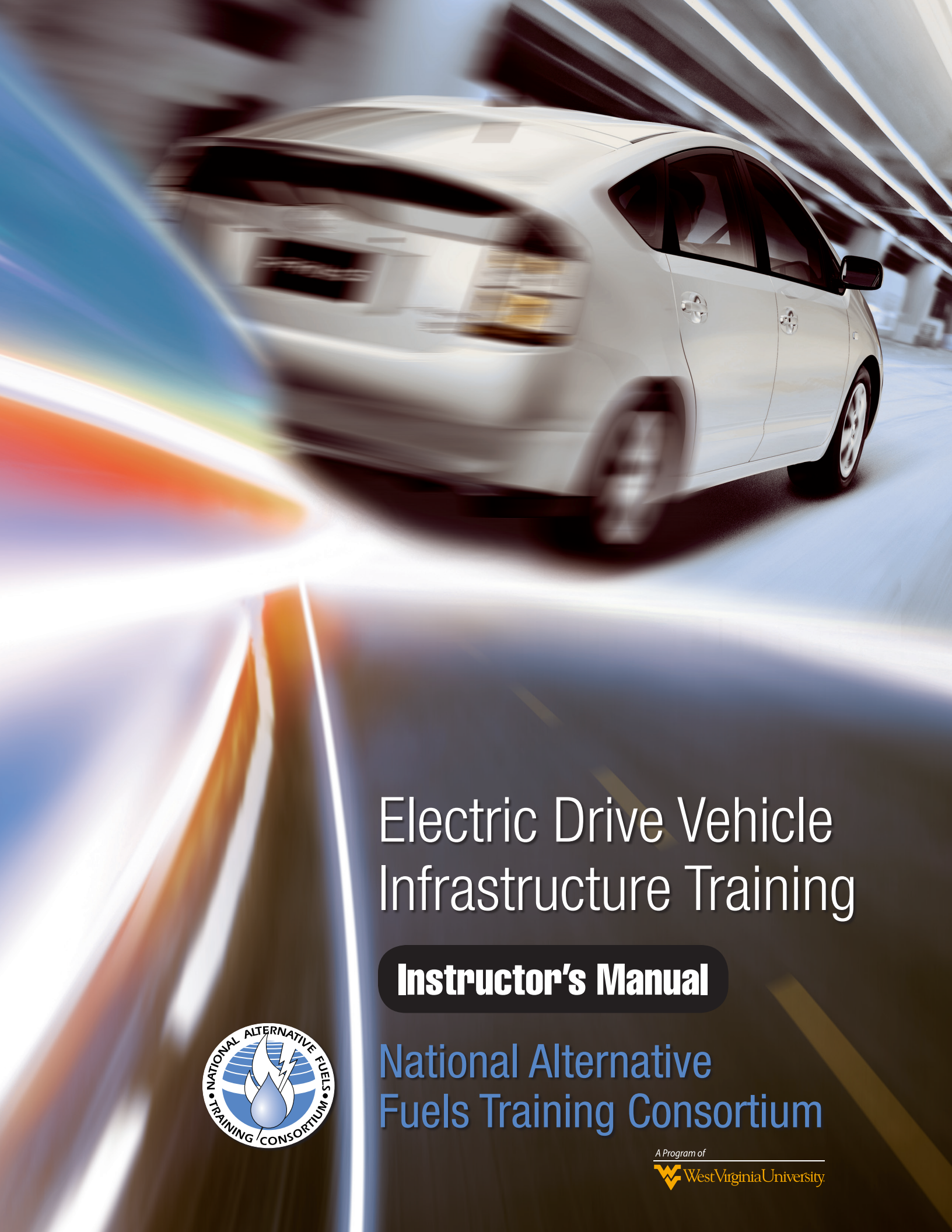

Electric Drive Vehicle Infrastructure Training

Instructor's Manual

National Alternative Fuels Training Consortium

A Program of

WestVirginiaUniversity

Part 4: Electrical Distribution System: Service Panel to Receptacle

PPT 4-14

Overview of Service Panel

The role of the service panel is to distribute power throughout the home or building as well as disconnect the power from any incoming electrical feed. It is the only location inside of the home where all of the electrical power can be shut off all at once. The service panel, also called the electric panel, breaker box or fuse box, is both the entry and distribution points for all of the circuits. All branch circuits go to the home or building's outlets/receptacles, switches and appliances from this service panel.

Review Question No. 6

There is typically only one service panel that feeds electricity to the entire home or building location. However, subpanels may be installed to serve a garage or other outside need. The service panel provides the ability to access all of the circuit breakers that are stacked within the panel. On the side of the service panel door is usually an outlined document or sticker identifying each circuit breaker to indicate the relative appliance or circuit it serves. It also will note any unused breaker space.

Service Panel Amperage Sizes

PPT 4-15

Typical service panel amperage sizes are:

- 100 amps
- 150 amps
- 200 amps
- 400 amps

The service panel amperage sizes vary for different locations. For individual residences, amperage sizes would include 100amps, 150amps, 200amps, and 400amps for larger electric-powered homes. For apartment building and multi-unit dwellings, typical amperage sizes would be 60amps to 100amps for each individual apartment or dwelling. For business and commercial locations, amperage sizes vary greatly. The range in amperage sizes could be from 60amps to 800amps, as the electricity needed could be to support an individual office or a warehouse, heavy duty electrical equipment, or other commercial process requiring large amounts of power. The amperage size will depend on whatever is needed to supply the business loads. The business location may be on a single phase or multiple phase system depending upon the load needed to support the purposes of the business.

It is important to adhere to safety regulations required for the space and clearance around service panels. In an emergency, a service panel must always be readily accessible in order to be able to shut off the electricity to the home or business. The service panel cannot be obstructed by another object in front of it or on the side of it that can restrict the opening of the service panel door. The required clearance and space around the service panel is 3 foot deep, by 2.5 feet wide, by 6.5 feet in height.


PPT 4-16

Older and Outdated Service Panels

More than half of homes today were constructed before 1970 and were built decades before some of the more modern electrical conveniences. In some of these homes, they will have no more than 60amp electrical service. Unless the older home's electrical service has been upgraded, it is most likely being electrically overburdened and cannot safely handle the electric demands of today's electrical devices.

Some examples of older and outdated service panels include fuse boxes, Federal Pacific Electric panels, and Zinsco panels. Fuse boxes used to be the most common type of circuit protection before World War II. Fuse boxes still exist in many older homes even though they are quite old. Two of the most common types of fuses for the fuse box are plug/glass fuses and cartridge fuses.

The Federal Pacific Electric Panels have problems in failing to provide proper safety and protection for homes. Some of the problems included breakers failing to trip forcing an overcurrent, and short circuits overheating and causing fires. Whenever this type of panel is found within a house, it is recommended that a new service panel be installed.

There are also difficulties with the Zinsco panels as well, as they also have historically failed to operate properly. The Zinsco panels have show to overheat and melt in certain scenarios when an increase in electrical demand was placed on it.

It is important to note that whenever these types of older and outdated service panels are identified, they should have a new service panel installed by a certified electrician as well as their electrical service upgraded by their utility company. The content in this manual will be focused on up to date service panels utilizing circuit breakers.

Benefit of New Service Panels

As the electricity from the electric meter must enter the home or location, it is beneficial to have the service panel mounted back to back with the electric meter. This design saves on the installation expense on running cable, as well as installing a second cutoff panel near the electric meter base, which is required by most electrical codes.

Circuit Size Needed	125% Continuous Load Circuit Breaker Size	Appropriate AWG Size
15 amps	(18.75) 20amps	12 AWG
20 amps	25 amps	10 AWG
25 amps	(31.25) 30-40amps	10 or 8 AWG
30 amps	(37.4) 40amps	8 AWG
35 amps	(43.75) 50 amps	8 AWG
40 amps	50 amps	8 AWG
45 amps	(56.25) 60 amps	6 AWG
50 amps	(62.5) 65 amps	6 AWG
60 amps	75 amps	4 AWG
70 amps	(87.5) 90 amps	3 AWG
80 amps	100 amps	3 AWG
90 amps	(112.5) 115 amps	2 AWG
100 amps	125 amps	1 AWG
110 amps	(137.5) 140 amps	1/0 AWG
125 amps	(156.25) 160 amps	2/0 AWG
150 amps	(187.5) 190 amps	3/0 AWG
175 amps	(218.75) 220 amps	4/0 AWG
200 amps	250 amps	250 AWG
225 amps	(281.25) 285 amps	300 AWG
250 amps	(312.5) 320 amps	400 AWG


PPT 4-31

Circuit Review

The following will provide an overview of the journey of the circuit. Circuits originate at the service panel that houses electricity provided by the two thick hot wires. The black hot wires are attached to the two hot bus bars, and one neutral wire is attached to the neutral bus bar. These three wires originate from the electric meter (it is important to remember that there is also the ground bus bar as well in the service panel). Depending upon the amount of electricity a circuit needs to deliver, the circuit may attach to one hot bus bar and the neutral bus bar to supply 120 volts of electricity, or to both hot bus bars for 240 volts of electricity. The means of attachment for a circuit to the hot bus bars, neutral bus bar and ground bus bar are through the circuit breaker. As we have discussed, the circuit breaker protects the circuit from surges in the current. Neutral conductors are connected to the ground bus bar or to a grounding wire which renders the neutral wires to be grounded. Unlike the hot bus bars, the neutral bus bar does not have an overcurrent protection device; i.e. circuit breaker. The neutral wire can maintain 0 volts at all times.

A circuit's journey begins and ends all at the same place. A loop is a useful analogy when understanding the circuit's path. The current begins at a power source. It then powers the appliance or device along the circuit (remember the loop analogy) and then returns to the power source.

A review of the pathway and flow of electricity through the home can described with the following description. Electricity passes through the utility transformer outside the home, and leaves the transformer through three wires (two hot and one neutral). The three wires constitute a service drop, which is a voltage stepped down by the utility transformer to the amount of voltage needed for the home. The service drop travels to the home, either above or below ground. The wires go to the house and down the service entrance conduit to the electric utility meter (which records and keeps track of the electrical activity). The wires from the electric meter continue to the service panel, where the two hot wires are fed to the 2 hot bus bars and the grounded neutral wire is fed to the neutral bus bar. The service panel contains circuit breakers which are connected to the two hot bus bars and wired to the neutral bus bar. The circuit breakers distribute current through circuit wiring within the home and then the current is returned to the panel through the neutral white wire. From here the electricity that has been returned to the service panel then travels back through the electric utility meter which it is measured and back to the utility transformer. Electricity can never actually be consumed, you only "borrow" it. You transform much of its energy though and that is what you pay for to the utility company.

Branch Circuits

Each of the circuit breakers in the service panel controls electricity on a branch circuit. It is a loop of wire that runs from the service panel, out to the receptacles where the appliances are plugged in and then back to the panel.

PPT 4-32

Dedicated Branch Circuits

A dedicated branch circuit means that the circuit is dedicated to one particular device. The circuit has its own circuit breaker and it is intended for a single use and will power only one specific outlet or device. This type of circuit is designed to ensure that the circuit is used to power the specific appliance will not be overloaded, the power supply will be uninterrupted, and the operating conditions will remain safe. The dedicated circuit is mostly used for large appliances such as a range, water heater, air conditioner, and clothes dryer. This type of circuit can be either 120 volts or 240 volts.

Review Question No. 11

Hardwired

Hardwired refers to appliances and devices that are wired directly to the circuit wires. They are not connected through a receptacle, but rather the circuit supplies electricity to the appliance directly through its direct connection with the appliance.

Receptacles

Receptacles are commonly referred to as outlets that are used to provide an individual appliance or device a place to "plug in" for power distribution. Residential housing frequently uses 120 volts, 15amp and 20amp receptacles (outlets) for household equipment. Also included in residential housing are receptacles providing appliances with 240 volt and 30amp service.

PPT 4-33