NECA 111

Standard for Installing Nonmetallic Raceways (RNC, ENT, and LFNC)

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(This foreword is not a part of the standard)

Foreword

National Electrical Installation Standards™ (*NEIS™*) are designed 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:

> Nonmetallic raceways should be installed in accordance with NECA 111-2XXX, *Standard for Installing Nonmetallic Raceways (RNC, ENT, and LFNC)*.

Use of *NEIS*™ is voluntary, and the National Electrical Contractors Association (NECA) 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 installation methods permitted by applicable regulations.

This publication is intended to comply with the National Electrical Code (NEC). Because they are quality Standards, NEIS may in some instances go beyond the minimum safety requirements of the NEC. It is the responsibility of users of this publication to comply with State and local electrical Codes and Federal and State OSHA safety regulations as well as follow manufacturer instructions 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

This Standard describes installation procedures for nonmetallic raceways of circular cross-section used for electrical power wire and cable, communications wiring, or fiber optic cables.

1.1 Products and Applications Included

This Standard applies to the following, when installed for commercial, institutional, and industrial applications in nonhazardous locations within the confines of the building structure, including raceways installed under floor slabs:

- Rigid Nonmetallic Conduit (RNC):
  - Rigid Polyvinyl Chloride Conduit: Type PVC (NEC Article 352)
  - Reinforced Thermosetting Resin Conduit: Type RTRC (NEC Article 355)
- Electrical Nonmetallic Tubing (ENT): Type ENT (NEC Article 362)
- Liquidtight Flexible Nonmetallic Conduit (LFNC): Type LFNC (NEC Article 356)

1.2 Products and Applications Excluded

This Standard does not apply to:

- Outdoor installations
- Concrete, tile, or fibrous conduits or ducts
- High Density Polyethylene (HDPE) conduit
- Nonmetallic underground conduit with conductors (NUCC)
- Surface nonmetallic raceways (SNR)
- Nonmetallic extensions
- Nonmetallic auxiliary gutters
- Nonmetallic wireways
- Communication raceways as defined in NEC Article 100
- Plenum, Riser, or General-purpose communications raceways installed as innerduct

1.3 Regulatory and Other Requirements

All information in this publication is intended to conform to the National Electrical Code (ANSI/NFPA 70). Workers shall follow the NEC, applicable State and local Codes, manufacturer instructions, and contract documents when installing nonmetallic raceway systems.

Only qualified persons as defined in the NEC familiar with the construction and installation of nonmetallic raceways shall perform the technical work described in this publication. Administrative functions such as receiving, handling, and storing nonmetallic raceways and other tasks shall be performed under the supervision of a qualified person. All work shall be performed in accordance with NFPA 70E, Standard for Electrical Safety in the Workplace.

General requirements for installing electrical products and systems are described in NECA 1, Standard Practices for Good Workmanship in Electrical Construction (ANSI). Other NEIS provide additional guidance for installing particular types of electrical products and systems. A complete list of NEIS is provided in Annex B.

1.4 Mandatory Requirements, Permissive Requirements, Quality and Performance Recommendations, Explanatory Material, and Informative Annexes

Mandatory requirements in manufacturer instructions, Codes, or other mandatory Standards that may or may not be adopted into law are those that identify actions that are specifically required or prohibited and are characterized in this Standard by the use of the terms "must" or "must not," "shall" or "shall not," or "may not," or "are not permitted," or "are required," or by the use of positive phrasing of mandatory requirements. Examples of mandatory requirements may equally take the form of, "equipment must be protected…," "equipment shall be protected…," or "protect equipment…," with the latter interpreted (understood) as "(it is necessary to) protect equipment…"

Permissive requirements of manufacturer instructions, Codes, or other mandatory Standards that may or may not be adopted into law are those that identify actions that are allowed but not required or are normally used to describe options or alternative means and methods and are characterized in this Standard by the use of the terms "may," or "are permitted," or "are not required."

Quality and performance instructions identify actions that are recommended or not recommended to improve the overall quality or performance of the installation and are characterized in this Standard by the use of the terms "should" or "should not."

Explanatory material, such as references to other Codes, Standards, documents, references to related sections of this Standard, information related to another Code, Standard, or document, and supplemental application and design information and data, is included throughout this Standard to expand the understanding of mandatory requirements, permissive requirements, and quality and performance instructions. Such explanatory material is included for information only and is identified by the use of the term "NOTE," or by the use of italicized text.

Non-mandatory information and other reference Standards or documents relative to the application and use of materials, equipment, and systems covered by this Standard are provided in informative annexes. Informative annexes are not part of the enforceable requirements of this Standard but are included for information purposes only.

2. Definitions

NOTE: The following terms are used in this Standard. The definitions below apply only to the context in which the terms are used in this Standard.

Communications Raceway*. An enclosed channel of nonmetallic materials designed expressly for holding communications wires and cables; optical fiber cables; data cables associated with information technology and communications equipment; Class 2, Class 3, and Type PLTC cables; and power-limited fire alarm cables in plenum, riser, and general-purpose applications.

Electrical Nonmetallic Tubing (ENT). A nonmetallic, pliable, corrugated raceway of circular cross section with integral or associated couplings, connectors, and fittings for the installation of electrical conductors. ENT is composed of a material that is resistant to moisture and chemical atmospheres and is flame retardant.

High Density Polyethylene (HDPE) Conduit*. A nonmetallic raceway of circular cross section, with associated couplings, connectors, and fittings of the installation of electrical conductors.

Innerduct*. A nonmetallic raceway placed within a larger raceway.

Liquidtight Flexible Nonmetallic Conduit (LFNC). A raceway of circular cross section of various types as follows:

1. A smooth seamless inner core and cover bonded together and having one or more reinforcement layers between the core and covers, designated as Type LFNC-A.
2. A smooth inner surface with integral reinforcement within the raceway wall, designated as Type LFNC-B.
3. A corrugated internal and external surface without integral reinforcement within the raceway wall, designated as LFNC-C.

NOTE: FNMC is an alternative designation for LFNC.

Nonmetallic Underground Conduit with Conductors (NUCC)*. A factory assembly of conductors or cables inside a nonmetallic, smooth wall raceway with a circular cross section.

Reinforced Thermosetting Resin Conduit (RTRC). A rigid nonmetallic raceway of circular cross section, with integral or associated couplings, connectors, and fittings for the installation of electrical conductors and cables.

Rigid Nonmetallic Conduit (RNC). A listed raceway of circular cross-section of suitable nonmetallic material that is resistant to moisture and chemical atmospheres, flame retardant, resistant to impact and crushing, resistant to distortion from heat under conditions likely to be encountered in service, and resistant to low temperature and sunlight effects, with integral or associated couplings, connectors, and fittings.

Rigid Polyvinyl Chloride Conduit (PVC). A rigid nonmetallic raceway of circular cross section, with integral or associated couplings, connectors, and fittings for the installation of electrical conductors and cables.

Surface Nonmetallic Raceway (SNR)*. A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.

* Provided for information purposes only. This product is excluded from this Standard. See Section 1.2.

3. Delivery, Handling, and Storage

NOTE: Deliver, handle, and store products in accordance with manufacturer instructions and by methods and means that will prevent damage, deterioration, and loss, including theft, and that will protect against damage from climatic conditions.

3.1 Delivery

Coordinate delivery schedules to minimize storage of products at site and overcrowding of construction spaces.

Transport RNC in groups or bundles in a straight and level position. Transport LFNC and ENT in coils in cartons or shrink-wrapped or on reels.

Load larger diameter and heavy-walled raceways onto trucks or trailers first when loading multiple bundles of nonmetallic raceways.

Secure each vertical stack of bundles with a minimum of two nylon straps or slings. Use straps and slings a minimum of 100 mm (4 inches) in width. Carefully tighten straps and slings only enough to secure the load. *NOTE: Do not use chains or metal straps with nonmetallic raceways.*

3.2 Handling

Unload raceway bundles one at a time using equipment equipped with forks such as a fork lift or backhoe equipped with forks (Figure 3.2). Be careful not to damage raceways from excessive stresses while moving. Verify that the weights and dimensions of bundles and reels are within the rated capacity of the handling equipment.

When unloading bundles using slings, use two slings positioned such that the center of gravity of the bundle is centered on the lifting equipment. Use care to balance and distribute weight when handling bundles and reels with platform dollies, platform lifts, forklift trucks, skids, and rollers to prevent overturning. Do not damage raceways or protective wrappings with forklift forks.

If unloading reels is accomplished by crane, use a cradle or shaft through the arbor hole in the reel. Do not lift reels by pulling or lifting by the raceway that is wound on the reel.

Keep personnel clear of the unloading site to prevent injury in the event of equipment failure or shifting of the load.

Do not push bundles from trucks or trailers to the ground. Do not break bundles on the vehicle to allow raceways to fall to the ground.

3.3 Storage

Store raceways and bundles in a horizontal and level position.

Store reels on a hard surface to prevent the reel from sinking into the surface causing the raceway to support its weight and the weight of the reel. Do not store reels on their sides. Block reels to prevent accidental rolling.

Do not exceed manufacturer recommended heights when stacking bundles. Do not stack thin-walled raceway or small bundles of raceway more than 2 meters (6 feet high).

Store raceways in an environment free from excessive dirt, dust, or other airborne contaminants.

Do not cover raceway ends during storage. *NOTE: Covering raceway ends prevents air passage and may lead to heat buildup in raceways and bundles. The internal temperature of raceways and bundles should not exceed 60° C (140°F).* Provide environmental controls or shading to prevent excessive heating of raceways.

For storage up to 6 months, raceway may be stored outdoors uncovered. For outdoor storage longer than 6 months and for storage in altitudes greater than 1000 meters (3000 feet) above sea level, cover raceways with an opaque tarp or ultraviolet light resistant sheeting. *NOTE: Do not store ENT in an outdoor, exposed location for longer than 60 days.*

Store sealed solvent cement containers in temperature between 5ºC (40ºF) to 21ºC (70ºF) or in accordance with manufacturer instructions.

4. Installation

4.1 General

Use manufacturer recommended raceways, factory elbows, associated fittings, boxes, and accessories designed, identified, and listed for the intended purpose and environment. *NOTE: Liquidtight or wet location fitting designs might require a separate sealing ring to be installed outside a box or enclosure to ensure a sealed interface between the body of the fitting and the box.*

Install nonmetallic raceways in accordance with manufacturer instructions. Maintain manufacturer recommended and Code required clearances. Make joints between lengths of conduit, and between conduit and couplings, fittings, and boxes, by an approved method.

Use permitted wiring methods. Conductors and cables are permitted to be installed in nonmetallic raceways where such use is not prohibited. Ensure that the number of cables and/or conductors installed in nonmetallic raceways does not exceed the allowable percentage fill specified in Table 1, Chapter 9 of the NEC. See Annex A.

Install raceways, boxes, fittings, and accessories level and plumb, and parallel and perpendicular to nearby surfaces, exposed structural members, and other building systems and components. Run exposed, parallel, or banked conduits together on common supports where practical.

Clean and dry raceways, boxes, fittings, and accessories before installation. Complete installation of electrical raceways before starting installation of cables and conductors within raceways and fittings.

Install raceway systems giving right-of-way priority to other systems, such as plumbing, that are required to be installed at a specified slope.

Make raceway runs mechanically continuous. Provide a bushing or adapter where raceways enter boxes, fittings, cabinets, or other enclosures to protect wires from abrasion unless the box, fitting, cabinet, or enclosure design provides equivalent protection. In accordance with NEC 300.4, provide identified insulating bushings to protect conductors size 4 AWG and larger where these conductors enter a cabinet, a box, an enclosure, or a raceway unless the conductors are separated from the fitting or raceway by identified insulating material that is securely fastened in place, or where threaded hubs or bosses that are an integral part of a cabinet, box, enclosure, or raceway provide a smoothly rounded or flared entry for conductors. Securely connect raceways to boxes, cabinets, and enclosures.

Install raceways so that they do not damage or run through structural members. *NOTE: Raceways may be run in notches in wood studs, joists, rafters, or other structural members where those notches do not reduce their load bearing ability.* Protect raceways where nails or screws are likely to damage

nonmetallic raceways run through structural members by installing a steel sleeve, steel plate, or steel clip at least 2 mm (1/16 inch) thick to protect the raceway before the building finish is applied.

Provide bushings or grommets in holes punched in metal framing members, or use suitable tools in forming holes that raceways are not subjected to physical damage.

Run raceways for outlets on waterproof walls exposed. Set anchors for supporting raceway on waterproof walls in waterproof cement. Preferably, use supports that provide a space between the raceway and the wall.

Avoid moisture traps where possible. Where moisture traps are unavoidable, provide junction boxes with drain fittings at raceway low points. *NOTE: There are no listed outlet boxes or flush device boxes that come provided with drain fittings.*

Install a separate equipment grounding conductor in nonmetallic raceways where equipment grounding is required. Where required or installed, equipment grounding conductors must be installed in accordance with NEC 250.134. Where required or installed, equipment bonding jumpers must be installed in accordance with NEC 250.102.

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Do not install ENT or RNC where subject to ambient temperatures in excess of 50ºC (122ºF) unless otherwise listed in the manufacturer instructions. Do not install ENT, LFNC, or RNC for conductors whose operating temperatures would exceed the listing of the raceway. Do not use LFNC where any combination of ambient and conductor temperatures is in excess of that for which it is listed.

Do not install angle connectors when LFNC is installed concealed. Straight LFNC fittings are permitted to be concealed and for direct burial or encasement in concrete.

Install polyethylene rope having not less than 200-pound tensile strength in empty or spare raceways. Leave a minimum of 300 mm (12 inches) of slack at each end of the raceway. Check spare raceways for obstructions using a ball mandrel. Clear or replace any raceways which reject a ball mandrel.

Do not install soiled, damaged, broken, or marred material or products. Repair or replace with new materials.

ENT is not permitted to be reconditioned. Replace damaged ENT sections, couplings, connectors, and fittings with new materials.

4.1.1 Uses Permitted

NOTE: Some types of nonmetallic raceways become brittle and more susceptible to damage from physical contact in extreme cold temperatures.

Rigid PVC conduit is permitted to be used in accordance with the NEC in the following locations and applications:

- Concealed in walls, floors, and ceilings.
- Encased in concrete.
- In locations subject to severe corrosive influences as covered in NEC 300.6 and where subject to chemicals for which the materials are specifically approved.
- In cinder fill.

- In portions of dairies, laundries, canneries, or other wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, must be installed and equipped so as to prevent water from entering the conduit. All supports, bolts, straps, screws, and so forth, must be of corrosion-resistant materials or be protected against corrosion by approved corrosion-resistant materials.
- In dry and damp locations not prohibited by NEC 352.12. See Section 4.1.2.
- For exposed work. Where exposed to physical damage, Schedule 80 PVC conduit, Schedule 80 PVC elbows, and listed PVC fittings must be used.
- For underground installations, PVC is permitted for direct burial and underground encased in concrete. See NEC 300.5 and NEC 300.50.
- PVC conduit is permitted to support nonmetallic conduit bodies not larger than the largest trade size of an entering raceway. These conduit bodies must not support luminaires or other equipment and must not contain devices other than splicing devices as permitted by NEC 110.14(B) and NEC 314.16(C)(2).
- Conductors or cables rated at a temperature higher than the listed temperature rating of PVC conduit are permitted to be installed in PVC conduit, provided the conductors or cables are not operated at a temperature higher than the listed temperature rating of the PVC conduit.

RTRC is permitted to be used in accordance with the NEC in the following locations and applications:

- Concealed in walls, floors, and ceilings.
- In locations subject to severe corrosive influences as covered in NEC 300.6 and where subject to chemicals for which the materials are specifically approved.
- In cinder fill.
- In portions of dairies, laundries, canneries, or other wet locations, and in locations where walls are frequently washed, the entire conduit system, including boxes and fittings used, must be installed and equipped so as to prevent water from entering the conduit. All supports, bolts, straps, screws, and so forth, must be of corrosion-resistant materials or be protected against corrosion by approved corrosion-resistant materials.
- In dry and damp locations not prohibited by NEC 355.12. See Section 4.1.2.
- For exposed work if identified for such use. *NOTE: RTRC, Type XW, is identified for use in areas subject to physical damage.*
- For underground installations, see NEC 300.5 and NEC 300.50.
- RTRC is be permitted to support nonmetallic conduit bodies not larger than the largest trade size of an entering raceway. These conduit bodies must not support luminaires or other equipment and must not contain devices other than splicing devices as permitted by NEC 110.14(B) and NEC 314.16(C)(2).
- Conductors or cables rated at a temperature higher than the listed temperature rating of RTRC are permitted to be installed in RTRC, if the conductors or cables are not operated at a temperature higher than the listed temperature rating of the RTRC.

ENT is permitted to be used for the following purposes: *NOTE: For the purpose of defining the permitted uses of ENT, the first floor of a building is defined as that floor that has 50 percent or more of the exterior wall surface area level with or above finished grade. One additional level that is the first level and not designed for human habitation and used only for vehicle parking, storage, or similar use is permitted.*

- In any building not exceeding three floors above grade for exposed work (where not prohibited by the NEC; see Section 4.1.2), or concealed within walls, floors, and ceilings.
- In any building exceeding three floors above grade, ENT must be concealed within combustible or noncombustible walls, floors, and ceilings where the walls, floors, and ceilings. Provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of

fire-rated assemblies. Where an approved automatic fire protective system(s) is installed on all floors, ENT is permitted to be used within walls, floors, and ceilings, exposed or concealed, in buildings exceeding three floors above grade.

- In locations subject to severe corrosive influences as covered in NEC 300.6 and where subject to chemicals for which the materials are specifically approved.
- In concealed, dry, and damp locations not prohibited by NEC 362.12. See Section 4.1.2.
- Above suspended ceilings where the suspended ceilings provide a thermal barrier of material that has at least a 15-minute finish rating as identified in listings of fire-rated assemblies, except as permitted in NEC 362.10(1)(a).
- Where an approved automatic fire protection system(s) is installed on all floors, ENT is permitted to be installed above suspended ceilings in buildings exceeding three floors above grade.
- Encased in poured concrete floors, slabs, walls and ceilings.
- Embedded in a concrete slab on grade where ENT is placed on sand or approved screenings and where fittings identified for the purpose are used for connections.
- For wet locations indoors as permitted by NEC 362.10 or in a concrete slab on or below grade, with fittings listed for the purpose.
- Metric designator 16 through 27 (trade size ½ through 1) as a listed manufactured prewired assembly.
- Conductors or cables rated at a temperature higher than the listed temperature rating of ENT are permitted to be installed in ENT, if the conductors or cables are not operated at a temperature higher than the listed temperature rating of the ENT.

LFNC is permitted to be used in exposed or concealed locations for the following purposes:

- Where flexibility is required for installation, operation, or maintenance.
- Where protection of the contained conductors is required from vapors, liquids, or solids.
- For outdoor locations where listed and marked as suitable for the purpose.
- For direct burial where listed and marked for the purpose.
- Type LFNC is permitted to be installed in lengths longer than 1.8 meters (6 feet) where secured in accordance with NEC 356.30. See Section 4.3.
- Type LFNC-B as a listed manufactured prewired assembly, metric designator 16 through 27 (trade size ½ through 1) conduit.
- For encasement in concrete where listed for direct burial and installed in compliance with NEC 356.42.
- In locations subject to severe corrosive influences as covered in NEC 300.6 and where subject to chemicals for which the materials are specifically approved.
- Conductors or cables rated at a temperature higher than the listed temperature rating of LFNC are permitted to be installed in LFNC, if the conductors or cables are not operated at a temperature higher than the listed temperature rating of the LFNC.

4.1.2 Uses Not Permitted

Rigid PVC conduit is not permitted to be used in the following locations and applications:

- In any hazardous (classified) location, except as permitted by NEC Articles other than NEC 352.
- For the support of luminaires or other equipment not described in NEC 352.10(1).
- Where subject to physical damage unless identified for such use. See Section 4.1.1.
- Where subject to ambient temperatures in excess of 50°C (122°F) unless listed otherwise.
- In theaters and similar locations, except as provided in NEC 518.4 and NEC 520.5.

RTRC is not permitted to be used in the following locations and applications:

- In any hazardous (classified) location, except as permitted by NEC Articles other than NEC 355, or in Class I, Division 2 locations, except as permitted in NEC 501.10(B)(1)(6).
- For the support of luminaires or other equipment not described in NEC 355.10(H).
- Where subject to physical damage unless identified for such use. See Section 4.1.1.
- Where subject to ambient temperatures in excess of 50°C (122°F) unless listed otherwise.
- In theaters and similar locations, except as provided in NEC 518.4 and NEC 520.5.

ENT is not permitted to be used in the following locations and applications:

- In any hazardous (classified) location, except as permitted by NEC Articles other than NEC 362.
- For the support of luminaires and other equipment.
- Where subject to ambient temperatures in excess of 50°C (122°F) unless listed otherwise.
- For direct earth burial.
- In exposed locations, except as permitted by NEC 362.10(1), NEC 362.10(5), and NEC 362.10(7).
- In theaters and similar locations, except as provided in NEC 518.4 and NEC 520.5.
- Where exposed to direct sunlight unless identified as sunlight resistant.
- Where subject to physical damage.

LFNC is not permitted to be used in the following locations and applications:

- Where subject to physical damage.
- Where any combination of ambient and conductor temperatures is in excess of that for which the LFNC is listed.
- In lengths longer than 1.8 meters (6 feet), except as permitted by NEC 356.10(5) or where a longer length is approved as essential for a required degree of flexibility.
- In any hazardous (classified) location, except as permitted by NEC Articles other than NEC 356.

4.2 Coordination

Coordinate final rough-in locations with field measurements and with the requirements of the actual equipment to be connected.

Coordinate raceway locations where space is limited for installation and access. Install exposed raceways and raceways in spaces above hung ceilings and in crawl spaces so that they do not interfere with ceiling inserts, luminaires (lighting fixtures), and ventilation ducts or outlets. Do not install raceways within an air handling plenum. *NOTE: RNC and ENT are not recognized for use in other space used for environmental air or plenums as described in NEC Section 300.22(C).*

Coordinate with other trades to avoid installing raceways crossing pipe shafts, ventilating duct openings, water, steam or waste pipes, and radiator branches. Avoid horizontal or cross runs in building partitions or side walls. Maintain a minimum distance of 150 mm (6 inches) between nonmetallic raceways and parallel runs of flues, hot water pipes or other sources of heat. Install horizontal raceway runs above water and steam piping.

Arrange for chases, slots, and openings in building structure during the progress of construction to allow for electrical installations. Coordinate the installation of raceways, required supporting devices, and sleeves in masonry walls, poured-in-place concrete, and other structural components as they are constructed.

4.3 Supports

Support raceway in accordance with its listing, manufacturer instructions, and the National Electrical Code. Install nonmetallic raceways as a complete system in compliance with NEC 300.18.

Provide raceway supports, support hardware, and fasteners compatible with the raceway system, suitable for use in the installed environment, and designed specifically for the intended purpose.

Support raceways independently of supports for other trades, such as ceiling support wires, HVAC, and other piping, unless detailed in contract documents or approved by the Engineer of Record.

Properly support and anchor raceways for their entire length by structural materials. Do not install raceways without support across any span.

Support riser raceway at each floor level with clamp hangers. Arrange supports so the load produced by the weight of the raceway and the enclosed conductors are carried entirely by the raceway supports with no weight on terminals. Provide manufacturer recommended supports for conductors within raceway risers.

Support individual horizontal raceways by either pipe straps or separate pipe hangers. Spring steel fasteners may be used in lieu of pipe straps or hangers for 40 mm (1-1/2-inch) and smaller raceways in dry locations.

Arrange raceway supports and provide additional support strength where required to prevent raceway distortion during wire pulling.

Support raceways within 300 mm (12 inches) of unsupported boxes and accessible fittings. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry. *NOTE: RNC is permitted to support nonmetallic conduit bodies not larger than the largest trade size of an entering raceway. The conduit bodies cannot contain devices or support fixtures or other equipment.*

Use vibration and shock- resistant fasteners for attachment to concrete slabs.

Fasten raceways to the rib of corrugated metal roof decking.

Do not weld channels, angle-iron, pipe straps, or items other than threaded studs to steel structures.

Do not cut main reinforcing bars when drilling holes to a depth of more than 40 mm (1-1/2 inches) in reinforced concrete beams or to a depth of more than 3/4 inch in concrete decks. Fill unused holes.

Do not fasten raceway with wire, tie wraps, or perforated pipe straps.

Fasten rigid PVC conduit so that movement from thermal expansion or contraction is permitted.

Securely fasten RNC within 900 mm (3 feet) of each outlet box, junction box, device box, conduit body, or other conduit termination. RNC listed for securing at other than 900 mm (3 feet) is permitted to be installed in accordance with the listing.

Support RNC in accordance with NEC Table 352.30(B) for PVC conduit and NEC Table 355.30(B) for

RTRC. See Annex A. Conduit listed for support at spacing other than as shown in the applicable NEC Table is permitted to be installed in accordance with the listing. Horizontal runs of RNC supported by openings through framing members at intervals not exceeding those in the applicable NEC Table and securely fastened within 900 mm (3 feet) of termination points are permitted.

Securely fasten and support ENT at intervals not exceeding 900 mm (3 feet) and within 900 mm (3 feet) of each outlet box, device box, junction box, cabinet, or fitting where it terminates. *NOTE: Lengths of ENT not exceeding a distance of 1.8 meters (6 feet) from a luminaire terminal connection for tap connections to lighting luminaires are permitted without being secured. Lengths of ENT not exceeding 1.8 meters (6 feet) from the last point where the raceway is securely fastened for connections within an accessible ceiling to luminaire(s) or other equipment are permitted without being secured. For concealed work in finished buildings or prefinished wall panels where such securing is impracticable, unbroken lengths (without coupling) of ENT is permitted to be fished.*

Horizontal runs of ENT supported by openings in framing members at intervals not exceeding 900 mm (3 feet) and securely fastened within 900 mm (3 feet) of termination points are permitted.

Support LFNC at intervals not exceeding 900 mm (3 feet) and within 300 mm (12 inches) on each side of every outlet box, junction box, cabinet, or fitting. *NOTE: Where secured at the termination in accordance with the NEC, securing and supporting LFNC is not required where it is fished, installed in lengths not exceeding 900 mm (3 feet) at terminals where flexibility is required, or where installed in lengths not exceeding 1800 mm (6 feet) for lighting fixture connections.*

NOTE: Where securely fastened within 300 mm (12 inches) of termination points, LFNC can be run horizontally through framing member openings at intervals not exceeding 900 mm (3 feet) without additional securing or support.

4.4 Boxes

Provide boxes, conduit bodies, and fittings for nonmetallic raceway systems for making splices and taps. Install a box or conduit body at each conductor splice point, outlet point, switch point, junction point, termination point, or pull point, unless otherwise permitted in NEC 300.15.

Support boxes in accordance with manufacturer instructions and the NEC.

Follow manufacturer instructions for attaching nonmetallic raceways to boxes and enclosures. Where installed, tighten locknuts using appropriate tools in accordance with manufacturer instructions. When securing locknuts, avoid applying excessive pressure when gripping the body of the fitting. For threaded fittings, ensure that a minimum of 3-1/2 threads are engaged.

Install boxes in locations which ensure accessibility to enclosed electrical wiring. Avoid installing boxes back-to-back in walls. Provide not less than 175 mm (7 inches) of separation between boxes opening onto different sides of the same wall. Do not locate a pull or junction box within 600 mm (24 inches) of any other pull or junction box. Follow manufacturer instructions for spacing requirements.

Position recessed outlet boxes accurately (from flush to within 3 mm (1/8 inch) of wall surface) to allow for surface finish thickness. Do not span different types of building finishes with boxes, covers or device plates. Saw-cut box openings in masonry walls. Locate boxes at joint of masonry units.

Center outlet boxes above doorways 150 mm (6 inches) above the door head, unless otherwise indicated

on contract documents or required by physical conditions.

Locate boxes for switches near doorways on the side opposite the door hinges and within approximately 4" of the door trim, unless otherwise indicated on contract documents or required by physical conditions.

Locate outlet boxes for switches and receptacles on columns or pilasters off the centers of the columns far enough to allow for future installation of partitions where possible.

Mount outlet boxes for switches with the long axis vertical, unless otherwise indicated on contract documents. Mount three or more gang boxes with the long axis horizontal. Mount boxes for receptacles either vertically or horizontally, but consistently one way.

Mount pull boxes concealed in non-accessible walls or ceilings, with the covers flush with the finished wall or ceiling. Set floor boxes level and adjust to be flush with finish flooring material. Install floor boxes in concrete floor slabs so they are completely enveloped in concrete except at top.

Use standard sized coverplates.

4.5 Sleeves

Install sleeves for raceway penetrations of concrete slabs and walls and all other fire-rated floors and walls, except where core-drilled holes are used. Use listed penetration methods and certified firestopping methods for penetrations through masonry partitions, fire-rated gypsum board walls, and other fire-rated floor and wall assemblies.

Where sleeves are installed through existing slabs or partitions, completely fill the void between the sleeve and masonry with expanding cement grout.

Identify unused sleeves and slots for future use by permanently identifying the size and purpose of the covered slot or sleeve.

4.6 Expansion and Contraction of Rigid Nonmetallic Conduit (RNC)

Consult the manufacturer for recommendations for accommodating thermal expansion and contraction of the RNC system, rigid PVC conduit and RTRC, especially for installations where conduits are subjected to significant variations in temperature during normal operation. *NOTE: Backfill trenches soon after the installation of conduits to prevent expansion or contraction due to temperature changes in the ambient air.*

Allow conduit temperature to normalize near the ambient temperature or the expected service environment temperature before installation.

Install expansion fittings wherever structural expansion joints are crossed (see Figure 4.6). Leave pipe straps loose to allow movement of the raceway. *NOTE: Expansion joints are not required where RNC crosses building control joints, if the control joint does not act as an expansion joint.*

Provide expansion fittings or change of direction fittings to control thermal expansion and contraction where the length change is estimated to be 6 mm (¼ inch) or greater in a straight run between securely mounted items such as boxes, cabinets, elbows, or other conduit terminations. Calculate the total change

in length of the conduit run using actual conduit lengths and temperatures and applicable NEC Tables.

See NEMA FB 2.40-2019 for additional guidance.

4.7 Bending

Make bends in accordance with manufacturer instructions and NEC requirements.

Allow joints to thoroughly set before bending and placement. See Section 4.9.

Make bends so that the tubing or conduit will not be damaged and that the internal diameter will not be effectively reduced.

Make field bends of RNC with bending equipment identified for the purpose. Do not make field bends less than the manufacturer recommended and Code required minimum bending radius. The radius of the curve to the centerline of such bends must not be less than shown in NEC Table 2, Chapter 9. See Annex A. Use factory elbows for all bends smaller than manufacturer recommended minimum bending radius.

Do not exceed the equivalent of four quarter bends (360 degrees total) between pull points, such as between conduit bodies and boxes.

Make bends in parallel or banked runs from the same center line so that the bends are parallel. Use factory elbows in banked runs only where they can be installed parallel.

Make bends and offsets such that the legs of a bend are in the same plane and the straight legs of offsets are parallel.

Run concealed raceways with a minimum of bends. Arrange raceways concealed in walls and slabs such that the curved portions of bends are not visible above the finished surface.

4.8 Cutting Raceways

Cut raceways to length using manufacturer recommended tools and methods. Ensure that all cuts are clean and square with the barrel of the raceway.

Deburr cut ends using suitable tools and as recommended by the manufacturer. Trim cut ends inside and outside to remove rough edges. *NOTE: Slightly chamfering the inside and outside edges of the cut end of the raceway can facilitate joining, can prevent cable damage during pulling operations, and can facilitate rope pulling through the raceway.*

Insert raceways fully into fittings until the raceway reaches the end stop of the fitting.

4.9 Solvent Cementing Joints

NOTE: Solvent cementing is not used for LFNC

NOTE: The best solvent cementing results are obtained in temperatures above 5°C (40°F). In colder temperatures, allow longer times for initial setting. In cold weather, do not put joints under stress for 24

to 48 hours after setting.

NOTE: Nonmetallic raceway solvent cement is highly flammable. Avoid using solvent cement in the presence of ignition sources such as lighted smoking materials, open flames, ongoing welding processes, and electrical arcing. Avoid breathing concentrated fumes and provide adequate ventilation in confined areas. Read and follow all manufacturer precautions on the container.

Check condition of cement before use. *NOTE: Cement should have a fluid consistency.* Dispose of gelled or lumpy cement in accordance with applicable environmental regulations. Do not attempt to liquefy or dilute gelled or lumpy cement. Do not attempt to warm cement using electric or propane heaters, or open flame. Keep can lids closed while not in use as cement will absorb moisture from the air.

Follow manufacturer instructions for selecting suitable solvent cement for the installation requirements. Match temperature rating of cement to installation conditions.

NOTE: Three types of cement are available for RNC, based on the viscosity: regular bodied, medium bodied, and heavy bodied. Regular bodied cement is suitable for most raceway applications up through 150 mm (6 inches). For better gap filling needs, a medium bodied cement should be selected. For raceways, where a watertight joint is needed, or for extremely hot weather use, select a heavy bodied cement. For cement joints in corrugated ENT, use manufacturer recommended ENT solvent cement. Do not use PVC solvent cement on the threads of threaded fittings.

Wipe joint surfaces clean of dirt or moisture or other contaminants. Clean dirty or oil-coated raceway joining surfaces using PVC cleaner or primer in accordance with manufacturer instructions. Thoroughly dry raceway joining surfaces. *NOTE: Do not attempt to join raceways when any indication of moisture is present.*

Cool joint areas of raceways that are 32ºC (90ºF) or above by shading or by applying a damp cloth. *NOTE: Allow joining surfaces of raceways to thoroughly dry before applying cement when using a damp cloth to cool raceways.*

NOTE: Hot raceway surfaces cause rapid drying of the cement, resulting in insufficient welding. Verify that cement is liquid on raceway surfaces when joining the spigot and bell or fitting. Using a heavier, slower drying cement may be appropriate when it is impractical to cool the raceway surfaces prior to joining.

Apply a full, even coat of cement to the entire area of the spigot that will be inserted into the bell or fitting. Use the dauber applicator supplied in the lid of the cement container. Apply the cement quickly and evenly around the spigot and inside the bell or fitting.

Insert the spigot fully into the bell or fitting while the cement is still liquid, twisting the spigot section one-quarter turn as insertion is made. Hold the joint firmly together for 10 to 20 seconds without movement. *NOTE: Cold weather applications may require a longer holding time.* If the spigot section backs out upon release, pull the joint apart, apply another coat of cement, reassemble, and hold until the joint does not back out upon release.

NOTE: A small bead of cement should appear around the lip of the bell or fitting if adequate cement has been applied. Wipe off excess cement after the joint has set.

Carefully handle newly assembled joints until the cement has fully cured. If manufacturer instructions

are unavailable, use the minimum recommended curing times found in *Table 4.9 Minimum Cement Curing Time.*

Table 4.9 Minimum Cement Curing Time.

Temperature Range	Time
15 to 40°C (60 to 100°F)	30 minutes
5 to 15°C (40 to 60°F)	1 hour
-5 to 5°C (20 to 40°F)	2 hours
-20 to -5°C (0 to 20°F)	4 hours

Note: Joint damage or loosening may occur up to 48 hours after assembly in temperatures below 5°C *(40°F), if the joints are severely stressed.*

4.9.1 Solvent Welding Fittings to ENT

Use only solvent cement or other PVC cement which is specifically labeled for use with ENT. *NOTE: Do not use heavy- or medium-bodied PVC cement or combinations of ABS and PVC cement.*

Remove all dust, dirt and moisture from ENT and fittings before applying cement. *NOTE: Do not use primer or cleaner.*

Apply solvent cement with the natural bristle brush supplied in the can lid. *NOTE: Do not use a dauber.*

Apply a light, uniform coat of cement inside the socket fitting. Apply a light, uniform coat of cement to the outside surface of the ENT to the depth of the fitting socket. Brush around the corrugations of the ENT. *NOTE: Do not brush longitudinally along the ENT.*

Brush away any excess cement out of the grooves of the ENT. *NOTE: Excess cement may cause burning and excess softening of the ENT which may result in joint failure under stress.*

Quickly insert the tubing into the fitting while the cement is still wet up to the center stop of the fitting. Give the fitting a one-quarter turn and hold firmly in place for 15 to 30 seconds. Do not disturb the fitting for two to five minutes to allow the joint to set firmly.

4.10 Raceways Concealed in Masonry and Concrete

Secure raceways to reinforcing rods or otherwise secure raceways to prevent movement such as floating or sagging when concrete is placed. Locate spacers, if used, at intervals not exceeding the maximum spacing indicated in *Table 4.10 Maximum Spacer Intervals.*

Table 4.10 Maximum Spacer Intervals.

Raceway Size	Maximum Spacing, Meters (Feet)

½ - 2	1.2 – 1.8 (4 – 6)
2-1/2 - 3-1/2	1.5 – 2.4 (5 – 8)
4 - 6	1.8 – 3.0 (6 – 10)

Rising temperatures from curing concrete can cause expansion of nonmetallic raceways. Pour concrete from the center of the raceway run toward each free end or from one tie-in point toward the free end of the raceway. Make permanent raceway end-connections after the concrete and raceway temperature has normalized.

Locate raceways in the middle third of cast-in-place slabs and walls. Ensure a minimum of 25 mm (1 inch) of concrete cover over raceways. Place raceways between the bottom reinforcing steel and top reinforcing steel. Route raceways parallel and perpendicular to the main reinforcing steel within slabs. When routing raceways at right angles to reinforcing steel, place raceways close to slab supports.

Provide a lateral separation of raceways not less than three raceway diameters, except where the arrangement is approved or where contract documents indicate that the concrete slab has been specially designed to accommodate a closer spacing, such as where raceways enter wire closets, panelboards, or electrical boxes.

Transition ENT to RNC before rising above floor slabs. *NOTE: Where permitted, ENT and LFNC may be used for final equipment connections 150 mm (6 inches) or more above the floor.*

Do not install raceways in slabs or walls when the outside raceway diameter exceeds 1/3 of the slab or wall thickness. Do not install raceways in a slab topping of 50 mm (2 inches) or less. Do not route raceways such that raceways cross in slabs above grade.

4.11 Seals

Use manufacturer recommended watertight and smoketight wall and floor seals, of types and sizes required, suitable for sealing around raceway, pipe, or tubing passing through concrete floors and walls, and where raceways pass between areas of differing temperatures, such as into or out of conditioned spaces, freezers, unheated and heated spaces, or between buildings.

Seal penetrations in floors, walls, or other general construction with a listed, 3 hour-rated smoke and firestopping sealant.

Close floor slots and openings with 16-gauge galvanized steel sheet supported on 25 mm by 25 mm by 3 mm (1-inch by 1-inch by 1/8-inch) structural angle drilled or supported with power-driven studs into the building structure. Firestop with a minimum of 25 mm (1 inch) thick layer of silicone elastomer, with the top surface of the silicone elastomer approximately 25 mm (1 inch) below the finished floor slab surface.

Close openings in walls with 16-gauge galvanized steel sheet securely attached at the midpoint of the wall thickness and firestopped on both sides of the steel sheet with a minimum of 13 mm (½ inch) thick layer of non-sagging silicone elastomer that completely covers the opening.

Tighten sleeve seal screws until grommets have expanded to form a watertight and smoketight seal.

4.12 Cleaning

Upon completing the raceway system installation, inspect the interior of raceways at all outlet, junction and pull boxes. Remove burrs, dirt, and construction debris. Repair damaged finish, including chips, scratches, and abrasions.

Run a swab or mandrel through raceways to remove dirt and blockages. Replace raceways which are deformed and prevent the passage of a mandrel.

Use suitable temporary closure protection to prevent further contamination from construction debris, foreign materials, dirt, moisture, and plaster. Provide knockout closures to cap unused knockout holes where blanks have been removed. Protect stub-ups from physical damage during construction where raceways rise from floor slabs.

Label and identify raceways in accordance with contract documents. Install electrical identification prior to installation of acoustical ceilings and similar finishes that conceal raceways.

(This annex is not part of the standard)

ANNEX A: NEC Tables

Table 352.30(B) Support of Rigid Polyvinyl Chloride Conduit (PVC)

(Insert Table Here)

Table 355.30(B) Support of Reinforced Thermosetting Resin Conduit (RTRC)

(Insert Table Here)

Table 1, Chapter 9 - Table 1 Percent of Cross Section of Conduit and Tubing for Conductors and Cables

(Insert Table Here)

Table 2, Chapter 9 – Table 2 Radius of Conduit and Tubing Bends

(Insert Table Here)

(This annex is not part of the standard)

ANNEX B: REFERENCE STANDARDS

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

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

NFPA 70-2023, *National Electrical Code* (ANSI)

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209
(703) 841-3200 tel
www.nema.org

NEMA FB 2.40-2019, *Installation Guidelines for Expansion and Expansion/Deflection Fittings*

National Electrical Contractors Association
3 Bethesda Metro Center Suite 1100
Bethesda, MD 20814
(301) 215-4504
(301) 215-4500 Fax
orderdesk@necanet.org
www.neca-neis.org

Other *National Electrical Installation Standards*™ Published by NECA

(Insert Current List of NEIS Here)

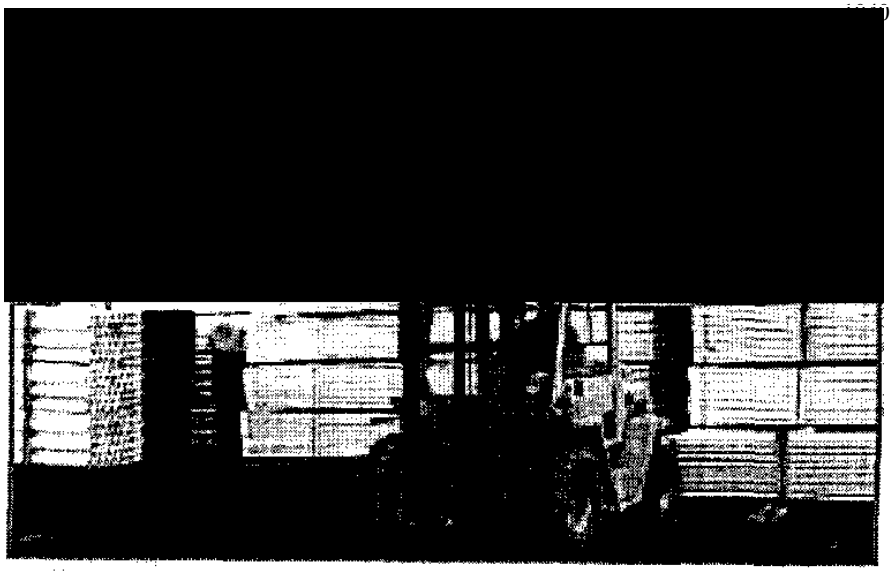

Figure 3.2 Transporting Bundle of Nonmetallic Raceway Using a Forklift

NOTE: LEAVE PIPE STRAPS LOOSE TO ALLOW MOVEMENT OF THE PIPE.

Figure 4.6 Installing Expansion Joint in Rigid Nonmetallic Conduit (RNC)