Commercial Electrical Inspection Course:
Historic Wyoming Bank

STUDY GUIDE

About This Course

Welcome to CCPIA's Historic Wyoming Bank Electrical Inspection Course.

This online course includes a series of videos and readings that follow a commercial electrical inspection of an historic bank building in Wyoming. There is a final exam at the end of the course. Upon successful completion, the student will be able to download a Certificate of Completion for the course.

Goal

The goal of this course is to teach the student the key items to look for during a commercial property inspection of the electrical system and its components. Many of the items and defects pointed out in this course are in accordance with the National Electrical Code (NEC)®, and are common findings within various commercial property types and renovated buildings.

Although a commercial property inspector is not a code official, it's important for the inspector to be familiar with these items while performing an inspection, conducting research on a property, and/or reviewing documents provided by a specialty consultant.

Objectives

Upon successful completion of this course, the student will be able to:

- identify common defects at a commercial property's electrical system;
- define common electrical terms and their applications; and
- perform an electrical inspection of an historic commercial building.

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Lesson 1: Introduction

This course will follow CCPIA Instructor Bob Aey as he performs an electrical inspection of the historic First National Bank in Rock River, Wyoming. The First National Bank was originally built in 1919, but has undergone more recent renovations. Some components of its electrical system were redone a year prior to Bob's inspection. As you'll see in this course, a recent alteration or repair on a building doesn't mean that finding defects is less likely.

This course covers:

- the service entrance;
- interior subpanels;
- and a walk-through of the rest of the building, including the kitchen, public safety alarm system, and other built-in components.

Lesson 2: Terms and Definitions

- **appliance:** Equipment that performs a function, such as a heater or air conditioner.

- **arc-fault circuit interrupter (AFCI):** A device that provide protection from the effects of arc faults by recognizing arcing, and de-energizing the circuit when an arc fault is detected.

- **bonded:** To be connected in order to establish electrical continuity and conductivity.

- **code:** The National Electrical Code (NEC)® and the National Electrical Safety Code, or other local codes or regulations in effect.

- **conduit:** Tube or covering used to protect and route electrical wiring.

- **device:** A unit of an electrical system, other than a conductor, that is intended to carry or control but not utilize electricity, such as switches and thermostats.

- **disconnect means:** A device by which the conductors of a circuit can be disconnected from their supply source.

- **electrical mast:** Vertical section of conduit that encloses the wiring between the service entrance and service drop.

- **feeder:** Cables or overhead lines that feed the electricity in an electrical distribution system.

- **ground:** A conducting connection between an electrical circuit or equipment, and earth, or some conducting body that acts as earth.

- **ground-fault circuit interrupter (GFCI):** A device that protects a person by de-energizing a circuit when a current to ground exceeds the value for the device.

- **knob-and-tube wiring:** A generic term that describes a system of wiring installed between the late 1800s and 1940s.

- **listed:** Equipment, materials or services included in a list published by an organization that is acceptable to the authority having jurisdiction (AHJ).

- **meter:** A device for measuring the electrical power and energy supplied to a building.

- **point of attachment:** The first point of contact on a building, mast or structure at which the service drop is attached.

- **receptacle:** A contact device installed at the outlet for the connection of an attachment plug.

- **remote head:** A stand-alone lamp with no internal power supply.

- **service:** Conductors and equipment used for delivering energy from the service utility to the wire system of the building.

- **service disconnect:** The first disconnect device after the utility meter.

- **service drop:** The portion of the overhead conductors between the utility company's distribution line and the first point of attachment on the building.

- **service entrance:** Wiring from the point of attachment or termination of the service drop or service lateral to and including the service equipment on the building.

- **subpanel:** A single panel that houses buses and over-current protection devices that connect the main service panel and branch circuits.

- **terminal:** The point at which a conductor, device or network comes to an end; commonly, the end of a wire that could be fitted with a connector or fastener.

- **weatherhead:** Weatherproof service-drop entry point where overhead wires enter a building, or where wires transition between overhead and underground cables.

- **wiremold:** Plastic molding that's designed to be attached directly to the wall with wires enclosed inside.

Lesson 3: Service Entrance

Start the inspection at the service entrance with the point of attachment. The point of the attachment is where the utility company spans overhead wires to the mast. The mast is where the conduit is sticking above the roof.

Defects:

1. Service-drop point of attachment: The point of attachment should be at least 1 foot below the weatherhead.

   In the video, the distance is short.

2. Coupled conduits on a mast: When conduits are coupled on a mast, the conduits should always be on the bottom.

   In the video, the short piece of pipe is at the top and the 10-foot pipe is below.

   The strain is greatest at the top of an overhead mast service. When the shorter piece of pipe is at the top, the support and strength of the mast may not be sufficient to hold the weight of snow, rain, wind, and other environmental factors. The mast may lean or collapse if not placed correctly.

3. Straps on rigid metal conduit (RMC): Conduit straps are required every 10 feet.

   In the video, there should be a strap within 3 feet of the meter, and another within 10 feet.

   Strapping ensures that the conduit is securely fastened. Generally, RMC and electric metallic tubing (EMT) should be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, conduit, body, or other conduit termination. Additionally, EMT must also be fastened within 3 feet of tubing termination.

   Fastening can be increased to a distance of 5 feet where fastening can't be secured within 3 feet. In some instances, conduit isn't required to be securely fastened within 3 feet of the service head for above-the-roof termination of a mast.

4. Meter height: Most utility companies set the meter at a height of no more than 6 feet from the ground to the top of the meter.

In the video, the meter is set too high and may cause accessibility issues.

The minimum height required for an electric meter box is 4 feet from the bottom of the meter to the ground level. Some utility companies may have different minimum and maximum heights, but they'll likely be within 1 foot of these requirements.

5. Conduit sealing: Conduit that transitions from inside to outside must be sealed to prevent pests from entering and condensation from forming.

   In the video, the conduit was replaced but not sealed through the wall.

6. Single-wire lugs: Single-wire lugs do not allow multiple wires under the same lug.

   In the video, there are two wires under a lug not listed for two holes. Wires should be terminated separately.

7. Cracked main breaker: A cracked breaker typically occurs when the breaker is forced into position, excessive current or load occurs, or when the set screw enclosing the electrical wire in the breaker slot is too tight.

   The system may still function with a crack or chip in the breaker, but this is still a safety concern and should be addressed.

   In the video, the set screw below the breaker is pushed forward and twisted. It is likely that someone over-tightened the set screw, which cracked the breaker.

8. Neutral-to-ground bond: The grounded (neutral) conductor should be separated from the metal parts of electrical equipment to prevent fire, electrical shock, and improper operation of circuit protection devices. This should be done in a manner that prevents objectionable current from flowing on conductive materials, electrical equipment, or on grounding and bonding paths.

   In the video, a ground wire is passing through a metal fitting. The fitting should be bonded on both sides. A common solution is a plastic fitting placed there.

9. Service grounding: The service is required to be grounded typically with one or two 8-foot ground rods.

   In the video, there isn't a ground rod present. It is typically under the ground's surface, but in the video, the ground wire isn't connected to anything. The service is essentially ungrounded.

Lesson 4: Subpanel, Exposed Ceiling Wires, and Emergency Lighting

This video starts at the subpanel. The subpanel is defined as a single panel that houses buses and over-current protection devices that connect the main service panel and branch circuits. The video then discusses the exposed ceiling and reviews information about emergency lighting systems.

Defects:

1. Proper panel labels: All breakers in every panel should be labeled to identify the main area or appliance served by the breaker's circuit. Labels may be stickers or handwritten, but they should always be next to the specific breaker or on a paper adhered to the inside of the panel door.

   In the video, none of the breakers is labeled.

2. Conduit sealing: Conduits that transition from inside to outside must be sealed to prevent pests from entering and condensation from forming.

   In the Service Entrance video, a lack of conduit sealing was noted on the exterior of the building. In this video, a lack of proper conduit sealing is also observed, which can cause air to migrate from the exterior to inside the subpanel. If the conduit isn't properly sealed, rust will form.

3. Quality indicator: The common practice for a two-phase electrical system in the U.S. is to indicate phase A as black and phase B as red.

   In the video, the system is not color-coded, which can indicate a lack of quality of workmanship of the job performed by the electrician.

4. Vapor barrier: The panel should be equipped with a vapor barrier to protect against damage caused by condensation.

   In the video, the subpanel is attached to a block wall. It is suggested that the panel be attached to a piece of plywood or raised from the wall to avoid moisture buildup between the wall and the subpanel.

5. Knob-and-tube wiring: Buildings with knob-and-tube wiring can be difficult to insure because of the increased risk of electrical fire or shock.

   In the video, the exposed ceiling shows the presence of extensive knob-and-tube wiring.

6. Support for conduit in ceiling: Conduit present in the ceiling should be securely fastened and supported.

In the video, there is a 4-square junction box hanging from a piece of wire. The 4-square box should be secured and supported with something more permanent. Additionally, the fixture whips extending from the 4-square box to the light fixtures need to be securely fastened and supported, rather than hanging loosely.

In the video, there is also conduit stretching from the walls to the 4-square box. Supports should be extended to those two pieces of conduit, as well.

7. Emergency lighting: A commercial building that is used by the public must have exit lighting installed at all exit doors on both the interior and exterior of the building. The lights installed on the exterior of the building should be remote-head so that, in the event of a power failure, when it's dark outside, people aren't exiting into darkness.

   In the video, there isn't any exit lighting present.

   Commercial buildings also have exit sign regulations. Generally, all exits should be marked by a readily visible sign. There are a number of regulatory agencies and codes that govern emergency lighting and exit sign requirements. However, the local AHJ is whoever's responsible for monitoring and enforcing local building and/or fire codes.

Lesson 5: Kitchen

This video covers the kitchen in the historic Wyoming bank. It is obvious that this building has had major renovations. Some of the items in the kitchen are disconnected and should be removed. However, the layout of this kitchen is similar to one found in a home during a residential inspection.

The video starts at another subpanel and covers other items in the kitchen, including various receptacles and fixtures.

Defects:

1. Wiremold fitting: The proper wiremold fitting allows the wiremold to act as a grounding for the system.

   In the video, improper wiremold fitting is present on the junction box, thus cancelling the wiremold's ability to act as grounding. The fitting on the junction box is listed as an EMT pipe connector.

2. Missing knockout: Unused openings on an electrical box or panelboard should be closed for safety reasons, including preventing accidental shocks, preventing hot sparks from escaping, and preventing pests from entering.

   In the video, the junction box is missing a knockout.

3. Kitchen receptacles: All receptacles in commercial buildings are required to have GFCI protection for all 15- and 20-amp, single phase, 125-volt receptacles located in all bathrooms, rooftops, and kitchens.

   In the video, the multiple receptacles in the kitchen should have GFCI protection.

4. Two-prong receptacles: The two-prong receptacle is connected to two-wire cables and are inefficient for large kitchen appliances to be plugged into for long periods of time. This type of receptacle is ungrounded.

   In the video, it is suggested that the two-prong receptacle be removed.

5. Termination requirement: Each neutral and equipment ground wire is required to have its own set of screw termination lugs. These wires cannot share with each other. This point has been discussed in the other videos of this course as a common defect.

   In this video, the wires under the termination lug are loose. These wires should be tightly secured.

6. Conduit fill capacity: This is the maximum number of electrical wires that can be run inside the conduit. The fill capacity is based on the conduit type and size, plus the type of wire itself. The conduit fill capacity limits heat buildup and ensures that the heat inside the conduit can dissipate, rather than melting the vinyl insulation of the wires.

   In the video, the 2-inch conduit is stuffed with wires, which is unsafe. De-rating is recommended.

7. Missing outlet cover: All outlets and light switches should have covers to cover exposed wire. This is key in preventing an electrical shock.

   In the video, an outlet cover is missing.

8. Painted receptacle: The integrity of electrical equipment and its connections are set by prohibiting contamination by paint, plaster, cleaners, abrasives, and corrosive residues. Electrical equipment includes receptacles. Painted receptacles are a fire hazard because paint can harden inside the receptacle slots, which can cause the outlet to overheat.

   In the video, painted receptacles are observed.

Lesson 6: Thermostat and Heating System

This video covers the thermostat and heating system. Some of the defects in this video have already been addressed in this course and are not listed in this section's list of defects, but they should be listed in the inspection report.

Defects:

1. Improper cover: All wire boxes should have a proper cover.

   In the video, it is obvious that the wrong box cover is installed.

2. Extension cords: Extension cords should not be used as a substitute for permanent wiring. They should not be attached to permanently installed or stationary appliances. Permanently installed or stationary appliances, such as heating equipment, should have a grounded wiring system that is permanently installed.

Lesson 7: Fusible Combination Starter, the Vault, and Exposed Wires

The last video of this course covers a fusible combination starter that was connected to the public safety alert system (horn). A fusible combination starter will always be fastened shut. A screwdriver will likely be needed to open the box. This video also covers various locations of exposed wires.

Defects:

1. Fuse and amp consistency: In a combination motor starter disconnect, the type of amp for all fuses should be the same.

   In the video, the combination motor starter disconnect has various amps and types of fuses. The fuses installed include 40 amp and 35 amp, and renewable and non-renewable. A renewable fuse is labeled "REN," while a non-renewable amp is labeled "NON."

2. Conduit strapping: All conduit should be strapped. Generally, conduit should be supported within 3 feet of a box, with additional attachments no more than 10 feet apart.

   In the video, no strapping is present at this electrical system.

3. EMT connector: EMT connectors are used to secure EMT conduits to a metallic electrical box.

In the video, an incorrect connector is used to connect the conduit to the box. Make sure the connector on an electrical box matches the conduit application. This can be verified with listed and labeled packaging.

4. Exposed wiring: All exposed wire at a commercial property should be blanked off or removed.

   In the video, exposed wiring is present where a light fixture was installed. This is a safety hazard.