NEMA Publication OS 3-2002

Selection and Installation Guidelines for Electrical Outlet Boxes

Setting Standards for Excellence

© 2002 by National Electrical Manufacturers Association

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

The National Electrical Manufacturers Association (NEMA) standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, expressed or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety–related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Table of Contents

Foreword iii

Introduction 1
Product Standards and Installation Codes 2
Coordination of Trades 2
Scope 2

Section 1 PRODUCT SELECTION 3
General 3
1.1 Select the Outlet Box for the Type of Wiring System Used 6
1.1.1 Connection to the Wiring System 6
1.1.2 Wiring Systems Employing Tubing or Conduit 6
1.1.3 Wiring Systems Employing Metal Jacketed or Nonmetallic-Sheathed Cable 6
1.1.4 Grounding 7
1.2 Select the Box Based on Contents and Function After Installation 7
1.2.1 Internal Volume Capacity of Boxes 7
1.2.2 Junction and Pull Boxes 7
1.2.3 Outlet and Device Boxes–Mounting of Wiring Devices 8
1.2.4 Outlet and Device Boxes–Support of Fixtures/Luminaires, Ceiling-Suspended Fans, and Other Products 8
1.2.5 Outlet and Device Boxes with Fire Resistance Ratings (Hours) 9
1.2.6 Boxes for High and Low Voltage Wiring Circuits (Class 1, Class 2, and Class 3 Circuits) 9
1.3 Select the Outlet Box for the Intended Location of Installation 10
1.3.1 General 10
1.3.2 Boxes for Installation in or on Walls or Ceilings 10
1.3.3 Boxes for Installation in Floors 12
1.3.4 Boxes for Other Locations 13
1.3.5 Outlet and Device Boxes for Use in Fire Resistance-Rated Construction 14
1.3.6 Special Use Boxes 15
1.3.7 Covers and Cover Plates for Dry Locations 15
1.3.8 Extension Rings and Box Extenders 16

FIGURES
Figure 1-1 – TYPICAL BOX MOUNTING POSITIONS 17
Figure 1-2 – TYPICAL BOX MOUNTING STYLES 19
Figure 1-3 – SEPARATELY SUPPLIED BOX SUPPORTS 20

Section 2 PRODUCT INSTALLATION 23
2.1 Introduction 23
2.1.1 Storage and Preparation for Installation 23
2.1.2 Coordinating Trades (After Boxes are Mounted) 23
2.2 Fire Resistance-Rated Construction 23
2.2.1 Metallic Boxes 23
2.2.2 Nonmetallic Boxes 24
2.3 Mounting and Securing of Electrical Boxes 24
2.3.1 General 24
2.3.2 Surface Mounting on Walls or Ceilings 24
2.3.3 Boxes Supported by Raceways 25
2.3.4 Flush Mounting in Walls and Ceilings 25
2.3.5 Pendant Mounting 26

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.3.6 Pedestal Mounting 26
2.3.7 Masonry Wall Mounting 26
2.3.8 Floor Box Mounting 26
2.3.9 Poke-Through Floor Fitting Mounting 27
2.3.10 Other Boxes 27
2.4 Connection to Wiring Systems 28
2.4.1 General 28
2.4.2 Connection to Conduit Entries 28
2.4.3 Connection to Cable Entries 29
2.4.4 Connection to High and Low Voltage Wiring Circuits 30
2.5 Completing the Installation 30
2.5.1 Introduction 30
2.5.2 Grounding and Bonding 31
2.5.3 Installation of Wiring Devices 32
2.5.4 Flush Device Boxes: Coordination with Finished Wall Surface Installation 34
2.5.5 Installation of the Cover and/or Cover Plate 34
2.6 Verification of Installation 34

FIGURES

Figure 2-1 – SQUARE BOXES IN 4” x 4” WALL OPENING 35
Figure 2-2 – TYPICAL THREADED CONDUIT ENTRIES 35

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Foreword

These selection and installation guidelines offer practical information on correct product selection and industry recommended practices for the installation of electrical outlet boxes in accordance with the National Electrical Code®.

These guidelines have been developed by the NEMA Outlet and Switch Box Section, which periodically reviews them for any revisions necessary to address changing conditions, product listing and installation requirements, and technical progress. Comments for proposed revisions are welcomed and should be submitted to:

Vice President, Engineering
National Electrical Manufacturers Association
1300 North 17th Street, Suite 1847
Rosslyn, VA 22209
www.nema.org

At the time of approval, the Outlet and Switch Box Section of the National Electrical Manufacturers Association had the following members:

Allied Moulded Products—Bryan, OH
Arlington Industries, Inc.—Scranton, PA
Bowers, A Subsidiary of Thomas & Betts—Memphis, TN
Bridgeport Fittings, Inc.—Bridgeport, CT
CANTEX, Inc.—Mineral Wells, TX
Cooper B-Line—Highland, IL
Crouse-Hinds—Syracuse, NY
EGS Electrical Group—Skokie, IL
Erico, Inc.—Solon, OH
Kellems Division, Hubbell Incorporated—Stonington, CT
Lamson & Sessions, Carlon—Cleveland, OH
Pass & Seymour/Legrand—Syracuse, NY
RACO—South Bend, IN
Steel City—Memphis, TN
Thomas & Betts Corporation—Memphis, TN
Wiremold Company, Walker Systems—Williamstown, WV
Wiegmann, Hubbell Electrical Products—Freeburg, IL

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

This page is intentionally left blank.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Introduction

There may be no other component of our electrical distribution system that serves more purposes than the electrical outlet box.

When installed with a cover, the box

1. provides connection to a raceway system and a means to access wiring;
2. houses and provides a degree of mechanical protection for conductor splices, and wiring devices such as switches and receptacles; and
3. limits access to live parts; and where applicable, bonds electrically conductive components to the equipment grounding conductor.

When designed and specifically identified for the purpose, a box and other components form an enclosure system which

1. provides degrees of protection from external environmental conditions (rain, dust, scrub water, etc);
2. preserves the integrity of fire resistance rated walls, ceilings, floors, partitions, or furniture in which it is installed; and/or
3. provides independent support for attached fixtures such as luminaires, ceiling suspended fans, and safety and security devices.

For the most part, boxes within the scope of these guidelines fall into just a few general classifications. Each classification has been adapted over the years to meet market needs.

These guidelines are written by the NEMA Outlet and Switch Box Section (5-OS) to provide qualified designers, installers, and inspectors with an industry perspective of the appropriate selection and installation criteria based on the designed, intended use of the product. The member companies of the NEMA 5-OS Section promote selection and installation of listed boxes and covers, and listed raceways and fittings. Listing of electrical system components qualifies them to minimum performance requirements and provides for ongoing conformity surveillance. Listed boxes and covers can be recognized by the trademark of the qualified electrical testing laboratory on the part or its smallest unit container.

It is our objective to develop a closer liaison with the installers of our products and the professional electrical inspector. Through this liaison, we intend to provide uniform education and understanding as to the intended use and application of our products. Through education, we hope to develop an alliance, founded in trust that will ensure that the concerns and challenges we each face are addressed.

Compatibility of Boxes with Metallic and Nonmetallic Wiring Systems–Grounding and Bonding

Metal and nonmetallic outlet boxes are typically designed for use in electrical distribution systems rated 600 volts or less.

Metal systems and raceways that are recognized as equipment grounding conductors provide protection by grounding and bonding the entire system. All the components of the system (boxes, fittings, devices, fixtures, raceways, etc.) with proper installation are designed to maintain continuous grounding and bonding throughout the system. Products must be installed so that the removal of any device, fixture, or box cover does *not* interrupt the downstream grounding or bonding path.

Nonmetallic systems protect the installer and end users by providing isolation (insulation) throughout the wiring system. All the components (boxes, fittings, devices, fixtures, raceways, etc.) with proper installation are designed to maintain this isolation (insulation).

When nonmetallic systems are installed:

a) there are no ungrounded exposed metal parts that may be likely to become energized in case of a ground fault;

b) ground wires are installed inside the raceways and throughout the system; and

c) ground wires are joined so that removal of a device or fixture does not interrupt the downstream ground path.

Generally, this is done by joining the incoming and outgoing ground wires with a third ground wire that then attaches to the device or fixture.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Thus, the removal of the device or fixture does not affect the downstream ground path.

Each system is designed to distribute electrical power while protecting the installer and end users. Metallic and nonmetallic systems employ different means to provide protection. Therefore, for safety reasons, these two systems should not be randomly mixed without due consideration.

Where it is necessary and desirable to mix metallic and nonmetallic components in a wiring system, special products, applications, and procedures can be used to ensure the desired level of safety in accordance with the National Electrical Code®.

Product Standards and Installation Codes

Boxes and covers within the scope of these guidelines are designed for installation in compliance with the National Electrical Code® (NEC®) NFPA 70. The broadest range of general purpose designs are included in ANSI/NEMA OS 1, *Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports*; and ANSI/NEMA OS 2, *Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.* NEMA FB 1, *Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Tubing, and Cable Assemblies*, contains those boxes described in its title, and ANSI/NEMA WD 6, *Wiring Devices–Dimensional Requirements*, includes flush-device cover plates. Conformity to these standards provides assurance of the compatibility and interchangeability of box designs with covers, raceways, wiring devices, and other components of the electrical distribution system whose performance may be dependent on the box design.

Listed boxes are typically evaluated to the safety and performance requirements of ANSI/UL 514A, *Metallic Outlet Boxes* or ANSI/UL 514C, *Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.* The safety and performance requirements for flush device cover plates are covered in ANSI/UL 514D, *Covers for Flush-Mounted Wiring Devices*. Boxes intended to provide degrees of protection from external environmental conditions may also be subject to the requirements found in ANSI/NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)* or ANSI/UL 50, *Enclosures for Electrical Equipment.* Nonmetallic boxes intended to be installed in fire resistant rated walls, ceilings, floors, partitions, or furniture must also be separately evaluated to establish a rating classification in accordance with ANSI/UL 263 and ASTM E 119.

Given that all listed boxes have met the same minimum safety and performance requirements, ***selection*** of the right box for the application is the single most important factor for safe, effective, and permanent installations. Design preference completes the selection process, as there are many optional features that distinguish alternative brands. Beyond ***selection***, almost every other variable comes down to good *workmanship*, something every craftsman takes pride in and that is fundamentally required by the NEC®.

NOTE: All references to the NEC® are to the 2002 edition. References to the 1999 NEC® are included in brackets.

Coordination of Trades

With regard to workmanship, the quality of a box installation can be seriously compromised when an effort is not made to coordinate the installation of electrical outlet boxes with other construction trades. In particular, installation problems have been evidenced where there was insufficient coordination with the trades that apply finished surfaces (drywall) and poured concrete (concrete boxes and floor boxes). Every effort should be made to coordinate with these and other trades who, through lack of careful consideration may compromise the quality of an installation.

Scope

This publication covers guidelines for selection and installation of general purpose and specialty metallic, nonmetallic, and composite outlet boxes such as device boxes, fixture boxes, and junction boxes; extension rings; covers; and flush device cover plates. The boxes addressed in these guidelines are intended for use in ordinary, non-hazardous locations. With the exception of masonry boxes and some multi-gang boxes and floor boxes, the boxes addressed in these guidelines are limited to 1650 cm³ (100 in³) internal volume.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 1
Product Selection

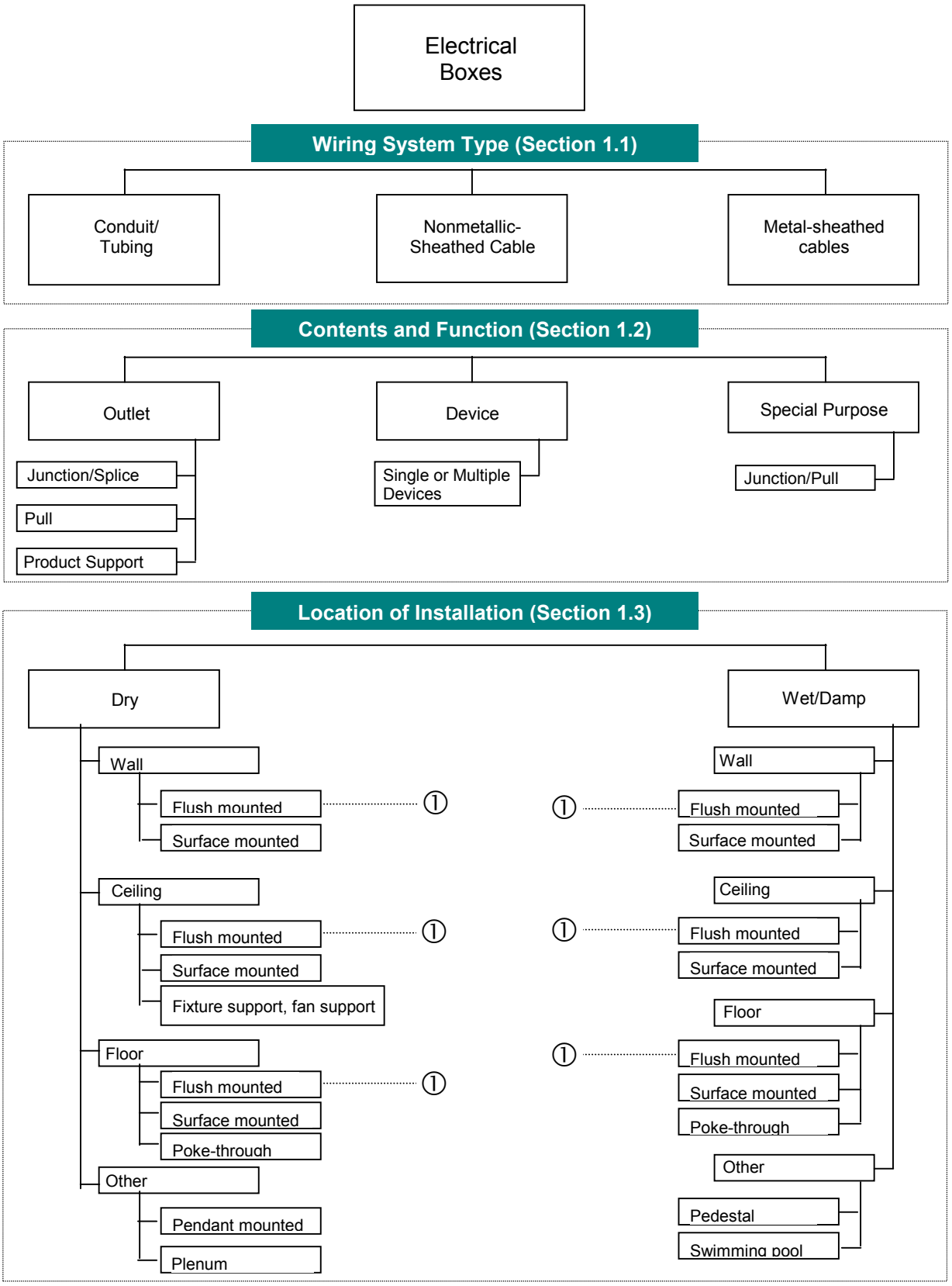
General

The three key elements to the selection of an electrical outlet box are:

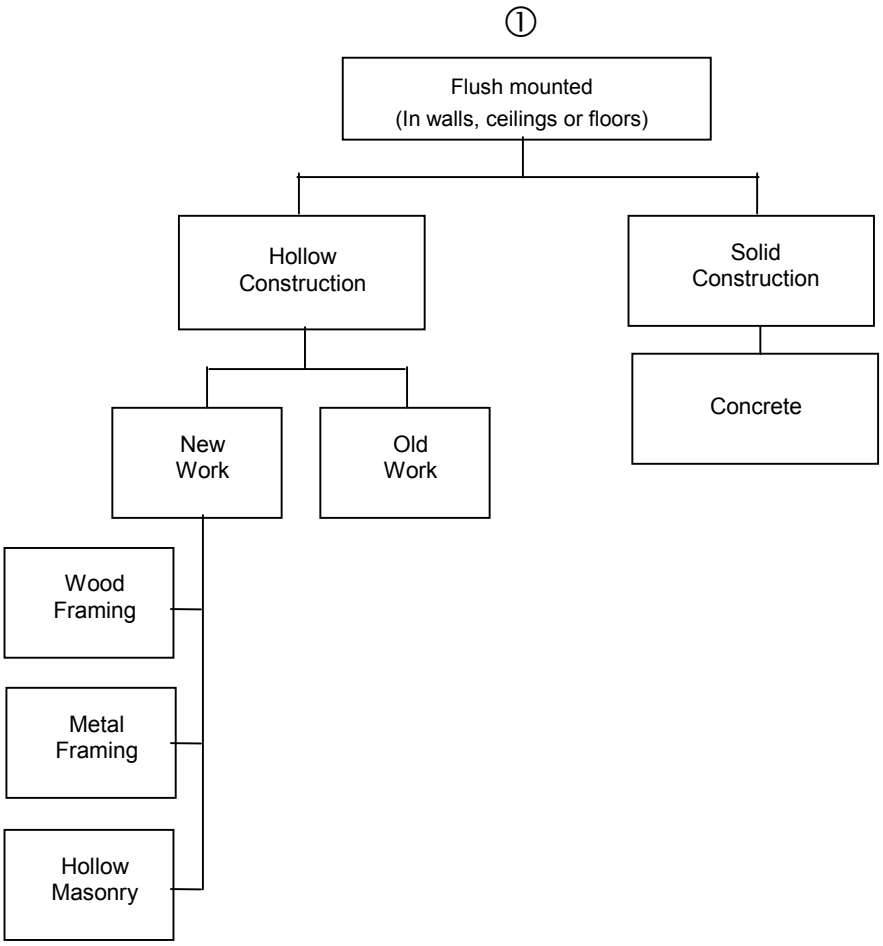
- Type of wiring system
- Contents and function after installation
- Location and type of construction

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

The following chart illustrates the critical underlying elements that should be considered when making the appropriate outlet box selection. The sections that follow are intended to further guide the user in making these choices.



Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale



Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

1.1 Select the Outlet Box for the Type of Wiring System Used

Local electrical and building codes determine the acceptable wiring methods for the building structure.

1.1.1 Connection to the Wiring System

The outlet box is an integral part of the wiring system, and as such, the box selected must be provided with a means to connect to the wiring system.

Mechanical connection—Every outlet box must have a means for entry of conduit, tubing, or cable. In addition, outlet boxes must provide for secure mechanical attachment of the conduit, tubing or cable at the point of entry. SINGLE-GANG nonmetallic outlet boxes intended for use only with Nonmetallic Sheathed Cable (NM), where the cable can be secured within 200 mm (8 inches) of the box, need not have a direct mechanical attachment means.

1.1.2 Wiring Systems Employing Tubing or Conduit

Conduit Entries: Conduit entries in an outlet box may be either threaded or unthreaded. It is important to select boxes having the correct number and size of conduit entries for the installation. Boxes such as junction and pull boxes supplied without conduit entries are intended to have such entries made in the field in accordance with manufacturer's instructions.

Threaded entries in outlet boxes for threaded conduit or threaded fittings are permitted to have taper or straight threads conforming to the specifications in NEMA FB 1.

Unthreaded entries in outlet boxes for conduit or tubing include knockouts, or sockets (hubs).

Knockouts are removable to provide openings in metallic and nonmetallic outlet boxes that allow for a secure mechanical attachment of conduit and cables with the use of appropriate fittings.

Unthreaded sockets (hubs) are provided in some cast metal box designs. Set screws are assembled in such sockets to securely attach Rigid Metal Conduit, Intermediate Metal Conduit (IMC) or Electrical Metallic Tubing (EMT) to the box.

In the case of nonmetallic outlet boxes, such entries may include sockets (integrally molded hubs) for attachment of Rigid Nonmetallic Conduit (RNC) or Electrical Nonmetallic Tubing (ENT). Some sockets may contain knockouts. Connection of RNC or ENT to sockets is made using the appropriate solvent cement. These boxes are typically designed for one size of conduit or tubing. An appropriate sized reducer bushing is to be used where a smaller trade size conduit or tubing is to be installed.

1.1.3 Wiring Systems Employing Metal Jacketed or Nonmetallic-Sheathed Cable

Cable Entries: Cable entries in an outlet box are provided in several forms.

Threaded entries or unthreaded entries such as knockouts described for conduit entries above, also serve for the attachment of cables by means of specific cable fittings.

Cable entries that permit entry of the cable into metal outlet boxes without use of a separate fitting are often called pryouts. Pryouts allow easy access to cable entries in metal outlet boxes intended to accommodate electrical cables having an outside diameter of up to 15.9 mm (5/8 inch). A metal box with pryouts is always supplied with cable securement means. Typically they are in the form of a clamp installed in the box, but can be in the form of a cable fitting that is suitable for the application. These boxes have markings on the clamps and carton labels that tell the user the types and sizes of cables for which the product is suitable.

Cable entries in nonmetallic outlet boxes are designed for use with nonmetallic-sheathed cable or flexible nonmetallic tubing.

Non-circular cable entries are provided in nonmetallic outlet boxes intended for use with Nonmetallic-Sheathed Cable. Where direct mechanical attachment of the cable is required, a box design that includes cable securement clamps is to be selected. Boxes are available that include removable and replaceable clamps, or clamps that are integrally molded as part of the box.

A cable securement clamp is not required for a single-gang nonmetallic outlet box when the cable can be secured within 200 mm (8 inches) of the box.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

1.1.4 Grounding

Electrical connection—A box intended for connection to metal raceway or metal jacketed cable must provide a continuous electrical grounding connection. A metallic outlet box connected to a nonmetallic conduit, tubing, or cable must have provision for connection of a separate grounding conductor. A nonmetallic outlet box may be connected to a metal enclosed cable or metallic raceway, as long as a bonding jumper is installed between the raceways or cables.

Where it is necessary or desirable to use a nonmetallic outlet box at any point in a metallic raceway or wiring system, special precautions are necessary. Often special grounding and bonding accessories and techniques are required to ensure the electrical connection of the metallic raceway or wiring system remains continuous (See "Compatibility of Outlet Boxes…" section in the Introduction).

1.2 Select the Box Based on Contents and Function After Installation

The intended purpose of an outlet box is the second major criteria for selection. An outlet box may be used as a JUNCTION or PULL BOX, or a DEVICE BOX to house a wiring device such as a switch or receptacle or communication circuit accessory. An additional function of the outlet box may be to provide means for supporting equipment such as lighting fixtures (luminaires), ceiling-suspended fans, safety and security devices, etc. Although the primary function of each of these types of boxes is described separately below, each type when appropriately equipped may provide additional functions.

Covers and/or cover plates are required to complete the enclosure. The style of cover or cover plate selected to complete the enclosure is also determined by the contents and function, as well as the location (See 1.3) of the box. A cover for a junction or pull box will have no pre-formed openings other than for mounting screws, whereas the cover or cover plate for a device box must have appropriate openings to accommodate the device. A canopy provided as a part of a luminaire, ceiling-suspended fan or other product that may be attached to a box, also serves to complete the enclosure.

1.2.1 Internal Volume Capacity of Boxes

An outlet box must have sufficient internal volume capacity. The electrical system design will determine the size and number of conductors, the type and number of wiring devices, and the type of conduit or cable securement. This information is essential in order to select the appropriate outlet box design having at least the minimum required internal volume capacity, and size. Strong consideration should be given to selecting a box having a larger internal volume whenever the installation requirements approach the box volume capacity. Additional volume makes installation easier by allowing for longer conductor ends and more room for devices. Where used for high-performance data conductors such as fiber-optics, larger volume outlet boxes also ensure adequate cable bend radius. When longer conductor ends are available, future maintenance of wiring devices is easier to accomplish, and the additional volume in the box will allow for the substitution of a larger wiring device.

The internal volume of an outlet box, historically measured in cubic inches (cu-in) but now also referenced in cubic centimeters (cm^3), is an essential, easily understood, and almost universal basis for reliable selection of an outlet box. For many years the most common metallic box designs have been standardized based on nominal dimensions and internal volume capacity in accordance with Table 314.16 (A) [370-16(a)] of the National Electrical Code® and are not required to have their volume marking on the box. Metallic boxes having dimensions different from this table are marked with their internal volume. All nonmetallic boxes are marked with their internal volume. From selection to verification of a completed installation, use of internal volume of a box based on the standardized set of deductions presented in the National Electrical Code® in Article 314 [370], has a proven safety record in North American electrical distribution systems.

1.2.2 Junction and Pull Boxes

A JUNCTION BOX is used to join different runs of raceway or cables, or both, and provides space for the connection and branching of the enclosed conductors. Most boxes can be used

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

solely as junction boxes as long as they are used with an appropriate cover.

A PULL BOX is a JUNCTION BOX having the minimum dimensional requirements for wire bending radius. A PULL BOX provides internal access to the conductors in the raceway or changes the direction of the raceway system.

A CONDUIT BODY may serve as a pull or junction box.

1.2.3 Outlet and Device Boxes—Mounting of Wiring Devices

A device box has a provision for attaching and housing electrical switches, receptacles, or similar wiring devices in accordance with NEMA OS 1 and NEMA OS 2. Types of device boxes include single device (SINGLE GANG), multiple device (MULTIPLE GANG), and modular design configurations (GANGABLE) that may be field assembled, one to another, to accommodate multiple devices. Clauses 1.2.3.1 through 1.2.3.5 describe various boxes designed for mounting of wiring devices.

1.2.3.1 Device Boxes for Flush Mounting

When installed as intended, these boxes position the face of the securely mounted wiring device flush to a structure's finished surface covering. Some flush device boxes are designed specifically for installation during the building process (new work), while others have special features that enable them to be flush mounted in an existing finished surface (old work). See Clause 1.3.2.2 and Figure 1.

1.2.3.2 Device Boxes for Surface Mounting

Commonly referred to as “utility” boxes, these boxes are specifically designed for mounting onto a structure's finished surface. Such surfaces may include appliances or machinery. See Clause 1.3.2.1 and Figure 1.

1.2.3.3 Outlet Boxes for Flush Mounting

Some outlet boxes, such as square boxes, can be used in conjunction with raised covers (commonly referred to as mud rings) for flush mounting wiring devices. Selecting this type of installation provides increased internal volume. See Figure 1.

1.2.3.4 Outlet Boxes for Surface Mounting

Some outlet boxes, such as square boxes, can be used in conjunction with appropriate covers for surface mounting wiring devices. When a raised-surface cover is selected, this type of installation provides increased internal volume (See Figure 1).

1.2.3.5 FS and FD Boxes

FS and FD boxes are designed for direct attachment of a wiring device. “FS” refers to shallow boxes (typically up to 1-1/4” deep) and “FD” refers to deeper boxes (typically up to 1-5/8” deep) for larger devices and increased wiring capacity.

1.2.4 Outlet and Device Boxes—Support of Fixtures/Luminaires, Ceiling Suspended Fans, and Other Products

1.2.4.1 Outlet and Device Boxes Intended for Support of Luminaires and Other Fixtures

1.2.4.1.1 For Products Weighing 2.7 kg (6 lbs.) or Less

In or on walls, in old work or new work, all outlet boxes including device boxes are capable of supporting products, such as a fixture/luminaire, smoke or gas detector or similar product, weighing up to 2.7 kg (6 lbs.). In or on ceilings, an outlet box other than a device box is capable of supporting any product weighing up to 2.7 kg (6 lbs.). A device box mounted in or on a ceiling is capable of supporting a product other than a luminaire weighing up to 2.7 kg (6 lbs.). No markings are required to identify boxes for these uses.

1.2.4.1.2 For Products Weighing More Than 2.7 kg (6 lbs.) Up to 22 kg (49 lbs.) or Less

In or on walls, in old work or new work, outlet boxes identified for such use, including device boxes, are capable of supporting products weighing between 2.7–22 kg (6–49 lbs.). Boxes listed for support of products weighing between 2.7–22 kg (6–49 lbs.) are marked to indicate the maximum weight, the intended end use application (wall, ceiling, or both) and any specific installation techniques.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

1.2.4.1.3 For Products Weighing Between 2.7 and 23 kg (6 to 50 lbs.)–New Work Only

Where structural framework is accessible for mounting a box in or on a wall or ceiling, an outlet box is capable of supporting a fixture/luminaire or other products weighing 23 kg (50 lbs.) or less. The most common boxes intended for this purpose are round, octagon, or square. When listed for this purpose, the smallest unit shipping carton containing such boxes will be marked to indicate "For Fixture/Luminaire Support" or similar wording.

Summary Table for Support of Luminaires/ Fixtures and Other Products

Maximum Weight of Luminaire/ Fixture or Product kg (lbs.)	Wall Installation		Ceiling Installation	
	Outlet Box	Device Box	Outlet Box	Device Box
0 to 2.7 (0 to 6)	YES	YES	YES	YES Other than a luminaire
2.7+ to 22 (6+ to 49)	YES[a]	YES[a]	YES[a]	
2.7 to 23 (6 to 50) New Work Only	YES[b]	YES[b]	YES[b]	
23+ (50+) New Work Only			YES[a]	

[a] Marking required on product: Maximum weight, installation instructions, wall or ceiling

[b] Marking required on carton label: "Luminaire/Fixture Support"

1.2.4.1.4 For Products Weighing Greater Than 23 kg (50 lbs.) in or on Ceilings–New Work Only

Where structural framework is accessible for mounting a box in or on a ceiling, an outlet box may be listed to support fixtures greater than 23 kg (50 lbs.). These boxes are required to be marked with the maximum weight the box is listed to support.

Articles 314 [370] and 410 [410] of the NEC® provide details on the use of boxes to support luminaires/lighting fixtures.

Safety Consideration: *In old work installations, where structural framing members are not accessible for mounting the box, the installer must consider if the mounting surface, such as drywall, will provide adequate support for the box and the fixture/luminaire.*

1.2.4.2 Outlet Boxes Intended to Support Ceiling-Suspended Fans

Boxes and box-hanger assemblies that are listed and marked "Fan Support" or other similar wording are intended to support a ceiling-suspended fan (with or without accessories such as fixtures/luminaires) weighing 16 kg (35 lbs.) or less. Boxes may be listed for supporting a fan (with or without accessories such as fixtures/luminaires) weighing up to 32 kg (70 lbs.), when marked "Acceptable for Fan Support of 32 kg (70 lbs.)" or equivalent. Ceiling fan boxes are to be supported from structural framing members. These boxes are also suitable for support of a fixture/luminaire when additionally marked in accordance 1.2.4.1.

Where a separately supplied bracket such as a bar hanger is to be used with a box marked "Acceptable for fan support," the separately supplied bracket must also be marked to indicate its acceptability for this use.

NEC® Section 422.18 [422-18] provides details on the use of boxes to support ceiling-suspended fans.

1.2.5 Outlet and Device Boxes with Fire Resistance Ratings (Hours)

Outlet and device boxes for flush mounting in fire-resistance rated walls or ceilings are addressed in Clause 1.3.5.

1.2.6 Boxes for High and Low Voltage Wiring Circuits (Class 1, Class 2, and Class 3 Circuits)

Typical metallic and nonmetallic outlet and switch boxes are designed for both high and low voltage wiring circuits. These same boxes will accommodate a wide variety of electric light, power, data and communications circuits and devices. For the purpose of these guidelines, we will consider electric light and power circuits and Class 1 circuits under the category of "high voltage," and communications and fiber optic and Class 2 and 3 circuits as being "low voltage." NEC Article 725 [725] contains appropriate wiring methods for Class 1, 2, and 3 circuits. This Article also includes important restrictions for boxes and enclosures that are intended to house Class 2 or 3 circuit wiring with Class 1 circuit wiring.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Additional low voltage wiring methods are similarly addressed in NEC® Articles 770 [770] and 800 [800].

1.2.6.1 Low Voltage Wiring Circuits (Class 2 and Class 3 Circuits)

Although the distinction between high and low voltage is not clearly defined in the NEC, Class 2 and Class 3 wiring circuits and devices are not typically required to be installed in an electrical outlet box unless the installation will be subject to physical abuse in normal use as required in NEC 725.6 [725-7]. Simple cover/device mounting frames are available to conveniently complete these installations.

1.2.6.2 High and Low Voltage Wiring Systems Installed Together

Where it is desirable or necessary for both a high voltage wiring circuit (electric light, power, Class 1) and a low voltage wiring circuit (Class 2 or 3) to be installed in the same box, special consideration must be given to the restrictions detailed in NEC® Sections 725.26 [725-26] and 725.54 through 725.57 [725-54]. Where permitted for installation in the same outlet box, the low voltage wiring must be separated from the high voltage wiring. Outlet boxes of the square and multi-gang type, and certain gangable device boxes are available for use with partitions specifically designed to separate the wiring compartments.

Additional low voltage wiring methods are similarly addressed in NEC® Articles 770 [770] and 800 [800].

1.2.6.3 Voltage Between Adjacent Devices

NEC® Section 404.8(B) [380-8(b)] requires that a snap switch shall not be grouped or ganged in an enclosure with other snap switches, receptacles or similar devices, unless they are arranged so that the voltage between adjacent devices does not exceed 300 volts. Use of square or multi-gang type, or certain gangable device boxes with provision for partitioning the boxes to provide a barrier between such devices, is an accepted method to comply with this requirement.

1.3 Select the Outlet Box for the Intended Location of Installation

1.3.1 General

The building construction style, materials used, and environment are largely determined by local electrical and building codes, depending on the intended use for the finished structure. Selection of components for the electrical distribution system, including outlet boxes and covers, is dependent upon building design, system compatibility, and environmental considerations. It is important to recognize that several different environmental considerations may affect the selection process for outlet boxes and covers depending on the intended use of the structure. Special consideration is needed when selecting outlet boxes for use in fire resistance-rated construction, and other special areas as specifically addressed in applicable codes.

Other important selection criteria are the structure and composition of the wall, ceiling, floor, partition, or furniture on or in which the box is to be mounted. Among the issues to consider: Is the structural framework accessible for attaching the box? What is the composition of the structural framework—wood studs or steel studs or concrete/masonry?

Electrical outlet boxes are available in designs intended for installation on finished surfaces, or flush mounted in walls, ceilings or floors (See Figure 1). General-purpose outlet and device boxes are designed for use indoors in dry locations. When installed as intended with weatherproof covers or cover plates, general-purpose outlet boxes can be flush mounted in the exterior walls of a structure. Special purpose boxes such as weatherproof boxes and boxes intended for use in swimming pool areas, partitions, furniture and equipment, as well as those for use in surface raceway systems are also available, and require special consideration during the selection process.

1.3.2 Boxes for Installation in or on Walls or Ceilings

1.3.2.1 Surface Mounting Outlet Boxes (Indoors and Outdoors)

When selecting an outlet box for surface mounting, primary consideration is given to providing maximum protection from physical

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

damage both to the outlet box and its contents during normal use *(see section 2.3.2 of Product Installation)*. Since surface-mounted outlet boxes are typically attached to surface mounted raceways, surface mounted boxes typically must have conduit entries. Gangable device boxes are not typically recommended for surface mounting.

General-purpose outlet boxes are provided with holes or other means for mounting the box to a surface of the building structure.

Outlet and device boxes that are intended for use in wet locations are often referred to as "weatherproof" boxes and are provided with the means to completely close all unused openings. Metallic outlet boxes for these applications typically have threaded conduit entries for threaded Rigid Metal Conduit or Intermediate Metal Conduit, while nonmetallic outlet boxes typically have integrally molded sockets for Rigid Nonmetallic Conduit. Manufacturer's instructions may vary as to specific installation methods necessary to ensure the proper finished installation. These same boxes are also acceptable for use as part of a pedestal-mounted enclosure where a structural mounting surface is not available. See Figure 1.

1.3.2.2 Flush Mounting Outlet and Device Boxes in Hollow Walls or Ceilings

Many outlet and device boxes are designed with specific features that assist in properly mounting the box. When flush mounted in hollow walls or ceilings, the face of the completed enclosure—the cover plate, switch, receptacle, or other device—will be essentially flush with the finished surface. See Figure 1. The types of boxes available for flush mounting include gangable device boxes, square and octagonal boxes with raised covers, and multiple gang boxes.

When selecting outlet or switch boxes for use in hollow walls, consideration should be given to the depth of the wall cavity. The total depth of the box including installed clamp screws that will protrude out the back of the box must be considered. Alternative box designs or combinations of certain boxes and covers are available to address this situation.

Where structural framework in a hollow wall or ceiling is accessible for attaching the outlet box (NEW WORK), many options are available. These include pre-punched nail holes, integrally molded slots with either nails or screws pre-installed, brackets for mounting on vertical or horizontal framing members, and bar hangers that span and position the box between framing members. Consideration should be given to type of framing members (steel or wood) and thickness of wall coverings, when selecting a mounting bracket, or box/bracket assembly. Boxes with adjustable brackets may be specified when the finish wall surface thickness is unknown. See Figure 2 for typical mounting design options. When a bracket is supplied separately from a listed box assembly, it shall be listed for outlet box support. See Figure 3 for typical separately supplied box supports.

Where structural framework in a hollow wall or ceiling is not accessible for attaching the outlet box (OLD WORK), outlet boxes are available with special clips designed to secure the box face flush to the structure's finish surface covering. Outlet boxes provided with these OLD WORK CLIPS are generally device boxes intended to house a wiring device such as a switch or receptacle, or to support a small fixture such as a luminaire or other product. Alternatively, separate box supports are available which are intended to serve this purpose. These separate supports shall be listed for outlet box support.

1.3.2.3 Flush Mounting Boxes in Concrete and Masonry Walls and Ceilings

A CONCRETE BOX or mud box, often called a CONCRETE RING, is selected when the installation calls for flush mounting the box by embedding it in poured concrete during the casting process.

Where the application calls for flush mounting of an outlet box in a hollow structure with a masonry finish surface covering such as tile or plaster, boxes typically designated MASONRY BOXES are available. These specialized box designs typically have a recessed flange bracket. The flange bracket of these masonry or tile boxes is intended to mount to the face of a subsurface. When the tile or plaster is added, the face of the box is flush with the finished surface.

Masonry boxes are available in both single and multiple gang styles for installation in a concrete-block masonry wall having open cells. A specialty "THROUGH-WALL BOX" is intended to

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

provide two-way access from either end on both sides of the wall. See Figure 1.

1.3.2.4 General Purpose Boxes Installed Above Suspended Ceilings

General purpose outlet boxes, including device boxes, may be installed in accessible areas above suspended ceilings in accordance with the requirements in NEC® Article 314 [370].

1.3.3 Boxes for Installation in Floors

1.3.3.1 General

All listed floor boxes are marked "Floor box" on the product or its smallest unit shipping carton, to indicate the intended use. All floor boxes are designed for installation at or below the floor surface. The first consideration in selecting a floor box is the type of floor into which it is to be installed. When fitted with the appropriate cover and accessories, the interior of the floor box and its contents are provided with a degree of protection from physical damage and the entrance of liquids (scrub water) or dirt.

Because of the high cost of expanding branch circuits installed in floors and increasing available capacity in floor boxes, special consideration should be given during the design phase to plan for future capacity needs and access options. Often it is desirable to locate additional floor boxes in a floor plan to provide for future access. Many floor box designs have optional "abandonment" kits that complete an unused enclosure intended for planned or unplanned future use. It is not necessary to install devices and device access covers in these boxes at the time of installation. Future capacity considerations might also include selecting a floor box that has provisions for adding data and communications wiring circuits as well as power.

1.3.3.2 Concrete Floors

Boxes specifically designed for installation in concrete floors, and also marked "Concrete-Tight" on the smallest unit shipping container, may be encased in concrete slabs on grade, or in concrete covered decking on the upper floors of buildings. These boxes are positioned and assembled to the raceway system prior to the pouring of the concrete. The thickness of the floor is another important consideration in product selection.

Each floor box for concrete floors is provided with a cover to protect against the entrance of concrete aggregate during the pour. This cover is often not intended as a permanent cover for the enclosure. Some such covers may serve a permanent function, to complete an enclosure where the floor box is used as a junction box or left empty for future use.

1.3.3.3 Through-Floor Penetrations

Poke-through floor fittings are specially designed floor outlet assemblies that when installed as intended, fully penetrate the concrete floor in which it is installed. The electrical outlet box component of the assembly is suspended in the open area below the concrete floor after installation. This open area is also the area above the ceiling of the floor below. Additionally, if the space below the concrete floor is used for the transfer of environmental air, the outlet box component may have to meet the requirements for use in such locations. See Clause 1.3.4.3, **Plenum Boxes**.

1.3.3.4 Hollow Floors

Floor boxes intended for installation in hollow floors are designed for support by either the sub-floor or a structural member.

1.3.3.5 Raised Floors

Floor boxes intended for installation in raised floors, such as computer room floors, are designed to be supported by insertion into access holes that are cut into raised floor panels.

1.3.3.6 Floor Box Covers

Floor box covers are required to complete the enclosure. Care should be taken to select a floor box cover that is designed to mount as intended to the floor box. The desired finished floor covering will help to determine the selection of the appropriate cover assembly. The cover assembly includes the cover itself and any necessary accessories such as carpet flanges, tile rings, fasteners, etc. The selection of the cover will depend on such factors as the required service to be provided (power, data, communication, etc.), finished floor covering

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

(carpet, tile, wood, etc.), and aesthetic preferences (colors, finishes, etc.).

1.3.4 Boxes for Other Locations

1.3.4.1 Pendant Box Assemblies

For the purpose of these guidelines, a pendant assembly typically consists of a junction box on one end, from which a flexible cord or raceway is used to suspend a device box. See Figure 1. Similar assemblies are also common on cord reels. The assembly shall be approved for the specific application. The device box shall provide the mechanical protection required of a box installed in areas that may be subject to physical damage. Cast metal or plastic molded weatherproof boxes (such as FS and FD), and conduit bodies are most often recommended to house the devices in a pendant box assembly. Particular product features may be considered in order to comply with the rules for pendant mounting in NEC® Section 314.23(H) [370-23(h)].

1.3.4.2 Pedestal Box Assemblies

Boxes intended for support by approved non-flexible raceways must have threaded conduit entries. The assembly shall be approved for the specific application. The device box shall provide the mechanical protection required of a box installed in areas that may be subject to physical damage. Cast metal or plastic molded weatherproof boxes (such as FS and FD), and conduit bodies are most often recommended to house the devices in a pedestal box assembly.

1.3.4.3 Plenum Boxes

Special-purpose box and cover enclosure assemblies are available, specifically designed for installation either flush or suspended in areas classified as air-handling spaces. All unused openings in such boxes must be sealed and the cover interface with the box must be gasketed to form a reliable seal when completely installed.

For the purposes of these guidelines, air-handling spaces are ducts or plenums used for environmental air; other spaces used for environmental air such as above hung ceilings or below raised floors. This does not include plenums used for the removal of dust, loose stock, or vapor, or for ventilation of commercial type cooking equipment. Refer to NEC® Section 300.22 (A) through (D) [300-22 (a) through (d)].

Plenums and air-handling spaces are within the jurisdiction of Mechanical Code officials. However, many jurisdictions still consider small discrete products such as nonmetallic outlet boxes, as minor combustible components with respect to this application.

1.3.4.4 Swimming Pool Boxes

A swimming pool box is a specially designed Junction Box for the connection of lighting circuits for luminaires (fixtures) installed in or near a swimming pool. NEC Article 680 [680] includes requirements for swimming pools, fountains, and similar installations.

A swimming pool junction box is typically required to have threaded entries or hubs for rigid steel conduit or sockets for rigid PVC conduit. Threaded entries may also be used to assemble fittings designed to accept flexible cords. Conduit entries are only permitted to be in the bottom of the junction box. Because of the corrosive nature of the environment around a swimming pool or similar location, swimming pool junction boxes must be constructed of metallic materials that are inherently resistant to corrosion, such as copper or brass, or of a suitable nonmetallic material. Swimming pool junction boxes are provided for mounting either flush with the deck surrounding a swimming pool or for installation pedestal style supported above the deck and water's surface. All components necessary for the assembly of a swimming pool junction box are provided with an assembly including the box, its cover, grounding bus, gaskets, sealing materials, etc., and any hardware necessary to complete the enclosure.

1.3.4.5 Boxes for Use in Wet and Damp Locations and Adverse Environments

An enclosure intended for use in wet, damp, or adverse environments consists of a box, a cover, and possibly other materials or accessories, and may involve special installation methods.

General-purpose flush mounted outlet boxes and device boxes are suitable for use in wet or damp locations, when installed with an appropriate cover.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Boxes for surface mounting, such as FS and FD boxes and conduit bodies having threaded conduit entries, and such nonmetallic boxes with sockets suitable for use with Rigid Nonmetallic Conduit, are suitable for use in wet or damp locations when installed with an appropriate cover.

The cover of a junction box intended for use in wet locations must be marked "Wet Locations."

The suitability of covers used with boxes intended for use in wet and damp locations, is dependent upon several conditions such as:

a) *Attended or Unattended Outdoor Wet Locations (15 or 20 A, 125 or 250 V receptacle)*: A cover plate marked "Wet Locations" or a hood marked "Wet Location Only When Hood Closed" or equivalent must be used with a device box for mounting a 15 or 20 ampere, 125 or 250 V receptacle outdoors in a wet location. A cover plate or hood with this marking is intended for installation in accordance with NEC® Section 406.8(B)(1) [410-57(b)(1)]. Effective 2002, this requirement applies to all such cover plates or hoods installed outdoors.

b) *Unattended Indoor (Wet Locations (all receptacles) or Unattended Outdoor Wet Locations (other than a 15 or 20 A, 125 or 250 V receptacle)*: A cover plate or hood used with a device box for mounting other than a 15 or 20 ampere, 125 or 250 V receptacles intended for unattended use in wet locations with a power-supply cord attached, must be marked as described in a) above. A cover plate or hood with this marking is intended for installation in accordance with NEC® Section 406.8(B)(2)(a) [410-57(b)(2)].

c) *Attended Indoor Wet Locations (all receptacles) or Attended Outdoor Wet Locations (other than 15 or 20 A, 125 or 250 V receptacle*: A cover plate used with a device box for mounting receptacles intended for use in wet locations only while attended, with the power-supply cord attached, must be marked "Wet Locations Only When Cover Closed." A cover plate or hood marked as described in a) is also suitable for this application. Cover plates or hoods with these markings are intended for installation in accordance with NEC Section 406.8(B)(2)(b) [410-57(b)(2)].

d) A cover plate or outlet box hood used with a device box for use in damp locations must be marked "Damp Locations." Either of these, when used with a device box for use in wet locations can also be used in damp locations.

e) An enclosure intended for use in adverse environments will be marked with a Type rating in accordance with ANSI/NEMA 250 or ANSI/UL 50, which reflects the environmental conditions for which the box or enclosure is suitable.

1.3.4.6 Boxes for Direct Burial in Earth

When listed for the purpose and approved by the local jurisdiction as meeting the requirements for accessibility in accordance with NEC® Section 314.29 [370-29], an outlet box such as a junction or pull box, or conduit body is permitted for direct burial.

1.3.4.7 Boxes in or on Partitions

A box for use in a partition, such as a wall in a modular office, is either a listed component of a manufactured assembly, or a general-purpose box that is surface mounted.

1.3.4.8 Boxes in or on Furniture

A box for use in furniture is either a listed component of a manufactured assembly, or a general-purpose box that is surface mounted.

1.3.4.9 Boxes in Surface Raceway Systems

A box for use in surface raceway systems typically is a component of the listed system. Where components of separate systems are to be used in an installation, consideration shall be given to compatibility of the components.

1.3.5 Outlet and Device Boxes for Use in Fire Resistance-Rated Construction

1.3.5.1 General

The fire-resistance rating for boxes and poke-through floor fittings must have a rating in hours, that is at least that of the wall, ceiling or floor assembly into which it is to be installed.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

1.3.5.2 Metallic Boxes

Listed metallic single and double gang outlet and device boxes with metallic or nonmetallic cover plates are suitable for flush mounting in ceilings, and in bearing and non-bearing wood stud and steel stud walls with fire-resistance ratings not exceeding 2 hours. Metallic boxes do not require any markings other than the listing mark.

1.3.5.3 Nonmetallic Boxes

Listed nonmetallic outlet and device boxes, marked to indicate their classification and fire-resistance rating in hours, are suitable for use with metallic or nonmetallic cover plates, in fire-resistance rated bearing and non-bearing wood stud and steel stud walls, and ceilings.

1.3.5.4 Poke-Through Floor Fittings

Listed poke-through floor fittings marked to indicate classification and fire resistance rating in hours, are suitable for use in fire-resistance rated floor construction.

1.3.6 Special Use Boxes

Both general-purpose boxes and specially designed boxes, such as boxes without backs, or combination high-low voltage boxes, are available for mounting of Class 2 wiring such as communication and other low voltage cables and devices (See 1.2.6).

1.3.7 Covers and Cover Plates for Dry Locations

Covers and cover plates installed on a box complete the enclosure. See Figure 1 for typical covers and cover plates. Both metal and nonmetallic covers and cover plates are available. The appropriate cover or cover plate should be selected for the intended application. Covers and cover plates may be blank, have knockouts or threaded entries, or have openings for wiring devices or pendant cords. Holes provided for mounting covers or cover plates to outlet boxes and device boxes are standardized in accordance with ANSI/NEMA OS 1 and ANSI/NEMA OS 2, with respect to minimum dimensions. Holes and other openings in cover plates that are designed for use with various types of devices are standardized in accordance with NEMA WD 6 and NEMA OS 1 and OS 2.

The durability of a cover is an important consideration when selecting a cover for a box to be installed in areas that are subject to physical damage. Outlet and device box covers are intended to provide the same degree of protection as the boxes to which they are attached. They are available for both surface mounting and flush mounting. A flush device cover plate is intended only for flush mounting applications.

A FLAT COVER for a flush or surface mounted outlet box may be blank, have a knockout in the middle, or be designed for attachment of a wiring device directly to the flat cover. This assembly completes the enclosure.

A RAISED SURFACE COVER for a surface mounted outlet box (typically a square box) is designed for attachment of a wiring device directly to the RAISED SURFACE COVER and provides additional internal volume to the enclosure. This assembly completes the enclosure.

A RAISED COVER (also called a plaster ring or mud ring) for a flush mounted outlet box is designed for attachment of a wiring device directly to the RAISED COVER and provides additional internal volume to the enclosure. Since in this installation, the box is mounted flush with the structural framing member, consideration must be given to the thickness of the finished wall surface in selecting the appropriate height of the raised cover. The raised cover alone does not complete the enclosure. A cover plate is required to finish the enclosure (See Figure 1).

A COVER PLATE (face plate or wall plate) for flush-mounted wiring devices is a cover intended to close a flush-device box and cover the edges of the wall opening in which the box is located. The cover is either a blank plate fastened to the box or a plate fastened directly to a wiring device. This type of cover completes the enclosure.

Covers and cover plates for floor boxes and those specifically intended to provide degrees of protection in damp and wet locations and adverse environments are addressed separately

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

in this section under “Boxes for Installation in Floors” (See 1.3.3.6).

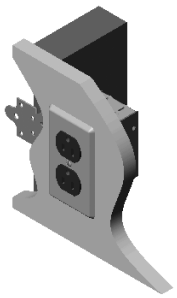
1.3.8 Extension Rings and Box Extenders

Extension rings are commonly used to extend the walls of an outlet box or a flush device box in order to increase the box depth, volume or both. Since they function as an extension of the walls of the outlet box they are required to provide the same degree of protection as the box to which they are attached.

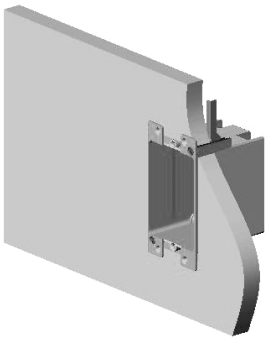
A box extender is a device installed in or on a box that is mounted in a finished structure. The box extender rests on the edge of the existing box or extends into the box, but is not mechanically secured to the box. The flange of the box extender, if provided, rests on the finished surface. The combination of the box, the box extender, and the appropriate cover plate forms a complete enclosure.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

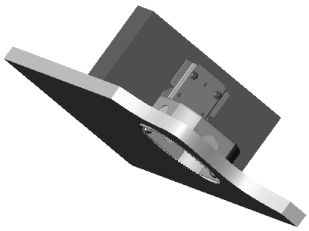
Figure 1-1
Typical Box Mounting Positions



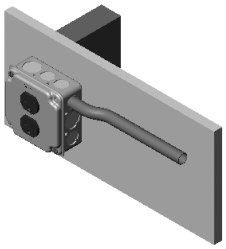
Flush Mount – New Work



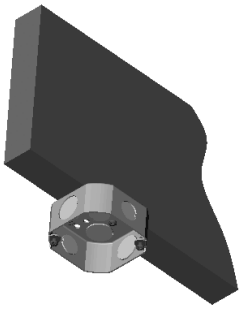
Flush Mount – Old Work



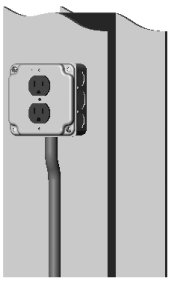
Flush Mount – New Work – Ceiling



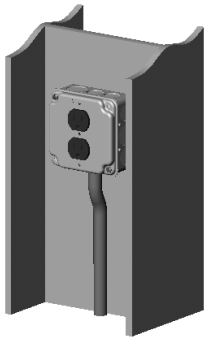
Surface Mount – Walls



Surface Mount –
Exposed Ceiling Stud



Surface Mount – Exposed



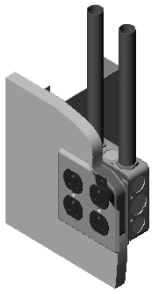
Surface Mount – Protected



Pendant Mount

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Figure 1-1 (continued)
Typical Box Mounting Positions



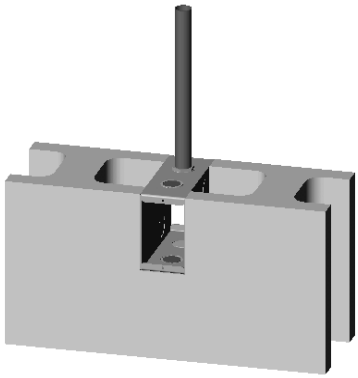
Flush Mount
Square Box with Raised Cover



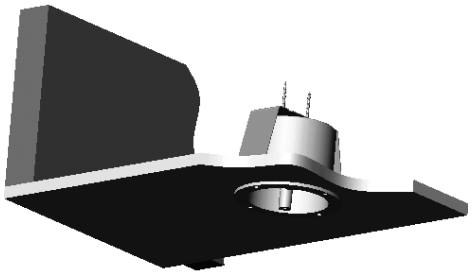
Pedestal Mount



Pedestal Mount



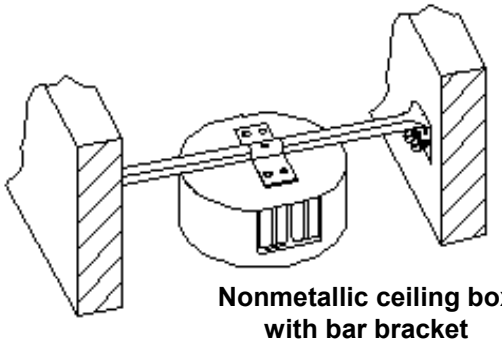
Through–Wall
Masonry Box



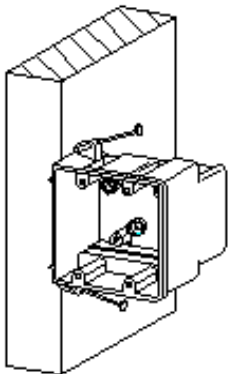
Flush Mount
Old Work – Ceiling

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

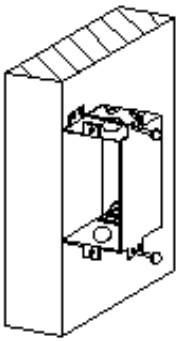
Figure 1-2
Typical Box Mounting Styles



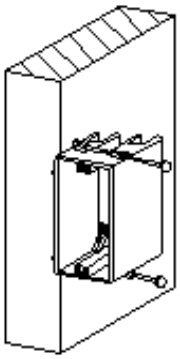
Nonmetallic ceiling box with bar bracket



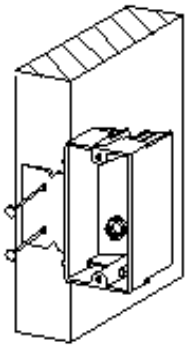
Nonmetallic wall mount 2 gang box with nails



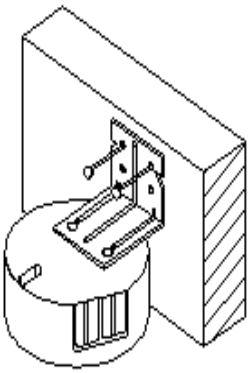
Metallic wall mount box with nails



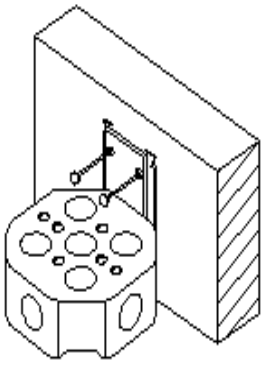
Nonmetallic wall mount box with nails



Nonmetallic wall mount box with bracket



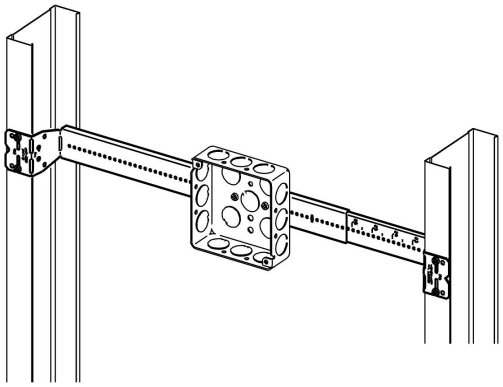
Nonmetallic ceiling box with bracket

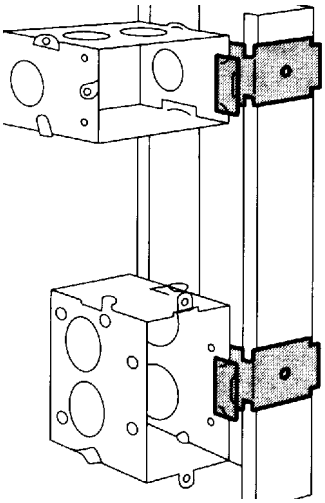


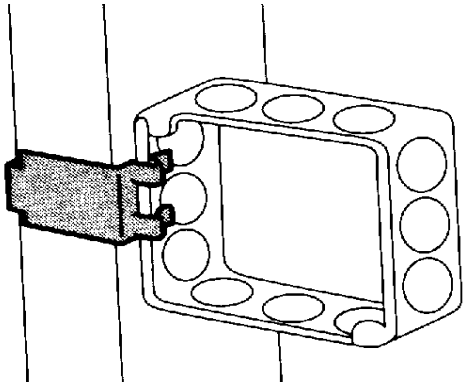
Metallic ceiling box with bracket

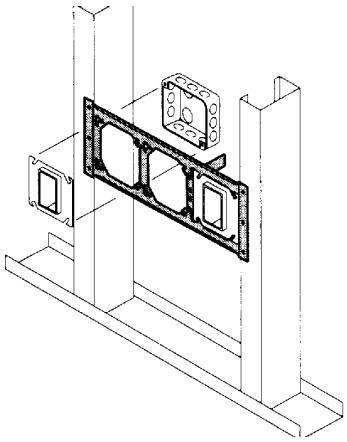
Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

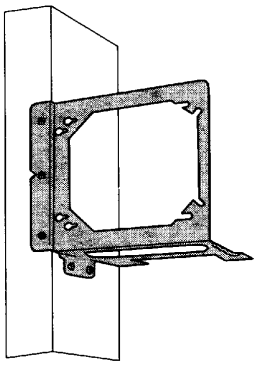
Figure 1-3
Separately Supplied Box Supports

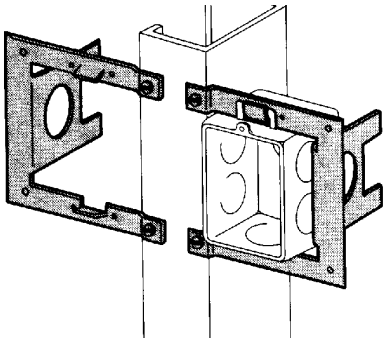






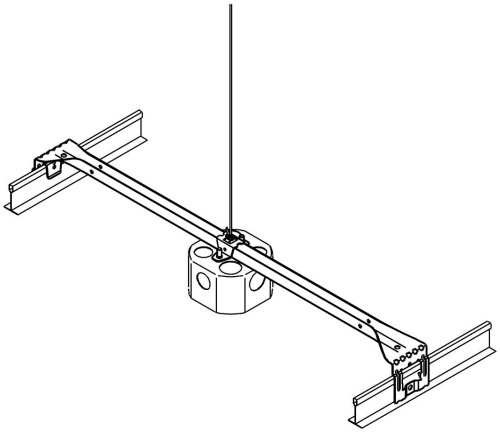




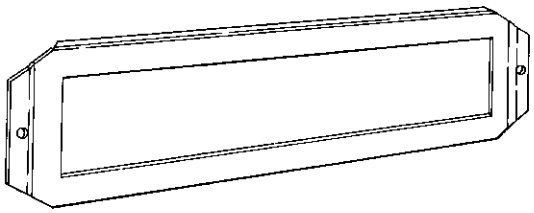


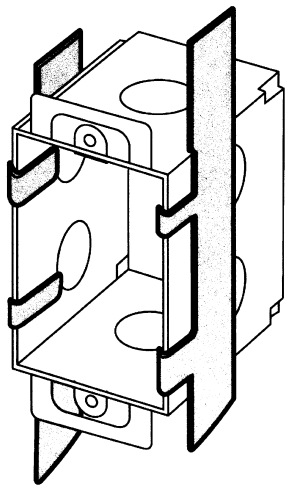
Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Figure 1-3 (continued)
Separately Supplied Box Supports

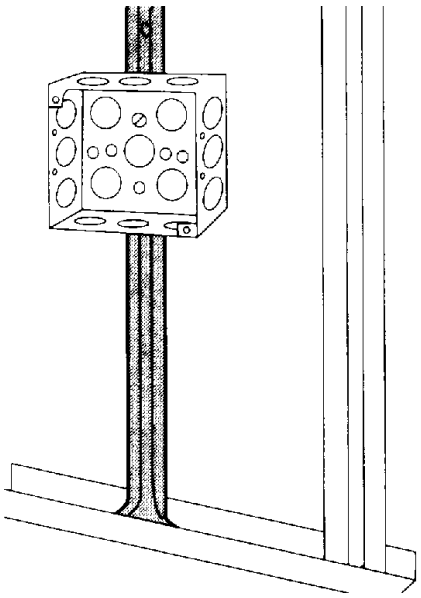


BOX TO T-BAR





OLD WORK BOX SUPPORT



Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

This page is intentionally left blank.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Section 2
Product Installation

2.1 Introduction

Having selected the right box for the application, there are both general and specific guidelines for installation of an electrical outlet box related to each of the general selection criteria, restated as follows:

- Type of wiring system
- Contents and function after installation
- Location and type of construction

2.1.1 Storage and Preparation for Installation

When received on the jobsite, prior to installation, boxes should be stored in a clean dry location that is not subject to physical abuse.

Immediately prior to installation, inspect boxes to confirm that appropriate product selection has been made in accordance with Section 1. To avoid unforeseen problems during installation, boxes should be inspected to identify damaged or missing features or parts, including, where applicable:

Knockouts
Closure plugs
Cable clamps
Cover mounting means
Box mounting means
Sides of gangable boxes
Threads in threaded holes or entries
Staking and leveling means for concrete floor boxes

2.1.2 Coordinating Trades (After Boxes are Mounted)

The quality of a box installation can be seriously compromised when an effort is not made to coordinate the installation of the electrical outlet boxes, and enclosed devices and wiring, with other construction trades. In particular, installation problems have been evidenced where there was insufficient coordination with the trades that apply finished surfaces and poured concrete. Every effort should be made to coordinate with these and other trades who, through lack of careful consideration, may compromise the quality of the installation.

2.2 Fire Resistance-Rated Construction

The installation of an outlet box in a fire resistance rated wall or floor-ceiling assembly requires particular attention to detail. After the installation has been completed, the penetration that is made in the wall, ceiling, or floor to accommodate the box must not compromise the designed fire resistance rating of the assembly.

General installation rules apply to metallic outlet boxes in these special installations. Particular installation instructions must be followed for nonmetallic outlet boxes that have been classified for this use. Both general and particular instructions are detailed in published directories such as the UL Fire Resistance Directory.

The following summarizes the general rules for installation of outlet boxes as described in the UL Fire Resistance Directory.

2.2.1 Metallic Boxes

Listed single and double gang metallic outlet and switch boxes with metallic and nonmetallic cover plates may be used in bearing and nonbearing wood stud and steel stud walls with ratings not exceeding 2 (hours). These walls shall have gypsum wallboard facings similar to those shown in Design Nos. U301, U411 and U425. The metallic outlet or switch boxes shall be securely fastened to the studs and the opening in the wallboard facing shall be cut so that the clearance between the box and the wallboard does not exceed 1/8 inch. The surface area of individual metallic outlet and switch boxes shall not exceed 16 sq. in. The aggregate surface area of the boxes shall not exceed 100 sq. in. per 100 sq. ft. of wall surface.

Metallic outlet boxes located on opposite sides of walls or partition, shall be separated by a minimum horizontal distance of 24 in. This minimum separation distance between metallic boxes may be reduced when "Wall Opening Protective Materials" (CLIV) are installed according to the requirements of their Classification.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Metallic boxes shall not be installed on opposite side of walls or partitions of staggered stud construction unless "Wall Opening Protection Materials" are installed with the metallic boxes in accordance with Classification requirements for the protective materials.

Listed metallic outlet boxes with metallic or nonmetallic cover plates may be used in floor-ceiling and roof-ceiling assemblies with ratings not exceeding 2 hours. These assemblies shall have gypsum wallboard membranes. The metallic outlet boxes shall be securely fastened to the joists and the opening in the wallboard facing shall be cut so that the clearance between the box and the gypsum wallboard does not exceed 1/8 in. The surface area of individual boxes shall not exceed 16 sq. in. The aggregate surface area of the boxes shall not exceed 100 sq. in. per 100 sq. ft of ceiling surface.

(Copyright–2001 Underwriters Laboratories Inc.; reprinted from 2001 Fire Resistance Directory (BXUZ) with permission from Underwriters Laboratories Inc.)

When applying the requirement for surface area of individual outlet and switch boxes (16 sq. in.), many jurisdictions permit installation of standard 4-11/16 inch square trade size boxes, which are installed in wall penetrations that do not exceed 16 square inches. These boxes are typically covered by a raised cover (see Figure 2-1).

2.2.2 Nonmetallic Boxes

Listed nonmetallic outlet and device boxes that are identified with a specific fire resistance rating in hours are to be installed according to specific instructions shown in the UL Fire Resistance Directory or provided by the manufacturer. Often installation instructions may vary slightly requiring particular attention to the details.

The following summarizes the general direction provided in the UL Fire Resistance Directory relative to nonmetallic boxes.

The category of "Outlet Boxes and Fittings Classified for Fire Resistance" (CEYY) includes Classifications for nonmetallic outlet and switch boxes for use in wall or partition assemblies. The information provided for each Classification includes the model numbers for the Classified products, a description of the rated assemblies, the spacing limitations for the boxes and the installation details. Nonmetallic outlet boxes shall not be installed on opposite sides of walls or partitions of staggered stud construction unless Classified for use in such constructions.

Nonmetallic outlet boxes evaluated for installation in floor-ceiling or roof-ceiling assemblies are included in Outlet Boxes and Fittings Classified for Fire Resistance (CEYY).

(Copyright–2001 Underwriters Laboratories Inc.; reprinted from 2001 Fire Resistance Directory (CEYY) with permission from Underwriters Laboratories Inc.)

When installed in accordance with the requirements for "Wall Opening Protective Materials" (CLIV), additional installation options may be available for specified nonmetallic outlet and device boxes.

2.3 Mounting and Securing of Electrical Boxes

2.3.1 General

The National Electrical Code® requires that electrical boxes be securely mounted in place so that they remain secure during the construction process (raceway attachment, wire pulling, dry wall installation, etc.). Mounting hardware (screws, nails, etc.) provided with the box is not to be substituted. When the box is not supplied with mounting hardware, the hardware shall be acceptable for the installation by the local authority having jurisdiction (AHJ). When installing nonmetallic boxes, only holes provided for mounting shall be used. Brackets intended to support electrical boxes that are supplied separately from the box should be listed for the specific purpose.

2.3.2 Surface Mounting on Walls or Ceilings

Surface mounted boxes should be mounted in a manner that prevents the box from turning. This can be accomplished by relying on the attached raceway for additional support. The back of surface mounted boxes should be secured against a surface that provides adequate support for the box. Placement of surface mounted boxes should take the exposure to possible physical damage into consideration. For instance, placing the box in the U-shaped channel portion of an I-beam would provide more protection than mounting it to the exposed surface of the flange (See Figure 1, Pole Mount-Protected).

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

The hardware used to mount a box shall be suitable for the surface to which it is mounted. For surface mounting on drywall or other hollow wall or ceiling surfaces, where a nail or screw is not able to securely attach to a structural framing member, suitable wall anchors and appropriate fasteners must be used. Suitable concrete anchors or special masonry nails may be used with concrete or masonry block construction. The heads of nails or screws inside a metallic box shall be driven to where they do not present a risk of damaging conductors during installation or in normal use. Listed nonmetallic boxes have a molded pocket or barrier around the screw or nail head. Where it is necessary to install a ground screw, consideration should be given before installation to providing clearance for the end of the screw.

2.3.3 Boxes Supported by Raceways

Under certain circumstances, NEC® Section 314.23 [370-23] permits boxes to be supported by raceways. Where boxes are located on the surface of a structure and supported in an approved manner by a raceway, the box is not required to be secured to the surface of the structure.

2.3.4 Flush Mounting in Walls and Ceilings

Flush mounting means that an enclosed wiring device, when mounted as intended, will be essentially flush with the finished wall or ceiling surface. Therefore, a flush device box should be mounted with an offset from the stud or joist that will accommodate the thickness of the wallboard that will be installed later. Most flush device boxes have convenience markings that can be used to allow for proper alignment with the edge of the stud.

2.3.4.1 New Work Installations

Flush device boxes for direct mounting to a wood stud are provided with mounting brackets, nails, or clearance holes for nails or screws, which permit the box to be properly positioned and secured to the stud. Boxes for mounting to a steel stud have brackets that attach to the stud by various means. If the box being installed has a bracket that attaches to the face of the stud, screws or nails with low profile heads should be used to minimize the amount of bulge that the finished wall will have at the box location. NEC® 314.23 (B) [370-23(b)] specifies the conditions for structural mounting of a box.

NEC® 314.20 [370-20] requires that a box installed in a wall or ceiling made of non-combustible material such as concrete, tile or gypsum may be recessed a maximum of 6 mm (1/4 in.) from the wall surface. When the box is installed in a wall or ceiling that is made of combustible material or has a combustible surface material, the face of the box must be flush or project slightly from the finished surface of the wall or ceiling. The box should be installed so that the wiring device cover plate will be in contact with the wall surface.

Square boxes being used for flush mounting should be mounted close to flush with the stud or joist, with consideration given to the head of the screw and the thickness of the cover (see Figure 1, Flush Mount – Square Box with Raised Cover). This will allow the properly selected raised cover to fit flush with the installed surface.

Boxes with brackets on the side can be secured using nails or screws installed through the holes provided in the bracket. The screw or nail should be suitable for the material (wood or metal stud) to which the box is being secured.

Single gang boxes without brackets can be mounted using nails or screws that pass through both walls of the box. The nails or screws should be long enough to adequately engage the wood. Only those holes provided in boxes for through-nailing should be used as they have been examined for proper clearance of devices and conductors.

Toe-nailing of square boxes without brackets is not recommended where it can be avoided. When using this practice however, care should be taken to keep the head of the nail or screw from interfering with the conductors, and to prevent splitting of wood studs or joists. Toe-nailing of single gang flush device boxes is not recommended.

Mounting screws that pass through the interior of metallic boxes must have all exposed threads covered to prevent damage to the insulation on the conductors. Listed nonmetallic boxes are required to have design elements that protect conductors from exposed screw threads.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Screws for conduit or cable clamps, that will protrude out the back of the box must be allowed sufficient space for tightening in the wall cavity behind where the box is to be mounted. The amount of available space should be verified during installation. If it is found that the screws will hit the opposite side wallboard then adjustments should be made. Moving the box slightly forward will often times solve this problem. If the box cannot be moved far enough forward then a different box design or box-cover combination should be selected.

2.3.4.2 Old Work Installations

When structural framing is not accessible (old work), flush device boxes may be installed by attaching the box directly to the finished wall surface, such as gypsum wallboard, by means of clips or brackets. NEC® 314.23(C) [370-23(c)] requires the box to be rigidly mounted in the finished surface and secured by methods intended for the application. Particular care must be taken when mounting the box so that a finished wall surface (such as paneling) will permit mounting of a wiring device in accordance with NEC 404.10 (B) [380-10(b)] and 406.4(A) [410-56(f)(1)].

When a new wall surface is being applied to an existing wall where there is a box already properly installed, an accessory such as a box extender may be necessary to maintain the proper mounting position of the device, with respect to the new wall surface.

2.3.5 Pendant Mounting

A pendant assembly typically consists of two boxes. The first is a junction box that may be surface mounted or flush mounted. Mounting of this junction box shall be in accordance with the guidelines for the applicable mounting. This junction box may be placed in either an accessible or inaccessible location. The second box typically houses a switch or device or supports a fixture such as a luminaire. Particular installation methods, such as strain relief or anti-rotational locking, may be required to comply with pendant mounting rules in NEC Section 314.23(H) [370-23(h)].

The location for access to pendant-hung device boxes should not pose a hazard to personnel when used. Pendant-mounted device boxes should not be hung in high traffic areas.

Guidelines for attachment of wiring systems to pendant boxes are found in Clause 2.4.

2.3.6 Pedestal Mounting

Wherever possible, pedestal mounted boxes should be located where they are provided with maximum protection from physical damage. Where this is not possible, consideration should be given to providing additional support for the assembly. NEC Section 314.23(E) and (F) [370-23(e) and (f)] covers support of pedestal boxes. A pedestal box assembly should not be located in a high traffic area. Pedestal boxes are not typically permitted to be supported by a single raceway.

Guidelines for the attachment of wiring systems to pedestal mounted boxes are found in Clause 2.4.

2.3.7 Masonry Wall Mounting

Single and multiple gang outlet boxes are able to be installed in concrete-block masonry walls having open cells. Sufficient support for these installations is provided by the tightness of fit in the concrete block and the attachment of a non-flexible raceway. A close fitting opening should be cut in the concrete block and any area around the box should be mortared.

2.3.8 Floor Box Mounting

Because of the many unique floor box design features, care should be taken to closely adhere to the manufacturer's installation instructions. Check to be sure all components necessary to complete the floor box installation in accordance with the instructions provided by the manufacturer are on hand.

2.3.8.1 Hollow Floors

Floor boxes in hollow floors, in new or old construction, are typically mounted in a hole that is cut through a sub-floor. The hole should be cut so that all flanges provided with the floor box are in secure contact and able to be secured as instructed to the sub-floor surface. In old construction, the security of the sub-floor should be inspected first. The depth of the sub-floor surface in relation to the finished floor surface should be predetermined to ensure proper cover mounting.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.3.8.2 Concrete Floors

Be certain to stake or otherwise secure the box and attached raceway in place in accordance with manufacturer's instructions (See "Floor Boxes in Concrete Floors" in Section 2.4, *Connection to Wiring Systems*.) In fire resistance rated floor/ceiling assemblies, the box should be positioned and mounted to ensure a minimum of 25 mm (1 in.) of concrete will flow and set beneath the floor box.

Level the box using the means described in the manufacturer's instructions.

Secure in place the cover or other means provided to ensure that concrete does not enter the box during the pour.

A metal floor box installed in poured concrete floors is typically placed at a distance above the bottom of the form (or grade on the ground floor) that will allow access to the box opening after the pour without requiring removal of a significant amount of concrete above the box. As a helpful guide, the maximum adjustment permitted by the adjusting ring portion of the box will help determine the maximum depth for locating the top of the box before the concrete pour.

Nonmetallic floor boxes are typically designed to protrude out of the poured concrete and need to be located at a height that will allow this.

2.3.9 Poke-Through Floor Fitting Mounting

Local building codes contain explicit limits on the type, size, number, and placement of through-floor penetrations in concrete floors and decks. Since many poke-through floor fittings are designed for installation in fire resistant rated floor/ceiling assemblies, the installation instructions required with these products must be strictly adhered to.

Poke-through floor fittings are mounted into holes that are core drilled through pre-cast concrete floors and decks of variable depth. It is very important that the appropriate type and size of equipment, and core drilling technique is used. Be certain the poke-through is the correct size for the depth of the floor before installing.

2.3.10 Other Boxes

2.3.10.1 Swimming Pool Boxes

When installing a swimming pool junction box, installation according to manufacturer's instruction is important. The bottom of the box containing the conduit entries must always be positioned facing downward. General guidelines for assembly to threaded entries or sockets provided in Section 2.2 are to be followed. Where flexible cord is to be installed using a specific fitting assembled to a threaded entry in a box, adequate strain relief for the cord should be provided. Often, the manufacturer will recommend the use of a potting compound to help seal the cord entry. Be certain all gaskets are in place.

Where the swimming pool junction box is installed pedestal style above the pool's deck and water's surface, adequate support should be provided for the box. See guidelines in Section 2.3.7 for support of pedestal mounted outlet boxes.

2.3.10.2 Boxes for Use in Wet and Damp Locations and Adverse Environments

The installation guidelines for flush mounting or surface mounting apply.

2.3.10.3 Boxes for Direct Burial in Earth

Boxes for direct burial in earth are not within the scope of these guidelines.

2.3.10.4 Boxes in or on Partitions

The installation guidelines for flush mounting or surface mounting apply. Special consideration as described in boxes for fire resistance-rated construction should be given to partitions with fire-resistance ratings.

2.3.10.5 Boxes in or on Furniture or Equipment

For field installation, guidelines for flush and surface mounting apply. Boxes that are provided as part of furniture or equipment assemblies should be installed according to the recommendations of the furniture or equipment manufacturer.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.3.10.6 Boxes in Surface Raceway Systems

Boxes in surface raceway systems are not within the scope of these guidelines. Only boxes that are specifically designed for use in these systems are to be installed.

2.3.10.7 Special Use Boxes

Special use boxes such as those that are without backs, for mounting of Class 2 wiring, must be installed in accordance with the manufacturers instructions included with the box.

2.4 Connection to Wiring Systems

2.4.1 General

Proper installation of outlet boxes will provide for secure mechanical attachment of the conduit, tubing, or cable at the point of entry. In addition, proper installation of metallic outlet boxes connected to metallic conduit, tubing, or metal-jacketed cables will provide a reliable connection to ground.

See NEMA FB 2.10, *Selection and Installation Guidelines for Fittings for Non-flexible Conduit and Tubing*, and NEMA FB 2.20, *Selection and Installation Guidelines for Fittings for Flexible Conduit, Tubing and Cable* for guidance in the connection of fittings to conduit and cable entries in boxes.[1]

Where a fitting or box manufacturer marks a particular tightening torque for installing the securement means provided for connection of a wiring system, this torque should be measured at the time of installation and verified when the installation has been completed.

2.4.2 Connection to Conduit Entries

2.4.2.1 Threaded Entries for Threaded Conduit or Threaded Fittings

Where a conduit entry has threads tapped all the way through (no integral bushing), care must be taken to ensure that at least 3½ threads of the conduit or threaded fitting are fully engaged with the threads of the conduit entry when wrench tightened. When a conduit entry has an integral bushing, care must be taken to ensure that at least 5 threads of the conduit and three threads of a fitting are fully engaged with the threads of the conduit entry when wrench tightened (see Figure 2-2).

After installation is completed all unused conduit entries must be plugged with properly sized closure plugs.

2.4.2.2 Unthreaded Entries for Unthreaded Conduit or Tubing

2.4.2.2.1 Knockouts

Knockouts used for connection of conduit and tubing are to be completely removed. When removing the inner segment of a combination knockout, care should be taken so as not to break the connection between the box and the remaining segment.

For metallic boxes, listed reducing washers, where needed, may be used on both sides of a knockout to allow installation of smaller sized conduit or tubing. If any knockout is inadvertently removed and not used, it is to be plugged with a properly sized closure plug.

Boxes such as junction and pull boxes supplied without conduit entries are intended to have such entries made in the field in accordance with manufacturer's instructions.

For nonmetallic boxes, if a knockout is inadvertently removed and not used, the knockout is to be effectively closed with an approved closure plug. If one is not available the box is to be discarded and replaced.

2.4.2.2.2 Unthreaded Sockets (Hubs)

Set screws provided in unthreaded sockets (hubs) of metallic boxes to attach Rigid Metal Conduit, Intermediate Metal Conduit (IMC) or Electrical Metallic Tubing (EMT), shall be adequately tightened to ensure a secure mechanical and electrical connection. Unless otherwise specified in the manufacturer's instructions, the reference maximum tightening torque shall be as follows:

For screws tightened with a screwdriver:
No. 10 and larger, 35 pound-inches (3.96 N•m)

For wrench-tightened bolthead screws:
160 pound-inches (18.1 N•m)

Over-tightening should be avoided as this can cause damage to the raceway.

[1] These documents are available free of charge for downloading at www.nema.org.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Sockets (integrally molded hubs) for attachment of Rigid Nonmetallic Conduit (RNC) or Electrical Nonmetallic Tubing (ENT) in nonmetallic boxes are typically designed for one size of conduit or tubing. Where a smaller trade size conduit or tubing is to be installed, an appropriate sized reducer bushing must be cemented into the socket before inserting the conduit or tubing. The recommended method for cementing the reducer in place is to apply the appropriate solvent cement both inside of the hub and on the surface of the reducer. After completely inserting the reducer, to where it is seated against the end stop of the socket, the reducer is then rotated 1/4 turn. Similarly, the solvent cement is applied to both the surface of the conduit or tubing and inside the socket. The conduit or tubing is then completely inserted into the socket so that it is seated against the socket's end stop and rotated 1/4 turn.

PVC conduit should be cut to length using a hacksaw, fine-toothed saw, rotating pipe cutter, or a shear type cutting tool. All cuts should be clean and square with the barrel of the conduit, all burrs or ridges from the conduit removed with a knife, file, or abrasive paper, and joint surfaces wiped clean of dirt, moisture, or other contaminants. Use PVC cleaner or primer if necessary. Dry fit the joint to assure conduit and the socket can be joined. Apply the cement quickly and evenly to the inside of the socket and to the end of the conduit. Immediately insert the conduit fully into the socket and apply a one-quarter twist on the conduit as insertion is made to evenly distribute the cement. Hold the joint firmly together for 10 to 20 seconds without movement. Cold weather applications may require a longer holding time. A small bead of cement should appear around the lip of the socket if adequate cement has been applied; wipe off this excess bead after the joint has set. Handle the newly assembled joint carefully until the cement has gone through an adequate set time. The recommended set times for cemented joints are related to the temperature of the joint (See Table 2-1).

Table 2-1
Recommended Set Times for Cemented Joints

Application temperature during cementing	Minimum set time
15 to 40ºC (60 to 100ºF)	30 minutes
5 to 15ºC (40 to 60ºF)	1 hour
-5 to 5ºC (20 to 40ºF)	2 hours
-20 to -5ºC (0 to 20ºF)	4 hours

2.4.2.2.3 Floor Boxes in Concrete Floors

Because of the permanence of the installation, the following special precautions are necessary before the concrete is poured. Double-check all conduit entries. Be certain conduit connections are secured. Perform an electrical continuity test on metallic raceway and box systems. Be certain all unused conduit entries are securely closed with appropriate closure plugs.

2.4.3 Connection to Cable Entries

2.4.3.1 General

Cable may enter a box through a knockout when assembled to an appropriate cable fitting. In this case, installation of a cable fitting in a knockout is the same as described for conduit entries, above.

2.4.3.2 Metallic Boxes

2.4.3.2.1 General

When assembling cable, small diameter tubing, or flexible metal conduit through a pryout in a metallic outlet box, remove the pryout completely, making sure that no sharp edges remain. Insert the conduit, tubing, or cable through the pryout and the securement clamp provided with the box. NEC® 300.14 (300-14) provides the required minimum length of conductors in a box. Depending on the type of wiring system used, the method of installation will vary.

2.4.3.2.2 Nonmetallic-Sheathed Cable

Once the appropriate length cable is inserted into the box, the cable jacket is secured with a minimum of 6 mm (1/4 in.) of the cable jacket extended beyond the securement clamp. Only after the appropriate length of cable jacket has been removed should the securement clamp be tightened in place. Particular care should be taken to position the cable's jacket in the clamp so that it will not be abraded by exposed screw threads when the securement clamp is tightened. The securement screw, when provided, should be tightened so that the cable is secure. Overtightening of the screw is to be avoided as damage to the outer jacket of the cable can occur, either at the time of installation or, over time as a result of cold flow of the jacket material under excessive pressure of the clamp.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.4.3.2.3 Metal Jacketed Cables

Once the appropriate length of cable jacket has been removed, and the end of the metal jacket squared, the cable is inserted into the box. The conductors are extended beyond the securement clamp and the squared end of the metal jacket is seated against the end stop provided in typical clamp designs. The bushing required for Armored Cable must be held securely in place. The clamp is then tightened so that it seats on the metal jacket of the cable. Be certain that the clamp is properly seated on cable jackets having irregular surfaces. Seating can be ensured by hand-tightening the clamp securement screw then slightly rotating the cable until the clamp seats itself. The securement screw can then be tightened in place.

2.4.3.2.4 Flexible Metal Conduit or Tubing

Once the end of the flexible metal conduit or tubing is squared it is inserted into the box. The squared end of the conduit or tubing is seated against the securement clamp's smooth rounded end stop. Be certain that the clamp is properly seated as described for metal jacketed cables.

2.4.3.2.5 Screw Torque

Unless otherwise specified in the manufacturer's instructions, No. 8 securement screws are tightened to a torque of 20 pound-inches (2.26 N•m), and No. 10 securement screws are tightened to a torque of 35 pound-inches (3.96 N•m). Over-tightening should be avoided as this can cause damage to the cable, conduit or tubing.

2.4.3.3 Nonmetallic Boxes

2.4.3.3.1 Nonmetallic-Sheathed Cable

If a cable entry contains a knockout that must be removed for the cable to be inserted, it is to be removed cleanly and completely. Then the appropriate length of cable is inserted into the box, and the cable jacket is secured with a minimum of 6 mm (1/4 in.) of the cable jacket extending beyond the securement clamp. Care should be taken when stripping the outer jacket of the cable to avoid unnecessary strain on the securement clamp. When using a screw-type securement clamp, the screw should be tightened in place only after the appropriate length of cable jacket has been removed, applying the same torque indicated above for clamps in metal boxes.

Electrical connection – A box intended for connection to metal raceway or metal enclosed cable must provide a continuous electrical grounding connection. A metallic outlet box connected to a nonmetallic conduit, tubing, or cable must have provision for connection of a separate grounding conductor. A nonmetallic outlet box may be connected to a metal enclosed cable or metallic raceway, as long as a bonding jumper is installed between the raceways or cables. See Section 2.5.2.

2.4.4 Connection to High and Low Voltage Wiring Circuits

Where both a high voltage wiring circuit (Electric light, power, and Class 1 circuits) and a low voltage wiring circuit (Communications and fiber optic circuits, and Class 2 or 3 circuits) is to be installed in the same outlet or device box, the high and low voltage wiring must enter the box through separate conduit or cable entries and be separated in discrete wiring compartments. Proper installation of partitions provided with multi-gang boxes, or proper assembly of modular, gangable boxes according to manufacturer's instructions assures the required separation of these wiring circuits. All such installations must conform to the requirements detailed in NEC® Articles 725 [725], 770 [770] and 800 [800].

2.5 Completing the Installation

2.5.1 Introduction

At this point in the process, the right box for the application has been selected, and the box has been mounted as intended and the raceway or cable has been secured to the box. All that remains is to complete the enclosure so that it is equipped to perform its intended function. As the saying goes, "the devil is in the details." The variety of specific uses that an electrical box can serve at this point is staggering. However, in large part, the most important guidelines for completing the installation of a box can be covered in a few general categories. Specific guidelines for particular types of boxes and installations are covered separately.

Make sure that construction debris such as sawdust, plaster dust, and Kraft paper is removed from the box before installing a wiring device.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.5.2 Grounding and Bonding

2.5.2.1 Metal Boxes

The NEC® requires that metal boxes be grounded independently of any devices installed. This may be accomplished through the use of a continuous grounded raceway or cable armor, or through the use of separate grounding conductors. If grounding conductors are used, the following methods may be employed to ground the box. If multiple grounding conductors are present they must be spliced together before attaching to the box.

1) Attach the conductor to the box using a 10-32 ground screw. This is the preferred method. Whenever there is paint or corrosion on the box surface, under a screw head, the area should be scraped or sanded shiny before the ground wire is wrapped around the screw. Other holes, including tapped holes containing other screws, are not intended for grounding.

2) Use a listed ground clip on the side of the box. Such clips are only suitable for use on flat surfaces. Ground clips are listed for the thicknesses of boxes for which they have been evaluated. If the clips have been evaluated for a range of thicknesses, the package of clips will be marked accordingly

2.5.2.2 Devices Installed in Surface-Mounted Metal Boxes (e.g. Device (Utility) Boxes; FS and FD Boxes; Square, Round, or Octagon Boxes)

Outlet devices such as receptacles that are depended upon to carry the fault current from equipment (appliances, power tools, etc.) can be bonded by either of the following two methods:

1) Run a bonding conductor or pigtail from the green hex shaped ground screw on the device to the box or to spliced grounding conductors attached to the box.

   With a rectangular box (single- or two-gang), remove non-conductive screw retainers located between device yoke(s) and box, and screw the device(s) down tight to the box, establishing metal-to-metal contact between the device yoke(s) and the grounded box. Then screw the cover plate to the device.

   Other approaches that were once common no longer comply with the NEC®. These include mounting a device to a metal cover over a 4 X 4-inch square box or an octagon box, where the bonding connection depends on the metal screws holding the cover to the box. This is now permissible only if the box and cover combination are listed as providing satisfactory ground continuity between the box and receptacle.

2) Other devices such as switches are required to be effectively grounded and to provide means to ground metal faceplates. This can be accomplished by either of the following methods:

   The equipment grounding conductor or equipment bonding jumper is connected to the equipment grounding terminal on the switch, when provided.

   The device is mounted, using metal screws, to a nonmetallic box with integral means for grounding via the mounting.

2.5.2.3 Devices Installed in Flush-Mounted Metal Boxes

Outlet devices such as receptacles that are depended upon to carry the fault current from attached equipment (appliances, power tools, etc.) can be bonded by either of the following two methods.

1) Run a bonding conductor or pigtail from the green hexagonally-shaped ground screw on the device to the box or to spliced grounding conductors attached to the box.

   Use a receptacle that includes a yoke or automatic ground clip specifically listed for the purpose of establishing the ground connection to the box in conjunction with the metal mounting screws.

2) Other devices such as switches are required to be effectively grounded and provide means to ground a metal faceplate. This can be accomplished as follows:

   An equipment grounding conductor or equipment bonding jumper is connected to the equipment grounding terminal on the switch, when provided.

   The device is mounted using metal screws to a metal box or mud ring, or to a nonmetallic box with integral means for grounding via the mounting.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.5.2.4 Common Grounding/Bonding Errors

Beware and avoid these three common means of attempting to ground/bond devices and metal boxes. The NEC® does not permit these!

1) Connecting the grounding wire to a device and ignoring box grounding, or relying on the wiring devices mounting to bond the box.

2) Connecting the wire to a screw that is simultaneously performing another function, such as securing a cable clamp.

3) Wrapping the wire under or around something, such as a cable sheath, that will be squeezed by metallic hardware in contact with the box, such as a cable clamp or part of a connector.

2.5.3 Installation of Wiring Devices

2.5.3.1 General

Device boxes and box/cover combinations intended for the installation of wiring devices such as switches, receptacles, dimmers, GFCIs and other similar products have mounting holes that are spaced to accept the screws provided in the mounting straps of wiring devices. The spacing of these mounting holes is standard for all wiring devices. The wiring device is secured to the box using the screws provided with the device. The screws should be tightened to securely mount the device but care should be taken not to overtighten the mounting screws, in order to prevent deforming the wiring device mounting strap or yoke, or stripping the threads in the mounting holes of the box.

Wiring devices may also be mounted on box extenders, extension rings, and raised covers if they have the appropriate mounting holes for accepting the wiring device mounting screws. Longer screws than those supplied with the device may be needed when mounting box extenders. Typically, box extenders are provided with the necessary longer screws. Where longer screws are not provided, use only the type of screw provided with the wiring device.

An appropriate cover or cover plate must be used to complete all wiring device installations.

2.5.3.2 Voltage Between Adjacent Devices

Where the voltage between a snap switch and adjacent snap switches, a receptacle or similar device will exceed 300 volts, the snap switch is not permitted to be grouped or ganged in an enclosure. Only when the devices are arranged to eliminate this condition, or where a properly installed barrier is provided, are the devices permitted to be grouped or ganged in the same enclosure. See 1.2.6.3 in the Selection section.

2.5.3.3 Boxes Intended to Support Fixtures/ Luminaires, Ceiling-Suspended Fans, and Other Products

Due to the importance for safety and the uniqueness of the design of boxes intended to support fixtures/luminaires, ceiling suspended fans, and other products, specific markings described in Section 1.2.4 must be verified prior to installation.

2.5.3.3.1 Boxes Intended to Support Fixtures/Luminaires

In old work installations, the installer must be aware that a box intended to support a fixture/luminaire is not supported by a structural member. Rather, the box is supported by the finished surface. Surfaces such as drywall may not provide adequate strength to support the box and the fixture. Strong consideration should be given before supporting a luminaire weighing more than 7 kg (15 lbs.) without additional supporting means.

2.5.3.3.2 Boxes Intended to Support Ceiling-Suspended Fans

Ceiling fan boxes are uniquely designed to support the dynamic loads generated by ceiling fans in normal use. Always use a listed ceiling fan box to support ceiling fans. All listed fan boxes have a permanent label, stamping, or marking stating “acceptable for fan support.” Make sure the box has this mark.

Another factor to consider is the total weight of the fan and the weight rating of the box. The total weight is the fan weight plus any add-ons such as light fixtures. If a box does not state a weight rating, then it can support a total weight up to 16 kg (35 pounds). Specially listed fan boxes are allowed to support a total fan weight up to 33 kg (70 pounds). If the box is listed for fan support over 16 kg (35 pounds), then its weight rating must be marked on the box.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Where the box will provide support for the weight of the fan, the instructions provided with the fan box for mounting the box to the structure shall always be followed. The installer must carefully consider both the installation instructions provided by the fan box manufacturer and those provided by the manufacturer of the fan when mounting the fan to the box. The fan manufacturer may provide alternative mounting instructions and hardware for mounting the fan to the box. If the preferred alternative mounting method is in conflict with the instructions provided with the fan box, the fan box manufacturer should be consulted for recommendations. The screws provided with the fan box for securing the fan to the box shall be used in all cases. Where the weight of the fan is to be supported by the structure, independently of the box, the instructions provided by the fan manufacturer shall always be followed.

2.5.3.6 Boxes for Fire Resistance-Rated Construction

For specific installation requirements for listed boxes, refer to directories such as the UL Fire Resistance Directory. Boxes classified for this application that are included in the UL Fire Resistance Directory typically comply with model building codes. See Section 2.2.

2.5.3.7 Floor Boxes

Because of the many unique floor box design features, care should be taken to closely adhere to the manufacturer's installation instructions when completing the installation.

The main areas of consideration at this phase in the installation of a floor box assembly are: final leveling adjustments and attachment of the floor box cover assembly to the finished floor surface.

Final Leveling Adjustments—Most floor boxes intended for installation in concrete provide options for final leveling adjustments after the concrete is poured and set. For floor boxes of nonmetallic material, one of these options is to trim the edge of the box opening so that it is level to the poured concrete surface. Trimming must be neat and even to ensure proper seating of the floor box cover.

Many floor box assemblies also include leveling rings that are mounted to an installed floor box and provide the means for mounting the floor box cover level with the floors finished surface covering.

Attachment of the Floor Box Cover Assembly—Since all floor boxes are installed beneath the finished floor surface, the floor box cover and sometimes, additional accessories are depended upon to complete the enclosure and interface with a particular floor covering (e.g, carpet, wood, tile, etc.). In normal use, the floor box cover assembly is expected to prevent the entry of foreign material into the wiring compartments of a floor box and enclosed wiring devices. A Listed floor box cover is designed to prevent the entry of dust and dirt. Listed floor box covers intended for use on carpet or tile covered floors are also designed to prevent the entry of scrubwater such as they might be exposed to in the normal maintenance of these floors. Close attention to the proper installation of these covers and specific accessories such as carpet flanges, tile rings, etc., is important to achieve the designed protection. At the interface of the cover or accessory and the floor or floor covering, carefully follow the manufacturer's instructions for trimming the tile or carpet. Manufacturer's instructions may also call for use of sealant or other materials as a provision for prevention of the entry of scrubwater into the floor box. Spaces between tiles should be grouted level where they enter under a floor box cover to prevent a channel for the entry of scrubwater.

Any concrete or debris that may enter the box during the construction process should be removed. The box should be covered to prevent entrance of foreign materials before and after the installation is completed.

If the floor box is not intended to be activated (completed by assembly of wiring devices) at the time that the electrical conductors are pulled, sufficient wire to complete the intended installation in the future shall be provided. The wiring should be looped inside the box, and the ends of the conductors shall be protected.

2.5.3.8 Poke-Through Floor Fittings

For attachment of the cover assembly to a poke-through floor fitting, refer the section above "Attachment of the Floor Box Cover Assembly."

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

2.5.4 Flush Device Boxes: Coordination with Finished Wall Surface Installation

In new work installations, finished wall surfaces and wall coverings are installed after mounting of electrical boxes. Often, the wiring system has been installed and de-energized conductors are present in the box. It is not uncommon for wiring devices such as switches and receptacles to have already been installed. Whenever possible, installation of wiring devices should be scheduled after the finished wall surface is installed and wall coverings (paint or wallpaper) are complete. Scheduling the work in this sequence will provide easier installation of the finished wall surface and avoid unintended damage to the wiring device. It will also give the electrician full knowledge of the final installation and the ability to make any necessary minor adjustments at the time the installation is completed.

The electrician should take the responsibility to provide all necessary protection for electrical conductors in the box to avoid damage or contamination by paint or other materials used during the installation of the finished wall covering and surface treatment. This preparation may include coiling the wires without stripping the conductor insulation or cable jacket, protecting exposed conductor ends, and stuffing the box with non-absorbent paper.

When wiring devices will be installed prior to installation of the finished wall surface and wall coverings, they should be adequately masked and protected by the electrician to prevent contamination or unintentional damage. The wall surface installer should be trained and made responsible for avoiding damage to the box and its contents during the installation of the wall surface and coverings. The common practice of using a hand router and the outside contour of the box as a template guide for cutting openings in the wall surface has resulted in many problems. The electrician must inspect the box and its contents after installation of the wall surface to identify and replace any damaged electrical components.

2.5.5 Installing Cover and/or Cover Plate

2.5.5.1 Damp or Wet Locations

After the device is installed, the properly selected weatherproof cover should be installed using either the mounting holes located on the device strap or the holes located in the box itself. Care should be taken to ensure that the cover and gasket are properly placed on the box with the gasket edges exposed on all sides of the box. This will enable the cover to provide the proper resistance to the entrance of water. When a weatherproof cover is installed on a flush mounted, dry location box, check to ensure that the cover and gasket are seated against the building material, and apply a sealing compound if necessary. Self-closing lids and hoods should be checked to ensure that they work properly.

2.5.5.2 Dry Locations

Covers for exposed work such as raised surface covers, as described in the Selection section in 1.3.7, require that the device be attached to the cover and the cover then attached to the box. The device should be attached to the cover using at least two mounting points. Listed covers contain these provisions and include the necessary hardware. Check to ensure that the faces of receptacles protrude from the face of metallic covers and are at least flush with the face of nonmetallic covers. Check to ensure that the covers do not allow any gaps between the boxes and covers.

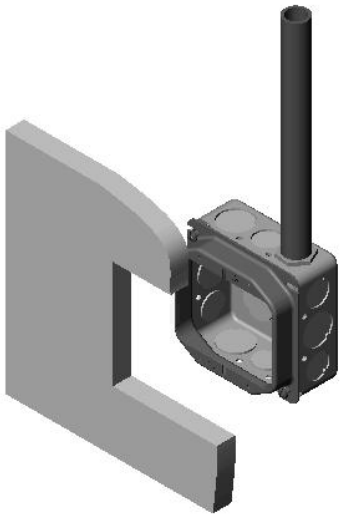
Cover plates (face plates, wall plates) for flush-mounted wiring devices should allow the face of receptacles to protrude from the face of metallic cover plates and be at least flush with the face of nonmetallic cover plates. This also applies to surface mounted single gang boxes. For flush mounted boxes, check to see that the cover plate completely covers the opening between the box and the wallboard. Inform the wallboard trades of any repairs necessary to meet this requirement.

2.6 Verification of Installation

Verify secureness of all connections of the wiring system to the box. Where a manufacturer marks a specific tightening torque for a wiring system securement means, the torque is to be verified using an appropriate torque verification tool. For wiring system connections that will not be accessible after the assembly of finished building surfaces, verification should take place prior to final building surface assembly.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

Figure 2-1
Square Boxes in 4” X 4” Wall Opening

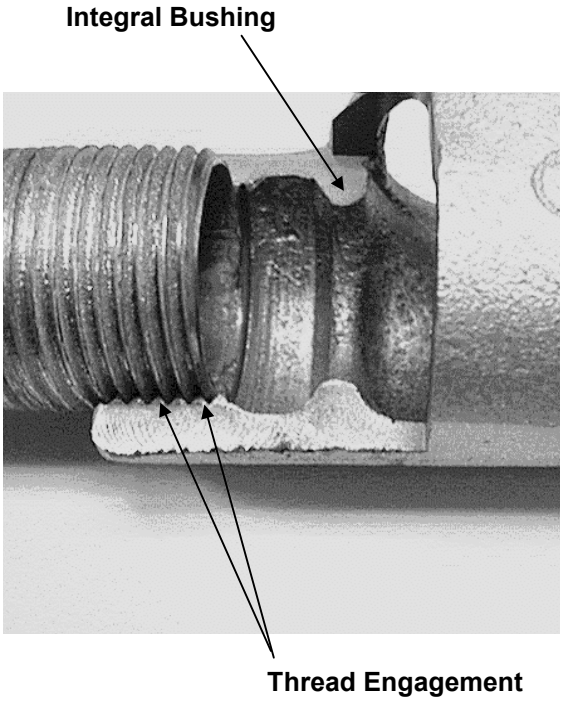


4” Square Box And Cover
with 4” x 4” wall opening



4-11/16” Square Box And Cover
with 4” x 4” wall opening

Figure 2-2
Typical Threaded Conduit Entries



Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale

This page is intentionally left blank.

Copyright National Electrical Manufacturers Association
Provided by IHS under license with NEMA
No reproduction or networking permitted without license from IHS
Not for Resale