a constant current equal to rated current of the output port, until its voltage is equal to the end-of-discharge voltage of the output port, specified by the manufacturer.

ENCLOSURE TESTS

21 General

21.1 The power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

21.2 Power banks with outer plastic enclosures shall be subjected to the tests described in Sections 22, 23, 24, and 25. Power banks with outer enclosures made from materials other than plastic, shall be subjected to the tests described in Sections 22, 23, and 25.

22 Steady Uniform Force Test

22.1 The power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

22.2 The built-in battery of the power bank shall be fully charged in accordance with the manufacturer's specifications.

22.3 External enclosures of the power bank are to be subjected to a steady force at a rate of 10 ±2.5 N/s (2.25 ±0.56 lbf/s) up to 250 ±10 N (56 ±2 lbf) and held for a period of 30 s, applied in turn to the top, bottom and sides of the power bank enclosure by means of a suitable test tool providing contact over a circular plane surface 30 mm (1.2 inch) in diameter. For cylindrical power banks, using external means to secure the product from rolling to allow the sides to be tested would be acceptable. Each side of a cylindrical power bank would be 90° rotation along the longitudinal axis.

22.4 The samples shall not explode or catch fire. The outer enclosure shall not crack to the extent that the cells or any protective devices are exposed.

22.5 The enclosure shall not separate as a result of the application of the steady force in accordance with 22.3.

22.6 The sample shall be examined 6 h after testing and shall not vent, flame, explode, or leak as described in 7.2.

23 Flexing Force Test

23.1 Two power banks are to be tested in an ambient temperature of 20 ±5 °C (68 ±9 °F).

23.2 Each sample is to be tested in accordance with 23.3 – 23.6. The second sample shall be tested rotated 180° about its longitudinal axis from the orientation of the first sample.

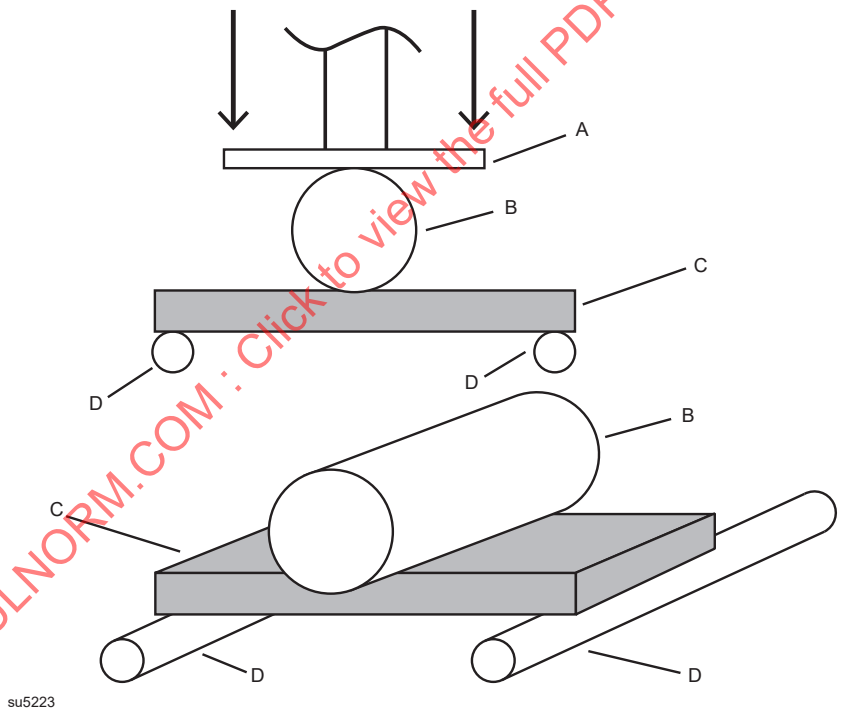
Exception: Power banks with all external dimensions greater than 40 mm (1.6 inch) do not apply.

23.3 The built-in battery of the power bank shall be fully charged in accordance with manufacturer's specifications.

23.4 The test shall be set up as shown in Figure 23.1 using a suitable test tool providing contact with the center rod through a flat plate with a circular plane surface 30 mm (1.2 inch) in diameter.

Figure 23.1

Flexing Force Test



A – 30-mm (1.2-inch) circular plane surface

B – 12.7-mm (1/2-inch) metal rod

C – Power bank

D – 3.175-mm (1/8-inch) metal rod