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NEMA STANDARDS PUBLICATION NO. BU 2

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Major Requirements Related to the Application and Testing of Low Voltage Busway

NEMA

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

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Major Requirements Related to the Application and Testing of Low Voltage Busway

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FOREWORD

In the preparation of this standards publication input of users and other interested parties has been sought and evaluated. Inquiries, comments, and proposed or recommended revisions should be submitted to the concerned NEMA product subdivision by contacting the:

Vice-President, Engineering
National Electrical Manufacturers Association
2101 L. Street, N.W.
Washington, DC 20037

SCOPE

This publication is intended to assist in understanding the application and testing of low voltage busway by giving a summary of the principal codes and standards applicable to the product. Since all codes and standards are revised from time to time and requirements vary from locality to locality, contact your local inspection authority and the manufacturer for the latest requirements applicable to your installation.

Groups which maintain standards enumerating busway construction and installation practices include:

a. Underwriters Laboratories, Inc.
b. The National Electrical Manufacturers Association
c. The National Fire Protection Association (The National Electrical Code)
d. State and local electrical codes
e. Power companies frequently specify minimum conductor sizes and spacing for connection to their equipment

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Section 1
REFERENCES AND REQUIREMENTS

1.1 REFERENCES

The publications referred to in the preceding discussions on testing and codes are as follows:

Underwriters Laboratories, Inc.
333 Pfingsten Road
Northbrook, Illinois 60062

UL 857-1990 — *Busways and Associated Fittings, Standard for Safety*

National Fire Protection Association
Batterymarch Park
Quincy, MA 02269

NFPA 70-1990 — *National Electrical Code*

National Electrical Manufacturers Association
2101 L Street, N.W. Suite 300
Washington, D.C. 20037

AB 1-1986 — *Molded Case Circuit Breakers*
BU 1-1988 — *Busways*
ICS 1-1988 — *General Standards for Industrial Control and Systems*
ICS 2-1988 — *Industrial Control Devices Controllers and Assemblies*
ICS 3-1988 — *Industrial Systems*
KS 1-1990 — *Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)*

1.2 UNDERWRITERS LABORATORIES REQUIREMENTS

Busway bearing the Underwriters Laboratories listing mark must pass a series of performance tests (see UL 857). Among the tests which may be required are:

1.2.1 Heating (Temperature Rise) Test

Busway with suitably plated joint connections must carry its rated current continuously without any part showing a temperature rise above ambient of more than 55°C. Tests are conducted on three 10-foot sections bolted together, at any convenient voltage, at design frequency, with rated current flowing.

1.2.2 Resistance to Impact Test

The Resistance to Impact Test will ordinarily not be required for non-ventilated busway if its construction conforms to the specifications spelled out in Table A. However, all other busway must be tested to ensure that no hazardous condition will exist after any side of the enclosure has been subjected to a blow from a 50-pound weight suspended from a 30-inch long pendulum arm going through a 60 degree angle from the vertical.

1.2.3 Dielectric Test

A busway shall withstand for 1 minute without breakdown the application of a 60 hertz potential of 1,000 volts plus twice maximum rated voltage between live parts and the enclosure and between live parts of opposite polarity.

1.2.4 Resistance to Bending Test

Busway intended for a spacing of not more than 5 feet between mounting supports will ordinarily be accepted without a bending test. However, to qualify for horizontal mounting on a 10-foot support basis, or on 16-foot centers in vertical risers, a busway must withstand for 5 minutes without rupture of the joint, appreciable permanent distortion, or short-circuiting or grounding of the phase or neutral bus bars, a bending moment equivalent to the weight of a 10-foot section plus an additional 100-pound force applied at the end of the 10-foot section.

1.2.5 Resistance to Crushing Test

Busway intended to employ a spacing of not more than 5 feet between mounting supports and whose construction is in accordance with Table 1-1 will ordinarily be accepted without a crushing test. However, if the busway

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does not meet these spacing or construction requirements, it shall be tested to ensure that it will be able to withstand a crushing force of 200 pounds plus three times the weight of a 10-foot section.

1.2.6 Bus Bar Pullout Test

Busway intended for mounting in a vertical run shall be capable of supporting a downward force equal to five times the weight of each bus bar in a 10-foot section applied simultaneously to each of the bus bars, without rupture or permanent distortion of bus bar supports.

1.2.7 Insulation Resistance and Dielectric Strength Test After Exposure to Rain

Outdoor busway must withstand a simulated rain for 8 hours per day for 5 successive days without dielectric breakdown.

1.2.8 Short Circuit Test

All busway and fittings rated 100 amperes or less and having a short circuit current rating of more than 5000 amperes shall be tested and marked with their respective rating(s). Busway and fittings rated over 100 amperes and having a short circuit current rating over 10,000 amperes shall be tested and marked with their respective rating. In order to verify these rating(s), representative samples of the busway shall be subjected to phase-to-phase, phase-to-enclosure, and phase-to-ground conductor (when applicable) short circuit tests. Tests may be conducted either with or without fuse or circuit breaker protection ahead of the busway being tested, and the ratings and markings will so indicate.

1.2.9 Test When Busway Enclosure Is Used as an Equipment Grounding Conductor

In order for the busway enclosure to be accepted as an equipment grounding conductor, the busway shall be subjected to the short circuit tests described above. In addition, two other conditions shall be met: (1) the busway enclosure shall comply with minimum cross-sectional area requirements, and (2) a maximum resistance of .005 ohm is allowed when passing a direct current of 30 amperes between adjacent busway sections.

Table 1-1
THICKNESS OF SHEET METAL

Maximum Inside Width of Widest Surface		Minimum Acceptable Thickness of Sheet Metal					
		Steel					
		Zinc-Coated		Uncoated		Aluminum	
Inches	(mm)	Inches	(mm)	Inches	(mm)	Inches	(mm)
12*	305	0.056	1.42	0.053	1.35	0.075	1.91
18	457	0.070	1.78	0.067	1.70	0.095	2.41
30	762	0.097	2.46	0.093	2.36	0.122	3.1
more than 30		0.126	3.20	0.123	3.12	0.153	3.89

*18 inches if enclosure does not support the weight of the bus bar assembly

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Section 2
NEMA STANDARDS

2.1 SHORT-CIRCUIT CURRENT RATINGS

There are no minimum or maximum standards on short-circuit current ratings specified by Underwriters Laboratories. The minimum rating depends upon the maximum short-circuit current available at the line end of the installed busway run. However, NEMA recommends the minimum ratings listed in Table 2-1.

Table 2-1
MINIMUM PARTS

Continuous Current Rating of Busway (Amperes)	Short-Circuit (Symmetrical Amperes)	
	Plug-In Busway	Feeder Busway
100	10,000	—
225	14,000	—
400	22,000	—
600	22,000	42,000
800	22,000	42,000
1000	42,000	75,000
1200	42,000	75,000
1350	42,000	75,000
1600	65,000	100,000
2000	65,000	100,000
2500	65,000	150,000
3000	85,000	150,000
4000	85,000	200,000
5000	—	200,000

2.2 VOLTAGE DROP

There are no minimum or maximum standards on voltage drop since these values may vary considerably depending upon several factors including:

a. Design
b. Conductor material
c. Continuous current design
d. Current load
e. Power factor of the load
f. Operating temperatures
g. Length of the run
h. Distribution of the load

Actual values of voltage drop in given situations can best be determined by obtaining the necessary data from a busway manufacturer and applying it to the specific situation. In general, the line-to-line voltage drop of fully loaded, three-phase busway will usually be less than 6 volts per hundred feet. Voltage drops for plug-in busway are based upon an evenly distributed load along the run and are one-half that of a load concentrated at one end.

2.3 RESISTANCE, REACTANCE AND IMPEDANCE

There are no minimum or maximum values of resistance, reactance, or impedance since these values vary considerably with different ratings and busway constructions. Busway manufacturers can supply these data for their particular products. These data are used for calculating the voltage drop for a specific application.

2.4 UNUSUAL SERVICE CONDITIONS

For applications where the ambient temperature is higher than 40°C, the busway current rating should be derated in accordance with the manufacturer's recommendations, if furnished, or the temperature listed in Table 2-2.

Table 2-2
AMBIENT TEMPERATURE

Ambient Temperature	Multiplier
40°C	1.00
45°C	0.95
50°C	0.90
55°C	0.85
60°C	0.80
65°C	0.74
70°C	0.67

For applications where the ambient temperature is lower than the ambient temperature limits shown in Table 2-3 or at altitudes greater than 6600 feet (2000 meters), consult the manufacturer.

There are other service conditions which may require further consideration. Where such conditions exist, it is recommended that they be brought to the manufacturer's attention.

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Table 2-3
TEMPERATURE LIMITS

	Ambient Temperature Limits	NEMA Standards Publication No.
Busway lengths and fittings	-30°C through +40°C	BU 1
Molded case circuit fittings	0°C through +40°C	AB 1
Enclosed switches	-30°C through +40°C	KS 1
Low voltage cartridge fuses	See applicable UL standards	
Electromagnetic and manual motor controls at 6000 feet and less.	0°C through +40°C maximum	ICS 1 ICS 2, ICS 3

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Section 3
NATIONAL ELECTRICAL CODE REQUIREMENTS

The *National Electrical Code*, which is sponsored by the National Fire Protection Association, outlines the general guidelines which are necessary for safe application of electrical equipment. Article 364 of the Code specifically applies to busways, although other articles in the Code are applicable in certain situations. Thorough familiarization with the NEC requirements for busway is recommended before attempting to apply busways to specific applications.

Some of the major requirements for safe application of busways, as outlined in the 1990 NEC are as follows.

364-4. **Use.**

a. **Use Permitted.** Busways shall be installed only where they are located in the open and are visible.
Exception (1): Busways shall be permitted to be installed behind panels if means of access are provided and if all the following conditions are met.
   a. No overcurrent devices are installed on the busway other than for an individual fixture.
   b. The space behind the access panels is not used for air-handling purposes.
   c. The busway is totally enclosed, non-ventilating type.
   d. Busway is so installed that the joints between sections and fittings are accessible for maintenance purposes.

   Exception (2): Busways shall be permitted to be installed behind access panels in accordance with Section 300-22(c).

b. **Use Prohibited.** Busways shall not be installed (1) where subject to severe physical damage or corrosive vapors; (2) in hoistways; (3) in any hazardous (classified) location, unless specifically approved for such use [see Section 501-4(b)]; nor (4) outdoors or in wet or damp locations unless identified for such use.

364-5. **Support.** Busways shall be securely supported at intervals not exceeding 5 feet (1.52 m) unless otherwise designed and marked.

364-6. **Through Walls and Floors.** It shall be permissible to extend unbroken lengths of busway through dry walls. It shall be permissible to extend busways vertically through dry floors if totally enclosed (unventilated) where passing through and for a minimum distance of 6 feet (1.83 m) above the floor to provide adequate protection from physical damage.

300-21. **Spread of Fire or Products of Combustion.** Electrical installations in hollow spaces, vertical shafts, and ventilation or air-handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors, or ceilings shall be fire-stopped using approved methods to maintain the fire-resistance rating.
(FPN): Firestops may require decreasing the allowable load on the conductors.

364-11. **Reduction in Size of Busway.** Omission of overcurrent protection shall be permitted at points where busways are reduced in size, provided that the smaller busway length does not exceed 50 feet (15.2 m) and has a current rating at least equal to 1/3 the rating or setting of the overcurrent device next back on the line, and provided further that such busway is free from contact with combustible material.

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Section 4
STATE AND LOCAL ELECTRICAL CODES

Many states and cities have electrical codes which supplement the National Electrical Code. Before attempting to apply or install busway, as well as any other type of electrical equipment, contact your local electrical inspection authority for a copy of the latest requirements applicable to the location of the installation.

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Section 5
ELECTRIC POWER COMPANY REQUIREMENTS

Busways are commonly used for the main services of buildings, in which case they are usually connected to one or more distribution transformers owned by the local electric power company. This connection may be made by either cable or bus bars, depending upon local practices. Since the various electric power companies throughout the United States often prefer different methods of connection to busway services, it is recommended that the local power company supplying the power be contacted before applying or installing a service entrance busway run.

5.1 CONTACTING BUSWAY MANUFACTURERS

Since the practical applications and uses of busway are nearly unlimited, it is not possible to outline in this publication all of the technical information available pertaining to busway. For this reason, it is advisable to contact one or more of the manufacturers of busway for more specific information any time that a possible application for busway is contemplated. All companies in the industry have technical experts who will assist in properly selecting and applying the busway system best suited for the specific requirements.

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NEMA STANDARDIZIATION BACKGROUND

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 their particular needs. 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.

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, dimensions, tolerances, safety, operating characteristics, performance, rating, testing, and the service for which they are designed.

(Standardization Policies and Procedures, p. 1)

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. 6)

Categories of Standards

National Electrical Manufacturers Association Standards are of three classes, which have received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative:

1. NEMA Standard, which relates to a product, process, or procedure commercially standardized and subject to repetitive manufacture.
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.
3. Adoptive Standard, which is adopted in whole or in part from the standards of another organization, either domestic, regional, or international.

(Standardization Policies and Procedures, pp. 5)

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 received the affirmative vote of at least two-thirds of the Subdivision votes cast in the affirmative or negative.

(Standardization Policies and Procedures, pp. 5)

Identification of Status

Standards in NEMA Standards Publications are identified as "NEMA Standard," "Suggested Standard for Future Design," or "Adoptive Standard." These indicate the status of the standard. A statement incorporating the auxiliary verb "shall" indicates that compliance with a requirement is mandatory for compliance with the standard. These classes of standards are identified in the foreword or throughout the text.

The material identified as "Authorized Engineering Information" is designated similarly. Statements incorporating other auxiliary verbs such as "should," "may," etc. refer to the authorized engineering information and not to procedures required for compliance with the standard.

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BUSWAY SECTION
OF THE
NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION
MEMBER COMPANIES

Challenger Electrical Equipment Corporation
Malvern, PA 19355

Controlled Power LTD Partnership
Canton, OH 44710

Eaton Corp/Cutler-Hammer Products
Milwaukee, WI 53216

GE
Plainville, CT 06062

Siemens Energy and Automation, Inc.
Alpharetta, GA 30201

Square D Company
Palatine, IL 60067

Westinghouse Electric Corporation
Greenwood, SC 29646

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