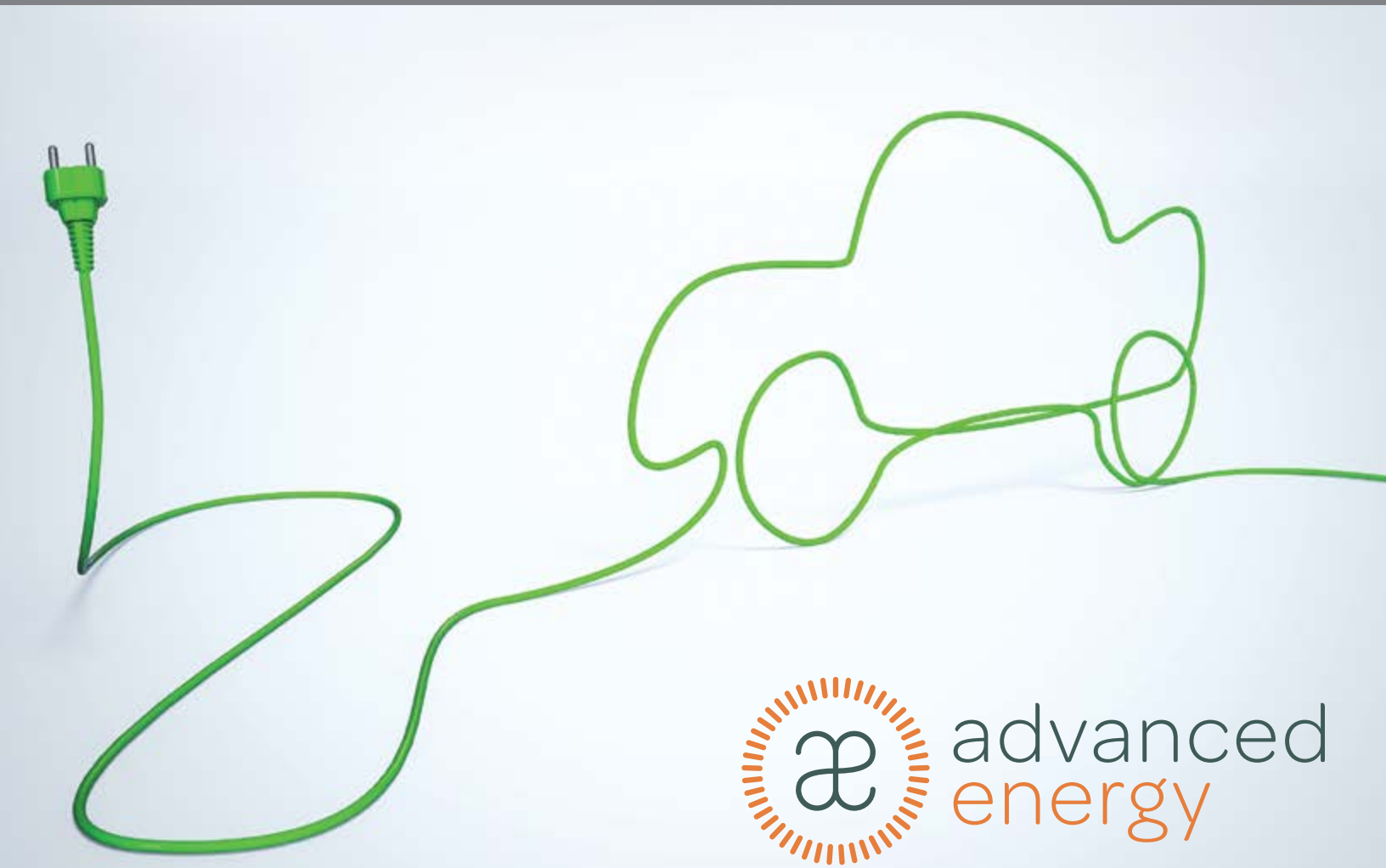
CHARGING STATION INSTALLATION HANDBOOK

for Electrical Contractors and Inspectors

VERSION 3.0



advanced energy

You understand and agree that the installation, operation, maintenance and inspection of electrical charging stations for electric vehicles is an extremely complex and dangerous activity.

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May 2013

This handbook was made possible through the support of Duke Energy, the North Carolina Electric Membership Corporation and Dominion North Carolina Power, as well as the City of Raleigh, who supplied information and shared best practices regarding charging station installation.

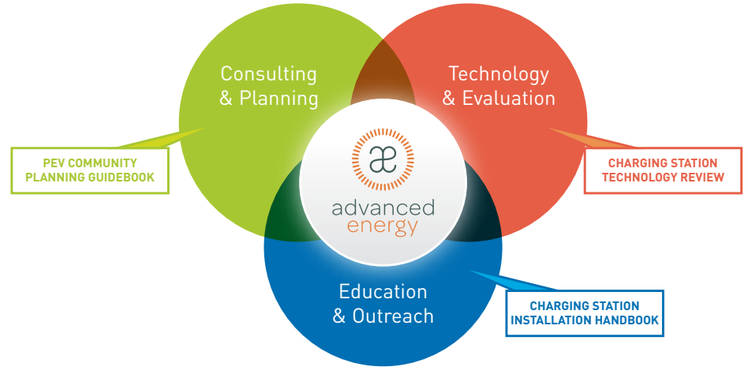
Your Feedback Matters!

With publication of Version 3.0 of the Charging Station Installation Handbook for Electrical Contractors and Inspectors, Advanced Energy is currently seeking feedback on the information presented, methods used and best practices. This feedback will then be reviewed and incorporated into the next version of the handbook. To provide your feedback, please visit www.AdvancedEnergy.org/transportation/feedback.php

DRIVING THE FUTURE OF TRANSPORTATION

Advanced Energy's Electric Transportation sector is working to assist utilities, charging station vendors, municipalities and all initial stakeholders in understanding, planning and implementing electric transportation initiatives. As your trusted resource for advancing electric transportation, we can assist you in creating a strong foundation for successful change through:

- **Consulting and Planning**
- **Technical Evaluation**
- **Education and Outreach**



The future of transportation is here! As more and more consumers purchase plug-in electric vehicles (PEVs), the demand for electrical charging stations will increase. As such, contractors will receive more requests to install charging stations – from new construction and existing homes to retail outlets, corporate campuses and parking decks. With this evolving technology, electrical inspectors will also be challenged as requests for approvals increase and the scope of installation varies.

We're here to help. Our handbook includes overviews, guidelines and checklists to help contractors and inspectors deal with the influx of requests.

CONTENTS

CHARGING LEVELS

With the rollout/adoption of PEVs, there is a clear and present need for electric vehicle supply equipment (EVSE), most commonly referred to as charging stations. Charging stations are the point of power for electric vehicles, ranging in style and charging levels and subject to standards and codes. It is important to note while an EVSE is normally referred to as a charging station, for Level 1 & 2 stations, it is not a battery charger. Only DC Fast Chargers include an actual charger. The main purpose of a charging station is to establish communication with the vehicle and to transfer power to the PEV while providing proper grounding, shock protection, overload protection and general safety. The PEV will have an onboard battery management system and charger.

There are three levels of charging, offering a range in charge time and infrastructure simplicity. For infrastructure planning purposes, charging stations are considered to be continuous loads.

CHARGING LEVEL	FEATURES
Level 1	◢ 120 VAC, 15 or 20 A circuit based on the standard American home outlet ◢ Will take the longest time – eight to 10 hour full charge* ◢ Simplest; easily accessible for vehicle owners ◢ Uses amount of power similar to a hair dryer or microwave ◢ Suited for low-speed NEVs and some PEVs with short electric-only range; may also be well suited for locations where a PEV will be parked for extended periods (days/weeks)
Level 2	◢ 208/240 VAC, 80 A maximum current (100 A circuit) ◢ Will use only the SAE J1772 specified plug ◢ Uses amount of power similar to large appliances, such as air conditioners or clothes dryers ◢ Requires two to three hour full charge*
DC Fast Charge	◢ 480 VDC / 100 A (and up) fast charge ◢ 80% charge in around 30 minutes*

**Estimated charge time based on a vehicle utilizing 40 miles of electric-only driving between charges.*

Level 2 charging is likely to be the most common form of vehicle charging in the foreseeable future. The majority of this document refers to the installation of Level 2 conductive charging

APPLICABLE CODES & STANDARDS

Society of Automotive Engineers and National Electrical Code Standards

In order to ensure common standards for vehicle charging, the Society of Automotive Engineers (SAE) has developed standards for energy transfer and a common cord set. These standards will ensure all PEVs have a common charging 'plug,' meaning any PEV will be able to plug into any charging station. The two main standards are SAE J1772 and SAE J2293, which reference other SAE, National Electrical Code (NEC) and Underwriters Laboratories (UL) standards or codes.

SAE STANDARDS FOR CHARGING STATIONS	
Standard	Description
J1772	Electrical and mechanical aspects of the cord set; references UL for safety and shock protection as well as the NEC for the cord and couple
J2293	Standard for the electric vehicle energy transfer system. This system encompasses what goes from the charging station to the car.
J2293-1	Functionality requirements and system architecture
J2293-2	Communication requirements and network architecture

NEC STANDARDS FOR CHARGING STATIONS	
Standard	Description
NEC 110.11	Deteriorating Agents
NEC 110.28	Enclosure Types
NEC 110.26	Electrical Equipment Spacing
NEC 110.26 (A)(2)	Width of Working Space
NEC 110.27(B)	Guarding of Live Parts – Prevent Physical Damage
NEC 210.70(A)(2)	Lighting Outlets Required – Dwelling Units – Additional Locations
NEC 300.4	Protection [of conductors] Against Physical Damage
NEC 334.15	Exposed Work [requirements for nonmetallic-sheathed cable]
NEC 334.30	Securing and supporting nonmetallic-sheathed cable
NEC 625.1 – 625.5	General (Scope, Definitions, Other Articles, Voltage, Listed/Labeled)
NEC 625.9 (A-F)	Wiring Methods (Electric Vehicle Coupler)
NEC 625.13 – 625.19	Equipment Construction
NEC 625.21 – 625.26	Control and Protection
NEC 625.28 – 625.30	Electric Vehicle Supply Equipment Locations

UL Standards

In conjunction with other PEV and charging station standards in development, UL is currently developing safety standards for charging electric vehicles. There are five primary standards:

UL STANDARDS FOR CHARGING STATIONS	
Standard	Description
UL 62	Standard for flexible cords and cables required by NEC 625
UL 2202	Charging station design and construction
UL 2231	Charging station shock prevention measures define proper grounding and ground fault interruption
UL 2251	Cord design and safety covers the plug, cord, receptacle, connectors and other items related to the charging cord set. Also verifies the cord's safety and ability to carry its rated load.
UL Subject 2594	Charging station safety covers off-board equipment that supplies power to a vehicle, including PEV power outlets, cord sets, or standalone charging station

APPLICABLE CODES & STANDARDS

Governing Standards

As municipalities and businesses install publically available PEV charging stations, an important design requirement is to ensure accessibility for disabled users. In the United States, the accessibility of public facilities is mandated by the Americans with Disabilities Act (ADA) and is generally governed by three standards:

- The International Building Code (IBC);
- The American National Standards Institute's (ANSI) Standard A117.1 "Accessible and Usable Buildings and Facilities;" and
- The U.S. Department of Justice (DOJ) 2010 ADA Standards for Accessible Design.

ADA Guidance in North Carolina

Conversations with North Carolina city and county officials, as well as with accessibility code consultants at the North Carolina Department of Insurance (NC DOI), which is responsible for interpretation of North Carolina's building and related codes, have assisted in the development of the following guidelines. This is the best known guidance at this time for local officials and property owners who are preparing to install charging stations.

Public and private entities intending to install charging stations for public use have one major challenge: governing codes and standards do not yet specifically address PEV charging stations.

Some generic accessibility requirements for public infrastructure or services are easily assessed (for example, reach ranges for operable controls). However, the most common type of public charging is currently provided by adding charging hardware to an existing parking space. In many cases these new charging spaces are restricted for use by PEV owners.

As a result, the primary purpose of the space becomes fueling instead of parking. This can create confusion as to which accessibility requirements should apply and how they should be interpreted. While several requirements are simply undefined at this time, there are existing accessibility requirements for parking facilities that can be used as a guide.

The following sections outline the areas of disabled-accessibility to be considered when installing a charging station.

Applicable Codes

The codes and standards governing accessibility at a given facility can vary depending on which codes have been adopted by the applicable state or local jurisdiction and by the type of facility. Title II facilities are state or local government facilities, and Title III facilities are public accommodations and commercial facilities.

In North Carolina, the local Authority Having Jurisdiction (AHJ)

is responsible for enforcement of the applicable requirements[1]:

- Title II facilities must comply with the U.S. DOJ 2010 ADA Standards[2] AND the 2012 NC Building Code[3], Chapter 11, which references the 2009 ANSI A117.1 Standard.
- Title III facilities must comply with the 2012 NC Building Code, Chapter 11, which references the 2009 ANSI A117.1 Standard.

1 NC Department of Insurance Access Update Newsletter, Vol. 3 Issue 2, August 2012
2 Note that the ADA Standards may also be enforced by the US DOJ.
3 The 2012 NC Building Code is the 2009 International Building Code with NC amendments

Anticipating Code Updates

Site owners must keep in mind that the accessibility code does not function in the same manner as most other codes with regard to updates. Construction that pre-dates a building code revision is typically "grandfathered" in compliance with the code that was in effect at the time of construction. Instead, as the accessibility code is updated, facilities are generally required to upgrade to the current standard. It may be more cost effective to proactively provide charging station accessibility because doing so may reduce future legal liability, and future retrofits could cost significantly more than enhanced construction in the present.

Charging station installations may also be governed by regulations found in a local zoning ordinance or unified development ordinance.

The requirements and recommendations described herein are provided as guidance only – official compliance for any electric vehicle charging station is subject to the code enforcement of the local AHJ, which may be supported by a formal interpretation from the NC DOI. Where available, specific code references are provided.

Site Design

For simplicity parking spaces served by EVSE are referred to as "charging spaces," and "charging hardware" refers specifically to the EVSE.

Number of Accessible Charging Stations

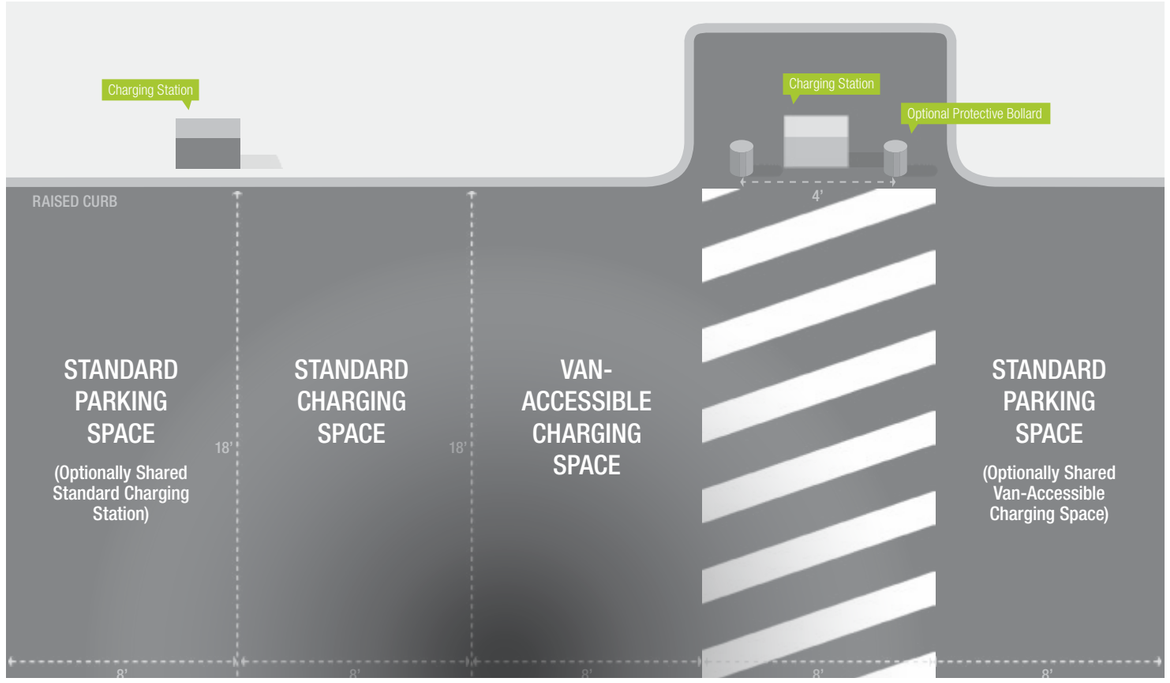
On a given site the NC DOI views a contiguous group of charging spaces as a distinct parking facility, as described in NC Building Code (NCBC) 1106.1. Although there are no explicit requirements at this time for the number of charging spaces that must be accessible, it is recommended to follow the requirements for standard and van-accessible parking spaces presented in NCBC Table 1106.1 and Section 1106.5 (see Table 1).

- The first charging space that is installed should be sized for van-accessibility.
- A second accessible charging space is recommended when the 26th charging space is installed, and that second accessible

Total Charging Spaces	Total Accessible Charging Spaces	Van-Accessible Charging Spaces
1-25	1	1
26-50	2	1
51-75	3	1
76-100	4	1
101-150	5	1
151-200	6	1
201-300	7	2

APPLICABLE CODES & STANDARDS

Accessible Sample Design #1: **Installation in Parking Lots at Medians or Grade Perimeters**



charging space should be sized as a standard (non-van) accessible space. At least one space should be sized for van-accessibility out of every six accessible charging spaces that are present (1:6).

In some designs, a facility owner may install charging hardware such that it can be shared by a standard charging space and an accessible charging space. Such installations may be interpreted as satisfying the requirement for accessible charging spaces.

In multi-level parking structures, all charging spaces may be allowed to be located on one level. In parking facilities for buildings with multiple accessible entrances, charging spaces are not required to be dispersed. However, if charging spaces are provided in multiple locations for buildings with multiple accessible entrances, then accessible charging spaces must be provided at each location.

There is an exception to NCBC 1106.1 for certain types of fleet vehicle and motor pool parking facilities where lots accessed by the public are provided with an accessible passenger loading zone. Accessible passenger loading zones are addressed in NCBC 1106.7 and ANSI 503, where the basic requirements include a pull-up space that is a minimum eight feet wide by 20 feet long with an adjacent access aisle that is a minimum five feet wide by 20 feet long, marked so as to discourage parking in the aisle.

Layout of Accessible Charging Spaces

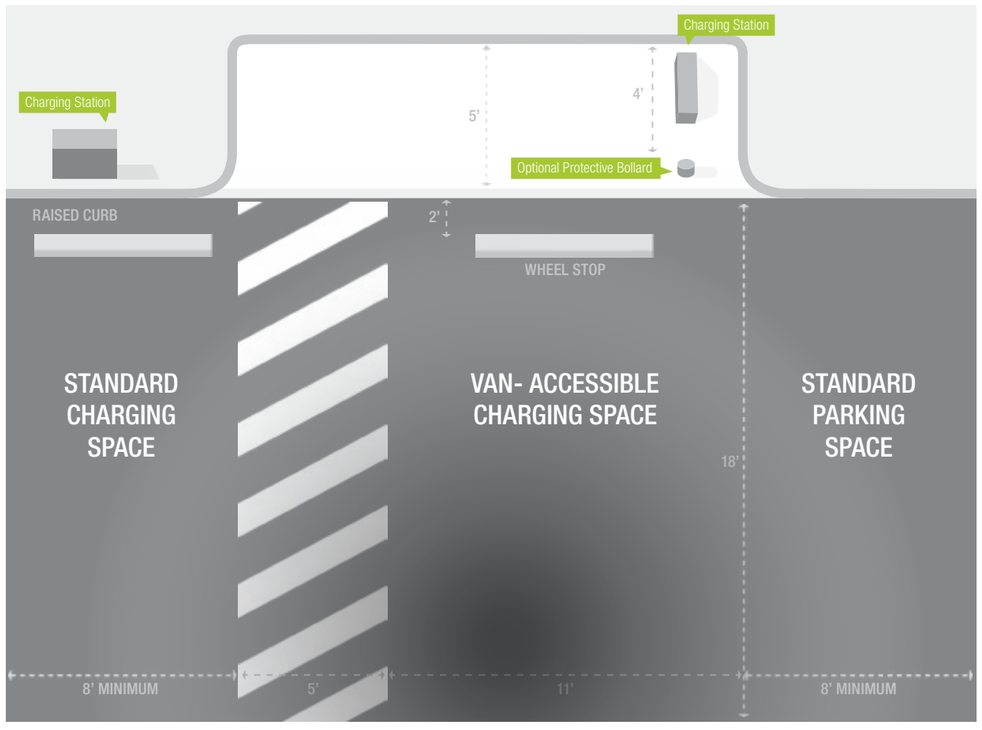
Layout and dimensions of accessible parking spaces are defined in ANSI 502. Accessible charging spaces should follow the same guidelines, namely that the first charging space, sized for van-accessibility, be a minimum 11 feet wide with an adjacent access aisle that is a minimum five feet wide. Alternately, the van-accessible parking space may be eight feet wide if the adjacent access aisle is at least eight feet wide, but the standard 11 foot width is preferred to provide more flexibility to the driver for positioning of the vehicle. Any standard (non-van) accessible stalls must be a minimum eight feet wide with an adjacent access aisle that is at least five feet wide. In both cases, the minimum length of the parking spaces should be 18 feet. Note that local ordinances may require a longer space.

Accessible Routes

While the primary purpose of a charging space is vehicle fueling, it is also reasonable to expect that drivers may want to use a particular charging station due to its association with a specific building on a site. NCBC 1104.2 requires that at least one accessible route connect accessible buildings and other accessible elements or spaces that are on the same site.

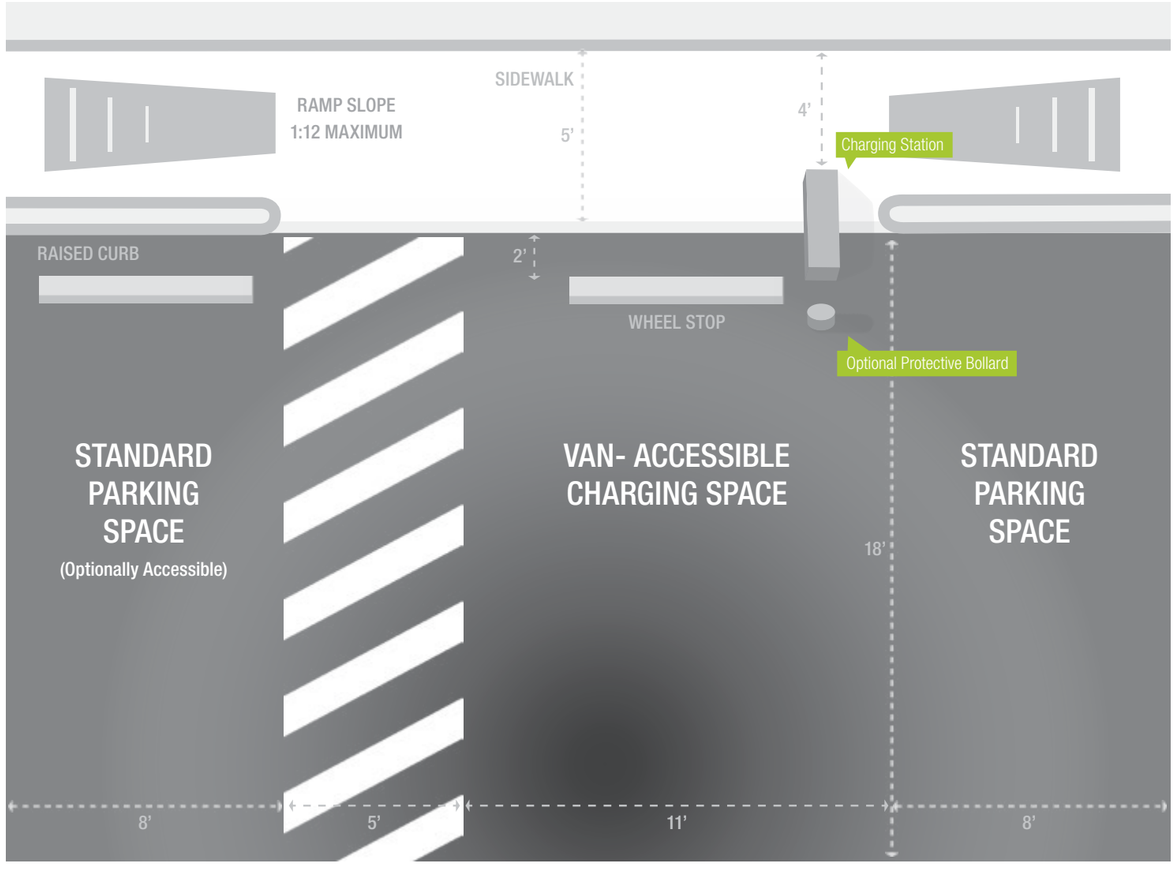
While accessible parking spaces must be on the shortest accessible route to the associated building entrance, accessible charging spaces may be on a longer route, because the primary purpose of the charging space is vehicle fueling.

Accessible Sample Design #2: **Installation in Parking Lots at Medians or Grade Perimeters**



APPLICABLE CODES & STANDARDS

Accessible Sample Design #3: **Installation in Parking Lots at Sidewalk Boundaries**



Note that NCBC 1104 requires an accessible route to be a fixed, firm, non-slip path of travel that is a minimum 48" wide, which exceeds the requirement in ANSI 403.5 for a 36" minimum width. Other key requirements for accessible routes include:

- A maximum running slope of 1:20 and maximum cross slope of 1:48, specified in ANSI 403.3.
- Any ramps or curb ramps present on an accessible route must comply with ANSI 405 and 406, respectively.

The addition of charging spaces to an existing parking facility will generally be interpreted as new construction, not an alteration. As a result, exceptions to the requirement for an accessible route due to disproportionality of costs are unlikely to be available unless they result from interpretation by the AHJ and/or NC DOI.

Parking facilities not associated with a specific building must provide an accessible route from the accessible charging space to an accessible pedestrian entrance to the parking facility per NCBC 1104.2.

While any requirement for an accessible route from an accessible charging space to an associated building may be subject to interpretation, it is clear that there must be an accessible route between the charging space and the charging hardware. The goal: ensure that once a PEV is maneuvered into the space, the driver can connect the charging cord to the vehicle charging inlet. It is acceptable for the driver to place the charging cord in or along that accessible route for the duration of the charging process.

However, charging stations should be positioned in such a manner that their cords WILL NOT block any sidewalk or obstruct any other accessible route while the cord is connected to a vehicle. It is possible that designs may be required to prevent or restrict such an impediment, especially if the accessible route (or access aisle, if applicable) serves a function or pathway beyond access to the charging hardware itself, e.g. complementary access to a building entrance or to a public way.

Availability for Use

It is not recommended to mark accessible charging spaces for the use of only disabled-marked vehicles because:

- The primary purpose of charging spaces is vehicle fueling; and
- The installation of accessible charging spaces does not reduce the number of required accessible parking spaces at the same site.

This model is similar to the provision of accessible hotel rooms governed by NCBC 1107.6, where accommodation is available for, but not limited to, use by disabled patrons. Charging station owners may choose to install signage that indicates "accessible priority" at accessible charging spaces, guiding non-disabled users to park in any available standard charging space before using an accessible charging space. Should the owner decide to mark accessible charging stalls for the use of disabled-marked vehicles only, NCBC 1110 and ANSI 502.7 define the related requirements.

Charging station owners may choose to install signage that indicates "accessible priority" at accessible charging spaces, guiding non-disabled users to park in any available standard charging space before using an accessible charging space.

Charging station owners may or may not choose to restrict the use of charging spaces to specific types of vehicles (e.g. PEVs only). Municipal station owners may establish ordinances defining the legal use of public charging spaces as well as the potential penalties for improper use, and commercial owners may define similar policies that are enforced at their discretion.

Finally, a site owner may choose to install charging hardware at a marked-accessible parking space, or to install charging hardware such that it can be shared between a marked-accessible parking space and another charging space. In such cases, the primary purpose of the marked space would remain the parking of disabled-marked vehicles. Such installations may be interpreted as satisfying the requirement for accessible charging spaces. In such cases, the NC DOI recommends that signage be provided to clarify that charging is not required in order to use the space. For example, "Accessible Parking. EV Charging is an Accessory Use" Or "EV Charging Optional."

APPLICABLE CODES & STANDARDS

Charging Station Installation

The charging hardware may be mounted on a pedestal or attached to a pole, a wall or another vertical surface. Regardless of mounting style, the base should be at the same elevation as the parking surface, i.e. at street level. This significantly improves the ability to establish an accessible route from the hardware to the vehicle.

Consider alternatives for the orientation of the charging hardware. Depending on the charging space layout, the location of the access aisle and the associated accessible route, achieving accessibility may be more feasible by orienting the charging hardware at 45, 90 or 180 degrees to the charging space.

Operational Standards

Fuel dispensers are required to comply with ANSI 309 "Operable Parts" which includes three key elements:

1. Charging hardware must be installed with a clear floor space as defined in ANSI 305. A frontal approach on an accessible route will satisfy the typical clear floor space requirement (30" wide and 48" long), but the dimensions will vary if the approach is from the side (parallel), if the hardware is in an alcove, or if there are surrounding obstructions.

2. Operable parts must comply with the reach ranges specified in ANSI 308. The default unobstructed range of 15" minimum to 48" maximum applies to the charging connector at the end of the cord as well as to other operable controls on the charging hardware.

   Note that the 2011 National Electrical Code (NEC) Section 625 "Electric Vehicle Supply Equipment" requires minimum connector heights of 18" for indoor installations and 24" for outdoor installations, so compliance with the NEC should satisfy the minimum reach requirement for accessibility. The NEC maximum allowed height for the connector is also 48".

   When hardware controls include the use of a display screen it is recommended that owners assess the visibility of the display from a wheelchair seated position. ANSI 707.7 addresses display screens for Automatic Teller Machines and Fare Machines by requiring that the screen be visible from a point located 40" above the center of the clear floor space in front of the machine. That specification could be used as a model for assessing display screens on charging hardware if desired.

3. Gas pump nozzles are explicitly exempted from the maximum activating force requirement. This exemption may be interpreted to apply to electric charging connectors as well. This will likely only be a concern for high-power charging equipment.

Note that ANSI 707 "Automatic Teller Machines (ATMs) and Fare Machines) may apply to charging stations if they incorporate hardware and controls for assessing fees for the use of the charging space.

Protection

Curbs, bollards and wheel stops may be used to protect the charging hardware and/or delineate an accessible route. However, any of these protection devices may also obstruct access, introduce a trip hazard or make it more difficult to establish an accessible route from the charging space to the charging hardware. It is recommended to simply install the minimum protection required.

Accessible Parking at a Public Library

Figure 1. Accessible public charging station at the Durham County Main Library, Durham, NC.

Several key design features are visible in Figure 1, which is a photograph of public charging stations at a county library:

- Provision of a van-accessible charging space (eight foot wide space with adjacent access aisle greater than eight feet wide)
- Provision of an accessible route from the parking space to the charging hardware that is greater than 48" in width
- Mounting of the charging hardware at street level and set back from the original curb line
- Mounting of the charging hardware such that it is not in the direct line of vehicle travel to reduce the need for protection by bollards
- Installation of bollards no closer than four feet to each other to avoid obstructing the accessible route
- Connection to an accessible route, from the charging space to the nearest entrance of the library, which is approximately 50 feet longer than the route from the farthest existing ADA-marked parking space at the site

Wheel stops were placed four feet from the curb to indicate an accessible route to the front of a parked vehicle. In retrospect, these wheel stops may be unnecessary, with omission providing drivers greater flexibility for vehicle positioning.

Accessible Parking at a Human Services Facility

Figure 2. Charging stations at the Durham County Human Services Complex, Durham, NC

Figure 2 shows the side view across charging spaces at a county human services facility. This installation uses the same design shown in Sample Design #1. While wheel stops can preserve an accessible route at the front of the charging space, note that omitting them gives drivers more flexibility in the ideal positioning of their vehicle.

Consider alternatives for the orientation of the charging hardware. Depending on the charging space layout, the location of the access aisle and the associated accessible route, achieving accessibility may be more feasible by orienting the charging hardware at 45, 90 or 180 degrees to the charging space.

APPLICABLE CODES & STANDARDS

Over-Protection Should be Avoided

Figure 3. Over-protection can hinder accessibility of charging stations

Figure 3 shows charging hardware that has been installed with a two foot curb extension, protective bollards and wheel stops. Despite the adjoining access aisle and the sidewalk's generous width of nearly six feet, this charging hardware may not be deemed accessible due to the protective elements creating obstruction to the space. Furthermore, the space length has been reduced to less than 13 feet from the wheel stop to the end of the stripe, which may only accommodate compact vehicles.

On-Street Accessible Parking is Challenging

Figure 4. On-street van-accessible parking requires lots of adjacent space.

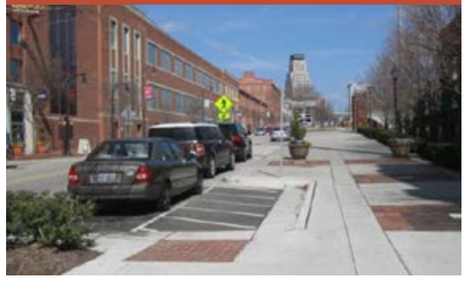


Figure 4 shows an example of van-accessible on-street parking. This space does not include PEV charging at this time, and would likely require additional curb removal at the front of the space to accommodate access to the charging hardware. Figure 4 illustrates the large amount of adjacent space required for an access aisle in this configuration. Typical adjoining sidewalks on existing streets may not be wide enough to accommodate this type of installation.

References

The national accessibility standards may be found online in several formats:

- ***ANSI Standard A117.1-2009 "Accessible and Usable Buildings and Facilities"***
  - + Viewable online (with no fee) at: http://publicecodes cyberregs.com/icc/ansi/2009/a117p1/icc_ansi_2009_a117p1_cover.htm?bu=IC-P-2009-000025
  - + Available for purchase in pdf, CD-ROM or soft cover format at: http://www.iccsafe.org/Store/Pages/Product.aspx?id=9033S09
- ***DOJ 2010 ADA Standards for Accessible Design***
  - + Available for download in pdf or html formats, along with companion guidance manual, at: http://www.ada gov/2010ADAstandards_index.htm

Advanced Energy performed a national survey of EVSE-related accessibility guidelines and regulations as part of the research and discussion to establish requirements and recommendations for North Carolina. Two references stand out as key sources of information for any entity intending to address accessibility:

- ***"EV Project: Accessibility at Public EV Charging Locations"***
  - + Available at http://www.theevproject.com/downloads/documents/EV Project - Accessibility at Public EV Charging Locations (97).pdf
- ***"Electric Vehicle Infrastructure: A Guide for Local Governments in Washington State"***
  - + Available at http://www.commerce.wa.gov/DesktopModules/CTEDPublications/CTEDPublicationsView.aspx?tabID=0&ItemID=8851&MI=863&wversion=Staging

INSTALLATION LOCATIONS

Single-Family Housing

Residential Garage

- Simple, most basic installation
- Level 1 or 2 charging
- Charging typically occurs early evening/overnight
- Limits exposure to the elements
- Prevents unwanted access

Carport/Driveway

- Increased exposure to the elements
- External cords present increased potential for trip hazards
- Requires greater ability to withstand weather and physical damage
- Historical home considerations may need to be addressed (See Appendix A)

On-Street Parking

- Parking location does not usually belong to the homeowner
- No means of ensuring necessary space will be available when needed
- Presence of sidewalk presents increased potential for trip hazards; possible reason for inspection failure from permitting entity
- Potential solutions of installing a curb-cut or a driveway require approval/permits from local municipality or permitting entity

Multi-Family Housing

- Similar to single-family housing in terms of time-of-day charging and general power requirements, but installation requirements may be more similar to parking lots and decks
- More difficulty in ability to reserve a space and utilize a circuit that can be directly tied to the vehicle owner, leading to a more often need for a new meter and/or communications
- Will likely need to involve the homeowners association (HOA)/property management.

Apartment Buildings

- Lack of property ownership on the part of the vehicle owner
- Charging infrastructure will need to be owned and maintained by the apartment building/ parking owner
- Limited potential to directly tie the charging station into an existing apartment electric circuit
- Building/parking owner will likely need a new utility meter to charge directly to the vehicle owner or may need to develop another means to recoup costs without charging for electricity

Condominiums and Townhomes

- Vehicle owner may have limited ownership of resources
- Parking spaces may be reserved for specific persons
- HOA or other organization typically involved and must approve installations
- Limited ability to utilize an existing meter or panel

Non-Residential

Mixed-Use

Mixed-Use locations are a combination of multi-family housing and retail parking. Unless parking is specifically designated, these parking locations should be treated as retail locations.

Workplace

- Second most common location for charging infrastructure
- Charging occurs during the day and may overlap with a utility's peak hours
- Can serve both fleet vehicles and company employees
- Typical usage duration is lower than residential charging, but greater than public or retail charging
- Potential for multiple vehicles to use the same charging station leads to greater probability that the station may require data collection and communication capabilities

Long-Term

- Parking in which vehicles are likely to be left for more than a day, such as airport and other multi-modal transit locations
- Due to duration of parking, this scenario will typically be best served with a Level 1 connection

Retail

- Organization offers charging to customers, rather than tenants or employees
- Charging will occur during the day and by multiple vehicles, which increases the need for charging control strategies and data collection
- Retailers offering charging to customers may seek reimbursement for the cost of providing the equipment and electricity
- NOTE: Reselling of power is illegal in most locations throughout the United States; however many retailers may look to find various means of recovering the cost of installation. If this were to occur, additional communications would be required along with a payment system.

Public

- Parking is provided by a municipality, other government organization or private company which is not seeking to sell any additional product or serve employee needs
- Many organizations may look to provide free charging to either encourage the adoption of plug-in vehicles or to provide an offering that will bring additional vehicles to a particular lot or deck. If not, organizations may require communications and data collection to assist with cost recovery to support the provision of charging.
- Installation of charging stations in a road Right of Way (ROW), may require an Enchrachment Agreement from the proper entity (See Appendix B)

INSTALLATION PREPARATION

When contacted regarding the installation of a charging station, planning is vital. Taking the time up front to gather specific information will allow for time savings over the course of the installation.

The following information provides a general overview of the installation process, and is broken down into three steps.

STEP 1
PREP WORK

STEP 2
ON-SITE EVALUATION

STEP 3
INSTALLATION + INSPECTION

Please note the following series of checklists provides a simplified version of this process based on location.

STEP 1: PREP WORK

After gathering initial information from the customer, it is important to suggest actions the customer can take in order to save time during the installation process.

Contacting the Utility

The customer should contact their local utility to inform them vehicle charging infrastructure will be installed at the site.

The customer should ask their utility the following questions:

- **Are there any incentives or different rate structures that may save the customer cost in installation or ongoing electricity cost?**
- **What is the size of the electrical service to the site? The utility may be able to provide knowledge as to the likelihood of needing a service upgrade based on the existing service and the intended number of charging stations.**

If there has been a determined need for a service upgrade or a new meter, an appointment should be made with a utility planner to visit the site. When possible, this should be coordinated with the contractor.

The customer may find it easier to allow the contractor to speak directly with the utility regarding the installation. If so, the customer will need to contact their utility and provide permission for the contractor to speak with the utility regarding the particular site.

Contacting the Local Permit Office

Different jurisdictions may have slightly different requirements or processes regarding the permitting, installation and inspection of charging stations. The contractor should contact the permitting office with jurisdiction over the installation site to identify specific requirements. Requirements of interest are listed below.

Concealment

While uncommon, certain municipalities may require charging stations are concealed with a hedge, fence or other object.

Engineering Calculations

Municipalities may require load calculations to be performed and/or stamped by a licensed engineer.
This can vary based on the location and number of charging stations to be installed.

If engineering calculations are required, the contractor should coordinate the assessment time with the visit of a utility planner (if deemed necessary), the initial contractor visit and the customer's schedule. If these cannot be coordinated, each visit should be encouraged to happen as quickly as possible and all information should be reported to the contractor.

STEP 1: SITE INFORMATION

✓ CHECKLIST

Address _____

An address must be available in order to obtain a permit in most areas. If an address does not exist for the parking area, the building address for the supporting parking site may be used in many areas. In some cases where a dedicated meter is installed, a new address may be needed. The local permitting entity should be contacted for questions regarding address assignment.

Location Type

Identify as one of the following:

	SINGLE-FAMILY OR DUPLEX	MULTI-FAMILY	MIXED USE	RETAIL	WORKPLACE	PUBLIC
Garage	○	○	○			
Driveway/Carport	○	○	○	○	○	○
Parking Lot		○	○	○	○	○
Parking Deck		○	○	○	○	○
On-Street	○	○	○	○	○	○

Does Customer have ownership of the site in which charging station(s) will be installed? ○ YES ○ NO

NO Does the customer have necessary approval to install charging station(s) at site? ○ YES ○ NO

YES The customer should have authorization form available upon site visit and/or be willing to sign forms claiming permission to install charging station(s) at the site.

NO The customer will need to obtain approval from site owner.

Intended Uses

In order to ensure proper technology selection and charging station placement, it is important to understand the intended use of the charging station(s). The intended use should be one or more of the following:

○ Personal ○ Fleet ○ Employee ○ Customer ○ Visitor

Customer Decisions

The customer will make a number of decisions regarding the installation. All decisions should be reviewed to ensure requirements will be met and to avoid potential problems. Remaining decisions should be finalized following the initial on-site portion of this process.

Vehicle Type

○ NEV

Neighborhood Electric Vehicles have a maximum speed of 25 miles per hour and typically have different charging requirements than highway-capable vehicles.

○ PEV

Electric vehicles include plug-in hybrids and all-electric vehicles. Plug-in hybrids typically have smaller batteries than all-electric vehicles; however, infrastructure needs are typically the same.

Vehicle Make _____

Model _____

This information will allow for knowledge of the vehicle's power inlet location as well as any specific requirements or suggestions the vehicle manufacturer may have. The following items may be known or desired by the customer. It is important to note this difference.

Charging Station Make _____

Model _____

From this information, the contractor can determine important information regarding the charging station including the following:

Mounting Type

○ Bollard ○ Wall-mount

○ Pole-mount ○ Ceiling-mount

Number of charging stations to be installed: _____

It is important to understand whether this number refers to number of stations or the number of cord sets (which references the number of vehicles that can be served simultaneously).

Communications Requirements

○ Ethernet ○ Cellular ○ Wi-Fi

○ None ○ Other (specify) _____

NEMA Enclosure Type _____

Physical Dimensions

Height _____ Width _____ Depth _____

Base Dimensions (for bollard units): _____

Cord Length _____

**Ensure Charging Station meets necessary UL standards*

Parking Location

Have specific parking spaces been selected?

○ YES ○ NO

Power Source

Has a power source been selected?

○ YES ○ NO

YES Does the customer have ownership of the power source? ○ YES ○ NO

YES The customer must provide proof of approval and/ or be willing to sign documentation claiming necessary approval. This circumstance may result in the need for a separate utility billing meter.

NO Does the customer have approval to use the power source? ○ YES ○ NO

Approval must be gained prior to installation. Use of a power source without necessary approval is considered electricity theft and is illegal.

NO The contractor will need to aid in this decision during the on-site portion of this process.

STEP 2:
ONSITE EVALUATION

Number of Charging Stations

Number of charging stations should be defined as the total number of cord sets. This must be determined before moving on to further steps in the evaluation process.

Surveying Charging Station Locations

Contractors are encouraged to use the following site surveying guidelines for surveying charging station locations. Locations are site-specific and include:

Residential Garage

Residential Carport/Driveway

Parking Decks and Spaces

Parking Lots and Spaces

On-Street Parking and Spaces

STEP 2:
CHARGING STATION SELECTION

✓ CHECKLIST

Charging Station Selection Guidelines

Once the necessary information is gathered and appointments are coordinated, the contractor will visit the site. The first site visit will answer any additional questions and resolve any decisions yet to be made. The charging station selected will influence the site selection and vice versa. If the customer has selected both the charging station and the site in advance, it will be important to check that NEC is adhered to and potential problems are avoided.

Whether a charging station has already been selected or still needs to be selected, contractors should ensure the charging station meets the following guidelines:

	The selected charging station:	✓ YES	✗ NO
1	Meets UL requirements and is listed by UL or another nationally recognized testing laboratory.	○	○
2	Has an appropriate NEMA rated enclosure (NEC 110.28) based on environment and customer needs, such as weatherization or greater levels of resistance to water and corrosive agents (see NEMA Enclosure Type Table, Appendix C).	○	○
3	Has been selected based on customer's vehicle (most vehicles recommend a maximum of a 240V / 32A circuit (40A breaker), though some vehicles may have different requirements.)	○	○
4	Cord is less than 25' in length (NEC 625.17).	○	○
5	Cord length is determined to reach a vehicle's charging inlet without excessive slack.	○	○
6	Cord management methodologies have been considered to reduce the risk of tripping hazards and accidental damage to the connector.	○	○
7	Mounting type selection has been based on requirements to meet site guidelines ◢ ***Bollard and Pole-mount*** works best in carports/driveways, parking lots and on-street parking locations. ◢ ***Wall-mount*** works best where a wall or pole exists or can be installed at reasonable cost and while maintaining site guidelines. ◢ ***Ceiling-mount*** works best in residential and parking garages or in any location where a sturdy overhead structure can be installed at low cost and within site guidelines.	○	○
8	***Communications are not required.*** Speak with customer and the local utility to determine whether communications are desired or may be beneficial to the customer.	○	○

SURVEYING CHARGING STATIONS: RESIDENTIAL GARAGE

SURVEYING STEPS

1 Consider available space on floor, walls and ceiling.

- Ensure overhead doors do not conflict, along with other objects.
- Ensure installation does not conflict with vehicle ability to park in garage.

2 Note the location of the charging port on the expected vehicle.

- If no vehicle has been selected, most vehicles are expected to have a charging port toward the front end of the vehicle.

3 Note whether the homeowner typically backs into the garage or pulls in head-first.

4 Compile steps two and three to determine where the charging port is likely to be when parked in a garage.

- Eliminate locations in a garage requiring a cord to be wrapped around or draped over the vehicle in order to reach the charging port.

5 Ensure remaining locations best meet guidelines for a residential garage as follows:

LIGHTING

REQUIREMENTS Garages are required by the NEC to provide a switch-controlled lighting outlet (NEC 210.70).

RECOMMENDATION Ensure functionality of lighting in garage.

CONNECTOR HEIGHT

REQUIREMENTS Mount the connector at a height between 18" and 48" from the ground (NEC 625.29).

RECOMMENDATION Mount the station such that the connector is at a height between 36˝ and 48˝ from the ground, unless otherwise indicated by the manufacturer.

ENCLOSURE HEIGHT

REQUIREMENTS Per manufacturers' specifications.

RECOMMENDATION Install wall/pole-mount stations and enclosures at a height above 36˝. Greater heights are typically recommended, provided the connector can be mounted below 48˝.

SPACE AROUND ENCLOSURE

REQUIREMENTS Ensure sufficient space exists around electrical equipment for safe operation and maintenance (NEC 110.26).

RECOMMENDATION A space 30˝ wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3´ from the front of the enclosure without physical obstruction, at a height of 6´ 6˝.

TRIPPING HAZARD MITIGATION

REQUIREMENTS None

RECOMMENDATION Charging stations be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk. Charging stations should also be mounted in close proximity to the vehicle charge port.

PHYSICAL DAMAGE PREVENTION

REQUIREMENTS Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27)

RECOMMENDATION: When possible, placement of the enclosure above 36˝ may be sufficient in a residential garage. When possible, placement of the charging station out of the line of vehicle travel is advised. If desired, a wheel stop or protective bollards may be installed as well.

6 If spaces are comparable, selection based on cost and/or ease of installation is advised.

If no locations meet criteria, consider locations not based on items #2 and #3 and discuss with customer.

SURVEYING CHARGING STATIONS: RESIDENTIAL CARPORT/DRIVEWAY

SURVEYING STEPS

1 Consider available parking areas.

- If a particular charging station has been selected, eliminate surfaces to which it cannot mount.

2 Note the location of the charging port on the expected vehicle.

- If no vehicle has been selected, most vehicles are expected to have a charging port toward the front end of the vehicle.

3 Note whether the homeowner typically backs into the driveway or pulls in head first.

4 Compile steps two and three to determine where the charging port is likely to be when parked in a driveway or carport.

- Eliminate locations requiring a cord to be wrapped around or draped over the vehicle in order to reach the charging port.

5 Ensure remaining locations best meet guidelines for a residential carport or driveway as follows:

LIGHTING

REQUIREMENT None

RECOMMENDATION Lighting should minimize the risk of tripping, vehicle impact and vandalism. Charging stations should be installed in a well-lit location. If no lighting exists, the installation of a separate lighting circuit should be discussed with the homeowner. A light level of a minimum of 2 foot candles is recommended.

CONNECTOR HEIGHT

REQUIREMENT Mount the station such that the connector is at a height between 24˝ and 48˝ from the ground (NEC 625.30(B)).

RECOMMENDATION Mount the connector at a height between 36˝ and 48˝ from the ground unless otherwise indicated by the manufacturer.

ENCLOSURE HEIGHT

REQUIREMENT Per manufacturers' specifications.

RECOMMENDATION For wall/ pole-mount stations, enclosure should be installed at a height above 36˝. Greater heights are typically recommended, provided the connector can be mounted below 48˝.

SPACE AROUND ENCLOSURE

REQUIREMENT Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).

RECOMMENDATION A space of 30˝ wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3´ from the front of the enclosure without physical obstruction, at a height of 6´ 6˝.

TRIPPING HAZARD MITIGATION

REQUIREMENT None

RECOMMENDATION Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk. Charging stations should also be mounted in close proximity to the vehicle charge port.

PHYSICAL DAMAGE PREVENTION

REQUIREMENT Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).

RECOMMENDATION When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection. Wheel stops may be beneficial; however they may present a tripping hazard in poorly lit areas.

6 If spaces are comparable, selection based on cost and/or ease of installation is advised.

If no locations meet criteria, consider locations not based on items #2 and #3 and discuss with customer.

SURVEYING CHARGING STATIONS: PARKING DECKS AND SPACES

SURVEYING STEPS

1 Select appropriate parking spaces based on the following criteria:

VISIBILITY

- Locations more visible to drivers and pedestrians are less likely to be vandalized.

PROXIMITY TO BUILDING ENTRANCE OR OTHER DESTINATION

- Particularly important in locations where vehicle charging is viewed as an incentive, such as retail locations and places of work.

PROXIMITY TO POWER SOURCE

- Typically an electrical closet, this translates to shorter run length and fewer barriers to avoid or bore through, saving cost.

LENGTH OF PARKING SPACES

- If there is a difference in length of parking spaces in a parking deck, longer spaces will allow for greater room to fit a charging station while maintaining usability and limiting the risk of vehicle impact.
- It is important that the installation of a charging station does not shorten parking spaces to below minimum local zoning requirements.

WIDTH OF PARKING SPACES

- Wider parking spaces decrease the risk of a cord set being damaged if it lies to the side of PEV, connected or otherwise.

LIGHTING

- A well-lit parking space translates to a lower risk of tripping and damage to the charging station from vehicle impact or vandalism.

ADA ACCESSIBILITY

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook.

WEATHER

- If possible, placement of charging station toward the interior of a parking deck can improve the life of a charging station and improve user perception of safety. Charging station enclosures should be selected to meet weather conditions.

2 Survey the charging station at the particular parking space(s)

CONSIDER AVAILABLE SPACE ON FLOOR, WALLS AND CEILING.

- If a charging station has been selected, only consider appropriate mounting surfaces.

3 ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR A PARKING DECK AS FOLLOWS:

LIGHTING

- ***REQUIREMENT*** Lighting in parking decks and lots is typically governed by a location's zoning codes.
- ***RECOMMENDATION*** Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Recommended light levels at the charging station are recommended to be five foot candles or higher.

CONNECTOR HEIGHT

- ***REQUIREMENT*** Connector will be mounted at a height between 24˝ and 48˝ from the ground (NEC 625.30(B)). Most parking decks, unless fully enclosed, are considered to be outdoor locations.
- ***RECOMMENDATION*** Connector should be mounted at a height between 36˝ and 48˝ from the ground.

ENCLOSURE HEIGHT

- ***REQUIREMENT*** Per manufacturers' specifications.
- ***RECOMMENDATION*** For wall/ pole-mount stations, the enclosure should be installed at a height above 36˝. Greater heights are typically recommended, provided the connector can be mounted below 48˝.

SPACE AROUND ENCLOSURE

- ***REQUIREMENT*** Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).
- ***RECOMMENDATION*** A space 30˝ wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3´ from the front of the enclosure without physical obstruction, at a height of 6´ 6˝.

TRIPPING HAZARD MITIGATION

- ***REQUIREMENT*** None
- ***RECOMMENDATION*** Charging stations be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.
- ***RECOMMENDATION*** Charging stations with multiple cords should be placed to avoid crossing other parking spaces.
- ***RECOMMENDATION*** Use informative signage to identify potential tripping hazzards.

PHYSICAL DAMAGE PREVENTION

- ***REQUIREMENT*** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ***RECOMMENDATION*** When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection where there is sufficient space. Wheel stops may be beneficial; however they may present a tripping hazard in poorly lit areas.

ADA CONSIDERATIONS

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook.

SURVEYING CHARGING STATIONS: PARKING LOTS AND SPACES

1 Select appropriate parking spaces based on the following criteria:

VISIBILITY

- Locations more visible to drivers and pedestrians are less likely to be vandalized.

PROXIMITY TO BUILDING ENTRANCE OR OTHER DESTINATION

- Particularly important in locations where vehicle charging is viewed as an incentive, such as retail locations and places of work.

PROXIMITY TO POWER SOURCE

- Selecting spaces close to an existing transformer or panel with sufficient electrical capacity will save cost.

AVOIDANCE OF EXISTING INFRASTRUCTURE AND LANDSCAPING

- Installing charging stations close to existing infrastructure or trees can cause damage which may result in higher costs, potential hazards and other undesirable outcomes.

LENGTH OF PARKING SPACES

- If there is a difference in length of parking spaces in a parking deck, longer parking spaces will allow for greater room to fit a charging station while maintaining usability and limiting the risk of vehicle impact. It is important the installation of a charging station does not shorten parking spaces to below minimum local zoning requirements.

WIDTH OF PARKING SPACES

- Wider parking spaces decrease the risk of a cord set being damaged if it lies to the side of PEV, connected or otherwise.

Additionally, wider spaces provided space for proper operation of the charging station and plugging the PEV in should the charge port be located in the side of the vehicle.

LIGHTING

- A well-lit parking space may reduce the risk of tripping and damage to the charging station from vehicle impact or vandalism. Additionally, it may aid in the operation of the charging station, including plugging the vehicle in.

ADA ACCESSIBILITY

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook.

2 Survey the charging station at the particular parking space(s)

CONSIDER AVAILABLE SPACE ON FLOOR, WALLS AND CEILING.

- If a charging station mounting type has been selected, eliminate types of location that do not match (ie: ceiling-mount units may not work on walls).
- Ensure installation does not conflict with vehicle's ability to park within the space and to adequately use the charging station and plug in the vehicle.

PARKING LOTS

- Parking lots can be assumed to use head-in parking for consistency.

NUMBER OF CORDS

- If a charging station has been selected, or if a particular model is desired, note the number of cord sets per charging station.
- The charging station should be placed to provide direct access to each parking space without a cord being draped across another space and without blocking walking paths.

3 ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR A PARKING LOT AS FOLLOWS:

LIGHTING

- ***REQUIREMENT*** Lighting in parking lots is typically governed by local zoning codes. Review local codes to ensure compliance.
- ***RECOMMENDATION*** Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Lighting levels are recommended to be two foot candles or higher.

CONNECTOR HEIGHT

- ***REQUIREMENT*** Connector will be mounted at a height between 24˝ and 48˝ from the ground (NEC 625.30(B)).
- ***RECOMMENDATION*** Connector should be mounted at a height between 36˝ and 48˝ from the ground.

ENCLOSURE HEIGHT

- ***REQUIREMENTS*** Per manufacturers' specifications.
- ***RECOMMENDATION*** For wall/pole-mount stations, the enclosure should be installed at a height above 36˝. Greater heights are typically recommended, provided the connector can be mounted below 48˝.

SPACE AROUND ENCLOSURE

- ***REQUIREMENTS*** Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26).
- ***RECOMMENDATION*** A space 30˝ wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3´ from the front of the enclosure without physical obstruction, at a height of 6´ 6˝.

TRIPPING HAZARD MITIGATION

- ***REQUIREMENT*** None
- ***RECOMMENDATION*** Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.

PHYSICAL DAMAGE PREVENTION

- ***REQUIREMENT*** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ***RECOMMENDATION*** When possible, placement of the charging station out of the line of vehicle travel is advised. Protective bollards can offer significant protection where there is sufficient space. Wheel stops may be beneficial in areas where bollards are not feasible.

ADA CONSIDERATIONS

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook.

SURVEYING STEPS

SURVEYING CHARGING STATIONS: ON-STREET PARKING & SPACES

1 Select appropriate parking spaces based on the following criteria:

VISIBILITY

- Installations along streets with high foot and vehicle traffic, especially at night, are less likely to be vandalized.

PROXIMITY TO POWER SOURCE

- Selecting spaces close to an existing transformer or panel with sufficient electrical capacity will save cost.

AVOIDANCE OF EXISTING INFRASTRUCTURE AND LANDSCAPING

- Installing charging stations and conduit close to existing infrastructure or trees can cause damage which may result in higher costs and potential hazards.

LIGHTING

- A well-lit parking space may reduce the risk of tripping and damage to the charging station from vehicle impact or vandalism.

ADA ACCESSIBILITY

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook. .

2 Survey the charging station at the particular parking space(s).

CONSIDER AVAILABLE MOUNTING SPACES

- Most on-street charging stations will be either bollard or pole-mount units.

PULL–IN SPACES

- For pull-in spaces, charging stations should be placed in front of the space and either centered on the space or placed between two spaces.
- Centered stations can serve one vehicle while stations placed between spaces can serve two vehicles.
- Charging stations with two connectors should be placed between spaces. Charging stations with more than two connectors should not be used in on-street locations.

PARALLEL PARKING

- For parallel parking locations, the charging station should be installed at the front third of a parked vehicle, based on the direction of traffic flow.
- Charging stations with single connectors are typically recommended due to the lower potential trip hazard versus a station with multiple connectors.

3 ENSURE REMAINING LOCATIONS BEST MEET GUIDELINES FOR ON-STREET PARKING AS FOLLOWS:

LIGHTING

- ***REQUIREMENT*** Lighting on streets is typically governed by local zoning codes. Review local codes to ensure compliance.
- ***RECOMMENDATION*** Ensure lighting is functional and discuss the addition of a separate lighting circuit if lighting levels are determined to be insufficient. Lighting levels are recommended to be two foot candles or higher.

CONNECTOR HEIGHT

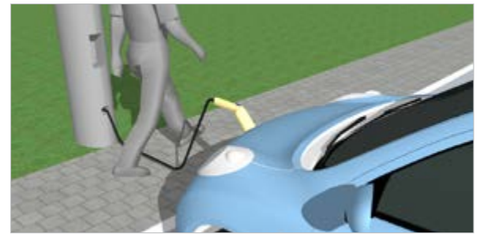
- ***REQUIREMENT*** Connector will be mounted at a height between 24˝ and 48˝ from the ground (NEC 625. 30(B)).
- ***RECOMMENDATION*** Connector should be mounted at a height between 36˝ and 48˝ from the ground.

ENCLOSURE HEIGHT

- ***REQUIREMENTS*** Per manufacturers' specifications.
- ***RECOMMENDATION*** For wall/ pole-mount stations, it is advised the enclosure be installed at a height above 36˝. Greater heights are typically recommended, provided the connector can be mounted below 48˝.

SPACE AROUND ENCLOSURE

- ***REQUIREMENTS*** Sufficient space will exist around electrical equipment for safe operation and maintenance (NEC 110.26)
- ***RECOMMENDATION*** A space 30˝ wide or the width of the charging station, whichever is greater, should be maintained to a depth of 3´ from the front of the enclosure without physical obstruction, at a height of 6´ 6˝.



TRIPPING HAZARD MITIGATION

- ***REQUIREMENTS*** None
- ***RECOMMENDATIONS*** Charging stations should be placed as to minimize the intersection of cords with typical walking paths. Stations mounted at greater heights and equipped with cord management technologies may further reduce this risk.

PHYSICAL DAMAGE PREVENTION

- ***REQUIREMENTS*** Equipment operating above 50 volts will be protected against accidental physical damage (NEC 110.27).
- ***RECOMMENDATIONS*** Use protective bollards for on-street locations. Wheel stops may be beneficial in preventing vehicles from impacting the bollards.

ADA CONSIDERATIONS

- See a summary of requirements and recommendations for compliance with the Americans with Disabilities Act at the beginning of this handbook.
- ***RECOMMENDATION*** Charging stations should not be placed if a cord will drape across a pathway. The width of the pathway should be kept as great as possible in order to minimize liability. A pathway width of more than 48˝ is highly recommended and greater widths are recommended when possible.

STEP 3:
INSTALLATION + INSPECTION

Installation will vary based on type of site and number of stations to be installed; however, the processes will be similar.

PROCESS:

1 Post permit at site in visible location

2 Excavation

- Excavation includes any removal of material for the purpose of running conduit and/or wiring as well as being able to install a charging station.
- Typical actions include removal of drywall, insulation, pavers and concrete or pavement, as well as hand digging, trenching, boring and drilling.
- ***NOTE*** In areas where existing infrastructure is in place (determined from utility marking), hand excavation is generally advised versus mechanical excavation.

3 Run Conduit from power source to station location

- Conduit should be run in most locations. Residential garages may allow for the use of nonmetallic-sheathed cable and do not require conduit to be run.
- For charging stations rated more than 60 amperes, a separate disconnect is required (NEC 625.23) and should be installed when running conduit. Some customers may desire a separate disconnect for stations rated below 60 amperes as well. A separate disconnect should be visible from the charging station.
- Note: Chapter 3 of the NEC addresses wiring methods and materials. Many options exist. Contractors are strongly advised to examine requirements for installation sites and types of wiring and conduit to be used.

LESSON LEARNED An interpretation of the NEC does not consider removable pavers to be sufficient in decreasing required depth of conduit.

4 Rough Inspection

- An initial electrical inspection should take place after conduit has been run and prior to connecting equipment and running wires.
- If the installation does not pass inspection, the contractor will need to correct any items discussed by the inspector and schedule a second rough inspection prior to moving on to the next step.
- ***NOTE*** For some installations, typically detached or semi-detached homes, this may be the only inspection required.

5 Pull Wires

- Charging equipment is considered to be a continuous load.
- Conductors should be sized to support 125 percent of the rated equipment load (NEC 625.21).

6 Prepare mounting surface per charging station manufacturer instruction

- Floor-mount: typically requires a concrete foundation allowing conductors to enter through the base of the charging station and appropriate installation of J-bolts based on station base plate.
- Wall/ Pole/ Ceiling-mount: brackets may be installed to allow for the mounting of the charging equipment.

7 Mount Charging station(s)

- Ensure equipment is level and mounted in accordance with manufacturer instructions.

8 Install protective bollard(s) and/or wheel stop(s) if necessary

9 Install any electrical panels or sub-panels that may be necessary

10 Utility work performed

- Service upgrades, new service or and/ or new meter is installed. The utility may also pull a meter in order to allow for the charging station wires to be connected to a panel.

11 Make electrical connection

12 Perform Finish Work

- Replacement of drywall
- Burial of conduit and conductors
- Filled and compacted as necessary
- Replacement of walking surfaces
  - Concrete
  - Asphalt
  - Pavers

NOTE If any existing infrastructure has been damaged during excavation or installation, repairs should be made prior to finish work.

13 Final Inspection

- If required, the inspector will examine wiring, connections, mounting and finish work, and ensure the charging station is safe for operation in its given location.

14 Performance Verification

- If possible, the contractor should verify the charging station functions properly.

CHECKLIST

STEP 3: INSTALLATION PREPARATION

Following the initial site visit, the contractor should prepare for the installation phase of the process. Complete the following checklist:

- **Price quote submitted to customer and approved.**
  Ensure total cost of installation including utility upgrades and all other work is understood by the customer.
- **Order equipment including selected charging station(s).**
- **If determined to be necessary, Engineering calculations are performed and stamped.**
  Contact local permit department for questions regarding the need for load calculations.
- **Site plan modification complete with necessary diagrams.**
  Typically required for parking lots, decks and on-street parking
- **Service upgrade and/or new service assessment complete or unnecessary.**
- **Permit application complete with site plan modification, load calculations and any other information deemed necessary by the local permitting department**
- **Permit is approved.**
- **Scheduling (all necessary parties are contacted and scheduled)**

  Additional contractors

  - Boring
  - Concrete
  - Paving or Other Surface Restoration

  Utility work

  - Utility marking
  - Service upgrade
  - New service
  - Meter pull

- **Utility marking of existing power lines, gas lines and other infrastructure should take place prior to installation. Utilize "Call Before You Dig" services.**

CHECKLIST

FULL PROCESS CHECKLIST

		ACTION	PERSON RESPONSIBLE	
STEP 1	1	Decision made/approval obtained to install charging station		
		◢ Single-Family home (excludes street parking)	Residential Owner	
		◢ Multi-Family Home	Property Owner/HOA	
		◢ Individual Townhome/Condominium	Owner (must gain approval for installation from HOA/similar group)	○
		◢ Apartment Complexes	Parking Owner	
		◢ Workplace, Retail, Public Lots/Decks	Parking Owner	
		◢ On-Street Parking, Residential Owner (obtaining permit and reserving parking space)	Residential Owner	
		◢ On-Street Parking, Non-Residential	Right of Way Owner	
	2	Charging level and number of charging stations determined	Owner	○
STEP 2	3	Charging station(s) selected	Owner	○
	4	Location survey complete and Parking space(s) selected	Owner/Contractor	○
	5	Power source selected	Owner/Utility	○
	6	Installation estimate made	Contractor	○
	7	Need for electrical upgrade determined	Contractor/Utility	○
	8	Estimate approved/accepted	Owner/Contractor	○
STEP 3	9	Permit application filed (including site plan, if applicable)	Contractor	○
	10	Electrical upgrade completed, if required	Utility	○
		◢ Panel upgrade/new panel	Contractor	
		◢ Service upgrade/new service	Utility	
		◢ New meter	Utility	
	11	Power restored	Utility	○
	12	Installation	Contractor	○
	13	Inspection	Inspector	○
	14	Work completed/Performance verified	Contractor	○

GLOSSARY

Charging Station
Device that transfers power to a PEV while providing proper grounding, shock protection, overload protection and general communication.

Electric Vehicle Supply Equipment (EVSE)
The official term for electric vehicle charging infrastructure; more commonly referred to as charging stations.

J1772 Standard
Defines a common charging plug for PEV charging stations

Mounting Style
Refers to placement/location of charging stations such as: Bollard (Floor), Wall, Ceiling or Pole mount

NEC
National Electrical Code

NEMA
National Electrical Manufacturers Association

PEV
Plug-in Electric Vehicles

Power Supply Owner
Depends on location; can have a variety of owners ranging from the electric utility to the customer. Important to identify the owner of the power supply and develop an agreement that allows for the power supply to be used. Note: if the customer is not the parking and power supply owner, it will be important to gain approval from applicable groups, such as home owner associations, prior to any installation work.

UL Standards
Safety standards for charging electric vehicles developed by Underwriters Laboratories

Utility Contractor
Individual from utility that provides service upgrade, new service, new electric panel or new meter if/when needed

Utility Planner
Verifies the need for a utility contractor to be brought in following the assessment of the electrical contractor. In any event, the electric utility should be notified of installations in order to ensure grid reliability.

APPENDIX A:
SPECIAL INSTALLATION CASE: HISTORICAL HOMES

The Regulation of Historic Homes

A historic property is an official building, structure, object, site or district worthy of preservation for its significance in American history, architecture, archaeology and culture. The National Register of Historic Places is a government agency that registers and lists the nation's historic properties. Its purpose is to ensure that properties significant in national, state and local history are considered in the planning of federal activities, and to encourage historic preservation at the state and local government level and within the private sector. The listing of a property in the National Register places no restrictions on what a private property owner using private resources can do to maintain or alter their property. Each state has a Historic Preservation Office and associated local historic preservation commissions that oversee historic preservation in the state and may have established local preservation laws that must be adhered to.

PEV Charging in Historic Homes and Areas in North Carolina

The North Carolina State Historic Preservation Office does not issue statewide laws or guidelines for historic areas. Local historic preservation commissions are responsible for the design review guidelines for historic landmarks or districts based on procedures and standards required by the enabling legislation.

At the writing of this report, no local commissions that were queried have guidelines or regulations specifically addressing PEV charging stations on historic properties. However, the expectation is that charging stations will be treated as any other "above-ground utility structure" installation, such as satellite dishes, HVAC equipment, electric panels, etc. A general guideline with such installations is that they should be installed so they are not visible from a public right-of-way or a surrounding yard. Often, they are located on a rear roof elevation or on the ground behind the building. Landscaping can also be used to conceal these structures.

Design review of a proposed charging station installation might be based on size, location and appearance of the charging station. Consideration would also be given to the installation of required power

lines. Power for the station would need to be carefully routed for the protection of large trees and other landscaping on the property.

In addition to aesthetic considerations, a concern for PEV charging in historic properties is the available electrical capacity. Supplying a 40 amp circuit for a PEV charging station might pose challenges for some homes and buildings if they haven't had an electrical service upgrade.

Overall, the queried local preservation commissions did not foresee charging station installation being a problem, but they acknowledged that each commission would have to review the installations on a case-by-case basis.

Resources

North Carolina State Historic Preservation Office
www.hpo.ncdcr.gov/default.htm

North Carolina Historic Preservation Commissions
A complete list of all historic preservation commissions in North Carolina
www.hpo.ncdcr.gov/commstaf.htm

Preservation North Carolina
A private non-profit membership organization that conducts preservation advocacy, education, and stewardship programs, as well as operates a fund for the sale of historic properties
www.presnc.org

APPENDIX B:
ENCROACHMENT AGREEMENTS

If you are considering installing an electric vehicle charging station in a road Right-of-Way (ROW), this Encroachment Agreements guide provides information to help with this process through asking key questions and connecting with the correct decision making authorities. Charging stations for plug-in electric vehicles (PEVs) are being placed in a variety of locations to serve electric vehicle drivers. These locations include not only off-street parking lots, but on-street parking as well. For charging stations installed to serve on-street parking facilities, the installer generally must obtain a ROW encroachment agreement from the proper entity.

Who Maintains the Road?

In many cities, there is a mixture of locally maintained and state maintained roads. The first step will include determining who maintains the road so the installer will know who to approach to obtain an encroachment agreement.

- ***MUNICIPALITIES*** Municipalities are granted the authority to control public streets, and other ways of public passage within its corporate limits (NCGS 160A-296) and within this power is the right to grant easements, as long as the easement doesn't hinder the use of the public passage way (NCGS 160A-273).
- ***STATE*** The North Carolina Department of Transportation issues encroachment agreements for state maintained roadways.
- ***PRIVATE*** For privately maintained roads, the charging station installer will need to contact the appropriate entity who is responsible for the road maintenance.
- ***RECOMMENDATION*** Determine which entity maintains the road. If the road is state-maintained, then speak with the local DOT District Office.

Considerations for Installation of a Charging Station in the Road ROW

- ***PROCESSING TIME*** Encroachment agreements, in some cases, can take four-to-six weeks or even more, depending on the agency who issues the easement and the situation.
- ***RECOMMENDATION*** First contact the entity that owns and maintains the ROW to go over any site specific considerations and to understand the time needed to process the permit. By understanding the process up front, time can be built into the installation process.
- ***OWNERSHIP AND MAINTENANCE*** When installing a charging station within a ROW, the entity who is responsible for the ownership and maintenance of the charging station may have additional responsibilities when compared to a charging station on a private lot. Additionally, there may be restrictions on the type of entity that may be able to install a station within the ROW.
- ***EXAMPLE*** Some entities may restrict the installation of charging stations to only public sector owners.

Underground Utilities in the Right-of-Way

- ***UNDERGROUND UTILITIES IN THE RIGHT-OF-WAY*** Many times underground utilities including water, sewer, electric, cable and other lines may run directly adjacent to the road. This may impede the installation of a charging station. Also, it may be the responsibility of the person obtaining the encroachment agreement to locate underground facilities and to bear the burden of repair if any of these lines are damaged during the charging station installation.
- ***SIGNAGE*** When charging stations are located in the ROW, there may be additional regulations on the types of signage that is permitted or restricted.
- ***EXAMPLE*** Signage may be restricted to posting information only, with no station branding or other types of logos.

Performance Bond

- ***RECOMMENDATION:*** In some cases a performance bond for the installation of the charging station may be required. A performance bond would be held by the entity who issues the encroachment agreement to ensure the installation is in compliance with the applicable codes. The performance bond may be required to be held for a period of time after the installation.

Additional Resources

- Charging Station Installation Handbook by Advanced Energy: Recommendations for siting and installing charging stations www.advancedenergy.org/transportation/resources
- Southeast Regional EV Readiness Workbook, Sections 3.1.1, 3.2.3, 3.4.5

Disclaimer

Advanced Energy makes information available to enhance public knowledge. The information in this guide is provided "as is" and at your own risk. Advanced Energy does not make any representation or warranties of any kind, express or implied, about the accuracy, suitability for any purpose, merchantability of, title to or usefulness of the information in this guide.

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APPENDIX C:
NEMA ENCLOSURE TYPE

		Indoor Enclosures						Outdoor (Weatherproof) Enclosures									
		1	2	5	12	12K	13	3	3R	3S	3X	3RX	3SX	4	4X	6	6P
REQUIREMENTS	Sufficient for Indoor Applications	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
	Sufficient for Outdoor Applications							•	•	•	•	•	•	•	•	•	•
RECOMMENDATIONS	Dust Resistant			•	•	•	•	•		•	•		•	•	•	•	•
	Salt Resistant										•	•	•		•		•
	Pressurized Water Resistant													•	•	•	•
	Able to be Submersed															•	•
	Ice Resistant									•			•				

Notes
Naming convention is in reference to Table 110.20 in the National Electric Code (2008). See the most recent edition for any updates.
All NEMA enclosures are acceptable for permit and inspection with indoor applications. The determination of whether a location is considered 'indoors' is at the discretion of the inspector.
Outdoor enclosures provide weatherproofing capability. Such enclosures will pass inspection for the majority of outdoor applications, as well as indoor applications.
Dust resistance for indoor enclosures refers to settling dust while resistance for outdoor enclosures refers to windblown dust. Dust resistant enclosures are also considered 'raintight'.
Enclosures are resistant to corrosive agents including salt. This may be a consideration when installing charging stations in coastal areas and areas where roads are salted.
The resistance to pressurized water may be a consideration when charging stations are expected to be cleaned with a hose or power washer. Such enclosures are referred to as 'watertight'.
The ability to withstand submersion may be a consideration when installing charging infrastructure in a floodplain. NEMA 6P enclosures are resistant to prolonged submersion.
Ice resistant enclosures are able to operate while covered in ice. This may be a consideration for extreme instances in which ice covering is likely.

RAMP UP YOUR KNOWLEDGE

There's more to successfully implementing electric transportation than just installing charging stations. In fact, communities and municipalities should be wary of installing free or low-cost systems without proper planning.

As adoption and integration of PEVs becomes more mainstream, there is a need to review, analyze, test and evaluate available charging stations. Additionally, communities will need to have a clear understanding of each vendor's offerings in order to determine the best solution for each site. Education and outreach efforts are integral components. From workshops, training and webinars to web-based tools and best practices guides, Advanced Energy continues to drive the future of electric transportation.

Equipment Evaluation

Advanced Energy's interactive, web-based tool – Charging Station Technology Review for Plug-in Electric Vehicles – compares charging stations from various vendors across the United States. A result of an ongoing comprehensive review of technical information submitted by commercial vendors, service providers and other interested parties on EVSE, this online tool includes an overview of:

- Charging equipment and related systems/services
- Use of "smart charging" concepts
- Projected maintenance/repair schedules and costs
- Anticipated charging station billing models/systems

Learn more at http://www.advancedenergy.org/transportation/evse.

Prepare for the Road Ahead

Preparation for electric vehicles begins with a good plan. It may be tempting to jump forward with implementation, but experience in rollout cities across North Carolina has shown the benefits of taking the time to assemble a planning team, educating the planning team on PEVs, and defining short- and long-term goals.

It's not a question of if PEVs are adopted into mainstream culture – it's knowing that your local government, public utilities, permitting offices, electricians and code inspectors and other key stakeholders will be ready to support the demand as it occurs. We can help!

From stakeholder development and decision support to on-site assessments, performance evaluations and codes and standards guidance, our unique model allows us to guide you remotely – providing the technical knowledge to keep you on track and moving forward.

Advanced Energy's "Train-the-Trainer" approach builds your local training capacity, providing you with the ongoing capability to educate staff and new hires. Through classroom style and hands-on workshops, we work with communities to initially educate trainers on performing the critical details needed for successful completion of the tasks mentioned throughout this handbook. Additionally, our courses can also be customized to fit your specific needs.

Proper planning defines critical requirements, eliminates unnecessary work, streamlines necessary work and avoids implementation problems. Collaborative input from business, industry, government and academia will greatly contribute to efforts and viability. Advanced Energy also offers a Community Planning Guide to Electric Transportation to help communities:

- Identify opportunities
- Educate consumers
- Establish a sound infrastructure
- Develop relationships
- Explore opportunities for economic development

WHY ADVANCED ENERGY?

The electric transportation experts at Advanced Energy know handing a community a list of recommendations does not solve all of the challenges that must be overcome to move electric transportation forward; however, we help define ways to accomplish tasks smarter. We get excited about solving problems that no one else has solved, and we embrace new ideas and new ways of thinking. Our passion is to stimulate communities, utility partners and consumers with innovative technologies and ideas, to offer solutions, and to bring transformation and viability to the marketplace, enriching the lives of many.

Advanced Energy's Electric Transportation Initiatives team is working to assist communities in understanding, planning and implementing electric transportation initiatives. An established figure in the development and deployment of plug-in electric vehicle technologies, Advanced Energy has worked with our utility partners since 1991 to understand the potential of electric transportation through the conversion of several vehicles to all electric. We shifted our focus in 2001 from all electric vehicles to plug-in hybrids with the creation of the Plug-In Hybrid Electric School Bus Program. In 2003 we issued a comprehensive study showing the potential energy and emissions benefits of creating plug-in hybrid school buses. Through partnerships developed by Advanced Energy, we successfully facilitated the creation the world's first commercially available plug-in hybrid vehicle through this program in 2007.

Advanced Energy also works with municipalities, electric utilities and National Laboratories monitoring and evaluating the performance of numerous fleets of plug-in hybrid vehicles across the country. Advanced Energy currently manages the NC Get Ready program to accelerate the adoption of electrified transportation in North Carolina – one of the key initiatives in the nation making a true commitment to the widespread acceptance of electrified transportation. NC Get Ready is supported by a consortium of cities, government officials, industry leaders and not-for-profit organizations. The electric utilities Progress Energy and Duke Energy are also key supporters of this initiative. Today we continue to advance electric transportation through associations, supply-chain consulting, applied research, and decision support. For more information, visit www.AdvancedEnergy.org.

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