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NEMA STANDARDS PUBLICATION NO. IB 2

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Determination of Capacity of Lead-Acid Industrial Storage Batteries for Motive Power Service

NEMA

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION ■ 2101 L STREET, N.W., WASHINGTON, D.C. 20037

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NEMA IB 2-1987

IB 2

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

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Foreword

This Standards Publication has been developed by the Industrial Battery and Charger Section of NEMA which periodically reviews them for any revisions necessary to keep them up-to-date with advancing technology. Comments or recommended revisions are welcome and should be submitted to:

Manager, Engineering Department
National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

This 1987 edition revises and supersedes IB 2-1974(1980). It incorporates updated test conditions and test methods.

The purpose of this Standards Publication is to provide the users and manufacturers of lead-acid industrial storage batteries for motive power service a standard testing procedure to determine constant power and constant current performance.

User input has been considered throughout the development of this Standards Publication.

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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.

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

Section 1

REFERENCED STANDARDS AND DEFINITIONS

1.1 REFERENCED STANDARDS

The following publications are adopted in whole or in part as indicated by reference in this Standards Publication.

National Electrical Manufacturers Association
2101 L Street, N.W.
Washington, D.C. 20037

IB 1-1982 *Definitions and Precautionary Labels for Lead-Acid Industrial Storage Batteries*

1.2 DEFINITIONS

The terms contained in this Standards Publication shall be defined in accordance with NEMA IB 1, as applicable.

NEMA Standard 11-19-1987.

Section 2

PERFORMANCE REQUIREMENTS

2.1 STATE OF CHARGE

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 Section 4.

NEMA Standard 11-19-1987.

2.2 VOLTAGE

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

NEMA Standard 11-19-1987.

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Section 3
TEST CONDITIONS

3.1 CHARGED AND DRY BATTERIES

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

NEMA Standard 11-19-1987.

3.2 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.

NEMA Standard 11-19-1987.

3.3 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.

NEMA Standard 11-19-1987.

3.4 ELECTROLYTE LEVEL

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

NEMA Standard 11-19-1987.

3.5 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 63 °F (17.2 °C) through 91 °F (32.8 °C).

The electrolyte temperature of all cells at the start of a test discharge shall be within the range of 63 °F (17.2 °C) through 91 °F (32.8 °C).

NEMA Standard 11-19-1987.

3.6 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.

NEMA Standard 11-19-1987.

The specific gravity of the electrolyte may be corrected to a temperature of 77 °F (25 °C) by adding 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) by subtracting a like amount for every 3 °F (1.67 °C) below 77 °F (25 °C).

Authorized Engineering Information 11-19-1987.

3.7 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.

NEMA Standard 11-19-1987.

3.8 TEST EQUIPMENT

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

NEMA Standard 11-19-1987.

3.8.1 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).

NEMA Standard 11-19-1987.

3.8.2 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.

NEMA Standard 11-19-1987.

3.8.3 Voltmeter 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 Table 3-1.

NEMA Standard 11-19-1987.

Table 3-1
GALVANOMETER-TYPE VOLTMETER GRADUATIONS

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

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3.8.4 Galvanometer-type ammeters shall be graduated to have a minimum of 100 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.

NEMA Standard 11-19-1987.

3.8.5 The size of the shunt used during 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.

NEMA Standard 11-19-1987.

3.8.6 Timing devices shall be accurate within plus-or-minus 0.05 percent of the specified discharge time.

NEMA Standard 11-19-1987.

3.9 PILOT CELL

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

NEMA Standard 11-19-1987.

Section 4
TEST METHODS

4.1 Individual cell voltage, temperature and specific gravity, as well as total battery voltage and charging rate, shall be recorded during the last 30 minutes of the charge.

NEMA Standard 11-19-1987.

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

NEMA Standard 11-19-1987.

4.3 When all requirements of Section 3 and 4.1 and 4.2 have been met, the test discharge shall be initiated.

NEMA Standard 11-19-1987.

4.4 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 the final voltage.

NEMA Standard 11-19-1987.

4.5 The battery voltage shall be recorded at 30 minute intervals until it reaches a value of 1.80 volts times the number of cells at which the individual cell voltages shall be recorded. The battery voltage shall then be recorded at 5 minute intervals until it reaches the final voltage. The elapsed time in hours to final voltage shall be recorded.

NEMA Standard 11-19-1987.

4.6 When the elapsed time to final battery voltage has been recorded, the voltage of each cell shall be recorded and the discharge test shall then be terminated. The temperature and specific gravity of the electrolyte of all cells shall be recorded within 10 minutes of the termination of the test discharge.

NEMA Standard 11-19-1987.

4.7 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.

NEMA Standard 11-19-1987.

4.8 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:

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

Where:

t = the average pilot cell electrolyte temperature (°F) (See 4.2)

0.0025 = capacity temperature coefficient.

NEMA Standard 11-19-1987.

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

NEMA Standard 11-19-1987.

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NEMA STANDARDIZATION

The purpose of NEMA Standards, their classification and status, are set forth in certain clauses of the NEMA *Standardization Policies and Procedures* manual and are referenced 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. *(Standardization Policies and Procedures, p. 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.
(Standardization Policies and Procedures, p. 2)

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.
(Standardization Policies and Procedures, p. 9)

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.

(Standardization Policies and Procedures, pp. 8 & 17)

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, which standard has been approved by at least two-thirds of the members of the Subdivision eligible to vote on the standard.
(Standardization Policies and Procedures, pp. 8 & 17)

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, and which has been approved by at least 90 percent of the members of the Subdivision eligible to vote thereon.
(Standardization Policies and Procedures, pp. 8 & 17)

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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