Reference: The 2017 *National Electrical Code*

INTRODUCTION

The *National Electrical Code (NEC)* is a living document, constantly being revised, and always expanding and improving. The *NEC* is written to be practical, easy to read and apply, and be enforceable. Section 90.4 gives the authority having jurisdiction (AHJ) the responsibility of making the final interpretations of the rules, for approving equipment and installations, and granting special permission when conditions would require. It is important that the installer and AHJ maintain open communication and work together for a practical and safe installation.

NEC Section 90.3 arranges the layout of the *Code*. Chapters 1-4 apply generally and are modified or supplemented by the Special Chapters of 5, 6, and 7. When taking an EVITP class, many installers want to go straight to Article 625 to understand the specific requirements for the EVSE installation. While this is commendable and important, there are numerous general requirements of the *Code* that apply to the EVSE installation.

DEFINITIONS

The *NEC* Style Manual requires any definition used in two or more articles to be located in Article 100. Definitions used exclusively by only one article are to be located in the XXX.2 section of the article. From Article 100, some applicable definitions include *Listed*, *Labelled*, *Continuous Load*, *Receptacle Outlet*, *Readily Accessible*, and *Disconnecting Means*.

For example, Section 625.42 requires the disconnecting means to be located in a readily accessible location. If the disconnecting means is located in a locked electrical room, provided the person to whom access is requisite has a key, then the disconnecting means would still be considered readily accessible. In Section 625.5, all equipment, materials, devices, fittings and associated equipment are required to be listed. Electric vehicle supply equipment (EVSE) not only needs to be listed, tested, and evaluated, but also needs to be labeled. Without the field label, there is no verification of the listing of the product. *NEC* 110.3(B) further requires any listed product to be installed per the manufacturers' instructions, which could include voltage drop requirements. Definitions are an important and essential part of properly applying the *Code* to an EVSE installation.

REQUIREMENTS

Section 110.9 and 110.10 require the EVSE installers to determine the available fault current for an EVSE installation. Two critical points would be the branch circuit distribution point, so the branch circuit OCPD has an adequate interrupting rating, and at the EVSE location so it has an adequate short-circuit current rating. Failure to comply with these two requirements will result in a time bomb waiting to go off during a short-circuit or ground fault event. Section 110.12 requires a neat workmanship installation. The EVSE installer needs to install to a high level of quality, especially since the public will be exposed to the installation in an outdoor setting where a high level of shock hazard may be present. Professional, neat, and workmanlike installations are safe, and public safety should always be a top priority.

Additional considerations from Chapter 1 of the *NEC* would include labeling. Section 110.16 requires arc flash hazard warning stickers, and 110.22 requires the disconnecting means to be marked. All markings need to comply with 110.21 and be adequate for the environment. Circuit directories may also need to be updated for compliance with 210.5 and 215.12. The EVSE installer needs to fully understand all working clearance requirements of 110.26 and ensure adequate space is provided around all required equipment.

Chapter 2 contains many of the design requirements for a typical EVSE installation. Chapter 3 is essential to any successful EVSE installation. After a proper site assessment, design considerations and calculations performed from Chapter 2, the EVSE installer needs to build the installation. What wiring methods will be used and what routes for wiring methods will be permitted. Section 300.4 provides general guidelines for protection of conductors from physical damage, with distance requirements from the edge of framing members and distances below sheet metal corrugated roof decks. Section 300.5 lists requirements for underground installations which would be applicable to EVSE installations. Both 300.5 and 300.9 requires conductors for EVSE installation whether supplied underground or above ground in a wet location to have conductors identified for wet locations. Section 300.7 and 352.44 should not be overlooked for an outdoor installation subject to temperature extremes requiring expansion fittings for raceways. There are numerous more requirements the EVSE installer needs to consider.

The scope of Article 625 highlights two provisions. First, the article covers the electrical conductors and equipment external to an electric vehicle to connect the vehicle to a source of electricity, whether by a direct conductive connection (currently the most popular method) or by an inductive means. Secondly, it covers equipment and devices related to electric vehicle charging. In 625.2, it is important to understand the definition of an electric vehicle, which would include items

such as automotive-type vehicles for on-road use, such as passenger vehicles, buses, trucks, vans, motorcycles and others that are propelled by an electric motor powered by a rechargeable storage battery. Off-road vehicles, such as industrial trucks, golf carts, and airline ground support equipment, are not covered by the article.

Electric vehicle supply equipment (*EVSE*) is defined as all conductors, connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed to transfer energy between premise wiring and the electric vehicle. As it is defined as equipment, and not an appliance, Article 422 would not apply to an EVSE. Of the new definitions added to Article 625, *cable management system*, is noteworthy. Cable management in the EV market presents numerous challenges. In the northern climates, snow removal can be a source of damage to the cord if not properly stored. Additionally, for many, dirt, snow, and ice may limit how desirable it is to use the cable properly, or returning it to its proper position after usage. In all locations, if not properly located, cables can be a trip hazard and can be exposed to more physical damage. Cable management systems, although they increase the cost of the installation, provide solutions for all of these problems and will play a key role moving forward for the success of the EV market.

Three key sections provide for safety of the EVSE user. Section 625.18 requires the EVSE to be provided with an interlock that deenergizes the electric vehicle connector when it is not coupled to a vehicle. This provides safety to even a non-user of the EVSE by limiting what is energized when the EVSE is not used. Section 625.19 provides "roll away" protection. Although electric vehicles are provided with an interlock to prevent operation while the EVSE cable is attached, in the event the vehicle moves for any other reason, the EVSE is required to deenergize the cable upon exposure to strain when the vehicle is inadvertently moved. Relaxation of both requirements is only permitted by a cord-and-plug-connected Level 1 charger, or for DC supplies less than 50 volts DC. Additionally, a personnel protection system is required by Section 625.22 to protect personnel from electric shock.

While Article 100 defines a *continuous load* as one where the maximum current is expected to continue for three hours or more, Section 625.41 outright requires all EVSEs to be considered as a continuous load. Undeniably, Level 1 and Level 2 EVSE will operate for three hours or more, however, a DC fast charger may operate for 20 minutes to an hour depending on the vehicle but it is still required to be considered as a continuous load. Apply the scenario for the DC fast charger of a vehicle that is charging for 30 minutes, the vehicle disconnects, drives away, and immediately a new vehicle pulls into the charging station and begins to charge. This cycle repeats with different vehicles for a continued three hours or more and it is therefore reasonable to consider a DC fast charger as a continuous load. As a continuous load, Section 625.40 requires the overcurrent protection for both feeders and branch circuits to be sized at not less than 125% of the EVSE current rating.

Disconnecting means are required for any EVSE that is rated more than 60 amperes, or has a voltage to ground of more than 150 volts. The disconnecting means would be required in a readily accessible location and lockable open in accordance with 110.25. For example, a DC fast charger supplied by a 480/277-volt, 3-phase system would require a disconnecting means. A 208-volt, 3-phase DC fast charger rated more than 60 amperes would also require a disconnecting means. A Level 2 EVSE rated 240 volts, 30 amperes would not require a disconnecting means.

Section 625.44 currently permits a Level 1 EVSE to be cord-and-plug-connected. A Level 2 EVSE rated not more than 50 amperes, or a 208-volt DC fast charger rated not more than 50 amperes, would be permitted to be cord-and-plug-connected if the EVSE is fastened in place for either ready removal for interchange, facilitation of maintenance and repair, or repositioning of portable, movable, or EVSE fastened in place. Additionally, the power supply cord cannot exceed six feet in length, and the receptacle must be located to avoid physical damage. An example would be a commercial repair shop purchasing one EVSE and allowing it to be cord-and-plug-connected so it could be used as multiple service bays with the appropriate receptacle outlet installed in each bay. All other EVSE is required to be permanently wired and fastened in place.

Applying the requirements of the *Code* will result in an EVSE installation necessary for the practical safeguarding of persons and property. Communication with the authority having jurisdiction is essential for a code-compliant EVSE installation. Properly-installed, safe functioning EVSE is essential for the EV market to continue to grow.