

SECTION 16190 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. All sections of Division 15 and 16 apply to this section.
- C. Related Section include the following:
 - 1. Division 3
 - 2. Division 5
 - 3. Division 7

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. IMC: Intermediate metal conduit.
- C. RMC: Rigid metal conduit.

1.4 QUALITY ASSURANCE

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Manufacturer's Qualifications: Company specializing in manufacturing Products specified in this Section with minimum three years experience.
- C. Listing and Labeling: Provide products specified in this Section that are listed and labeled:

1. Listing and labeling Agency Qualifications: A “Nationally Recognized Testing Laboratory” as defined in OSHA Regulation 1910.7.

- D. Comply with City of Chicago Electrical Code.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Material delivered to jobsite shall be stored in original packaging per manufacturer’s requirements.

1.6 COORDINATION

- A. Provide steel supports, anchor bolts, inserts, etc., for all equipment specified under this section of the specifications.
- B. Floor-mounted electrical equipment shall be installed on a minimum of 4 inch concrete housekeeping pads with a minimum of 4 inch equipment inset on all sides. Concrete shall be in accordance with referenced concrete specification section.
- C. Provide formed steel support channels extending from and solidly anchored to the floor and ceiling slabs and mount the designated equipment thereto.
- D. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

1.7 PROVIDE CONCRETE PADS FOR:

- A. Switchboards.
- B. Transformers.

1.8 PROVIDE STEEL SUPPORT CHANNELS FOR:

- A. Communication and special systems cabinets.
- B. Disconnect switches.
- C. Fire alarm system cabinets.
- D. Individual motor starters.
- E. Individual circuit breakers.
- F. Panel boards.

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- G. Wall mounted transformers.

1.9 WARRANTY - NOT APPLICABLE

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following manufacturers:
 - 1. Steel Slotted Support Systems:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. GS Metals Corp.
 - d. Thomas & Betts Corporation.
 - e. Unistrut; Tyco International, Ltd.
 - 2. Powder Actuated Fasteners
 - a. Hilti Inc.
 - b. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - c. MKT Fastening, LLC.
 - d. Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 3. Mechanical-expansion Anchors
 - a. Cooper B-Line, Inc.; a division of Cooper Industries.
 - b. Empire Tool and Manufacturing Co., Inc.
 - c. Hilti Inc.
 - d. ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - e. MKT Fastening, LLC.
 - 4. Conduit Sealing Bushings:
 - a. Bridgeport Fittings, Inc.
 - b. Cooper Industries, Inc.
 - c. Killark Electric Mfg. Co.
 - d. O-Z/Gedney
 - e. Raco, Inc.
 - f. Spring City Electrical Mfg. Co.
 - 5. Vibration Isolators:
 - a. California Dynamics Company
 - b. Mason Industries

2.2 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
1. Products for outdoor use shall be hot-dip galvanized after fabrication and applied according to MFMA-4.
 2. Other supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

2.3 MANUFACTURER SUPPORTING DEVICES

- A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps as described in NECA 1 and NECA 101.
- B. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.
- C. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs shall have number and size of conductor gripping holes as required to suit individual risers. Construct body of malleable-iron casting with hot-dip galvanized finish. Provide OZ/Gedney type "S" cable support or equal.
- D. U-Channel Systems: 12-gauge steel channels, with 9/16 inch diameter holes, at a minimum of 2 inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacturer
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
1. Powder-Actuated Fasteners: Threaded-heat-treated steel stud, for use in hardened Portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened Portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.4 VIBRATION ISOLATORS

A. General: Provide vibration isolators with either known undeflected heights or other markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

1. Provide isolators that operate in the linear portion of their load versus deflection curve. Furnish load versus deflection curves from the manufacturer that are linear, over a deflection range 50% above the design deflection.

B. Vibration Isolator Types

1. General Properties:

- a. The ratio of lateral to vertical stiffness shall be not less than 0.9 or greater than 1.5.
- b. The theoretical vertical natural frequency for each support point, based upon the load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than (+/-) 10%.
- c. Wave motion through the isolator shall be reduced to the following extent: Isolation above the primary vertical system resonance frequency shall follow the theoretically predicted isolation curve for single degree of freedom systems with 1-dB to 50 dB at all frequencies above the 150 Hz.
- d. All neoprene mountings shall have a shore hardness of 40 –65 after minimum aging of 30 days, or corresponding open-aging.

2. Isolator Description:

- a. Type MS shall be spring type, without housings or snubbers, equipped with leveling bolts and with two layers of ribbed or waffled neoprene pads, separated by a 1/16" galvanized steel plate under the base plate. Neoprene sleeves and washer shall be installed at all anchor bolts.
- b. Type HS shall be suspension hangers having a steel frame and spring element, in series with a neoprene pad, cut or washer. The isolator shall be designed so that hanger rod may be misaligned 15 degrees in any direction relative to the vertical, without contacting hanger box frame.
- c. Type MN shall be neoprene isolator support type unit having a minimum static deflection of 1/4".
- d. Type HN shall be a suspension hanger type employing a neoprene isolator unit having a minimum static deflection of 1/4".

C. Equipment Frames

1. Mounting frames and brackets shall be provided to carry the load of the equipment without causing mechanical distortion or stress to the equipment.
2. The mounting frames shall consist of welded, wide flange or channel structural steel, with welder brackets to accept the isolators. The section depth of any frame member shall be not less than 1/10th of the length of the longest frame member, and not less than 1/10th of the greatest span between support points. All frame members shall have the same depth.

2.5 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Division 5 Section "Metal Fabrications" for steel shapes and plates.
- C. Pipe Sleeves: Provide pipe sleeves of one of the following:
 1. Sheet Metal: Fabricate from galvanized sheet metal; round tube closed with snap lock joint, welded spiral seams, or welded longitudinal joint. Fabricate sleeves from the following gage metal for sleeve diameter noted:
 - a. 3 inch and smaller: 2 gauge.
 - b. 4 inch to 6 inch: 16 gauge.
 - c. Over 6 inch: 14 gauge.
 2. Steel Pipe: Fabricate from Schedule 40 galvanized steel pipe.
 3. Plastic Pipe: Fabricate from Schedule 80 PVC plastic pipe.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as scheduled in Table 1. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with single-bolt conduit clamps single-bolt conduit clamps using spring friction action for retention in support channel.
- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.
- E. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- F. Dry Locations: Steel materials.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1, NECA 101 and manufacturer's instructions for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, RMC EMT, IMC, and RMC may be supported by openings through structure members, as permitted in the Chicago Electrical Code.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 1. To Wood: Fasten with lag screws or through bolts.
 2. To New Concrete: Bolt to concrete inserts.
 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 4. To Existing Concrete: Expansion anchor fasteners.
 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts Spring-tension clamps.
 7. To Light Steel: Sheet metal screws.
 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panel boards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
 9. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.

10. Fasteners: Select so the load applied to each fastener does not of its proof test load.
11. Holes cut to depth of more than 1-1/2" in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
12. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration and shock-resistant fasteners for attachments to concrete slabs.

E. Vibration Isolators:

1. All floor supported transformers in excess of 300 kVA located within the building shall be mounted on isolation units utilizing type MS springs, appropriately secured to the transformer housing. Spring units shall be selected for a minimum static deflection of 1.5 inch.
2. All floor supported transformers equal to or less than 300 kVA located within the building shall be mounted on vibration isolation rails utilizing type MN neoprene mounts selected to deflect a minimum of 0.25 inch.
3. Suspended transformers 45 kVA and less shall be supported on an appropriate steel frame from Type HS hangers, selected for a minimum static deflection of 0.75 inch.

3.3 INSTALLATION

- A. Where equipment supports are on concrete construction, take care not to weaken concrete or penetrate waterproofing.
- B. Obtain prior approval for installation method of structural steel required to frame into building structural members for the support of equipment, conduit, etc. Welding shall be permitted only when approved by Architect.
- C. Coordinate dimensions of concrete housekeeping pads with requirements for equipment supplied.
- D. Install supporting devices to fasten electric components securely and permanently in accordance with CEC requirements.
- E. Coordinate with the building structural system and with other electrical installation.
- F. In wet and damp locations use steel channel supports to stand cabinets and panel boards one inch off wall.
- G. Raceway Supports: Comply with the CEC and the following requirements:
 1. Conform to manufacturer's recommendations for selection and installation of supports.
 2. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.
 3. Support parallel runs of horizontal raceways together on trapeze-type hangers.

4. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1-1/2 inch and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4 inch diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.
 5. Space supports for raceways in accordance with Table I of this section. Space supports for raceway types not covered by the above in accordance with CEC.
- H. Vertical Conductors Supports: Install simultaneously with installation of conductors.
- I. Do not fasten supports to pipes, ducts, mechanical equipment and conduit.
- J. Do not use ceiling system components for support.
- K. Provide weight-distributing facilities, where required, so as not to exceed the load-bearing capabilities of floors or walls that bear the weight of, or support, electrical systems.
- L. Exposed part of hangers and supports shall be painted with one coat of rust-inhibiting primer.
- M. Equipment shall not be held in place by its own dead weight. Provide base anchor fasteners in each case.
- N. Miscellaneous Supports: Support miscellaneous electrical components as required to provide the same structural safety factors as specified for raceway supports. Install metal channel or angle iron racks for mounting cabinets, panel boards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.
- O. In overhead spaces, boxes shall be supported independently of raceways. Support boxes directly from the building structure or by bar hangers. Where bar hangers are used for boxes, attach the bar to raceways on opposite side of the box and support the raceway with an approved type of fasteners not more than 2 inches from the box.
- P. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. For sleeves through fire-rated wall or floor construction, see Division 8 Section "Fire stopping" for appropriate UL listed fire stopping system.
- Q. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.
- R. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, bus ways, cabinets, panel boards, transformers, boxes, disconnect switches, and control components in accordance with the following:
1. Wood: Fasten with wood screws or screw-type nails.
 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 3. New Concrete: Concrete inserts with machine screws and bolts.

4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs or nails driven by a power charge may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load or the manufacturer's published allowable load capacity. For electrical cable or premises wire hangers for communications. Select nail, screw, or anchor suitable for base material. Space hangers according to cable bundle weight and sagging requirements.
10. Holes cut to depth of more than 1-1/2" in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.
11. Use vibration and shock-resistant anchors for vibratory equipment or support attachments to concrete slabs.

S. Install metal channel racks for mounting cabinets, panel boards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

T. Vibration Isolators:

1. All floor supported transformers in excess of 300 kVA located within the building shall be mounted on isolation units utilizing type MS springs, appropriately secured to the transformer housing. Spring units shall be selected for a minimum static deflection of 1.5 inch.
2. All floor supported transformers equal to or less than 300 kVA located within the building shall be mounted on vibration isolation rails utilizing type MN neoprene mounts selected to deflect a minimum of 0.25 inch.
3. Suspended transformers 45 kVA and less shall be supported on an appropriate steel frame from Type HS hangers, selected for a minimum static deflection of 0.75 inch.

3.4 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Install metal channel racks for mounting cabinets, panel boards; disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- B. Comply with installation requirements in Division 5 Section "Metal Fabrications" for site-fabricated metal supports.
- C. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

- D. Field Welding: Comply with AWS D1.1/D1.1M.

3.5 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.6 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 9 painting Sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

TABLE I: SPACING FOR RACEWAY SUPPORTS

Raceway Size (Inches)	No. of Conductors in Run		Maximum Spacing of Supports (Feet)	
			RGS & IMC*	EMT
<u>Horizontal Runs</u>				
1/2, 3/4	1 or 2	Flat ceiling or wall.	5	5
1/2, 3/4	1 or 2	Where it's difficult to provide support except at intervals fixed by the building construction.	7	7
1/2, 3/4	3 or more	Any location.	7	7
1/2 - 1	3 or more	Any location.	7	7
1 & larger	1 or 2	Flat ceiling or wall.	6	6
1 & larger	1 or 2	Where it is difficult to provide support except as intervals fixed by the building construction.	10	10
1 & larger	3 or more	Any location.	10	10
Any	--	Concealed.	10	10
<u>Vertical Runs</u>				
1/2, 3/4	--	Exposed	7	7
1, 1 1/4	--	Exposed	8	8
1 1/2 and larger	--	Exposed	10	10
Up to 2--		Shaftway	14	10
2 1/2	--	Shaftway	16	10
3 & larger	--	Shaftway	20	10
Any	--	Concealed	10	10

* Maximum spacings for IMC above apply to straight runs only. Otherwise the maximums for EMT apply.

<u>Abbreviations</u>	EMT	Electrical metallic tubing.
	IMC	Intermediate metallic conduit.
	RGS	Rigid galvanized steel conduit.

3.7 CLEANING

- A. The Contractor shall at all times, keep the site free from accumulations of waste material or rubbish caused by its employees or work. Remove all crates, cartons, and other waste materials or trash from the working areas at the end of each working day. Flammable waste material must be removed from the working areas at the time of generation. All rubbish and debris, combustible or not, shall be discarded in covered metal containers daily and removed from the premises at least weekly and legally disposed of.
- B. The Contractor shall be responsible for the general cleaning and maintenance of the premises and for the coordination and direction of the cleanup work of all trades. Each trade shall clean and maintain its portion of the work as required and as directed by the General Contractor. In case of a dispute, the Owner may remove rubbish and charge the Contractor as shall be determined to be just.
- C. Clean all electronic equipment per manufacturer's requirements as it relates to the project.
- D. Clean interior and exterior of concentrator enclosures.
- E. All equipment shall be cleaned prior to final acceptance.

3.8 CONTRACTOR STARTUP AND REPORTING – NOT APPLICABLE

3.9 COMMISSIONING AND DEMONSTRATION – NOT APPLICABLE

END OF SECTION 16190