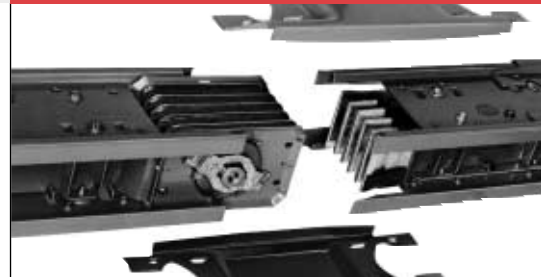


AMERICAN NATIONAL STANDARD

NECA 408-2002



Recommended Practice
for Installing and Maintaining

Busways



Published by
National Electrical
Contractors Association



An American National Standard

NECA 408–2002

Recommended Practice for

**Installing and
Maintaining Busways**



*National
Electrical
Installation
Standards®*

Published by
**National Electrical
Contractors Association**



National Electrical Installation Standards®

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(This foreword is not a part of the standard)

Foreword

National Electrical Installation Standards® are intended to improve communication among specifiers, purchasers, and suppliers of electrical construction services. They define a minimum baseline of quality and workmanship for installing electrical products and systems. *NEIS*® are intended to be referenced in contract documents for electrical construction projects. The following language is recommended:

Busways shall be installed and maintained in accordance with NECA 408-2002, *Recommended Practice for Installing and Maintaining Busways* (ANSI).

Use of *NEIS* is voluntary, and the National Electrical Contractors Association assumes no obligation or liability to users of this publication. Existence of a standard shall not preclude any member or non-member of NECA from specifying or using alternate construction methods permitted by applicable regulations.

Everything in this publication is intended to comply with the edition of the National Electrical Code® in effect at the time of publication. *NEIS* are not intended to duplicate *NEC*® requirements. It is the responsibility of users of this standard to comply with state and local electrical codes when installing electrical products and systems.

Suggestions for revisions and improvements to this standard are welcome. They should be addressed to:

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1. Scope

1.1 Equipment Included

This recommended practice describes installation procedures for feeder and plug-in busways and associated accessories rated 600 Volts AC or less, and 100 Amperes or more. It also covers periodic routine maintenance procedures for busway, and special procedures used after adverse operating conditions such as a short-circuit, ground-fault, or immersion in water.

1.2 Equipment Excluded

This publication does not cover Lighting Busway, Trolley Busway, Cablebus, or Metal Enclosed Busway (medium-voltage).

1.3 Regulatory and Other Requirements

All information in this publication is intended to conform to the National Electrical Code (ANSI/NFPA Standard 70). Installers should always follow the NEC, applicable state and local codes, and manufacturer's instructions when installing and maintaining busway systems.

Only qualified persons familiar with the construction and operation of busway should perform the work described in this publication.

Other *National Electrical Installation Standards*® provide additional guidance for installing particular types of electrical products and systems. A complete list of *NEIS*® is provided in Annex B.

2. Definitions

(NOTE: Definitions marked with an asterisk * are shown for information only. These types of busways are not within the scope of this publication.)

Accessories	A non-current-carrying busway system component that is used to protect the busway, to enclose the busway, or to mount the busway to the building structure. Busway accessories include such items as covers, end caps, fasteners, flanges, and weather shields.		terminations in a completely enclosed, ventilated protective metal housing. Cablebus is typically assembled in the field from components furnished or specified by the manufacturer in accordance with instructions for the specific job.
Adapter	A busway system fitting that permits the joining together of lengths and fittings of different shapes or designs.	Cable Tap Box	A busway device that provides for busway tap connections, such as a transformer tap box.
Busway	A grounded metal sectionalized enclosure containing factory-mounted bare or insulated conductors that are usually copper or aluminum bars, rods, or tubes. A busway system consists of straight lengths, accessories, adapters, connectors, devices, and fittings required to form a complete, continuous electrical distribution system.	Connector	A metallic coupling device of suitable electric conductance and mechanical strength used to splice together sections of busway and busway fittings.
		Cross	A busway fitting in the shape of a “cross” or “X” that contains four busway connections.
Bus Duct	Another term sometimes used for busway. <i>Busway</i> is the term used in the National Electrical Code and throughout this publication.	Device	A busway system component connected to a busway for the purpose of tapping the bus bars. Busway devices consist of such items as cable tap boxes and plug-in units.
*Cablebus	An approved assembly of insulated conductors with accessories, fittings, and conductor	Elbow	An angled busway fitting that contains two busway connections.

End Cap	A busway accessory that closes the end of a busway run.	Plug-In Busway	Busway having plug-in openings on one or both sides at spaced intervals and offering the means for electrical connection of busway devices to the busbars intended primarily for distributing power to various loads along the route of the busway.
Expansion Fitting	A busway fitting that provides for the expansion, contraction, and movement of the busway or building.	Plug-in Unit	A busway device that is factory designed and assembled to provide taps to plug-in busway. Plug-in units consist of items such as fusible switches, circuit breakers, static voltage protectors, ground indicating detectors, combination motor starters, lighting contactors, transformers, and capacitor plugs. Plug-in units may be equipped with additional accessories including control power transformers, relays, indicating lights, and terminal blocks for remote control and indication.
Feeder Busway	Busway having no plug-in openings and intended primarily to supply a single piece of electrical equipment, such as a distribution switchboard, motor control center, or large individual load.	Switchboard Stub (Mounting Flange)	A busway fitting that provides means for mechanically and electrically connecting the busway to other electrical equipment such as switchboards or switchgear.
Fitting	A busway system component other than a straight length, such as an expansion fitting, elbow, offset, cross, tee, switchboard stub, tap box, transformer throat connection, or similar component.	Transformer Tap Box	A busway fitting that extends the bus bars beyond its housing for the purpose of making final busway-to-transformer connections if using cables.
Flange	A busway accessory that mounts to the outside of the busway and covers an opening penetrated by the busway, such as a floor, walls, or roof, or an equipment enclosure such as a switchboard or transformer.	Transformer Throat Connection (Mounting Flange)	A busway fitting that provides means for mechanically and electrically connecting busway to a transformer. A transformer mounting flange extends the bus bars beyond its housing for
*Lighting Busway	Busway designed to provide electric power and mechanical support for luminaires (lighting fixtures) or small other loads.		
*Metal Enclosed Busway	Busway rated at greater than 600 Volts and less than 38,000 Volts.		
Offset	A busway fitting with two or more angles that contains two busway connections.		

the purpose of making final busway-to-transformer connections using cables, solid bussing, or flexible connectors.

***Trolley
Busway**

Busway having an insulated housing that contains exposed steel or copper bars, rods, or tubes that permits tap access at any point along the continuous length of the busway by the use of plug-in tap devices. Trolley plug-in devices are self supported and suspended from the trolley busway. Trolley busway accommodates mobile power taps for electric hoists, cranes, portable tools, etc.

3. Receiving Components

3.1 Delivery and Inspection

- a) Have busway system components delivered in accordance with manufacturer recommendations.
- b) Upon delivery, unpack busway system components sufficiently to inspect for concealed damage resulting from shipping and handling. If damage has occurred, notify the shipper immediately.
- c) Inspect busway for contamination during shipping. Check for evidence of moisture, dust, liquids, or other foreign materials. If contamination has occurred, notify the shipper and manufacturer immediately in writing. Do not proceed with installation until appropriate actions to clean or replace the busway have been undertaken.
- d) Check the bill of materials for conformance with the manufacturer's quotation and shop drawings.
- e) Compare actual busway system components with the bill of materials to verify that the shipment is complete. If the shipment is not complete, notify the manufacturer immediately.
- f) If busway system components are to be stored prior to installation, restore original packing materials or cover with heavy plastic or canvas to protect busway from exposure to corrosive fumes, liquids, salts, moisture, and concrete. When conditions permit, leave the packing materials intact until the busway system components are ready for installation.

3.2 Handling

- a) Handle busway carefully, in accordance with manufacturer's recommendations, to avoid damage to the enclosure and internal components. Avoid subjecting busway to rough handling, impact, twisting, etc.

- b) Verify that the weight of any busway sections or fittings are within the rated capacity of the handling equipment to be used.
- c) Use care to balance and distribute weight when handling busway with platform dollies, platform lifts, and fork-lift trucks.
- d) Use straps to balance and distribute weight when handling busway with a crane.
- e) When lifting busway, use spreaders as necessary to protect the enclosure.

3.3 Storage

- a) Store busway system components in accordance with manufacturer recommendations. Protect busway from dirt, water, and physical damage during storage.
- b) Store weatherproof busway in the same manner as indoor busway. Weatherproof busway is not weatherproof until completely and properly installed.
- c) Store busway in a clean, dry, heated building having a uniform temperature and adequate air circulation to prevent condensation.
- d) When storage in a heated building is not possible, store busway indoors in a clean, dry shelter having provisions for maintaining a uniform temperature and adequate air circulation to prevent condensation.
- e) Where storage indoors is not possible, protect busway from weather and contaminants. Install electric heating to maintain a uniform temperature to prevent condensation. (*NOTE: It is recommended that busway not be stored outdoors.*)

4. Installation Procedures

NOTE: Prior to release of busway to job site, compare manufacturer's shop drawings with field measurements for accuracy.

4.1 Busway System Layout and Coordination

- a) Lay out busway system in accordance with manufacturer recommendations.
- b) Verify building dimensions by field measurements. Measure all dimensions from fixed points such as columns, walls, or other building structures.
- c) Identify and locate building structures such as walls, ceilings, columns, etc., and other equipment that is in the busway route.
- d) Coordinate busway routing to ensure that other trades do not use required busway clear area.
- e) Verify sufficient horizontal and vertical clearance from walls and ceilings to provide easy access to joints and to comply with minimum required clearances specified in the National Electrical Code. Provide access space required for original installation and for the possible future removal of a section.
- f) Verify busway housing dimensions and locate obstructions within required clearances and installation tolerances of busway.
- g) Verify mounting clearances of plug-in units. Ensure mounting elevation is appropriate for plug-in busway. Allow sufficient clearances to install, operate, and remove devices, and to open plug-in busway covers.
- h) Start the dimensional layout from the most restrictive component in the busway run, such as a

transformer, switchboard or switchgear, or other critical fitting or termination.

- i) Where busway sections in other than standard lengths are required to complete a busway system installation, follow manufacturer recommendations for field-measurement. Custom-manufactured busway sections should be manufactured and delivered to the job site after the remainder of the run has been installed, to insure a precise fit.

4.2 General Installation Procedures

NOTE: Verify location where busway system is to be installed. Install busway only in environment for which the busway is suitably marked. Use discretion and comply with manufacturer recommendations and applicable codes and standards when installing busway in an inaccessible or classified location.

- a) Install busway system in accordance with manufacturer recommendations.
- b) Do not locate busway so that it is exposed to dust, vapors, abnormal vibration, shock or other such unusual operating conditions unless it is specifically designed for such conditions.
- c) Check for possible sources of water, such as fire suppression sprinklers, that may contact indoor busway. Install protective barriers as necessary.
- d) Install busway level and plumb except as necessary to follow building lines and/or as specified in the approved installation plan.
- e) Ensure that busway joint insulators are not damaged or cracked, and are firmly in place prior to installation.

- f) Ensure that busway components, materials, and mating surfaces are compatible prior to installation.
- g) Perform insulation resistance test on individual current-carrying busway components prior to installation (*see Annex A*). (*NOTE: Record and maintain testing results. Turn over to general contractor or owner at completion of the project.*)
- h) Start busway installation from the most restrictive component in the busway run, such as a main feed box, switchboard or switchgear, elbow, or other critical fitting or termination.
- i) Install busway hangers and supports along the busway route prior to installing busway components.
- j) Install busway system components on hangers and supports one at a time.
- k) Install plug-in busway with plug openings side-mounted such that all plug-in openings may be used simultaneously
- l) Conduct an insulation resistance test on the installed portion of the busway occasionally to check for improperly connected joints (*see Annex A*).

4.2.1 Phasing

- a) Establish bus bar phase sequence to maintain correct phasing throughout the system. Coordinate phasing at all points of connection and at all terminations, such as panelboards, switchboards, transformers, etc.
- b) Confirm physical orientation of busway components in accordance with manufacturer's labels and markings to maintain established phasing.
- c) Note any busway transposition lengths that may reverse the phase sequence of the busway run.

4.3 Busway Hangers and Supports

- a) Use hangers and supports in accordance with manufacturer recommendations. Provide supple-

mental seismic supports in accordance with applicable codes and standards.

- b) Do not support busway at joints.
- c) Provide hangers and supports that accommodate busway movement from normal thermal and building expansion.
- d) Fasten supports securely to building structures. Design each fastener and support to carry the greater of 200 pounds or 4 times the supported weight of the busway. Support busway with not less than 1/2-inch steel threaded drop rods where applicable.
- e) Install bracing to prevent swaying or movement of busway, hangers, and supports.
- f) Route busways above the bottom chord of the building steel, unless otherwise specified in contract documents.
- g) Align busway runs vertically and horizontally to minimize sags and twists.
- h) Adjust supports after busway installation to minimize strains and stresses on bus bars and housings.
- i) Maintain alignment of threaded rod hangers. Adjust hangers for correct elevation after the busway is installed.

4.3.1 Independent supports

- a) Support busway independently from supports for other building systems such as ceilings, piping, ductwork, conduits, etc.
- b) Support busway independently from equipment enclosures at connections to switchboards, panelboards, transformers, etc.
- c) Support busway devices independently from busway to prevent twisting or deformation of the busway.
- d) Support conduits attached to busway devices independently from the devices.

- e) Make connections between busway and fixed-mounted equipment using flexible conduits suitable for the environment.

4.3.2 Spacing of supports

- a) Provide one support for every 5 feet of vertical or horizontal busway.
- b) Horizontal busway suitable for supporting at intervals greater than 5 feet is plainly marked to indicate this, and may be supported at maximum intervals of 10 feet.
- c) Vertical busway that is suitable for supporting at intervals greater than 5 feet is plainly marked to indicate this, and may be supported at maximum intervals of 16 feet.

4.3.3 Vertical hangers

- a) Busway that is suitable for use in a vertical riser position is plainly marked to indicate this.
- b) Spring hangers. Support vertical busway with spring hangers in new or recently-constructed buildings where the concrete has not fully compressed and the building is likely to shrink.
- c) Fixed hangers. Vertical busway may be supported with fixed hangers in existing buildings where the concrete has fully compressed.

4.4 Expansion Joints

- a) Provide busway expansion joints in accordance with manufacturer recommendations for the project.
- b) Install an expansion joint at each location where the busway run crosses a building expansion joint.
- c) Install a busway expansion joint at each location where a straight run of busway exceeds 150 feet when the busway is not free to move at each end of the run.

4.5 Busway Penetrations

- a) Install firestop fittings where busway penetrates fire-rated elements such as walls, floors and ceilings.

- b) Provide an opening one inch larger than the busway cross-section where a busway run passes through a wall, floor, or roof. Provide a mounting flange to mask the opening after the busway is installed.

- c) Install an integral weather seal or vapor barrier where busway penetrates an exterior wall or roof. Provide weatherproof wall and roof flanges and seal around openings to maintain a weather tight installation.

- d) In other than industrial establishments, where a vertical riser penetrates two or more dry floors, provide a minimum 4-inch high waterproof curb around all floor openings around busway riser. Install the curb within 12 inches of the floor opening. Coordinate electrical equipment locations to prevent damage from liquids that are retained by the curb.

4.6 Busway Joint Connections

- a) Complete busway joint connection assemblies in accordance with manufacturer recommendations. *(NOTE: Busways typically use Belleville-type spring washers and torquing practices at the joints to maintain mechanical integrity.)*
- b) Cover busway during installation to protect joints from moisture or other types of contaminants.
- c) Ensure that all contact surfaces are clean and free of contaminants.
- d) Align the busbar ends of adjoining busway components, verifying proper phase alignment.
- e) Slide components together, using joint pullers if available.
- f) Adjust length of joint to suit installation requirements.
- g) Level and plumb busway (align horizontally and vertically) before the final tightening of joints.
- h) Tighten the busway joint connection bolt as each component is installed. Tighten busway joints with

torque wrench or similar tool recommended by the busway manufacturer. Alternatively, defer final torquing of connections until all components for a particular run of busway are in place to permit making up adjacent joints. (*NOTE: Do not overtighten connections.*)

- i) Install any additional joint hardware that may be required.
- j) Install drip-proof, splash-proof and outdoor busways by setting, tightening and sealing each joint at the nominal length as the installation proceeds. Consider the need to seal each joint to protect the busway from weather conditions versus the need to make length adjustments later. (*NOTE: Busway joint connections typically are field adjustable to plus or minus 1/2- inch of nominal length. No adjustments are possible once outdoor busway joints are gasketed and sealed. Also see 4.8*)

4.7 Vertically-Mounted Busways

- a) Busway suitable for vertical mounting is plainly marked to indicate this.
- b) During installation, protect vertical busways from moisture infiltration from unfinished roofs, walls, etc.
- c) Lower sections of vertical busway into position from the floor above where it will be installed.
- d) Use the vertical support system provided with the busway or as recommended by the manufacturer. Also see 4.3.3.
- e) Provide intermediate supports of the type recommended by the manufacturer when the distance between floor-mounted supports is greater than the intended maximum distance between supports for the busway.

4.8 Outdoor Busways

- a) Install outdoor, drip-proof, and splash-proof busways in accordance with manufacturer recommendations.

- b) Busway suitable for installation in wet locations or outdoors is plainly marked to indicate this.
- c) Coordinate the mounting position of outdoor busway system components for proper orientation of drain holes, if provided.
- d) Remove weep-hole screws and install joint shields, where applicable.
- e) Mount outdoor busway sufficiently above grade or roof level so that snow build-up does not surround the busway and result in water infiltration through weep-holes.

4.9 Busways with Plug-In Devices

- a) Provide additional bracing of busways where plug-in units are used only on one side, or when more plug-in devices are on one side of the busway than the other.
- b) Install busway plug-in units after busway installation is complete, in accordance with manufacturer recommendations. Ensure that all plug-in devices are in the “OFF” position during installation and removal.
- c) Install busway plug covers for all plug-in openings that are not in use.
- d) Complete feeder, branch, and control circuit wiring connections after plug-in units are installed.
- e) Set field-adjustable overload relays to match motor loads, where applicable. Ensure that circuit breakers and fuses have suitable ampacity to protect the conductors and are appropriate for the load served.

4.10 Grounding

- a) Connect busways and components to ground in accordance with manufacturer recommendations.
- b) Bond the busway enclosure and busway grounding bus bar, if so equipped, to a suitable grounding system and to the equipment grounding conductors of feeder and branch circuits supplied by the busway.

- c) Verify that all busway joint covers are properly installed.
- d) Tighten grounding connectors and terminals, including screws and bolts, according to the manufacturer's published torque tightening values for equipment connectors. (*NOTE: Do not overtighten connections.*)

5. Testing and Commissioning Busways

5.1 Cleaning

- a) Clean, dry, and lubricate busway components using products recommended by the busway manufacturer.
- b) Remove trash and construction debris from areas around busway.
- c) Remove accumulated dust, dirt, or other foreign matter from the busway enclosure using a brush, vacuum cleaner, or clean, lint-free rags. Do not use compressed air or a blower since this may cause debris to settle inside the busway or plug-in units, and impair their ability to function.
- d) Clean the interiors of switchboards, panelboards, transformers, etc., to remove construction debris from installing busway.
- e) Inspect exposed busway finish after completing system installation. Remove burrs, dirt and construction debris, and repair damaged finishes including chips, scratches and abrasions to match original finish.

5.2 General

- a) Confirm proper physical orientation of busways in accordance with manufacturer's labels.
- b) Compare equipment nameplates with drawings and specifications.
- c) Inspect the busway system for correct connections in accordance with electrical single-line diagram.
- d) Inspect for appropriate bracing, suspension, alignment, and enclosure ground.
- e) Visually inspect busway for physical damage.
- f) Examine busway for correct installation of joint shields and plug-in covers.
- g) Visually check busway with associated cables and raceways for proper grounding and bonding in accordance with the National Electrical Code.
- h) Ensure that ventilation openings are clear.
- i) Ensure that drain holes are operating properly.
- j) On outdoor busway, verify that weep-hole screws have been removed in accordance with manufacturer recommendations.
- k) Install all required busway safety labels.

5.3 Tests Prior to Energizing Busway

- a) Test installed busway in accordance with manufacturer recommendations.
- b) Ensure that all plug-in units are in the "OFF" position.
- c) Isolate the busway by disconnecting all connections to transformers, switchboards, meters, etc.
- d) Perform an insulation resistance test on the completed busway (*see Annex A*).
- e) Verify that the electrical distribution system phasing matches the busway phasing.
- f) Restore all electrical connections to transformers, switchboards, meters, etc.

5.4 Energizing Busway

NOTE: Immediately de-energize the busway if there is any evidence of arcing along the busway at any time during this procedure. The busway must remain de-energized until the arcing condition has been corrected.

NOTE: Consult busway manufacturer for any abnormal operating conditions encountered. Qualified personnel should be present when the equipment is energized for the first time. If short circuit conditions caused by damage or poor installation practices have not been detected in the procedure specified above, serious personal injury and property damage can occur when the equipment is energized.

- a) Ensure that all affected persons are notified prior to energizing busways.
- b) Ensure that there is no load on the busway and that all load isolation devices are open and locked or tagged.
- c) Energize the busway. Verify proper phase-to-phase and phase-to-neutral voltages.
- d) Energize equipment supplied from the busway starting at the source end and working toward the load. Close load isolation devices to verify proper phase rotation, with regard to the utilization equipment supplied from the panelboard. Close main, feeder, and branch circuit devices in sequence.
- e) Energize lighting circuits, contactors, motors, and heaters after all overcurrent devices have been closed.
- f) Properly installed busway will have a moderate hum. Mechanical rattles, hums, or excessive noise may be an indication of hardware that has not been tightened or of metal parts that have been improperly assembled. Investigate hardware that has not been tightened or metal parts that are improperly assembled as possible sources of extraneous noise.
- g) Measure secondary phase-to-ground and neutral-to-ground voltages after loading busway to ensure

proper neutral-to-ground bonding. Record measurements to assist in troubleshooting problems with low voltage at utilization equipment.

- h) Inspect all indicating and control devices for correct operation.
- i) Verify proper operation of busway heaters, if installed.
- j) Check phase orientation on each busway tie section energized from separate sources. Test busway from permanent sources.

5.5 Infrared Scan

- a) Perform infrared scan in accordance with busway and test equipment manufacturer recommendations (see Annex A).

- b) De-energize busway. Test busway to confirm that it is de-energized. Lock and tag source switching devices in the open position.

NOTE: Electrically isolate the busway in accordance with established procedures. Consider all circuits live until they are confirmed to be de-energized and are locked out of operation. Failure to observe these precautions may result in severe personal injury or death.

- c) Remove accessible covers, plates, weathershields, etc.
- d) Notify all affected persons that busway will be energized. Ensure that there is no load on the busway and that all load isolation devices are open and locked or tagged. Close the source disconnecting device and energize busway.
- e) Turn on all normal loads supplied by the busway starting at the source end, and perform infrared scan (see Annex A).
- f) De-energize busway in accordance with established safety procedures. Replace all accessible covers, plates, weathershields, etc.
- g) Energize busway in accordance with Section 5.4.

5.6 Correcting Problems

Repair or replace any malfunctioning components.
Re-test assembly to ensure that it is operating properly.

6. Closeout

6.1 Spare Parts and Special Tools

Deliver busway spare parts and special tools to the owner or general contractor in accordance with contract documents. In the absence of contractual requirements, deliver the busway manufacturer's minimum recommended spare parts and special tools.

6.2 Installation, Operation, and Maintenance Manuals and Data

a) Deliver the busway manufacturer's standard installation, operation, and maintenance manuals to the owner or general contractor in accordance with contract documents. In the absence of contractual requirements, deliver a minimum of one set of the busway manufacturer's standard installation, operation, and maintenance manuals.

b) Submit data and results from all factory and field completed testing of the busway system and components to the owner or general contractor

6.3 Training

Provide training for the owner's maintenance personnel if required by contract documents. Provide a minimum 7 days advance notice of such training. Discuss routine maintenance, operating procedures, cleaning, etc., using the manufacturer's standard operating and maintenance manual as a reference.

7. Inspection and Maintenance

7.1 Recommended Procedures During First Year of Operation

NOTE: This section describes recommended procedures for inspection and maintenance and of busways during the first year of operation. The installer is only responsible for these tasks if required or referenced by contract documents. Otherwise, these inspection and maintenance recommendations are provided as guidance for the owner during the first year of busway operation.

- a) De-energize the busway system in accordance with Section 7.4 and re-torque busway joints one month after busway is energized and placed into service. (*NOTE: Do not overtighten connections.*)
- b) Perform infrared scans of the busway system, including joints and devices, at intervals of two, six, and twelve months after busway is energized and placed into service. Infrared test procedure is described in 5.5 and Annex A.
- c) Adjust spring hangers in vertical busways to compensate for load changes and movement of the building in accordance with manufacturers recommendations for a period of one year from the date the busway is placed into service.

7.2 Frequency of Inspection and Maintenance

- a) Perform busway inspections and maintenance once a year, or after any severe electrical short circuit or ground fault.
- b) Inspect busway periodically to determine detrimental physical conditions or changes in operating conditions.

7.3 Inspection of Energized Busway

- a) Visually inspect the busway system for physical damage.
- b) Examine busway for correct installation of joint shields and plug-in covers.
- c) Check that equipment installed near the busway cannot cause damage because of external heating.
- d) Check outdoor busway to verify that weep-hole screws have been removed in accordance with manufacturer recommendations.
- e) Visually check busway with associated cables and raceways for proper grounding and bonding in accordance with the National Electrical Code.
- f) Verify proper operation of busway heaters, if installed.
- g) Measure spring supports and compare to manufacturer's minimum and maximum deflection tolerances. Consult manufacturer for recommendations.

7.3.1 Protecting busways from moisture

- a) Visually check indoor busway for evidence of exposure to liquids. Look for any recent changes in sprinklers or other plumbing that might now be a source of trouble to busway. Eliminate source or provide necessary protection.
- b) Protect indoor busway from leaking pipes or roofs by installing a temporary sheet metal or plastic shield or other protective cover to prevent water from falling onto the busway until the leak is repaired.
- c) Protect indoor busway from condensate where pipes pass directly above indoor busway. Insulate the

pipings or permanently shield the busway with sheet metal or plastic.

7.3.2 Partial discharge (corona)

Inspect the busway system for evidence of partial discharge, or corona. Investigate and correct sources of partial discharge. Possible sources of partial discharge include:

- a) Bus bar surface irregularities such as nicks and scratches.
- b) Protruding insulating materials.
- c) Breakdown of insulating materials
- d) Dry or wet airborne particles in the proximity of bus bars or busway fittings.
- e) Weather conditions for outdoor busway.

7.4 De-Energizing Busway

NOTE: Before cleaning, inspection, testing, or maintenance, electrically isolate the busway in accordance with established procedures. Consider all circuits live until they are confirmed to be de-energized and are locked out of operation. Failure to observe these precautions may result in severe personal injury or death.

- a) De-energize the busway. Test busway to confirm that it is de-energized. Padlock and tag out source switching devices in the open position.
- b) Install grounding leads to the busway phase, neutral, and grounding busbars.
- c) Open and lock or tag all load isolation devices to ensure no loads are connected to the busway.

7.5 Inspecting De-Energized Busway

- a) Check tightness of exposed busway bolts. Check torque of busway joints. Check Belleville spring washers visually to verify flatness. Contact the manufacturer for recommendations before re-torquing joint bolts. (*NOTE: Do not overtighten connections.*)

- b) Check for signs of overheating at joints and terminations.

- c) Inspect busway insulating materials. Replace insulating parts and assemblies if there is any indication that insulating material or sealing compound is deteriorated or melted.

- d) Check for missing or broken parts, proper spring tension, free movement, rust or corrosion, dirt, excessive wear, arc spatter, sooty deposits, and tracking. Clean or replace parts as required.

- e) Perform an infrared scan (*see Annex A*).

7.6 Cleaning De-Energized Busway

- a) Clean, dry, and lubricate busway components using products recommended by the busway manufacturer.

- b) Remove trash and combustible materials from areas around the busway.

- c) Remove accumulated dust, dirt, or other foreign matter from the busway enclosure using a brush, vacuum cleaner, or clean, lint-free rags. Do not use compressed air or a blower since this may cause debris to settle inside the busway or plug-in units, and impair their ability to function.

- d) Ensure that busway ventilation openings are clear.

- e) Ensure that all busway drain holes are operating properly.

- f) Seal off any cracks or openings which have allowed moisture to enter the busway or busway devices.

- g) Repair or replace busway components exposed to water in accordance with Section 8.

7.7 Testing De-Energized Busway

- a) Perform an insulation resistance test (*see Annex A*).

- b) Perform a contact resistance test (*see Annex A*).

7.8 Inspecting, Testing, and Servicing Devices with Busway De-Energized

- a) Verify that hook-sticks are available for busway devices that require them.
- b) Check for proper operation of all mechanical components.
- c) Examine fuse clip contact pressure and contact means. If there is any indication of overheating or looseness, follow manufacturer's maintenance procedures or replace the fuse clips.
- d) Inspect busway insulating materials. Replace insulating parts and assemblies if there is any indication that insulating material or sealing compound is deteriorated or melted.
- e) Exercise switch operating mechanisms and external operators for switches and circuit breakers several times to ensure proper working order. Switches and circuit breakers should operate freely to full "ON" and "OFF" positions.
- f) Check that electrical and mechanical interlocks and padlocking means are operating correctly.
- g) Check for missing or broken parts, proper spring tension, free movement, rusting or corrosion, dirt, and excessive wear.
- h) Examine all readily accessible busway components, accessible arc chutes and insulating parts for cracks or breakage and for arc spatter, sooty deposits, oil, or tracking. Clean off arc spatter, oil, and sooty deposits. Replace the device if appreciable material has burned away or if parts are charred or cracked.
- i) Check circuit breakers and fuses to ensure they have the proper ampere, voltage, and interrupting ratings. Ensure that non-current-limiting devices are not used to replace current-limiting devices.
- j) Check the torque of wire connections that show evidence of overheating according to manufacturer's instructions. (*NOTE: Do not overtighten connections. Repair or replace damaged conductors and connections.*)

- k) Check independent busway device supports and hangers for proper bonding and grounding.

- l) Perform an insulation resistance test of each busway device prior to the reinstallation on the busway (*see Annex A*).

7.8.1 Lubricating switch mechanisms

- a) Lubricate the operating parts of switch mechanisms and other moving parts according to manufacturer's instructions.
- b) Use clean, nonmetallic, light grease or oil in accordance with manufacturer recommendations.
- c) Do not oil or grease molded case circuit breakers.
- d) If no instructions are given on the devices, sliding copper contacts, operating mechanisms, and interlocks may be lubricated with clean, light grease.
- e) Wipe off excess lubrication to avoid accumulation of foreign material.

7.9 Final Infrared Scan

- a) After performing all inspections, tests, cleaning, and necessary repairs, energize busway and loads in accordance with Section 5.4.
- b) Perform a final infrared scan (*see Section 5.5 and Annex A*) after busway is re-energized and has reached a stabilized operating temperature.

8. Inspection and Re-energization After Adverse Operating Conditions

8.1 Inspection Following a Short-Circuit or Ground-Fault

- a) De-energize busway in accordance with Section 7.4.
- b) Inspect the de-energized busway for visible damage after any severe electrical short circuit or ground fault.
- c) Identify and remove the cause of the short circuit or ground fault.
- d) Perform an insulation resistance test (*see Annex A*).
- e) Perform a high-potential test on the busway (*see Annex A*).
- f) Replace any damaged busway system components.
- g) Turn on power to the busway and perform an infrared scan (*see Annex A*).

8.2 Busway Soaked By or Submerged Under Water

Replace busway and components.

8.3 Inspecting and Re-energizing Busway Sprayed or Splashed with Clean Water

- a) Replace the entire busway system, or follow steps (b) through (f).
- b) De-energize busway in accordance with Section 7.4.
- c) Thoroughly clean and dry any insulating material which is damp or wet, or which has dried deposits from evaporated moisture. Consult the manufacturer for proper procedures for specific busway components.
- d) Perform an insulation resistance test (*see Annex A*).
- e) Replace any damaged busway system components.
- f) Energize the busway and perform an infrared scan (*see 5.5 and Annex A*).

(This annex is not part of the standard)

Annex A: Electrical Test Procedures

A.1 Insulation Resistance Test

- a) Perform an insulation resistance test in accordance with manufacturer recommendations.
- b) Use a megohmmeter rated 1000 Volts dc, and test from each phase-to-phase, from each phase-to-ground, and from each phase-to-neutral, where installed, for one minute.
- c) Consult the manufacturer for acceptable values for a particular busway component.
 - Test results will vary with humidity, and will vary inversely with the length of busway run and with the number and width of bars per phase.
 - Minimum individual busway section megohm readings should not be less than 3 megohms.
 - Minimum busway system megohm readings should not be less than 100 divided by the length of the busway run in feet.
 - Consult manufacturer for recommendations if insulation resistance test results are below these values.
- d) Maintain a permanent record and plot insulation resistance results over time. Consult the busway manufacturer for recommendations if insulation resistance has decreased significantly over time.
- e) Perform a high potential test if busway system insulation resistance is below 100 divided by the length of the busway run measured in feet.

A.2 High Potential Test

- a) Perform a high potential test in accordance with manufacturer recommendations.
- b) Perform high-potential test on each busway phase-to-ground, with phases not under test grounded, in accordance with manufacturer recommendations.
- c) Consult the manufacturer if the busway insulation system does not withstand the high-potential test voltage.

A.3 Contact Resistance Test

- a) Perform a contact resistance test in accordance with manufacturer recommendations.
- b) Measure contact resistance on each connection point of non-insulated busway using one of the three following methods:
 - Check contact resistance of busway joint connections using a low-resistance ohmmeter. Values should not exceed normal range indicated in manufacturer's published data. In the absence of manufacturer's data, compare values of similar busway joints and connections. Investigate any values that deviate from similar joints and connections by more than 50% of the lowest value.
 - Verify tightness of accessible bolted electrical connections and bus joints by calibrated torque-wrench method in accordance with manufacturer's published data. (*NOTE: Do not overtighten connections.*)
 - Perform an infrared scan of the energized busway as described in A.4.

A.4 Infrared Scan

NOTE: Provide supplemental barriers and safety precautions during infrared scan to prevent accidental contact with exposed energized components.

- a) Perform an infrared scan of all electrical connections and joints, and of busway enclosure while busway is energized and operating under maximum load conditions.
- b) Use an infrared scanning device designed to measure actual operating temperatures, or designed to detect significant deviations from surrounding conditions. Provide documentation of device calibration.
- c) Prepare a certified report identifying the busway tested and describing the results of the infrared scan. Include notation of deficiencies detected, remedial action taken, and results from retesting after remedial action.
- d) Maintain a permanent record of all infrared scan results to track electrical characteristics of busway over time.
- e) Consult busway manufacturer for repair or replacement recommendations if infrared scan results indicate overheating of components.

A.5 Recordkeeping

The results of all testing should be recorded and maintained to track changes in electrical characteristics over time. Record the following:

- a) Date, time, and environmental conditions, such as temperature and humidity, during testing.
- b) Note whether the busway is housed in conditioned space. Note weather conditions for outdoor busway.
- c) Record the general condition of the busway along with the model number, general condition, and calibration history of all test equipment.
- d) Include the names of persons making and witnessing tests.

(This annex is not part of the standard)

Annex B: Reference Standards

This publication, when used in conjunction with the National Electrical Code and busway manufacturers' literature, provides sufficient information to install and maintain busways. The following publications may also provide useful information:

National Electrical Manufacturers Association
1300 North Seventeenth Street, Suite 1847
Rosslyn, VA 22209
(703) 841-3200 tel
(703) 841-3300 fax
www.nema.org

NEMA BU 1-1999, *Busways*

NEMA BU 1.1-1996, *General Instructions for Proper Handling, Installation, Operation, and Maintenance of Busway Rated 600 Volts or Less*

National Fire Protection Association
1 Batterymarch Park
P.O. Box 9101
Quincy, Massachusetts 02269-9101
(617) 770-3000 tel
(617) 770-3500 fax
www.nfpa.org

NFPA 70-2002, *National Electrical Code* (ANSI)

NFPA 70B-1998, *Electrical Equipment Maintenance* (ANSI)

InterNational Electrical Testing Association
106 Stone Street
P.O. Box 678
Morrison, CO 80465
(303) 697-8441 tel
(303) 697-8341 fax
www.netaworld.org

NETA ATS-1999, *Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems*

NETA MTS-2001, *Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*

NECA 408 Recommended Practice for Installing and Maintaining Busways

National Electrical Contractors Association
3 Bethesda Metro Center, Suite 1100
Bethesda, MD 20814
301-215-4504
301-215-4500 fax
www.neca-neis.org

Other *National Electrical Installation Standards*™ published by NECA:

NECA 1-2000, *Standard Practices for Good Workmanship in Electrical Contracting* (ANSI)

NECA 100-1999, *Symbols for Electrical Construction Drawings* (ANSI)

NECA 101-2001, *Standard for Installing Steel Conduits (Rigid, IMC, EMT)*

NECA/AA 104-2000, *Recommended Practice for Installing Aluminum Building Wire and Cable* (ANSI)

NECA/NEMA 105-2002, *Recommended Practice for Installing Metal Cable Tray Systems* (ANSI)

NECA 202-2001, *Recommended Practice for Installing and Maintaining Industrial Heat Tracing Systems* (ANSI)

NECA/FOA 301-1997, *Standard for Installing and Testing Fiber Optic Cables*

NECA 305-2001, *Standard for Fire Alarm System Job Practices* (ANSI)

NECA 400-1998, *Recommended Practice for Installing and Maintaining Switchboards* (ANSI)

NECA 402-2001, *Recommended Practice for Installing and Maintaining Motor Control Centers* (ANSI)

NECA/EGSA 404-2000, *Recommended Practice for Installing Generator Sets* (ANSI)

NECA 405-2001, *Recommended Practice for Installing and Commissioning Interconnected Generation Systems* (ANSI)

NECA 407-2002, *Recommended Practice for Installing and Maintaining Panelboards* (ANSI)

NECA 409-2002, *Recommended Practice for Installing and Maintaining Dry-Type Transformers* (ANSI)

NECA/IESNA 500-1998, *Recommended Practice for Installing Indoor Commercial Lighting Systems* (ANSI)

NECA/IESNA 501-2000, *Recommended Practice for Installing Exterior Lighting Systems* (ANSI)

NECA/IESNA 502-1999, *Recommended Practice for Installing Industrial Lighting Systems* (ANSI)

NECA/BICSI 568-2001, *Standard for Installing Commercial Building Telecommunications Cabling* (ANSI)



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