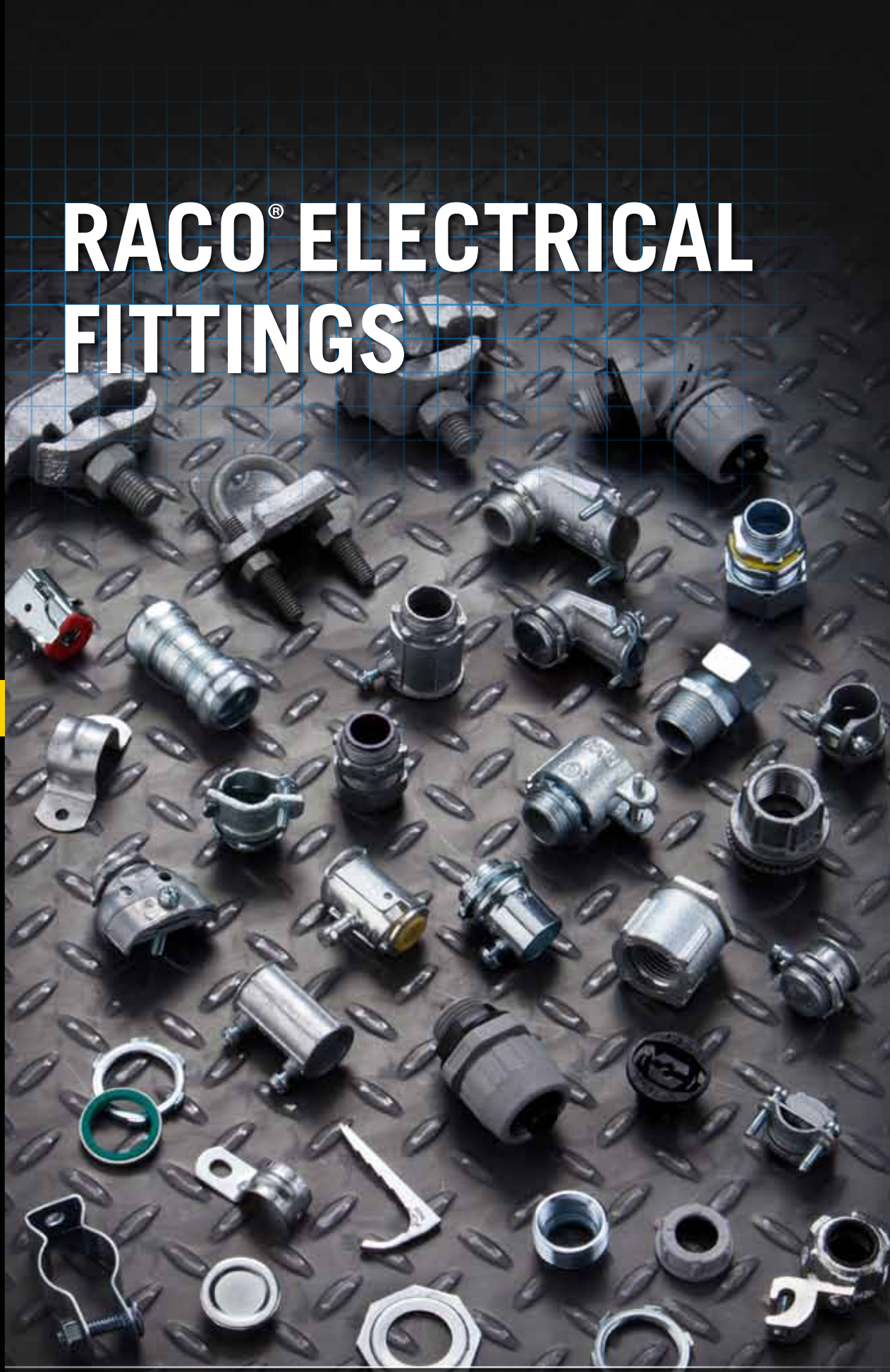
TRAINING MANUAL

RACO®

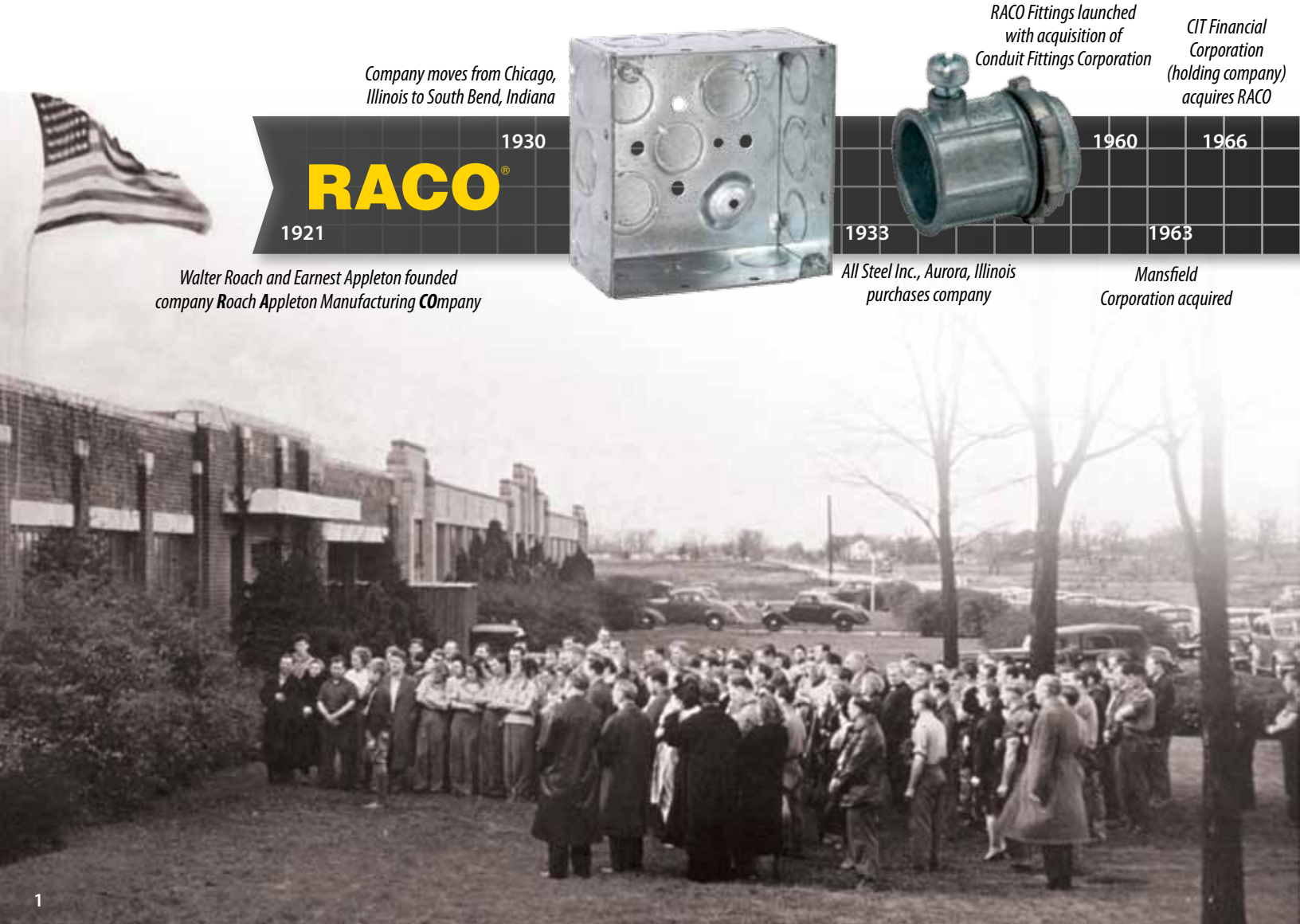
RACO® ELECTRICAL FITTINGS



HUBBELL® RACO® TAYMAC® BELL

HISTORY OF RACO

- RACO was founded by Walter Roach and Earnest Appleton in Chicago, Illinois in 1921. The business was moved to South Bend, Indiana in 1930.
- In 1930, RACO Inc., which was then known as Roach Appleton Manufacturing Company, began manufacturing steel electrical switch and outlet boxes at its present Sample Street location. All Steel Inc., based in Aurora, Illinois acquired the company in 1933. Since then, RACO brand electrical boxes have become the recognized leader in the construction industry.
- By 1960, acquisitions hastened RACO's entry into a related product, electrical fittings. Accelerated growth demanded larger facilities. During the 1960's, the adjoining Bike-Webb and Belleville Lumber properties on Sample Street were acquired and expanded into manufacturing facilities. In 1968 a 127,000 sq. ft. Curtiss-Wright plant on Chippewa Ave. was purchased. In 1970, RACO launched a comprehensive line of non-metallic boxes and covers.
- Hubbell Incorporated, a widely recognized leader in the electrical industry, acquired RACO in April 1981.
- On July 21, 1986, Hubbell acquired the weatherproof box, cover, and lighting business of Bell Electric Company from Square-D Company.
- Today, Hubbell RACO continues to dominate the domestic steel box segment. RACO boxes are sold through almost 3,000 electrical wholesalers and all major home improvement stores nationwide.



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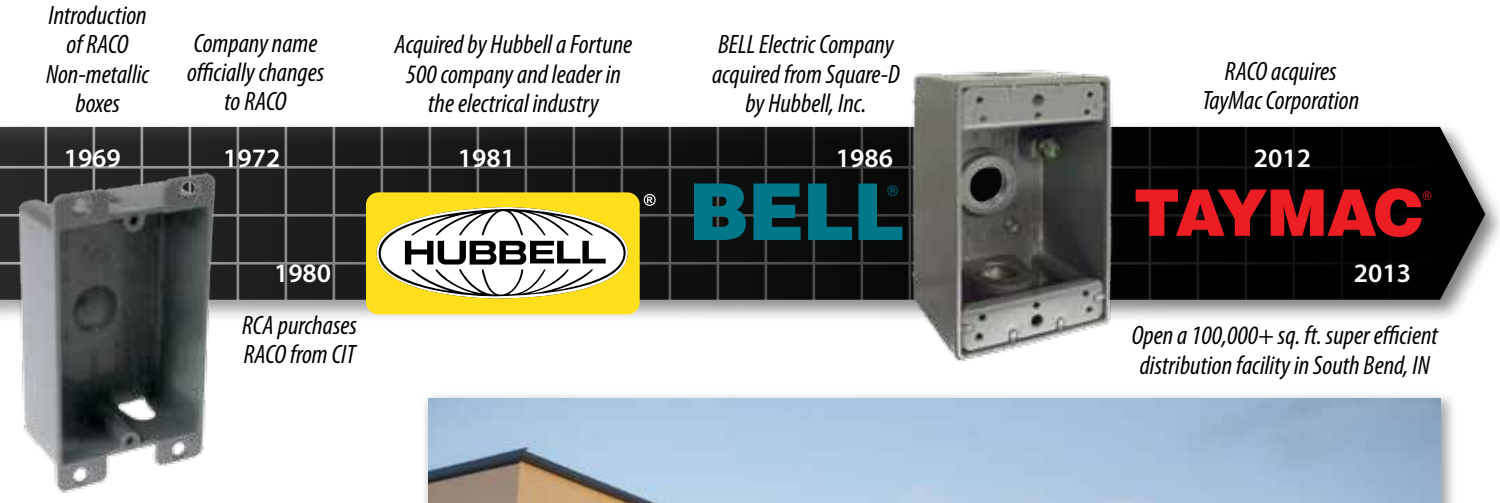
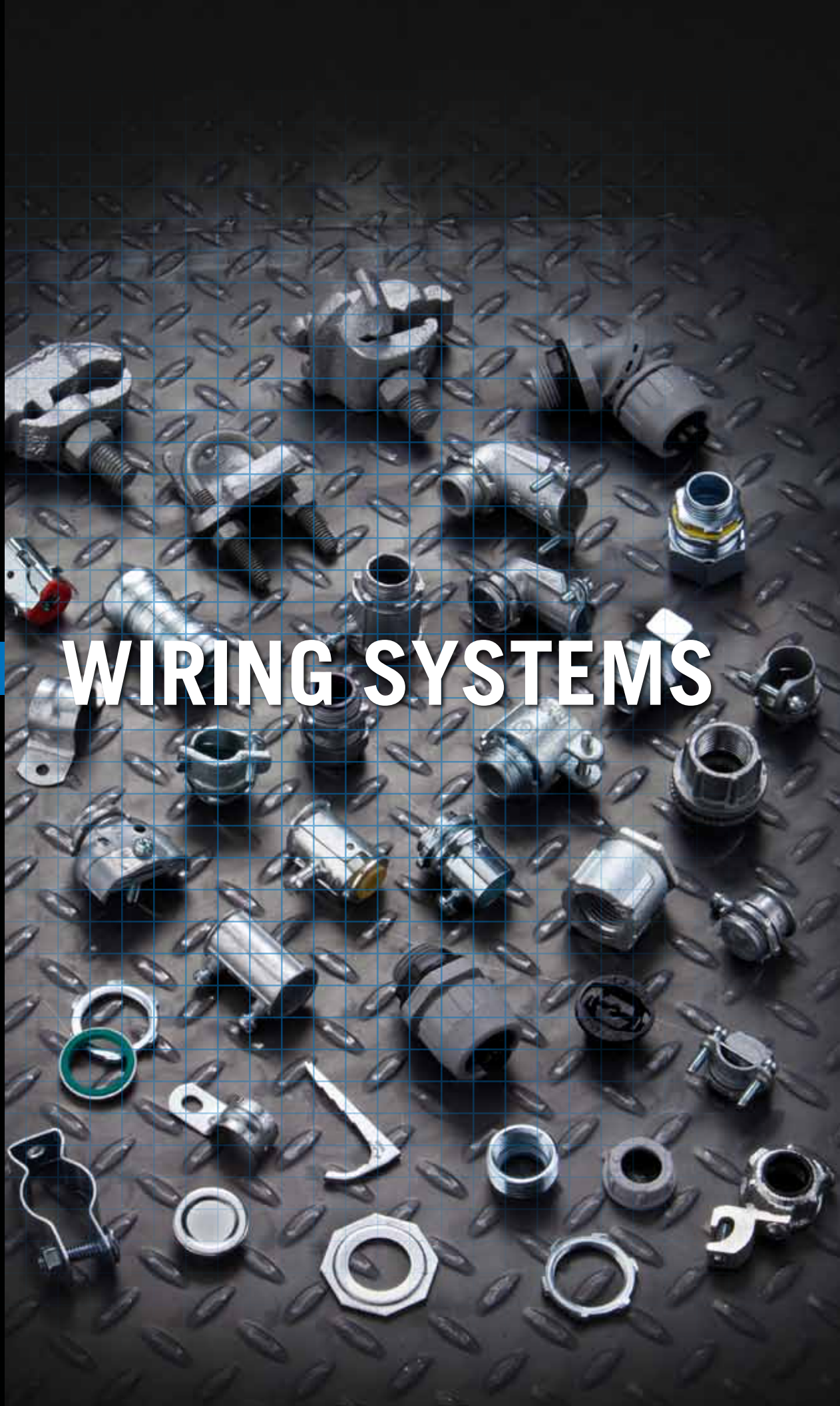


SECTION **A**

WIRING SYSTEMS



WIRING SYSTEMS: CONDUIT

Types of Wiring Systems (see Figure A)

There are various types of wiring systems used in construction today. Most are unique to either commercial or residential construction or various geographical regions throughout the U.S. This module highlights only the various types of conduit.

Conduit

Conduit is a term used for hollow channels designed to enclose and protect cable. Conduit shields conductors from physical damage. Conduit is referred to by "trade size". Common trade sizes range from ⅜" to 6", according to its inside diameter. The size of conduit needed depends upon the number and size of conductors the conduit will be holding. Conduit provides flexibility in the number and size of the conductors installed. If electrical requirements of the structure should change, conductors can be easily removed. If a short is suspected, individual conductors can be removed and inspected. Three types of conduits will be discussed below:

Rigid Metal Conduit (Rigid or Heavywall)

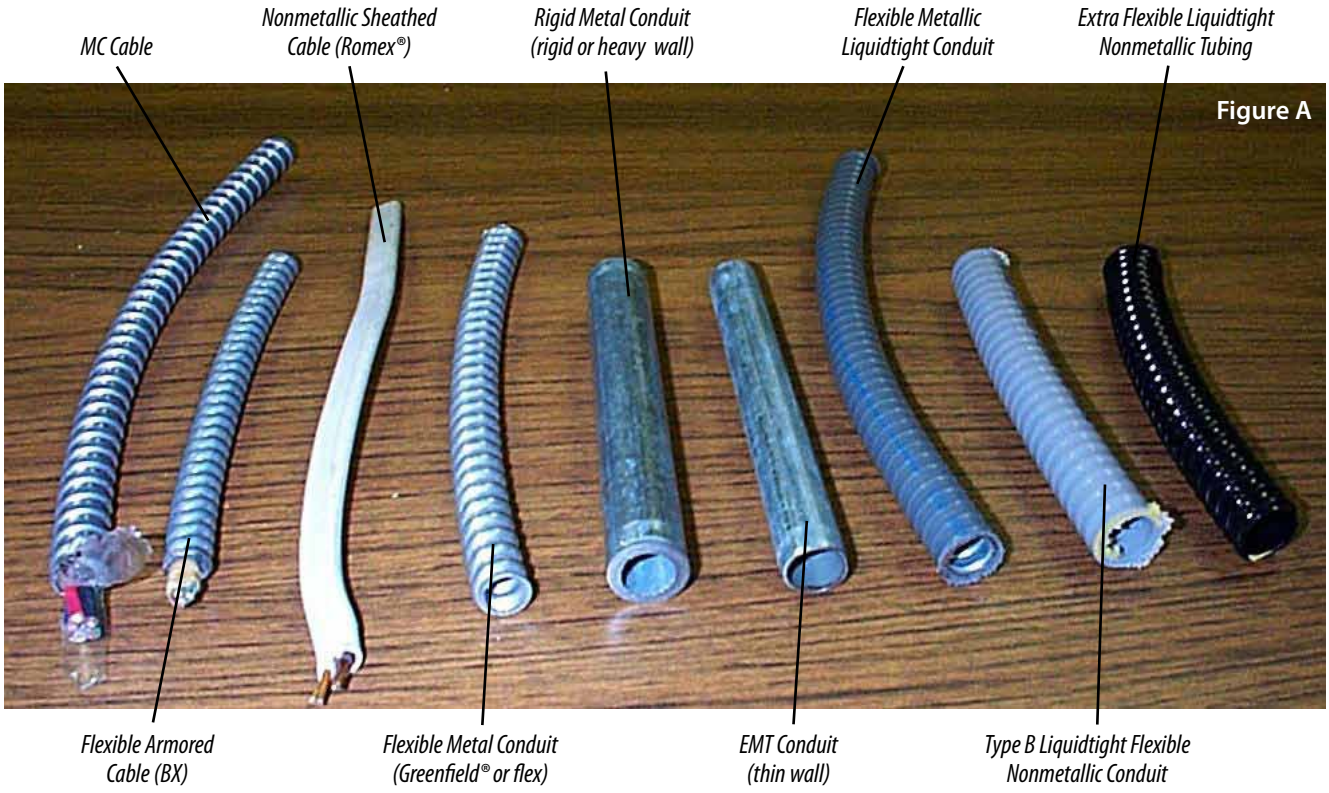
Rigid metal conduit is a heavy wall raceway that provides a high degree of mechanical protection indoors or outdoors, in dry or wet locations, exposed or concealed, in all types of atmospheric conditions and locations. Rigid conduit is made of steel with a heavy galvanized coating, or lighter weight aluminum, in ten or twenty foot lengths with tapered threads on both ends. One end has a metal threaded coupling used to join the next section of conduit. The opposite end has a plastic disposable bushing to protect the treads from damage during shipment. Rigid metal conduit is available in trade sizes1/2" to 6". It must be supported every ten feet or less and within three feet of every electrical box or enclosure. The conduit usually functions as the ground path.

Intermediate Metal Conduit (IMC)

In the mid 70's demand for a lighter weight, more economical version of rigid metal conduit brought IMC to the industry. It has the same diameter outside (O.D.) with a thinner wall, and uses the same fittings as Rigid. IMC is available in1/2" to 6" trade sizes and requires the same support requirements as rigid conduit. IMC continues to gain acceptance, but steel rigid conduit, despite its heavy weight and high cost, is still widely used.

Electrical Metallic Tubing (EMT or Thinwall)

Electrical metallic tubing (EMT) is often called thinwall as a contrast to heavy wall or rigid IMC. It may be used in concealed or exposed locations and provides adequate mechanical protection. EMT may be used in wet, but not underwater, locations and may be buried in concrete. It is not permitted in hazardous locations. The conduit is made of steel with a thin galvanized, or aluminum, coating and is produced in ten and twenty foot lengths. Because the walls are much thinner than rigid conduit, EMT is never threaded. Until the 1960's, EMT was only available in trade sizes1/2" to 2". These sizes have the same inside diameter (I.D.) as Rigid, but a smaller outside diameter (O.D.). For this reason, the fittings are not interchangeable. When 2½" to 4" EMT was developed, it had the same outside diameter as rigid and IMC, permitting interchangeable fittings. EMT, like rigid, must be supported every ten feet and within three feet of the box and usually functions as the ground path.


MC Cable
Nonmetallic Sheathed Cable (Romex®)
Rigid Metal Conduit (rigid or heavy wall)
Flexible Metallic Liquidtight Conduit
Extra Flexible Liquidtight Nonmetallic Tubing
Figure A
Flexible Armored Cable (BX)
Flexible Metal Conduit (Greenfield® or flex)
EMT Conduit (thin wall)
Type B Liquidtight Flexible Nonmetallic Conduit

WIRING SYSTEMS: CABLE & FLEXIBLE CONDUIT

Types of Wiring Systems (see Figure A)

There are various types of cable wiring systems used in construction today. Most are unique to either commercial or residential construction or various geographical regions throughout the U.S. This module highlights the different types of cable and flexible conduit.

Cable

Cable is manufactured with current carrying, and frequently grounding, conductors factory installed. Cables are flexible and available with metal or non-metallic outer coverings. Cables are described by the number and size of current carrying conductors and "with ground" when a grounding conductor is included. Cables are often covered by finished walls and changes are difficult to accomplish. A single conductor is an individual wire, usually sheathed with an insulating material. Conductors are shielded from one another by material that does not carry current - color coded PVC material. A grounding wire is green or green with one or more yellow stripes. It may also be bare. White or gray insulation indicates neutral wire; all other colors are used to identify hot wires. Copper is the best and most commonly used metal for conductors, aluminum and copper-clad aluminum are also used. Aluminum or copper-clad aluminum wire must be larger than a copper wire to conduct the same amount of electricity because aluminum is not as efficient a conductor as copper. "Conductor fill" refers to the number of current carrying and grounding conductors permitted by the NEC to be allowed in conduit. It relates to the trade size of conduit and varies by gauge and insulation. Generally, the conductors may fill only 40% of the conduit. Conduit fill has no relationship to the number of conductors allowed in a box.

Flexible Metallic Conduit

Flexible metallic conduit is frequently call "Greenfield™" which is the trade name of one manufacturer of this flexible steel or aluminum raceway. It is used around machinery where vibration or movement exists or where complex routing of the raceway dictates a flexible conduit. It is also used for short connections from junction box to light fixtures in false ceilings or commercial buildings. It offers good mechanical protection, but is approved for only dry locations. Flex is available in steel or aluminum, in trade sizes of ⅜" to 4", and is supplied in coils. Flex must be supported every 4½ feet and within 12" of a box. The only exceptions to the support requirements are light fixtures in old work applications. Usually the conduit serves as the ground path.

Flexible Armored Cable (BX®, AC)

Flexible armored cable is commonly called BX, a manufacturer's trade name. It may be described as pre-wired Greenfield™ since it includes two or more current carrying conductors and can be furnished with a grounding conductor. The conductors are individually insulated. BX/AC is permitted indoors in dry locations only. It must be supported every 4 feet and within 12" of a box, except in old work. AC cable has a bonding strip (16 AWG). This strip is in constant contact with the armor, and with the armor, forms an equipment ground.

WIRING SYSTEMS: CABLE & FLEXIBLE CONDUIT

Nonmetallic Sheathed Cable (ROMEX®)

Nonmetallic sheathed cable, often called by a manufacturer's trade name Romex®, is two or more insulated conductors, usually copper, protected by an outer covering of nonmetallic material. Type NM must be used in dry locations, but type NMC has an outer covering that resists dampness and fungus. Nonmetallic sheathed cable is used in one or two family dwellings, multi-family dwellings and other structures not exceeding three floors above ground. It is the accepted raceway for nonmetallic outlet and switch boxes. Nonmetallic sheathed cable is not permitted in industrial applications and prohibited by some local codes. Instead of "trade size", nonmetallic sheathed cable is described by conductor size, number of conductors, and with or without ground wire. Nonmetallic sheathed cable is sold in coils and is available in #14 through #12. Nonmetallic sheathed cable must be supported every 4.5' and within 12" of the box.

Metal Clad Cable (MC Cable)

MC Cable is a factory assembly of one or more insulated conductors wrapped in a polypropylene tape enclosed in a steel or aluminum armor. MC Cable is typically used indoors in exposed and concealed locations for power, lighting control and signal circuits. MC Cable, unlike Armored Cable, cannot be used as a grounding means.

MC Cable and Armored Cable are similar in look and feel. An easy way to differentiate between the two is to look for the type of material used to wrap the conductors inside the armor. Armored Cable typically uses moisture-resistant and fire retardant paper wraps around individual conductors, while Metal Clad Cable typically uses a clear plastic (polypropylene) tape as a wrap around the conductor bundle.

MC Cable must be supported and secured every 6 feet and within 12" of a box.

Service Entrance Cable (SE)

Service entrance cable can be compared to Romex in larger conductor sizes, #8-#4/0 with a weatherproof non-metallic outer covering. It may be used alone, without additional encasement, in locations where it will not be subjected to mechanical abuse. However, it is typically encased in rigid/IMC or EMT conduit for additional physical protection. The SE cable must be supported every 4 feet and within 12 inches of every box, panel, entrance cap, or enclosure. A separate grounding conductor is included in the SE cable. Type SEU cable is approved for underground use.

Underground Feeder Cable (UF)

Underground feeder cable (Type UF) is a group of conductors manufactured in the form of a cable assembly similar to type NM (Romex). The physical and electrical characteristics allow for direct burial in the ground. The individual conductors are covered with insulation and the entire cable has an outer sheath of plastic insulation that protects the cable from moisture, fungus, corrosion, and is flame retardant. In residential wiring the cable would be used to feed outside lighting and out-buildings.

Flexible Cords And Cables

Portable and flexible cords are a broad category of conductors from #27 to #2 encased in a wide variety of non-metallic coverings. This category includes lamp and portable appliance cords for which RACO does not offer connectors. RACO offers a line of liquid-tight strain relief connectors for the

portable cords used in industrial applications. These cords are popular because of convenience and flexibility of operation. Like all non-metallic cables, they must be used where they are not subject to mechanical abuse. They can be used as pendants and fixture wiring in plants. Non-metallic cords and cables also prevent the transmission of noise or vibration. They may not substitute for the final wiring of a structure (rigid/IMC and EMT) by being attached to building surfaces, or be concealed in walls or ceilings.

Non-Metallic Liquid-Tight Type CN & LNM

A flexible wiring conduit designed primarily for use on machine tools and other heavy equipment for protection against abrasion and physical damage, connections on moving heads and other components, protection of critical wiring from destructive oils, and console and remote control wiring. Available in trade sizes 3/8" to 2". CN Sealtite® has a smooth inner core, nylon reinforcing with a rugged outer jacket. Type LNM Liquatite® is constructed of two layers of specially formulated material, permanently bonded together and reinforced with braided cords.

Liquid-Tight Flexible Non-Metallic Conduit (NMLT)

Liquid-tight flexible non-metallic conduit is a raceway of circular cross section having a smooth inner surface with integral reinforcement within the conduit wall. This conduit is flame resistant and is approved for the installation of electrical conductors when used with the proper electrical fittings. NMLT shall be permitted to be used in exposed locations, where flexibility is required for installation, operation, or maintenance, and where protection is required from vapors, liquids, or solids. NMLT is used extensively in the machine tool and related industries. NMLT should never be used where it may be subject to physical damage. Available trade sizes are 3/8" to 2" and its use is limited to 6 feet in length.

ENMT- Electrical Non-Metallic Tubing

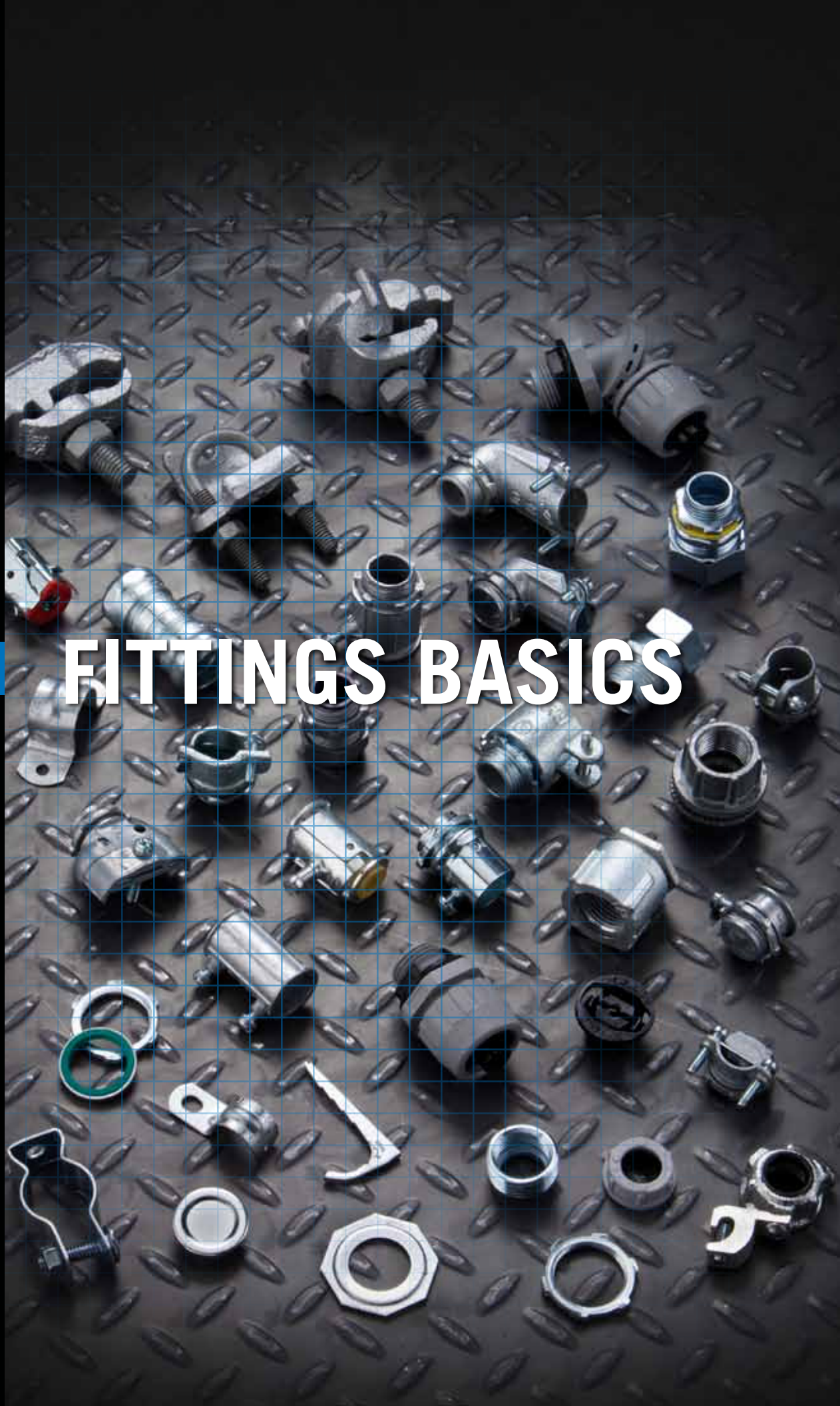
Electrical non-metallic tubing is a rigid corrugated raceway of circular cross-section with integral or associated couplings, connectors and fittings approved for the installation of electrical conductors. It is composed of a material that is resistant to moisture, chemical atmospheres, and is flame retardant. Tubing smaller than 1/2" electrical trade size or larger than 1" shall not be used.

Liquid-Tight Flexible Metal Conduit

Liquid-tight flexible metal conduit is Flexible metal conduit with a plastic outer jacket that protects the electrical system against moisture, dust, cutting oils, and it offers good mechanical protection as well. It may also be used in selected hazardous locations. It is available in trade sizes of 3/8" to 6" and must be supported every 4-1/2 feet and within 12 inches of the box or enclosure. Support exceptions are old work applications and lengths not more than three feet where flexibility is required. The raceway may be used as the ground path in trade sizes up to 1-1/4". Trade sizes 1-1/2" and larger in lengths over 6 feet require a separate grounding conductor.

SECTION **B**

FITTINGS BASICS

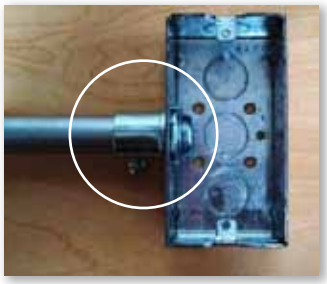


"RACO has a fitting answer from service-to-switch…"

A RACO advertisement printed in a magazine in the mid 1970's stated, "RACO has a fitting answer from service-to-switch." The ad portrayed a variety of fittings used in different raceway systems. Here, we will define the types of fittings and their suitable applications.

Couplings join two sections of conduit. Indentations in the center, known as conduit stops, position the two sections in the coupling. Types of couplings include compression, set screw, threaded, and indenter. Rigid/IMC, EMT, and flexible metal conduit may be joined by couplings. The others must be a single length between boxes.

Combination couplings join dissimilar raceways.



Connectors attach the raceways to an electrical box or panel board. One end secures the conduit by threading, compression, set screw, screw-in, indenting, or squeezing. The other end slips through the knockout and is tightened with a locknut.

Offset connectors bring the conduit away from a wall or ceiling into a box.

Insulated throat connectors have a thermoplastic liner pressed or glued into the throat. This liner helps to prevent damage to wire insulation when the conductors are being pulled.

Bushings that thread on rigid/IMC conduit also protect the conductors. Bushings are also used in conjunction with uninsulated connectors.

Straps fasten the conduit as required by electrical codes.

Beam clamps, conduit clamps, and hangers support conduit as required by electrical codes in industrial locations.

SELECTING THE MATERIAL

RACO fittings are manufactured from a variety of materials which have characteristics that make them particularly suitable, or completely unsuitable, for specific applications.

The general types are:

- **Malleable iron castings** are very rugged to withstand hammering, machining and temperature extremes without breaking. They are poured hot to shape in a mold and carefully cooled to produce an extremely tough casting. Malleable iron is considered the "Cadillac" of fittings. They are often called "specification grade", or industrial, and required by designers and federal specs.
- **Cast iron and gray iron** fittings are less durable and are offered only in types of fittings where the brittleness is acceptable.
- **Screw machine steel fittings** are very durable and generally more economical than castings. Since they are manufactured by feeding a length of steel tubing into a cut-off machine, which cuts it to length, chamfers, and threads the piece, they are limited to straight couplings or connectors. Steel fittings are electroplated for corrosion protection. These are also considered to be "specification grade" fittings.
- **Die cast (or pressure cast) zinc and aluminum** offer nonferrous (no rusting) fittings. They are casted quickly in one piece, many in a simple "gate" with all the details including threads. Since there is little machining and often no plating, die cast fittings are very economical in price and used wherever permitted by cost conscious electricians. They are not as rugged as malleable iron, sand cast, and machined steel fittings. They can easily break in temperature extremes, with a sharp blow of a hammer, or with improper handling.
- **Stamped steel** is an economical way to produce certain straps and several other fittings. A coil of steel is fed into a press which stamps out the basic shape, bends and taps in a high speed operation. These parts may be plated or made from "pre-coat" steel which is purchased with corrosion protection.
- **Powdered metal** fittings are very durable, comparable in strength to malleable iron. Powdered metal is iron ground into a fine powder with resins and carbon added. This powder is compressed and fused into one piece casted to exact finished dimension. Other materials used in RACO fittings, such as neoprene grommets, plastic insulators, steel ferrules, and bronze alloy ground fittings will be described for the appropriate product.

HAZARDOUS LOCATIONS

When electrical systems are used in hazardous locations, specifications for the components and their installation are very carefully controlled by the National Electrical Code to maintain the safety of the people and property. A brief description of hazardous locations follows:

Class 1 (Gases) - An area where flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures. Class 1 is subdivided into Division 1 where volatile liquids and flammable gases may be present in the air, and Division 2 where the liquids are handled and stored but normally confined to closed containers.

Class 2 (Dust) - An area where presence of combustible dust presents a fire or explosion hazard. Class II is subdivided into Division 1 where combustible dust may be in the air, and Division 2 where combustible dust is not normally present under normal operating conditions.

Class 3 (Fibers) An area hazardous because of the presence of easily ignitable fibers of flyings, but in which such fibers of flyings are not likely to be present in the air in quantities sufficient to produce ignitable mixtures. Class III is subdivided into Division 1 where ignitable fibers and flyings are handled, manufactured, or used. Division 2 is where ignitable fibers are stored or handled.

With the exception of connectors for liquid-tight flexible metal conduit, RACO does not make hazardous location boxes and fittings and RACO products should never be represented as being for hazardous locations.

RAIN-TIGHT, CONCRETE-TIGHT, LIQUID-TIGHT and WATER-TIGHT

Many RACO connectors and couplings are approved for use outdoors, imbedded in concrete, and on industrial machinery where cutting oils could enter the electrical system. They are designed to prevent the entry of smoke, dust, dirt, or grime in other applications. These uses are quite separate and distinct from the hazardous location criteria.

- **Concrete-tight** couplings and connectors pass a UL test before receiving this approval. Generally compression type and set screw type fittings for Rigid/IMC and EMT fit this category. Machine steel, die cast zinc, or aluminum fittings may qualify for this listing, however, the test does not relate to the durability of the material. On most concrete deck jobs, the concrete can enter the conduit through the fittings and, once it sets, blocks the pulling of wires. To insure this costly problem does not occur, most electrical contractors tape the connectors and stuff the boxes with removable material. UL now requires that labels identify this as "concrete-tight when taped". An alternative would be to use more expensive boxes and fittings.
- **Rain-tight** couplings and connectors must pass a UL test that "keeps out beating rain." However, the test does not relate to durability of material. Malleable iron, steel, and die cast zinc fittings qualify for this approval. Rain-tight also has been referred to as "suitable for wet locations."
- **Water-tight** is a term applied to RACO service entrance connectors with a rubberized grommet that is intended to keep rain out of the electrical system. In this context, the term is synonymous with "rain-tight." The connectors are not intended for submersion. Again, durability of material is not a criteria.
- **Liquid-tight** is a term applied to conduit and fittings that keep cutting oils, moisture, and grime out of electrical connectors on industrial machinery. The plastic sealing rings and neoprene grommets of RACO connectors will not break down under corrosive elements.

SECTION **C**

RIGID/IMC CONDUIT FITTINGS

RIGID/IMC CONDUIT FITTINGS

Steel rigid/IMC conduit is a very heavy, durable raceway that provides maximum mechanical protection to the conductors, thus RACO fittings are built equally rugged, usually in malleable iron or machined steel material. Also, the rigid conduit often is used outdoors or in areas exposed to moisture therefore, RACO fittings are galvanized zinc electro-plated to insure corrosion protection. RACO offers a complete line of products to couple, connect, and support the conduit.

Couplings for Rigid & IMC Conduit

The standard 10-foot lengths of conduit are threaded with iron pipe threads (IPT) on both ends. The threads are "tapered" to keep out moisture. They are protected with a plastic coupling on one end, which is discarded, and a steel coupling on the other end. This steel coupling is the basic coupling for joining straight sections of threaded conduit. One disadvantage is the necessity of turning each 10-foot length of conduit into the coupling. When there is a bend in the conduit, the threaded coupling may be unusable. RACO offers 3-piece couplings called a "union" in the plumbing trade, that attaches without need to turn the conduit. 3-piece couplings are also installed periodically in place of threaded couplings in long conduit runs to allow a place to "break the run." Federal specifications require them, and using the 3-piece coupling is pro-active in case the need to add a run in another direction arises. Otherwise, many sections of conduit would have to be taken down. RACO #1502 series 3-piece couplings are malleable iron and are available in trade sizes1/2" – 6".

Divide Last Digits of RACO Catalog Numbers by 4 for Trade Size

The trade size of most RACO couplings and connectors can be determined by dividing the last one or two digits by 4. For example, the #1502 coupling is 02 divided by 4 resulting in a 1/2" trade size. 03 is 3/4", 04 is 1" and 05 is 1-1/4". At this point the catalog numbers skip the odd numbers. 08 is 2", 10 is 2 1/2', 12 is 3", 14 is 3 l/2",and 16 is 4". Since there are no 4 1/2" or 5 1/2" sizes of conduit, the catalog numbers are 20 for 5" and 24 for 6". Usually the digits omitted are not used by RACO for other products. Sense numbers allow the customers to become more familiar with the RACO product line, however, we do consume far too many numbers. Due to our aggressive expansion programs, we have not been able to continue with the sense numbering scheme in all cases. Products with 3/8" trade size end in a 1. Thus, when the1/2" size is known, the other trade sizes can be determined. Straps and other miscellaneous fittings are in numerical sequence, therefore the "divide by 4" method applies primarily to popular connectors and couplings.

Catalog #	Divide by 4	Trade Size
1502	02 ÷ 4 =	**1/2"**
1503	03 ÷ 4 =	**3/4"**
1504	04 ÷ 4 =	**1"**
1505	05 ÷ 4 =	**1-1/4"**
1506	06 ÷ 4 =	**1-1/2"**
1508	08 ÷ 4 =	**2"**
1510	10 ÷ 4 =	**2-1/2"**
1512	12 ÷ 4 =	**3"**
1514	14 ÷ 4 =	**3-1/2"**
1516	16 ÷ 4 =	**4"**
1520	20 ÷ 4 =	**5"**
1524	24 ÷ 4 =	**6"**

Handy Ells

Handy ells, or "pulling elbows", with a removable cover permit a 90° turn in the conduit run. Normally the conduit is bent to change direction, but the radius of the bend takes far more space than a handy ell, and in tight locations that space may not be available. The handy ell has a removable cover that permits conductors to be pulled; however, splicing conductors in pulling ells is not permitted. Every bend in a conduit run limits the ability to pull conductors. The maximum is four bends per conduit run. RACO offers the #2652 series pressure cast zinc connectors from 1/2" to 1-1/4", female to female couplings are the #2662 series. The cover is held by two screws and a neoprene gasket is provided to keep out moisture.

1141
Steel

1160
Iron

Reducing Bushings

The purpose of a reducing bushings is to join two different trade sizes of threaded rigid/IMC conduit. The #1141 series steel bushings are offered in various size combinations up to 2", and iron bushings, #1160 series, start at 2-1/2" size combinations and go up to 4".

Coupling of Unthreaded Rigid & IMC Conduit

To permit coupling of unthreaded conduit, conduit with damaged threads, or conduit in an awkward location, RACO offers two types of couplings: 3022 series steel set screw couplings1/2" – 2"; 2150 series 2-1/2"- 4"; and 1822 "no thread" malleable iron compression couplings1/2" – 4".

3022

2150

1822

Combination Couplings

Combination couplings permit rigid/IMC conduit to be joined directly to EMT or flexible metal conduit without using an outlet box. Generally this practice applies to smaller size conduits, so RACO offers1/2", 3/4", or 1" sizes only. A typical application is rigid conduit stubbed out of concrete to run where less costly EMT is permitted. #1352 series of couplings is steel threaded for rigid conduit on one end, and has a compression fitting on the other for EMT. Often the conduit is cut in this application and no threads are available and the #1432 series of steel set screw couplings eliminates the need for costly or difficult threading. In industrial applications, a run of rigid/IMC conduit often ends with a connection to machinery which is subject to movement or constant vibration. For this application a short length of flexible metal conduit is needed. RACO's #1552 series of malleable iron rigid-to-flex couplings meets this need. One end is threaded for rigid and the other is a squeeze type that tightens around the flex. The runs of rigid/IMC conduit start at the main distribution panel and run to other sub-panels, junction boxes, and switch boxes.

1352
Rigid to EMT Threaded/Compression Coupling

1432
Rigid to EMT Set Screw coupling

1552
Rigid to Flex Threaded/ Compression Coupling

1001

1202

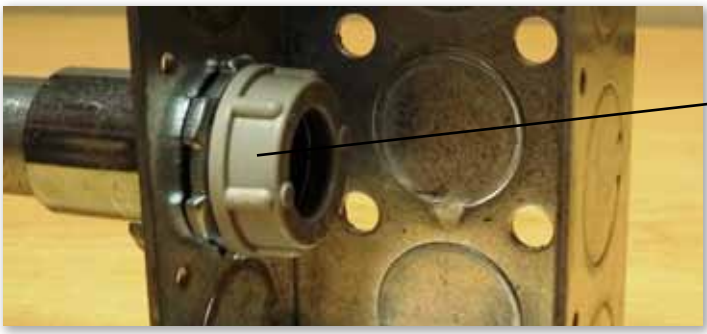
1242

Let's look at connecting *threaded* conduit…

Locknuts are hand tightened, then turned by tapping with a screwdriver until the tangs (sharp points) of the locknut actually cut into the metal of the box. It is essential that locknuts cut through any paint or corrosion to insure a reliable continuity of ground. The RACO #1001 series is the standard heavy duty UL listed steel locknuts and are available 3/8"- 6" for all trade sizes of the conduit. The 3/8" locknut is not for rigid conduit but fits bar hangers and other fixture studs. These locknuts also are used on connectors when a manufacturer does not supply a locknut. #1192 series is a lightweight line of locknuts occasionally used in competitive situations. They are not UL listed and should not be substituted for the #1001 series. In applications where there is vibration, #1242 series with a bonding screw is available to insure that a locknut does not vibrate loose causing loss of ground. The steel #1202 series includes a bonded yellow moisture sealing gasket and are used outdoors or indoors where moisture may be present.

Nonmetallic Insulating Bushings

To protect the insulation of the conductors from the raw edge of the conduit when they are pulled, an insulating bushing may be added. #1402 series is made from flame retardant material and is available in1/2"-6" sizes. Rolled edges cover the conduit end, and the heavy ridge on the outside helps speed installation. It is rated for 105°C, will not support combustion, and is sufficient for most applications. Occasionally, a specification will require a 150°C bushing, which will not melt during wire pulling, which RACO offers in a malleable iron version. Insulating bushings must not be used for mechanical strength. Shown here, the bushings can also be used inside of the box or enclosure, fastened to the threading of the connector to protect the conductor insulation.



Nonmetallic Insulating Bushing

Steel/Malleable Iron Bushings

Malleable iron bushings offer mechanical strength and will be occasionally used instead of the inside locknut. RACO offers four types of bushings, all constructed of malleable iron, from1/2"-4" sizes. All have clean threads and heavy lugs on the outside so they can quickly be tapped on with hammer and screwdriver.

- #1102 series is a malleable iron bushing available in1/2"-4" sizes.
- #1132 series includes a plastic insuliner, rated at 150˚C, to give additional protection to the insulating material on the conductors during wire pulling. When bushings are used around panel boards in hospitals a bonding jumper may be required to insure continuity of ground around a panel board.
- #1212 and 1262 series insulated throat bushings have lay-in ground lugs and an insuliner that is temperature rated at 150˚C.
- #1222 series also has a 150˚ temperature rating on the insuliner and has a feed-thru style ground lug.

The bushings have three tapped holes 90˚ apart. After the bushing has been tightened, the ground lug is attached to the most convenient hole. RACO listings include the minimum and the maximum wire capacity of the ground lug.

1102RAC Malleable Iron

1132 Malleable Iron Insulated

1212/1262 Malleable Iron Insulated w/ Lay-in ground Lug

1222 Malleable Iron Insulated w/ Feed-thru Lug

Hubs

A line of threaded hubs, often called "Myers™ hubs", are used outdoors and on indoor boxes in wet or dusty locations. They are available in1/2"-4" sizes, are insulated, supplied with an O-ring, and are made of die cast zinc. The RACO 1702 series is listed as raintight.

1702

90˚ Elbows & Offset Connectors For Threaded Conduit

Often the conduit cannot enter a panel or box in a straight run. Malleable 90˚ elbows thread onto the conduit and attach with a #1002 series locknut to a knockout in a box or enclosure. RACO 1722 is a1/2" short elbow, and the 1723 is a 3/4" short elbow, constructed of malleable iron. For a very tight 90˚ we recommend the #2662 series, die cast zinc handy ells, for the job. One end threads onto the conduit and the other attaches through the knockout of the box using a locknut which is supplied. The removable cover allows wire pulling. Sizes1/2", 3/4", and 1" are available.

1722

2662

1452

Offset nipples are used when two boxes or panels are close together but the knockouts are not in line. One common application is to join a handy box on a basement wall just below the panel. Often on furnaces and industrial machinery, offset nipples "save the day." RACO offers a standard 3/4" offset die cast nipple. The 1452 series is available in 1/2"- 2" sizes.

Connecting Unthreaded Rigid/IMC Conduit

RACO offers two types of connectors for unthreaded or damaged thread conduit. They are steel set screw and malleable iron compression connectors. The steel set screw connector is available with an insuliner in sizes 2-1/2" to 4". The set screw connectors also have hex head screws that must be tightened with a wrench. Cup points bite into the conduit for reliable continuity of ground. The smaller1/2" – 1-1/2 sizes have a single set screw. Sizes 2"- 4" have two set screws. RACO locates the pair of screws 45 degrees apart, rather than in line, for better installation of this heavy conduit. Sizes 2-1/2" to 4", insulated and uninsulated, are UL Listed for use on EMT.

The compression connectors have a tapered thread and use flat locknuts on all sizes. These steel and malleable iron connectors series #1802 come in sizes1/2"-4", and are uninsulated. The #3802RAC series is the insulated version and is available in sizes1/2" to 2".

2160

3002

3802RAC

1802

Rigid/IMC Mounting Straps

RACO offers four types of mounting straps for rigid/IMC conduit. Mounting straps are often referred to as “electrical hardware”. Our #1301 series provides the greatest support. It is constructed of malleable iron and is available in sizes 3/8”-4”. #1332 series one hole straps are stamped steel, offered in 1/2"- 4" sizes, and is the most popular strap for this conduit system. The #2232 series is a two hole economy strap made of a lighter weight stamped steel. #2252, 2253, 2254 stamped steel nail-up straps are only suitable for smaller size conduit and are most often used with EMT and flex. 2-1/2"- 4" straps, part numbers 2239-2242, are listed for use on both EMT and rigid/IMC conduits. In some industrial applications where walls are frequently wet, the #1342 series malleable iron clampbacks are required to keep the conduit away from the walls. They are most commonly used with the #1301 series malleable straps.

1301

1332

2232

2252

1342

SUPPORT PRODUCTS: RIGID/IMC AND EMT IN INDUSTRIAL LOCATIONS

Conduit Clamps, Beam Clamps, and Hangers

Conduit runs in industrial applications can be supported in many ways. RACO offers heavy duty conduit clamps, a basic beam clamp, and hangers which are all supplied with bolts.

Conduit clamps are offered in three styles in sizes1/2" up to 3" or 4". Constructed of hot dipped galvanized malleable iron.

Edge Type

Parallel Type

Right Angle

Beam clamps are constructed of steel/malleable iron. Offered in Sizes 1" to 2-1/2".

Conduit hangers are constructed of steel. Sizes offered are 3/8" to 4" for Rigid/IMC conduit, and1/2" to 4" for EMT conduit.

SECTION **D**

EMT CONDUIT FITTINGS

EMT CONDUIT FITTINGS

EMT is a lightweight steel conduit, or raceway, with walls that are too thin to be threaded.

Working With EMT

EMT is cut with a hacksaw or tube cutter with burrs removed.

EMT (thinwall) Fittings

EMT is a lightweight steel conduit, or raceway, with walls that are too thin to be threaded. Set screw and compression fittings are the most popular couplings and connectors followed by our indenters. These fittings have a much lighter weight and are more economical than rigid fittings. Electricians usually select economy grade die cast fittings for EMT unless codes or specifications call for steel. RACO offers three types of couplings for EMT. Compression and set screw types use the same principles as described in rigid. The third is the indenter method which requires a special tool, sold by RACO #1962 for1/2" EMT, to crimp it onto the conduit. The 1982 series indenters are steel, offered in1/2" and 3/4" sizes. All couplings have a chamfered, or indented, center called a conduit stop to keep the EMT from slipping too far into the coupling.

1982

1962

EMT COUPLINGS

Set Screw Couplings

The most popular are the set screw couplings. The #2022 series is available in1/2"– 4" sizes and is made of steel. The1/2", 3/4" and 1" use a single set screw to hold each piece of EMT, and the 1-1/4" to 4" sizes have two screws on each side of the coupling for greater protection. Tri-head set screws are used on fittings through 2" sizes, but 2-1/2" to 4" sizes use hex head screws which require a wrench. #2622 series set screw couplings are die cast zinc.1/2"–1" sizes have a single set screw on each end, and larger sizes have a pair in line. 90˚ Handy Ells, #2752 series, are also made of die cast zinc and are used when bending conduit is not practical. Both steel and die cast set screw couplings are listed by UL as concrete tight when taped.

2022
Steel

2622
Die cast zinc

2752
Die cast zinc

Compression Couplings

RACO also offers compression couplings in steel and die cast zinc construction. #2922 series in steel is available in1/2"- 4" sizes. The steel #2922RT series couplings are raintight and suitable for wet locations. The nuts have a blue tint for easy identification. These are also available in sizes1/2" to 4". #2822 series in zinc is also available in1/2"- 4" sizes. Both the #2922 and #2822 series are listed as concrete tight when taped.

2822
Die Cast Zinc

2922
Steel

Combination Couplings

RACO offers four types of combination couplings for EMT. #1352 series and #1432 series for rigid/IMC were described previously. The 1941 is a malleable iron body with a steel compression connector on one end, and a squeeze connector for flexible metal conduit on the other. It is used when a flexible connection is needed on machinery and the vibration calls for a flexible raceway. Other RACO combination couplings join the same trade sizes1/2" to1/2", 3/4" to 3/4", and 1" to 1", but #1941 joins 3/8" flex to1/2" EMT. 1942 and1943 join1/2" to1/2" and 3/4" to 3/4", respectively. #1482 series is a screw-in type, EMT to Flex compression coupling, made of die cast zinc. It is available in1/2" to 1" sizes.

1352
EMT to Rigid/IMC
Compression

1432
EMT to Rigid/IMC
Set Screw

1941
EMT to Flex
Squeeze/ Compression

1482
EMT-Flex
Screw-in/ Compression

EMT CONNECTORS

RACO offers set screw, compression, and indenter connectors like the couplings previously described. Also, compact two piece connectors, offset connectors, and 90 degree connectors are available in smaller sizes.

2122 Steel Insulated

Set Screw Connectors

Set screw connectors are available in sizes1/2"- 4", in steel or die cast zinc, and with insulated or uninsulated throats. RACO uses premium screws with deep milled slots that hold a large roughing-in screw driver. Threads are clean and create a tight, secure bind to prevent loosening. They also have a cup point that bites into the conduit maintaining the continuity of ground. The screws are installed flush inside during manufacturing so the EMT can be inserted into the connector without the electrician having to back off the screw. These screws stay in place so they will not fall out during shipment or as they are being installed. Steel bodies have extruded holes with enough threads so the screws will not strip. Die cast zinc bodies have reinforced hubs providing the same function. Insulated throat connectors have a plastic insuliner that protects the insulation of the wires during pulling.

2634 Die Cast Zinc Insulated

Straight and 90˚ Compression Connectors

Straight steel and die cast zinc compression connectors are available in sizes1/2"- 4", with or without insulated throats. Raintight (RT) series of straight connectors are also available insulated or uninsulated. 90 degree connectors are malleable iron since forming steel tubing into this shape is not practical. Compression connectors have a split steel gland ring inside the compression nut. As the nut tightens, the gland ring squeezes around the conduit, providing a secure connection. Compression connectors are ideal for keeping concrete outside of the connection.

2912 Steel

2912RT Steel

2832 Die Cast Zinc

2072 Malleable Iron

Handy Ells

2762 Die Cast Zinc

Handy ells permit an abrupt 90 degree bend in the conduit run. The conduit is normally bent to change direction, but the radius of the bend takes far more space than a handy ell, and in tight locations that space may not be available. The removable cover permits conductors to be pulled. Splicing conductors in ells is not permitted. Every bend in a conduit run limits the ability to pull conductors. The maximum is four 90 degree bends per conduit run.

Indenter Connectors and Tools

1992 Steel Insulated

1972 Steel Un-insulated

Indenter connectors and couplings are steel, and slightly larger in diameter than the EMT. A special tool sold by RACO is designed to crimp the connectors to the EMT. The tool has a pair of points that crimps the EMT on opposite sides with one squeeze. The tool then is rotated 90 degrees and squeezed again to make a total of four indentations. Indenters are streamlined and tamper-proof, making them popular in the Midwest and Northeast as the most economical steel connector on the market. Detractors of the method feel that the continuity of ground is less reliable than other methods. However, poor workmanship causes the same results with compression and set screw connections. Indenter connectors have a flat locknut. The #1962 tool is forged steel with yellow plastic grips on the handle.

1962 Indenter Tool

1961 Replacement Points

Offset Connectors

Die cast zinc offset connectors are available in compression and set screw type. When conduit is fastened directly to a wall or ceiling it does not always line up with the conduit knockouts of the box. Die cast zinc offset connectors series #1952 compression type, or series #1762 set screw type, are available in1/2" and 3/4" sizes. These offset connectors eliminate the need to make two bends in a short piece of conduit. One end attaches onto the conduit, the other attaches through a conduit KO with a locknut, which is included. This method is usually used on smaller sizes of conduit.

1762 Set Screw Die Cast Zinc

1952 Compression Die Cast Zinc

Two-Piece Connectors

2702 Die Cast Zinc

RACO offers a very compact, economical two-piece connector in1/2" and 3/4" sizes. This die cast zinc connector has a split beveled piece that attaches as shown and squeezes around the EMT as the compression nut is tightened. The two-piece connector is especially useful for very shallow 1" deep switch boxes.

EMT MOUNTING STRAPS

EMT is supported by the same kinds of mounting straps as rigid/IMC. Since the outside diameter of 1/2"- 2" EMT is smaller than rigid, these straps have the trade size and "TW" (thinwall) stamped on them. Rigid straps show only the trade size. As a field substitute, one size smaller rigid strap may fit EMT. EMT straps (by Code) may not be used on rigid. RACO double lists the 2-1/2" – 4" rigid straps for EMT. In the 2-1/2" – 4" size range, both kinds of conduit have the same outside diameter. #2082 series steel push- on straps are the most popular. The push-on feature frees both hands for installation. #2252 steel nail-up strap is economical and installs quickly.

2092 Steel

2252 Steel

2082 Steel

1310 Malleable Iron

SECTION **E**

LIQUIDTIGHT CONDUIT & CORD CONNECTORS

LIQUIDTIGHT CONDUIT & CORD CONNECTORS

Brief Introduction

Being the last to develop and manufacture the liquidtight connectors, RACO was able to combine the better features of competitors' and eliminate the problems being experienced by the installer. Pullout being the major problem, where the outer jacket separates from the metal core, pulls out of the connector and ruins the liquid-tight seal. RACO liquidtight connectors keep water, oil, and dust out of electrical systems for years…in the toughest applications. These connectors have exclusive design features for fast installation and reliable service. All parts are made of premium materials that fit perfectly without strain or distortion, and can be disassembled after years of service with all parts completely reusable. The split gland ring has many advantages over the one- piece type used on other liquid-tight fittings. When installing the gland ring, it opens wide to quickly slip on the conduit. It is also forgiving to the installer because it's reversible, which eliminates the chance of installing it backwards; and, because it is split, our gland ring can be installed before or after the grounding ferrule. The split gland ring is the key to maximum compression force that prevents pullouts. Pullout problems are the most obvious to installers of liquid-tight connectors. Our patented gland ring has a slight gap when placed on the conduit. This split allows maximum compression of the gland ring which will abide to the high and low side of tolerance used by the manufacturers of liquid- tight conduit.

When the connector is tightened, the gap in the gland ring is completely closed and the concave inner surfaces cause the PVC jacket material to cold flow and insure maximum retention of the fitting. Competitor's one-piece gland ring is deformed during application and must be cut off in order to remove the fitting. RACO's is easily removed and is reusable. The convex outer surface is forced into the flared portion of the grounding ferrule by tightening the compression nut sealing the conduit and the inner portions of the fittings from the outside environment. Both the metal conduit and the jacket are locked in the connector; whereas many competitors rely on the ferrule for retention and, in many cases, the jacket pulls free of the connector and ruins the liquid-tight seal.

RACO offers steel/malleable iron liquidtight connectors in straight, 45 degree, and 90 degree types, and in insulated and uninsulated versions. Die cast zinc connectors are available in straight and 90 degree, and either insulated or uninsulated versions. Insulated grounding type connectors are also available in straight, 45 degree, and 90 degree, with a steel/malleable iron construction.

LIQUIDTIGHT CONNECTORS

Below are images of the RACO straight, 45 degree, and 90 degree Liquidtight conduit connectors. These are constructed from steel and malleable iron.

3511RAC series Straight, Insulated
Steel body and nut 3/8" to 1"
Malleable Iron body and nut 1-1/4" to 4"

3441 series 45 Degree, Uninsulated
Malleable Iron body - All sizes
Steel nut 3/8" to 1"
Malleable iron nut 1-1/4" to 2"

3541RAC series
90 Degree, Insulated Malleable Iron Body
All sizes Steel nut 3/8" to 1"
Malleable iron nut 1-1/4" to 4"

Below are images of the RACO Grounding straight, 45 degree, and 90 degree Liquidtight conduit connectors. These are suitable for use in outdoor and indoor locations on flexible metallic liquidtight conduit, when installation of a copper or aluminum external bonding jumper is required. They are constructed from steel and malleable iron and have a ground lug.

3511-3 series Straight, Insulated
Steel body and nut 3/8" to 1"
Malleable Iron body and nut
1-1/4" to 4"

3561-3 45 Degree, Insulated
Malleable Iron body - All sizes
Steel nut 3/8" to 1"
Malleable iron nut 1-1/4" to 2"

3541-3 90 Degree, Insulated
Malleable iron body - All sizes
Steel nut 3/8" to 1"
Malleable iron nut 1-1/4" to 4"

Below are images of the RACO straight and 90 degree Die cast zinc Liquidtight conduit connectors. These are available in sizes from 3/8" up to 2".

3511 DC Straight,
Insulated Die Cast Zinc

3541DC 90 Degree,
Insulated Die Cast Zinc

NONMETALLIC – TYPE B AND EXTRA FLEXIBLE TUBING CONNECTORS

Nonmetallic Liquidtight conduit connectors are suitable for indoor and outdoor applications where the connectors will not be subject to physical damage. These connectors offer a solution whenever extra flexibility is required for installation, operation, or maintenance. RACO offers two styles including a straight and a Swivel LOK® which can be used in a straight or a 90 degree position. The straight connectors are available in sizes 3/8" to 2", and the Swivel LOK connectors are available up to 1" size.

4721
Straight Nylon

4741
Extra Flex tubing
Straight Nylon

4731
SWIVEL LOK
Straight and 90°
Nylon

4751
SWIVEL LOK
Extra Flex tubing
Straight and 90°
Nylon

STRAIN RELIEF CORD CONNECTORS

RACO offers Liquidtight strain relief cord connectors in steel/malleable iron (black or color-coded grommets) nylon, and aluminum. These strain relief connectors are suitable for use with flexible cord and cable, in wet or dry locations, and in Class 1, Div. 2; Class 2, Div. 1; and Class 3, Div. 1 and 2 hazardous locations.

The #3702-1 series are constructed of steel bodies and nuts in HUB sizes 3/8" to 1", and malleable iron bodies and nuts in HUB sizes 1-1/4" to 1-1/2". The cable ranges start at 0.125 and go up 1.400. RACO offers a 90 degree strain relief connector in HUB sizes1/2" (Form 1 & 2), and 3/4". Both sizes feature malleable iron bodies with a steel nut. The cable ranges start at 0.125 and go up to 0.850.

The color-coded grommet series are available in steel straight connectors, and in malleable iron for the 45 and 90 degree. Straight connectors are available in trade sizes1/2" through 1-1/2", and the 45 and 90 degree connectors are available in trade sizes1/2" through 1". The cable ranges start at 0.15 and go up to 1.375. The nylon straight connector, #4699-5 series, is a lightweight and easy to use alternative. It is available in 1/4" to 1" HUB sizes, with cable ranges from 0.312 up to 1.125. The last strain relief cord connector has an aluminum body and nut and is available in HUB sizes1/2" to 1", and cable ranges from 0.187 to 1.125. The patented split hinge Gotcha® rings are color-coded by cable diameter.

3702-1
Steel/malleable iron

3792-1
Steel/malleable iron

4699-5
Nylon

4801-2
Aluminum

3722-0, 3745-0, 3794-0
Steel/malleable iron
Color-coded grommets

SECTION **F**

FLEXIBLE METAL CONDUIT & ARMORED CABLE

FLEXIBLE METAL CONDUIT & ARMORED CABLE FITTINGS

RACO offers fittings for three types of flexible metallic raceways: flexible metal conduit, or flex; armored, which comes pre-wired; and liquidtight, which is flex with a non-metallic outer covering. Flex and armored use many of the same fittings and will be described together. Liquidtight fittings were mentioned previously. The flex conduit is available in 3/8" - 4", but usage in sizes larger than 2" are rare. RACO does carry up to 4" size connectors in some styles. In Rigid/IMC and EMT conduit, the smallest trade size was1/2", but all three flexible metal raceways offer a 3/8" trade size. However, these still attach to 1/2" conduit knockouts. RACO catalogs clearly specify this, although much of the trade refers to it simply as 3/8". Flex connectors are malleable iron or die cast zinc, since their configurations do not lend themselves to manufacturing with steel tubing.

Couplings for Flexible Metal Conduit

Flex and armored cable are supplied in coils up to 250 feet, therefore they are rarely coupled. In fact, armored cable (which is prewired) is never coupled to itself, running as a single length between boxes and panels. However, a screw-in coupling #2272 series is available from RACO for 3/8" and 3/4" sizes. It screws inside the flex, held by the convolutions of the flex. It is used in areas such as Southern California where longer runs of flex are common. Flex or armored cable can be joined to Rigid/IMC and EMT with the use of combination couplings. Our #1552 series of malleable iron couplings is threaded on one end for rigid, and #1941 series uses EMT compression attachment. These often are used in industrial applications where a flexible raceway is required because of machinery vibrations.

2272 Flex to Flex
Screw-in
Die Cast Zinc

1552 Flex to EMT
Malleable Iron

1482 Flex to EMT
Screw-in
Die Cast Zinc

1552 Flex to Rigid
Malleable Iron

Connectors for Flexible Metal Conduit

RACO offers a line of straight and 90° malleable iron connectors in 3/8" up to 4" in some cases, with either insulated or uninsulated throats. The appearance of the connectors varies by trade size with larger sizes using two screws. The smaller sizes have an inspection hole permitting their use with armored cable. In the smaller sizes, RACO has economical die cast zinc connectors with uninsulated throats, both straight and 90°. They also have inspection holes for armored cable. Other connectors available for flex include #2281 series die cast zinc screw-in 3/8" – 3/4", and the 2632 set screw connector for 1/2" flex, also die cast zinc. 2661 has two set screws to squeeze the flex. It can also be used on armored cable, and is dual listed for non-metallic sheathed cable. It is economical and versatile, minimizing inventory. There is some demand for a 45 degree angle flex connector and the #2221 series connector satisfies this requirement.

3301 Straight Squeeze-type Insulated Malleable Iron

2101 Straight Squeeze-type Uninsulated Malleable iron

2191 Straight Squeeze-type Uninsulated Die Cast Zinc

3201 90° Insulated Malleable iron

2201 90° Uninsulated Malleable iron

2691 90° Uninsulated Die Cast Zinc

2221 45° Uninsulated Die Cast Zinc

2632 Set screw Uninsulated Die Cast Zinc

2511 Set Screw Uninsulated Die Cast Zinc

2281 Screw-in Uninsulated Die Cast Zinc

2661 Clamp-type Uninsulated Die Cast Zinc

2611 Duplex Uninsulated Die Cast Zinc

Supporting Flexible Metal Conduit

When flex must be supported, RACO's nail-up straps will do the job for 3/8" and 1/2" sizes. For larger sizes, Rigid or EMT straps are selected. Generally, flex has a slightly larger outside diameter than EMT and one size larger strap is needed, i.e., 1" flex uses 1 1/4" EMT strap.

2252 Steel

2092 Steel

2082 Steel

1310 Malleable Iron

Connectors for Armored Cable

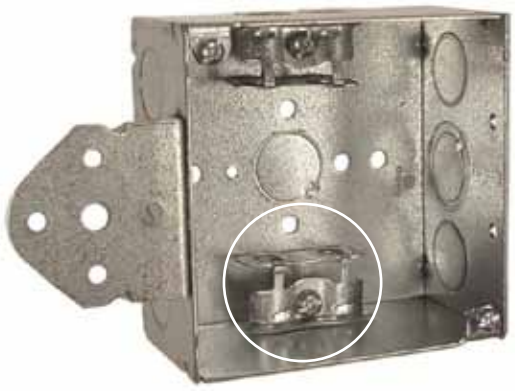
RACO offers three connectors designed for armored cable. The #2511 and #2611 are constructed of die cast zinc, and the Double Bite Saddle Connectors are constructed of steel. Both versions are UL listed for use on MC cable. The Double Bite Saddle Connectors are constructed of steel and have a set screw and saddle-style clamp that when tightened down secures the cable in place. These connectors are offered in straight from 3/8" to 4", and 90 degree in sizes 3/8" to 1". The 2511 and 2611 connectors are designed to hold the cable with a set screw that presses into the convolutions preventing pullout and maintaining continuity of ground. The 2511 and 2611 have an inspection hole allowing an electrical inspector to be sure the anti-short bushing is in place. Many of the smaller sizes of connectors have inspection holes for the anti-short bushing, and are used with armored cable as well as flex. RACO also offers more than two dozen steel outlet and switch boxes with clamps for armored cable which eliminate the need for a separate connector.

2511 Set screw Uninsulated Die Cast Zinc

2611 Duplex Uninsulated Die Cast Zinc

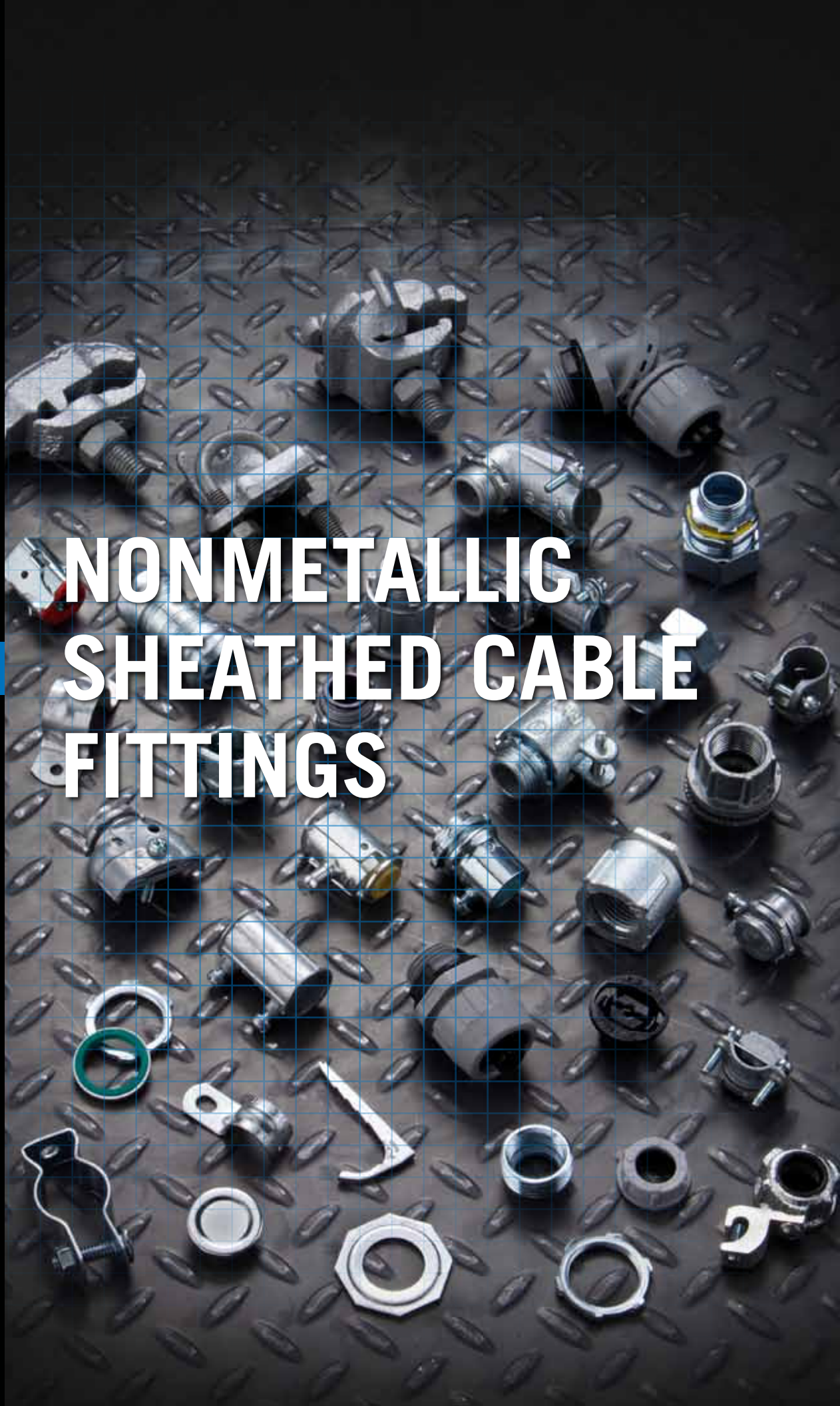
3201DB Double Bite Saddle Insulated Steel/Malleable Iron

3301DB Double Bite Saddle Insulated Steel



SECTION **G**

NONMETALLIC SHEATHED CABLE FITTINGS



NONMETALLIC SHEATHED CABLE FITTINGS

2709

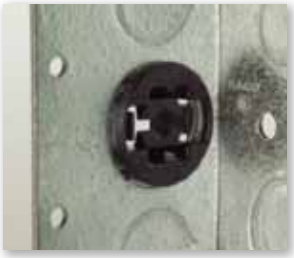
Non-metallic sheathed cable is the most popular of the four non-metallic raceways for which RACO offers fittings. Since the cable is pre-wired, it runs between panels and boxes in one continuous length. There are no couplings permitted. Romex does not provide the mechanical protection of a metal raceway and usually is hidden in a wall. Electricians staple Romex along the center of a stud, or drill through the center of studs and 1-1/2" from the front of ceiling joists. Sometimes an electrician will cut a shallow notch in the front of the stud for Romex. Since the drywall nails could pierce the Romex, #2710 or 2709 steel cable protector plates, offered by RACO, must be used to protect the Romex from damage.

2711

Romex fastens to the stud with Romex staples, currently not sold by RACO. When connecting Romex to single gang non-metallic switch boxes, electrical codes allow the Romex to be unsecured if it is stapled to a stud within 8" of the box. In all other cases, the Romex must be secured to the box or panel. RACO offers steel non-metallic switch and outlet boxes with internal cable clamps that quickly and economically hold the cable. RACO offers several connectors for1/2"- 1" conduit knockouts in steel boxes. The connectors are needed on panel boards or boxes when there are no clamps. The most popular Romex connector is #2711 made from die cast zinc. It fits1/2" KO's and accepts two or three #14 or #12 Romex with or without a grounding conductor.

RACO also offers a non-metallic version, #4714, which grips the cable and easily installs into the knockout simply by snapping it in place. It accepts single and dual runs of nonmetallic sheathed cable and accommodates one of the widest ranges of NMSC combinations in the industry. The 4714 fits1/2" knockouts and can be removed and reused easily by pushing one of the locking wing tabs with a screwdriver. The 4714 is great for old work applications as it can be installed last by sliding it up the cable and snap into the KO from inside the box.

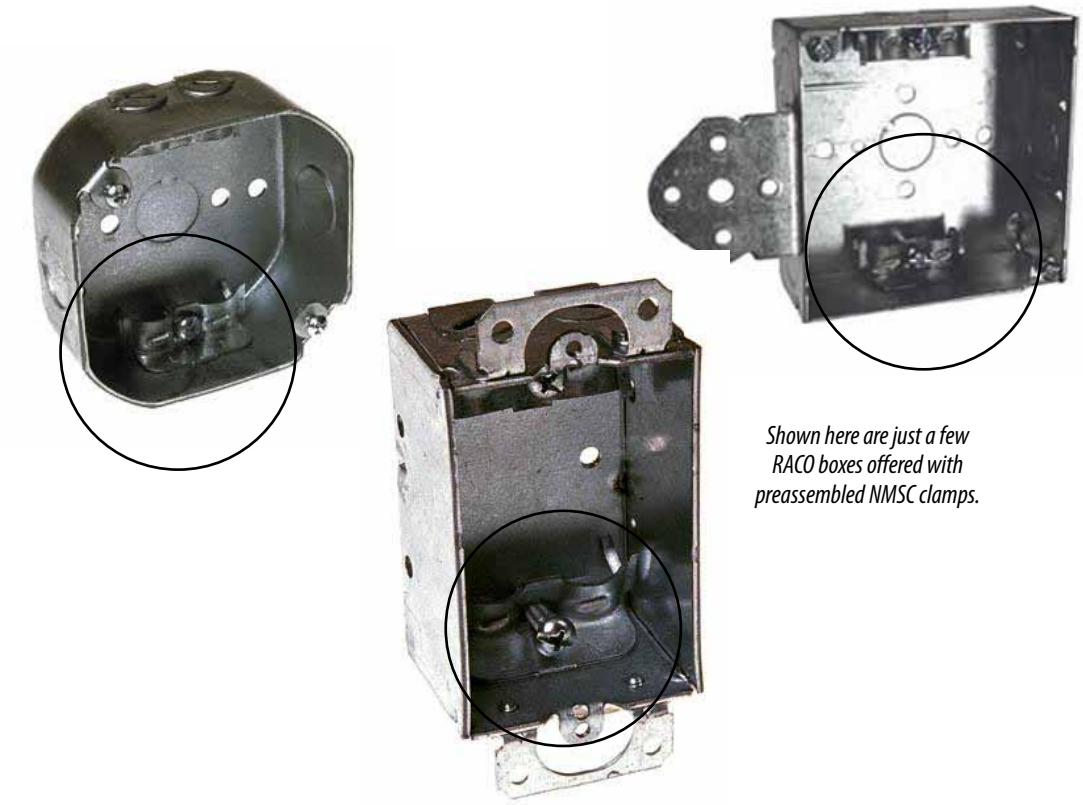
4714



The RACO 2661 all purpose connector, listed for flex and armored cable, also is acceptable for Romex. Many electricians keep it on hand for its versatility. For larger sizes of Romex, RACO has #2863 for 3/4" knockouts and #2864 for 1" KO's. The upper clamp is reversible which allows the connectors to be used with more sizes of cable.

2661

RACO also offers more than two dozen steel outlet and switch boxes with clamps for nonmetallic sheathed cable which eliminates the need for a separate connector.



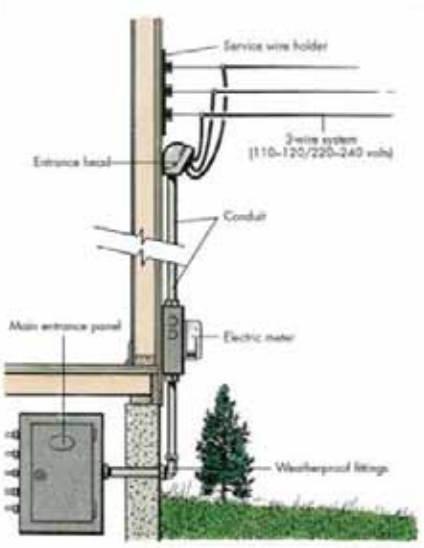
Shown here are just a few RACO boxes offered with preassembled NMSC clamps.

SECTION **H**

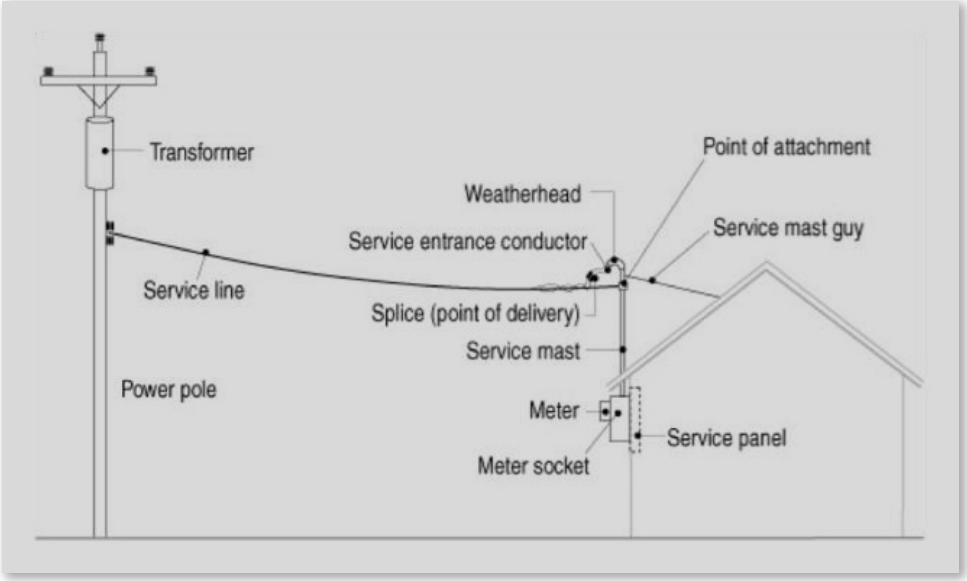
SERVICE ENTRANCE FITTINGS

SERVICE ENTRANCE FITTINGS

The fourth non-metallic raceway is a king size version of Romex used to bring the electrical service from the telephone pole into the electrical distribution panel of a building. Instead of the small conductors in Romex, like #14 and #12, SE cable goes from #8 up to #1. Then 1/0, 2/0, 3/0, and the largest for which RACO offers fittings, 4/0. SE cable has two or more insulated current carrying conductors of the same or different sizes and a bare grounding conductor encased in an outer jacket of neoprene, PVC, or braided material. The physical size of SE cable varies with the type of outer jacket therefore, fitting size must be selected by the user.



Typically the utility and the electrical contractor agrees on the location for the service, the contractor installs the service, and the utility makes the connection, called a "service drop". The service drop is made through an entrance cap mounted at least ten feet above the ground and runs vertically down the side of the building through a kilowatt hour meter and inside to the electrical panel. In many of the newer homes constructed today service is underground eliminating the need for entrance heads and the masts which were common in the 1950's. The service to homes is described in amperes.



SE Cable Caps/Heads, Connectors, and Straps

The 2430 series sand cast aluminum entrance caps, also called service heads or weather heads, are available in two sizes for 3 #8 to 3 #4/0 SE cable. The cap is securely fastened to the structure using the mounting slot. The top is removed, the conductors are inserted in the plastic insulator, and the top is replaced. The #2475 series watertight, die cast zinc connectors join the cable to the top of the meter. Meters have hubs threaded 1", 1-1/4", or 2" trade sizes, so locknuts are not included on these connectors unless specified. Tapered threads on the connectors furnish a watertight seal, and a neoprene grommet like those used on RACO liquid tight strain relief connectors, hold the cable and form a watertight seal as the compression nut is tightened. A steel retaining ring prevents distortion of the grommet. #2853 and #2863 series die cast zinc connectors are used below the meter and indoors to connect the cable to the electrical panel. #2863 with a reversible clamp also is listed for larger sizes of Romex. #2441 series of one hole steel straps fasten SE cable to the building.

2430 SEU cable entrance head

2475
Liquid-tight
Die cast zinc

2853
For oval cable
Die cast zinc

2863
For oval or round cable
Die cast zinc

2441
SEU strap
Steel

Rigid/IMC & EMT Caps/Heads

Usually codes require the SE cable to be protected from mechanical damage with Rigid/IMC or EMT conduit. This is true when the service is located near a walkway or driveway. Also, conduit is used for support when the service riser passes through a roof overhang. The conduit is often called a mast or riser by the trade. RACO offers many conduit fittings for this purpose. The mounting straps and standard connectors are described earlier in this section. The entrance heads are made of durable cast aluminum with a removable top and plastic insulator. The insulator is a round, one-piece design with several openings. The openings are covered with a thin layer of "flash" and those to be used have the "flash" removed. The number and size of the openings vary by conduit trade size, or more specifically, by the size of the SE cable. The #2402 series clamps on threaded or unthreaded conduit. Sizes are available for1/2" through 4" Rigid/IMC or EMT conduit. The 2"- 4" sizes have two set screws spaced 45 degrees apart for a stronger hold. Rigid/IMC thread into the top of the meter and the tapered threads allow a rain-tight connection. When EMT is the riser, a rain-tight or watertight connector is needed. The connection beneath the meter can be made with double locknuts when threaded Rigid/IMC is used.

Underground Service Entrance Cable Connectors

Electrical service frequently is brought to a building underground instead of overhead. This eliminates the entrance cap and conduit run down to the meter. The service runs up the exterior wall to the meter, then back down to the point where it enters the building. The buried conduit may be Rigid/IMC or SEU cable. SEU cable is SE cable with an outer jacket approved for direct burial. Usually the cable between the ground and meter is required to have 2" or larger section of Rigid/IMC for mechanical protection.

Underground feeder cable connectors are used for UFC, which is a flat parallel cable similar to Romex cable but especially treated for direct burial. These connectors are available in aluminum, nylon, and steel as shown below.

4899-9
Liquid-tight
Aluminum

4799-1
Liquid-tight
Nylon

2462
Liquid-tight
Steel

Ground Fittings

In many areas, the service is connected to a metal water pipe within a home. RACO offers several fittings that fasten to the water pipe and secure a ground wire from the panel box. Where it is not possible to ground to an existing water system, an approved ground rod is used. It is usually a1/2" diameter, eight foot long copper clad steel rod. Plastic water pipe, which bridges the water meter and insulating couplings, are elements that complicate the grounding of the service panel. RACO ground fittings feature a bronze cast construction. Three types are available, shown below, for bare ground wires, bare armored ground wire, and rigid conduit.

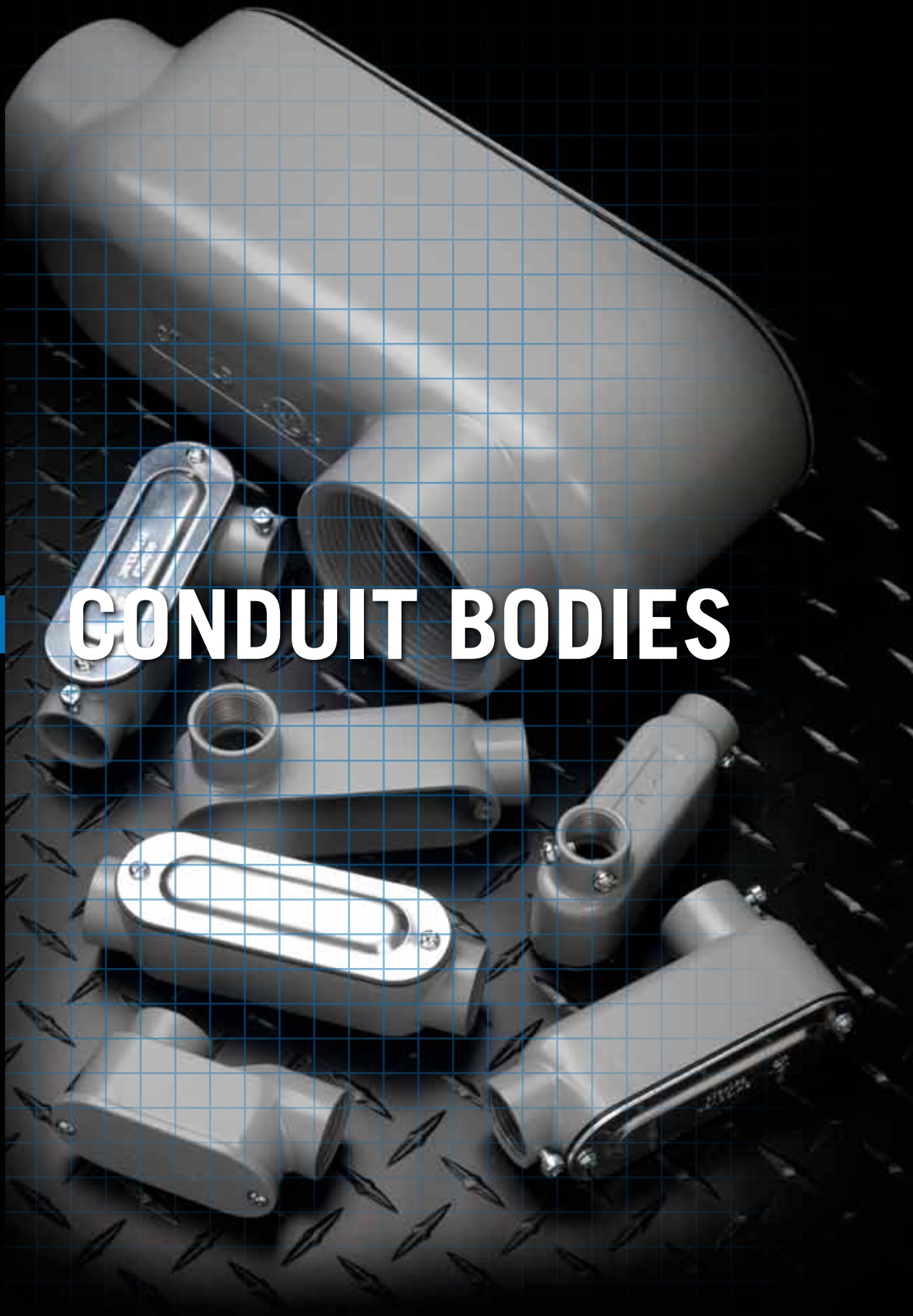
2504
For bare ground wire

2507
For bare armored ground wire

2512
For rigid conduit

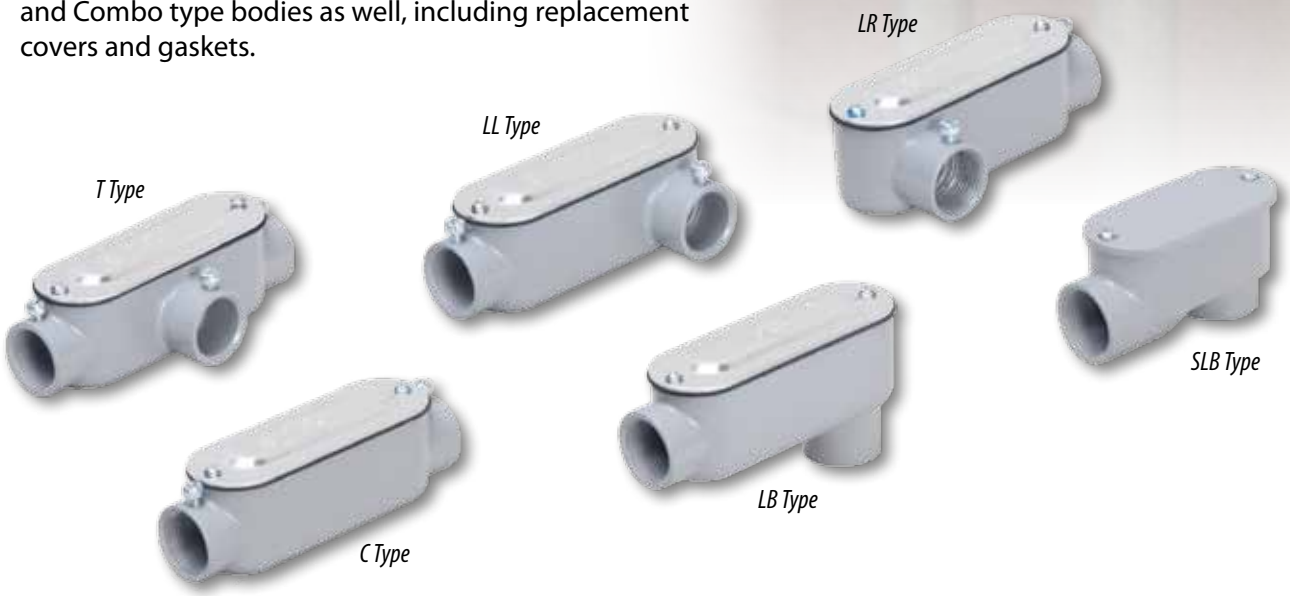
SECTION I

CONDUIT BODIES



CONDUIT BODIES

Conduit bodies are typically installed at various locations in conduit systems to accommodate bends in the run, provide taps for branch circuit runs, connect conduit systems, and serve as a pull outlet for installing conductors. The removable covers provide an easy access for maintenance, and to provide openings for taps or splices to conductors. Conduit bodies are made with set screws for use with EMT conduit in dry locations, with threaded hubs for rigid/IMC conduit for wet or dry locations, or with both known as a Combo which can be used on either conduit type. To accommodate different size conduit and installation requirements, the bodies are offered in sizes up to 4", and 2" on the SLB (service entrance elbow) type. The standard configurations available are LB, C, LL, LR, T, and SLB type. RACO carries a line of conduit bodies under the TayMac brand. Currently, we only offer the rigid/IMC threaded style body. They are sold as complete assemblies which include a stamped steel cover and rubber gasket. The bodies have a durable die cast aluminum construction with a powder coat finish. We are looking to expand the offering to include EMT and Combo type bodies as well, including replacement covers and gaskets.



SECTION J

MISCELLANEOUS FITTINGS

MISCELLANEOUS FITTINGS

Conduit Nipples, Washers, and Knockout Seals

Close nipples are used to run conductors to outlet and switch boxes that are in close proximity to each other. For example, to connect two 4" square boxes back-to-back with conductors passing through the nipple. Also, they may be used to join two masonry boxes. A knockout is removed in each box, then the nipple is inserted and secured with a #1002 series locknut (not provided with the nipple). RACO close nipples, #1662 series, are uninsulated die cast zinc and available in sizes1/2" through 4". Offset nipples, mentioned previously, are used when two boxes or panels are close together but the knockouts are not in line.

1662 Nipple
Uninsulated Die cast zinc

The conduit knockouts in steel boxes and panel boards must be closed for electrical safety. When a knockout is removed in error or by accident, a steel knockout seal easily closes the opening.1/2"-2 are one piece snap-in type (#1042 series), and 2-1/2"- 4" are a two-piece type that tighten with a bolt.

1042 One-piece

1037 Two-piece

1365 Reducing Washer Steel

Reducing washers are used when the raceway is a smaller trade size than the conduit knockout. This occurs often with panels that have many sizes of concentric knockouts and the wrong size knockout is accidentally removed. #1365 series washers will reduce two or three steps. Reducing washers should be used in pairs; one inside and one outside of the box or enclosure. They have an all steel construction. Trade sizes range from 3/4" reduced to1/2", and up to 4" reduced to 3".

Sealing washers are used whenever a positive seal is required between the shoulder of a fitting and an enclosure. The washers are available in sizes 1/2" up to 2", and feature a one-piece steel design that is zinc electro-plated for added corrosion protection.

1365 Sealing Washer
Steel

GLOSSARY OF TERMS

A

AIR PLENUM – a compartment or chamber to which one or more air ducts are connected and which forms part of the air distribution system.

AMP (A) – a measurement of the amount of electrical current in a circuit at any moment.

ARMOR – a metallic covering around the cable for mechanical protection. Typically interlocked steel or aluminum.

ARMORED CABLE CLAMP – a means of securing armored cable to a box, providing an electrical ground. The clamp will accommodate two cables.

B

BX – see flexible armored cable.

BEAM CLAMP – a fastening means, usually made of malleable iron or steel, commonly used with hangers and a threaded rod to fasten a raceway to an I-beam.

BONDING – the permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely any current likely to be imposed.

C

CSA – see Canadian Standards Association.

CABLE – two or more insulated conductors wrapped in metal or plastic sheathing.

CABLE BOX – a box provided with clamps to accommodate either metallic or nonmetallic sheathed cable.

CABLE CLAMP – a generic name for a clamp that mechanically secures the cable to the electrical outlet box.

CANADIAN STANDARDS ASSOCIATION (CSA) – an independent testing agency that certifies products to its established standards of safety and performance.

CIRCUIT – the path of electrical flow from a power source through an outlet and back to ground.

CLAMP BACK – a raceway fastening accessory typically used with a conduit strap to position a raceway away from a wall.

CLEAT HANGER – see bar hanger.

COMBINATION COUPLINGS – combination couplings join dissimilar raceways.

CONCRETE-TIGHT FITTING – a fitting that, when assembled to conduit or tubing of the proper size, excludes concrete aggregate.

CONDUCTOR FILL – refers to the number of current carrying and grounding conductors permitted by the National Electrical Code (NEC) to be used in conduit and tubing.

CONDUCTORS – electrical term describing wires capable of carrying an electrical current or wire being used as a ground, usually sheathed with an insulating material.

CONDUIT – (raceway) a pipe or tube designed to enclose and protect conductors or cables from moisture and physical damage.

GLOSSARY OF TERMS

CONDUIT CLAMP – a fastening clamp used to mount raceways.

CONDUIT HANGER – a fastening means used to support conduit.

CONNECTOR – a fitting intended to terminate a cable or raceway into a box, panel, etc.

D

DEVICE EARS – ears or tabs with holes spaced to accommodate wiring devices. Device ears are found on plaster rings, switch boxes and handy boxes.

DEVICE MOUNT – a term commonly used to denote where the screws of a device cover attach.

DUPLEX RECEPTACLE – a contact device for the connection of attachment plugs.

E

ELBOW – a curved section of raceway intended to change the direction of the run.

ELECTRICAL METALLIC TUBING (EMT OR THINWALL) – conduit called thinwall as a contrast to the "heavywall" of rigid or IMC.

ELECTRICAL NONMETALLIC TUBING (ENT) – a plastic corrugated raceway of circular cross section that is resistant to moisture and chemical atmospheres, and that is flame retardant.

ELECTROPLATING – a term used to describe the process of electrically depositing a layer of corrosion resistant material (I.e., zinc) onto steel or iron parts.

EMT – see electrical metallic tubing.

END RUN – that portion of the branch circuit that extends to the last fixture or device.

ETL – certification mark for Intertek Testing Services. ITS tests to the standards of UL, CSA and other international standards.

EXPOSED WORK – boxes and branch circuits that are mounted external or exposed on walls, beams, columns, etc.

F

FINISHED WALLS – studs, furring strips, joists, that are covered with wood paneling, drywall, plaster, Masonite or ceramic are considered finished.

FIXTURE – a lighting assembly that is permanently attached to a building's wiring system, usually to a ceiling box.

FLEX – see flexible metal conduit.

FLEXIBLE ARMORED CABLE (BX) – commonly called BX, a manufacturer's trade name. It may be described as prewired flexible metallic conduit since it includes two or more current carrying conductors and can be supplied with a grounding conductor.

FLEXIBLE METAL CONDUIT (GREENFIELD OR FLEX) – frequently called "Greenfield," which is the trade name of one manufacturer of this flexible steel or aluminum raceway. It is used around machinery where vibration or movement exists or where complex routing of the raceway dictates a flexible conduit.

FURRING STRIPS – small wood strips attached to an existing wall to provide a means to attach paneling or drywall.

GLOSSARY OF TERMS

G

GFCI – see Ground Fault Circuit Interrupter.

GAUGE – a term used to describe the physical size of a wire.

GREENFIELD – see flexible metal conduit.

GROUND – a conducting connection between an electrical circuit or equipment and the earth, or to some conducting body that serves in place of the earth. Neutral wires carry the current to ground in all circuits. An additional grounding wire, or the sheathing of metal clad cable or conduit, protects against shock from a malfunctioning tool or other device.

GROUND FAULT CIRCUIT INTERRUPTER (GFCI) – a safety device that senses shock hazard and automatically stops electrical flow in a circuit.

GROUND FITTING – a fitting used to attach a ground conductor to a ground pipe or rod.

GROUND LUG – means used to connect a ground wire to a fitting, clamp, or enclosure. Generally made of copper, aluminum, brass or bronze.

GROUND SCREW – a UL listed screw used to secure a grounding conductor to an enclosure.

GROUND WIRE – the conductor used to connect the electrical equipment to ground (or earth) at the service entrance point, minimizing the potential for electrical shock. Usually clad in green insulation or unclad.

H

HANDY ELL – a 90 degree elbow used either to connect two runs of conduit, or to connect a run of conduit to an enclosure.

HAZARDOUS LOCATIONS – are those locations where fire or explosion hazards may exist due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings.

HEAVYWALL – see rigid metal conduit.

HICKEY – (1) a threaded extension for support of a lighting fixture; (2) conduit bending tool.

HIDDEN WORK – residential and commercial construction where the electrical work is hidden by the finished wall; only the wiring device, switch, wall plate or light fixture is visible.

HOT WIRE – the higher voltage conductor carrying electrical current (usually black).

I

I.D. – inside diameter.

IMC – see intermediate metal conduit.

INSULATED THROAT –a thermoplastic liner that is pressed or glued into the throat of a connector. This liner helps to prevent damage to the insulation on conductors when pulled.

INSULATION – sheathing or jacket of nonconducting material used to cover wires.

INTERMEDIATE METAL CONDUIT (IMC) – a lighter weight, more economical version of rigid metal conduit. It has the same outside diameter (O.D.) as a thinner wall.

GLOSSARY OF TERMS

J

JOIST – horizontal beams that extend from wall to wall and support the floor or ceiling – typically 2" X 10", 2" X 8" or 2" X 6".

JUNCTION BOX – an enclosure used for splitting circuits into different branches. In a junction box, wires connect only to each other, never to a switch, receptacle, or fixture.

K

KILOWATT (KW) – one thousand watts, kilowatt measures power.

KILOWATT HOUR – a kilowatt hour is the standard measure of electrical consumption or energy.

KO (KNOCKOUT) – a circular tab on the side or bottom of a box pushed back in place with a small piece of steel remaining uncut to hold the tab in place until it is removed for installation.

L

LIQUID-TIGHT FLEXIBLE METAL CONDUIT– flexible metallic conduit with a plastic outer jacket that protects the electrical system against sunlight, liquids, vapors, or solids; it offers good mechanical protection and may be used in selected hazardous locations.

LIQUID-TIGHT FLEXIBLE NONMETALLIC CONDUIT –(NMLT) Liquid-tight flexible nonmetallic conduit is a raceway of circular cross section having a smooth inner surface with integral reinforcement within the conduit wall. NMLT is used in exposed or concealed locations, where flexibility is required for installation, operation or maintenance, and where protection of the conductors is required from vapors, liquids, or solids.

LOAD BEARING – walls that are an integral part of the structure that supports the joists.

LOCKNUT – an internally threaded barbed nut for use on conduit or fittings to prevent turning and to provide a secure joint.

LOW VOLTAGE PARTITION – a barrier added inside an electrical box to separate communication and power circuits. Also required where voltage levels between adjacent switches exceed 300.

LUG – see ground lug.

M

MC CABLE – metal clad cable. A UL classification indicating an assembly of insulated conductors with a metal cladding applied over the core and with grounding conductor(s) if the cladding is interlocked armor.

MADISON HOLD ITS® – registered trademark for #977 griplok old work brackets.

MOUNTING EARS – ears on a box which are used to mount a box cover, device or fixture.

MUD RING – all rings are called mud rings regardless of the finished wall material used. There are two styles of rings, one for mounting a switch or receptacle, and one for mounting lighting fixtures.

N

NEC – see National Electrical Code.

NEMA – National Electrical Manufacturer's Association.

NM – see nonmetallic sheathed cable.

GLOSSARY OF TERMS

NAIL-UP STRAPS – a fastening device used to mount raceways to wooden studs, siding, etc.

NATIONAL ELECTRICAL CODE (NEC) – a set of rules governing safe wiring methods drafted by the National Fire Protection Association. Local codes sometimes differ from and take precedence over NEC requirements.

NEUTRAL WIRE – a grounded conductor that complete a circuit by providing a return path to the source. Neutral wires are always identified by white or gray insulation.

NEW WORK – electrical work that is completed before the drywall or plaster is installed.

NIPPLE – an externally threaded fitting intended primarily to serve as a short raceway between close-spaced enclosures.

NONMETALLIC SHEATHED CABLE (ROMEX®) – nonmetallic sheathed cable, popularly called by a manufacturer's trade name of Romex, is two or more insulated conductors, usually copper, protected by an outer jacket or sheath of nonmetallic material.

O

O.D. – outside diameter (of conduit, etc.).

OCTAGON BOX – a metal box used on a wiring system, usually at an outlet. It provides means for connection to a wiring system and is intended primarily to enclose splices and wiring devices or to support a fixture or other equipment intended for similar installation.

OFFSET CONNECTORS –connectors which bring the conduit run away from a wall or ceiling into a box

OLD WORK – electrical work that takes place after the drywall or plaster is in place.

OUTLET – anything that allows access to the wiring system (e.g., box, conduit body, etc.).

P

PAN – see pancake box

PANCAKE BOX – this round box typically is the same depth as the finish wall material in which it is mounted.

PARTITION WALLS – walls that are nonload bearing – typically interior walls of an office building that can be removed.

PLASTER EARS – ears of switch boxes that prevent the box from falling back into the wall.

PLASTER RING – see mud-ring.

PLENUM – a compartment or chamber to which one or more air ducts are connected to form part of the air distribution system.

PRE-GALVANIZED – the application of hot zinc to the exterior surfaces of steel.

PRYOUT – a circle or pear shaped hole cut into the steel with a tie (a little piece of steel uncut) holding it in place; the priout has a slot in it where a screwdriver tip is inserted to pry out the steel, providing an opening for cable.

GLOSSARY OF TERMS

R

RACEWAY – enclosed channel designed expressly for holding wire or cables. Conduit is a raceway; so is a duct.

RAFTER – parallel beams that support a roof running from the top of the joist to the peak of the roof.

RAISED COVER – used for a job that is surface mounted. There are a variety of covers that may be used depending on the type of device being installed.

REDI-LOC® - a registered RACO trademark for MCI, AC and HCF cable connectors.

RIGID – see rigid metal conduit.

RIGID METAL CONDUIT (RIGID OR HEAVYWALL) – rigid metal conduit is a raceway that provides a high degree of mechanical protection indoors or out, in dry or wet locations, exposed or concealed, in all kinds of atmospheric conditions, locations, and in hazardous locations such as explosion proof, vapor tight and dust tight.

RIGID NONMETALLIC CONDUIT – three types of rigid nonmetallic conduit are listed by UL: (1) rigid nonmetallic plastic Schedule 40 and 80 PVC; (2) rigid nonmetallic underground plastic; and (3) rigid nonmetallic underground other than plastic, fiber type.

ROBERTSON HEAD SCREW – a type of screw with a square key that is popular in Canada. A special tool (called a Robbie) is required to drive the screw.

ROMEX® - see nonmetallic sheathed cable.

S

SERVICE DROP – service entrance conductors from the utility pole to the service entrance conductors of a building that has overhead service. The utility company usually supplies and connects the service drop.

SERVICE ENTRANCE – the point at which electrical service enters a building.

SERVICE ENTRANCE CABLE (SE) – service entrance cable can b compared to nonmetallic sheathed cable (Romex®) in large conductor sizes, with a weatherproof nonmetallic outer covering. It is often encased by rigid, IMC or EMT conduit for additional protection.

SERVICE-ENTRANCE HEAD – an enclosed fitting intended for use at service entrances where open wiring is connected to a service-entrance cable or raceway system.

SET BACK – the distance a box is set forward on a stud to accommodate the thickness of the finished wall and leave the face of the box flush with the front surface of the wall.

SET SCREW CONNECTOR – a fitting which terminates a run of conduit into an enclosure using set screws.

SET-UP BOX – trade term for an octagon box, factory installed on a bar hanger.

SHEATH – material, usually an extruded plastic material applied outermost to a wire or cable. Often called a jacket.

SHIELDED CABLE – a cable in which the insulated conductor(s) are enclosed in a conductive mesh envelope. The mesh is intended to protect the enclosed conductor(s) from external electrical interference.

GLOSSARY OF TERMS

SPLICE – the joining of two or more conductors.

SPLICE BOX – see junction box.

SPLIT COUPLING – a term used to refer to a coupling used for rigid/IMC conduit. Used where the conduits to be coupled cannot be rotated.

STRAIN RELIEF – a term used to describe the sealing and gripping action of a cord connector.

STRAPS – used to support conduit as required by Code. Beam and conduit clamps perform this function in industrial locations.

STUD – 2" X 4" or 2" X 6" wood or steel used to construct walls.

STUD WALL – wood or steel 2" X 4" spaced 16" or 24" on center – drywall or paneling typically is attached to the studs to finish the wall.

SWITCH BOX – boxes with device ears for direct mounting of switches as opposed to boxes requiring mud rings for switch mounting.

T

THINWALL – see electrical metallic tubing.

TIGER BOX® - RACO registered name for a patented switch box for old work applications.

TILE COVER – a series of covers designed for use with tile. These covers are for mounting switches or receptacles. Rings are available in different depths depending on the finished wall thickness.

TKO® - RACO trademark for combination1/2" and 3/4" knockout. The two knockouts are off-center to enable a1/2" locknut to engage the box for proper grounding of the electrical system.

TOGGLE SWITCH – a switch intended for use in general distribution and branch circuits.

TRADE SIZE – conduit is referred to by trade size according to its inside diameter.

U

UL – see Underwriters Laboratories.

UNDERGROUND FEEDER CABLE – underground feeder cable (Type UF) is a group of conductors manufactured in the form of a cable assembly similar to Type NM (Romex®) but with the physical and electrical characteristics that allow for direct burial in the earth.

UNDERWRITERS LABORATORIES (UL) - an independent testing agency that tests and lists electrical equipment to its established standards of safety and performance.

UTILITY BOX – see handy box.

V

VOLT (V) – Unit for electric potential (voltage), electric potential difference, and electromotive force.

W

WATT (W) – a measure of the power an electrical device consumes: [volts x amps = watts].