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STANDARDS PUBLICATION/NO. IB 2-1974

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determination of capacity of lead-acid industrial storage batteries for motive power service

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 155 EAST 44TH STREET, NEW YORK, N.Y. 10017

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CAPACITY DETERMINATION OF LEAD-ACID INDUSTRIAL STORAGE BATTERIES FOR MOTIVE POWER SERVICE

SCOPE

This NEMA Standards Publication covers performance requirements, test conditions and methods for determining the 6-hour amperehour capacity of lead-acid industrial storage batteries for motive power service.

These standards are periodically reviewed by the Industrial Storage Battery Section of NEMA for any revisions necessary to keep them up-to-date with advancing technology.

Proposed or recommended revisions should be submitted to:

Technical Director
Manager, Engineering and Safety Regulations Department
National Electrical Manufacturers Association
155 East 44th Street
New York, New York 10017

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IB 2-1.01 DEFINITIONS

The terms used in this publication shall be defined in accordance with the "NEMA Standards Publication for Definitions for Lead-acid Industrial Storage Batteries," IB 1-1971, if applicable.

NEMA Standard 1-17-1974.

IB 2-1.02 PERFORMANCE REQUIREMENTS

A new battery shall deliver a minimum of 90 percent of its rated 6-hour amperehour capacity on or before the third cycle, and a minimum of 100 percent on or before the tenth cycle, when all cycles are performed in accordance with Part 4, Test Methods.

A battery shall deliver a minimum of 80 percent of its rated 6-hour amperehour capacity throughout its life when tested in accordance with Part 4, Test Methods.

NEMA Standard 1-17-1974.

IB 2-1.03 TEST CONDITIONS

A. Charged and Dry Batteries

A charged and dry battery shall be filled with electrolyte and charged in accordance with the manufacturer's published instructions.

B. State of Charge

Batteries shall be fully charged in accordance with the manufacturer's published instructions within 24 hours prior to the start of the test discharge.

C. Voltage

The final voltage of the battery shall equal 1.70 volts times the number of cells.

The battery voltage shall be measured on the post of the terminal cells, excluding the battery cables.

D. Electrolyte Level

The electrolyte level shall be adjusted in accordance with the manufacturer's published instructions.

E. Temperature

The electrolyte temperature during charging shall be within the range of 65°F (18.3°C) through 115°F (46.1°C).

The ambient temperature during the test discharge shall be within the range of 72°F (22.2°C) through 93°F (33.9°C).

The electrolyte temperature of all cells at the start of a test discharge shall be within the range of 72°F (22.2°C) through 87°F (30.6°C).

F. Specific Gravity

The specific gravity of the electrolyte of a fully charged battery, when corrected to 77°F (25°C) and with the electrolyte at the maximum level, shall be within the range shown on the battery nameplate or in the manufacturer's published instructions.

If the specific gravity of the electrolyte of any cell is not within the specified range, the electrolyte shall be adjusted in accordance with the manufacturer's published instructions.

A method of correcting the specific gravity of the electrolyte to a temperature of 77°F (25°C) is to add 0.001 specific gravity units (one point) to the specific gravity reading for every 3°F (1.67°C) of electrolyte temperature above 77°F (25°C) and to subtract a like amount for every 3°F (1.67°C) below 77°F (25°C). (This paragraph is approved as Authorized Engineering Information.)

G. Readings

All voltage, specific gravity and temperature readings shall be taken from the positive terminal cell to the negative terminal cell, recorded in series and numbered.

H. Test Equipment

All equipment shall be clean, in good working order and calibrated.

1. Thermometer—Thermometers shall be graduated so that each scale division will not represent more than 2°F (1.1°C) and shall have an accuracy of at least plus-or minus 1°F (0.56°C).

2. Hydrometers—Hydrometers shall be graduated so that each scale division will not represent more than 0.005 units of specific gravity (5 points) and shall have an accuracy of at least plus-or-minus 0.0025 units of specific gravity.

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3. Voltmeters—Meter accuracy shall be a minimum of 0.5 percent of the full-scale value with a minimum resistance of 1000 ohms per volt.

Galvanometer-type voltmeter graduations shall be in accordance with the following:

Voltage Range, Volts	Maximum Voltage Per Scale Division, Volts
0 to 3	0.02
3 to 15	0.1
15 to 75	0.2
75 to 150	1.0

4. Ammeters — Galvanometer-type ammeters shall be graduated to have a minimum of one hundred scale divisions. Ammeters shall be used with an appropriate shunt so that current readings will fall in the upper third of the meter scale. The meter and shunt, including shunt leads, shall have an accuracy of at least 0.5 percent of the full-scale value.

5. Shunts—The size of the shunt used on a discharge shall have a current rating between the discharge rate and 1.5 times the discharge rate in amperes. The accuracy of shunts shall be within 0.5 percent of full value.

6. Timers—Timers shall be graduated so that each division will represent not more than 1 minute and, during a 360-minute period, shall have an accuracy of at least plus-or-minus 2 minutes.

I. Pilot Cell

A pilot cell shall be selected for every six cells in the battery in locations which represent average conditions.

NEMA Standard 1-17-1974.

IB 2-1.04 TEST METHODS

A. Prior to completion of the charge, the voltage, temperature, specific gravity and charging rate of all cells shall be recorded.

B. The pilot cell temperature and specific gravity readings shall be recorded just prior to the start of the test discharge.

C. When all of the requirements of IB 2-1.03, Test Conditions, have been met, the test discharge shall be initiated.

D. The discharge current shall be maintained within plus or minus 1 percent of a rate in amperes equal to one-sixth of the battery's rated 6-hour amperehour capacity until the battery voltage at the terminal cells equals 1.70 volts times the number of cells.

E. The battery voltage shall be recorded at 30-minute intervals until it reaches an average of 1.80 volts times the number of cells, at which time individual cell voltages shall be recorded. The battery voltage shall then be recorded at 5-minute intervals until it reaches an average of 1.70 volts per cell (final voltage).

F. The elapsed time to final voltage shall be recorded.

G. At the completion of the test discharge, the temperature and specific gravity of the electrolyte of all cells shall be recorded.

H. The actual capacity in amperehours obtained during the test discharge shall be the product of the discharge rate in amperes and the time in decimal hours required to reach final voltage.

I. If the electrolyte temperature at the start of the discharge differs from 77°F (25°C), the capacity in amperehours obtained shall be corrected by using the following formula:

$$\text{Corrected Capacity at } 77°F = \frac{\text{Actual Capacity}}{1 + 0.0025\,(t-77)}$$

Where—

t = the average pilot cell electrolyte temperature (°F) (see par. B).

0.0025 = capacity temperature coefficient.

J. The battery shall be recharged in accordance with the manufacturer's published instructions.

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APPENDIX A

During the development of these standards, International Electrotechnical Commission (IEC) Publication 254, first edition 1967, titled "Lead-Acid Traction Batteries," was reviewed. That publication is based on a 5-hour rate of discharge. This NEMA Standards Publication is based on a 6-hour rate of discharge.

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The purpose of NEMA Standards, their classification and status are set forth in certain clauses of the NEMA Bylaws, which are quoted below:

Purpose of Standards

National Electrical Manufacturers Association Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining the proper product for its particular need. Existence of a National Electrical Manufacturers Association Standard does not in any respect preclude any member or nonmember from manufacturing or selling products not conforming to the standard.

(Bylaw—Art. V, Sec. 1)

Definition of a Standard

A standard of the National Electrical Manufacturers Association defines a product, process or procedure with reference to one or more of the following: nomenclature, composition, construction, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Bylaw—Art. V, Sec. 2, Subsection A)

Dimensions

Where dimensions are given for interchangeability purposes, alternate dimensions satisfying the other provisions of the standards publication may be capable of otherwise equivalent performance.

(NEMA Policy Memorandum 84-2, dated June 7, 1984)

Classes of Standards

National Electrical Manufacturers Association Standards are of two classes:

1. NEMA Standard, which relates to a product commercially standardized and subject to repetitive manufacture, which standard has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon;
2. Suggested Standard for Future Design, which may not have been regularly applied to a commercial product, but which suggests a sound engineering approach to future development, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote thereon.

(Bylaw—Art. V, Sec. 2, Subsection B)

Authorized Engineering Information

Authorized Engineering Information consists of explanatory data and other engineering information of an informative character not falling within the classification of NEMA Standard or Suggested Standard for Future Design.

(Bylaw—Art. V, Sec. 6, 1st Sentence)

Official Standards Proposal

An Official Standards Proposal is an official draft of a proposed standard which is formally recommended to an outside organization(s) for consideration, comment and/or approval.

(Bylaw—Art. V, Sec. 4, Subsection A)

Identification of Status

Standards in NEMA Standards Publications are identified in the foreword or following each standard as "NEMA Standard" or "Suggested Standard for Future Design." These indicate the status of the standard. These words are followed by a date which indicates when the standard was adopted in its present form by the Association.

The material identified as "Authorized Engineering Information" and "Official Standards Proposal" is designated similarly.

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INDUSTRIAL STORAGE BATTERY SECTION

OF THE

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION

MEMBER COMPANIES

CBC, Inc.
Hillside, Ill. 60162

C & D Batteries Div.
An Eltra Co.
Plymouth Meeting, Pa. 19462

East Penn Manufacturing Co., Inc.
Lyon Station, Pa. 19562

Exide Power Systems Div.
ESB Inc.
Philadelphia, Pa. 19120

General Battery Corp.
Reading, Pa. 19603

Globe Battery Div.,
Globe-Union, Inc.
Milwaukee, Wis. 53201

Gould, Inc.
Industrial Battery Div.
Trenton, N.J. 08607

KW Battery Co.
Subsidiary of Westinghouse Corp.
Skokie, Ill. 60076

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