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TECHNICAL ARTICLE

Inspecting Existing Dwelling Electrical Systems Using NFPA 73

by Skip Walker September 2009

Many inspectors were contractors in some prior life. The progression from contractor to inspecting is fairly common. However, most of us with contracting backgrounds seem to have come from the "nail-pounding" side of the business. Because of this, it takes a while for many of us to become comfortable inspecting the electrical system in a dwelling. Luckily, there are some great books on this topic. My favorite is ***"Electrical Inspection of Existing Dwellings"*** *By Douglas Hansen, Redwood Kardon and Michael Casey*. CREIA is fortunate to have these gentlemen live in California and participate in our CREIA educational events. Personally, I try to never miss the opportunity to hear Douglas speak – no matter the topic. I seem to pick up some new tidbit every time.

The CREIA Standards of Practice give us the scope of work when we inspect electrical systems. The SOP's say the inspector shall:

SECTION 6 - Electrical Systems

A. Items to be inspected:

Service equipment

Electrical panels

Circuit wiring

Switches, receptacles, outlets, and lighting fixtures

B. The inspector is not required to:

Operate circuit breakers or circuit interrupters

Remove cover plates

Inspect de-icing systems or components

Inspect private or emergency electrical supply systems or components

At first glance, this may seem very basic. However, to properly evaluate the items listed is far from simple. CREIA Standards and California Business and Professions Code 7195-7199

require the inspector to identify "Material Defects." A "Material Defect" is a condition that significantly affects the Value, Desirability, Habitability, or Safety of the dwelling.

In our role as inspectors, we are not required to do anything that is unsafe; with electrical this is important because some of installations can have some very significant safety hazards lurking under those panel covers, in the crawlspaces, etc.

When inspecting electrical systems, another document that you may wish to review is ***NFPA 73 - Electrical Inspection Code for Existing Dwellings***. The intent here is not to expand the scope of work as defined in the CREIA Standards of Practice. Rather, it is to look at the areas we already cover in more detail. NFPA 73 is an optional electrical code. That means that unless it is specifically adopted by the local jurisdiction, it is not enforced. This is similar to the NFPA 211 document governing fireplaces. In my area, the San Francisco Bay Area, I am not aware of any jurisdictions that have adopted this document.

Development of NFPA 73 began in 1990. In deciding whether to develop the NFPA 73 code, the committee looked at statistical data from a number of sources. The original development drew on studies from NFPA, the insurance industry, Consumer Product Safety Commission (CPSC), National Institute of Standards and Technology (NIST). The data clearly shows that the risk of electrical fires is significantly lowered when the systems are installed and maintained in accordance with the electrical codes. One statistic that jumped out is that only 5% of all residential electrical fires occurred in homes ***less*** than 10 years old. Unlike wine, electrical systems do not improve with age.

The original version of NFPA 73 was adopted in 1993 as the "*Residential Electrical Maintenance Code for One- and Two-Family Dwellings."* The current version of the code is ***NFPA 73 - Electrical Inspection Code for Existing Dwellings 2006.*** This is available from NFPA at: http://www.nfpa.org/aboutthecodes/AboutTheCodes.asp?DocNum=73.
The cost is around $31.00 for non-members.

The NFPA document is around 18 pages long. The scope of the inspection is outlined Chapters 4 & 5. The areas to be inspected are broken down into several major categories. Each of these were identified as areas where improper installation/and or maintenance posed a significant safety issues, or could result in property loss or loss of life. I suggest that we look at NFPA 73 as a sort of "Best Practices" guide for electrical inspections.

The general electrical problem areas identified in NFPA 73 are:

1) *Services, Outside Feeders, and Outside Branch Circuits*
2) *Grounding Electrode Conductors*
3) *Panelboards and Distribution Equipment*
4) *Overcurrent Protective Devices*
5) *Cables, Cable Assemblies, and Conductors,*
6) *Flexible Cords and Cables*
7) *Raceways*
8) *Permanently Connected Luminaires (Lighting Fixtures)*

9) *Polarization of Luminaires (Fixtures)*
10) *Boxes and Enclosures*
11) *General-Use Switches and Receptacles*
12) *Appliances and Special Equipment Such As; Ground-Fault Circuit Interrupters, Smoke Alarms, Appliances and Utilization Equipment, Arc-Fault Circuit Interrupters, Ceiling-Suspended (Paddle) Fans*

Let's take a quick look at each of these areas in more detail.

- **Services, Outside Feeders, and Outside Branch Circuits**

  The service rating should be adequate for the loads imposed by the dwelling. Calculating the loads is technically exhaustive and beyond the scope of a general property inspection. Personally, I am of the opinion that any obvious issues should be noted in the report. A 100 Amp service panel on a 3,000 square foot property is probably too small and may prove inadequate given our electricity dependent life-style. The service entrance weather head and wiring should be evaluated to insure that it is properly secured, free from indications of damage or deterioration. Any exposed service entrance wiring should be inspected for indications of UV damage. The CEC 2007 specifically addresses this issue and requires the wiring to be UV rated or properly protected. The service entrance wiring should be installed with proper clearances to the roof, dwelling, openable windows, walking surfaces, etc. In most of California, the CEC does not actually govern service entrance clearance issues. The Public Utilities Commission (PUC) determines this. The local utility will publish the clearance requirements. In areas served by PG&E, they publish the "Green Book" that details the utility service access/clearance requirements in the PG&E service area. All the major providers will have a similar document.

  Service-entrance raceways and cables should be terminated with fittings or connectors that are approved for the type of raceways, cables, and environmental conditions. The service-entrance equipment should be readily accessible and have the required access and working area. The working area should be maintained to allow ready and safe operation and service. The service-entrance equipment, cables, raceways, or conductors should be inspected for evidence of physical damage, overheating, corrosion, or other deterioration.

  The service equipment must be effectively grounded. The grounding electrode conductor needs to be properly sized and terminated. The grounding electrode conductor should be connected to one or more grounding electrode(s) in order to provide a low impedance path to the earth. The system must have the current carrying capacity to prevent the buildup of voltages that would result in undue hazard to any connected equipment or to persons. All interior metal systems; i.e. as water piping, gas piping, etc. must be bonded to the electrical service grounding system.

- **Grounding Electrode Conductors**

  The grounding electrode conductor or bonding jumper connection to the grounding electrode must be made in a manner that will ensure a permanent and effective grounding path. Verify that the grounding electrode conductor is properly connected to the grounding electrode and that components show no visible evidence of physical damage or

deterioration. The grounding electrode conductor must be protected against physical damage. Metal enclosures/conduits providing physical protection of the grounding electrode conductor should be bonded at each end to the grounding electrode conductor. The grounding electrode conductor should be continuous unless specifically permitted to be spliced or joined. Any splices should be made using permanent/approved means. Any tap ground conductors connected to the grounding electrode conductor should be connected in such a manner that the grounding electrode conductor remains continuous without a splice. The dwelling grounding electrode system and other grounding systems, such as those for communications, CATV, and satellite, must be bonded together.

- **Panelboards and Distribution Equipment**

  It is important that panelboards and distribution equipment be accessible. The required access and working space should be provided and maintained to permit safe operation and maintenance of the equipment. No storage is permitted in this area. The panelboards and distribution equipment should be inspected for evidence of physical damage, overheating, corrosion, or other deterioration. All cables or conduits entering the equipment shall be fastened with approved connectors. Any unused openings must be sealed/closed using a material that is equivalent to the characteristic of the panelboard or distribution equipment. All metal parts must be effectively grounded or bonded using approved fittings. All dead-front panels, partitions, or parts of the enclosure should be properly installed to ensure protection from live parts. The dead-front panels should be listed for the panelboard. The labeling for all disconnecting means should conform to the following:

  1) All disconnecting means for motors and appliances, and each service, feeder, or branch circuit at the point where it originates, should be legibly marked to indicate its purpose unless located and arranged so the purpose is evident.
  2) The marking shall be capable of withstanding the environment involved.
  3) The designations should not be subject to change over time; i.e. the blue bedroom versus the northeast bedroom.

- **Overcurrent Protective Devices**

  All overcurrent protective devices should be rated for the conductor under the conditions of use. The overcurrent protective devices should be inspected and must not show evidence of physical damage or overheating. All connections and terminations at the overcurrent protective devices should be tight and not show evidence of corrosion. The wire size should not be too large for the overcurrent protective device terminal. Most overcurrent protective devices are designed for wires no more than one standard size larger than the device ampacity rating. The overcurrent protective devices must be Listed and used or installed in accordance with any instructions included in the listing or labeling. In most cases, the overcurrent brand should match the panelboard brand. Where there is evidence of overfusing of or tampering with Edison-based-type fuses, Type S non-tamperable adapters and fuses are required to be installed.

- **Cables, Cable Assemblies, and Conductors**

The inspector should examine all exposed cables and cable assemblies to ensure that they are properly supported to prevent physical damage to the cable or cable assembly. All of the cables and cable assemblies entering a panelboard, box, or device should be properly secured and supported as required. This is to ensure that any stress is not transmitted to the conductors and termination(s). All conductors must be terminated as required at panelboards, devices, and boxes. The connections must be properly tightened, but must not damage the terminal lugs or the conductors. The inspector should verify that the conductor size is adequate for the overcurrent rating of the circuit protection device. Special exceptions may apply to specific types of utilization equipment such as air conditioning condensing coils, etc. Cutting strands from conductors to make them "fit" in a terminal is improper. Verify that any visible splices and taps have been made in an approved manner. Visually inspect all conductors, cables, and cable assemblies for evidence of overheating or deterioration. The conductors, cables, and cable assemblies should not show evidence of fraying, damage, or physical abuse.

- **Flexible Cords and Cables**

  Flexible cords and cables should ***never*** be used as follows:
  1) As a substitute for the permanent/fixed wiring system
  2) Routed through holes in walls, ceilings, floors or other concealed spaces
  3) Run through doorways or windows, under carpets, etc.

  Flexible cords or cables are never a substitute for permanent/fixed wiring to supply outlets in rooms. The inspector should report any improperly installed flexible cords or cables and recommend removal. Where permanently installed receptacles, luminaires, etc. are required, the installation of approved wiring methods should be recommended.

- **Raceways**

  The inspector should verify that all conduits, raceways are properly fastened in place. All raceways should be properly terminated using fittings or connectors that are listed for the specific wiring method with which they are used. Inspect all raceways for evidence of deterioration or physical damage.

- **Permanently Connected Luminaires (Lighting Fixtures)**

  The visible portions of the supply conductors for all luminaire (lighting fixture) taps and branch-circuits should be inspected for evidence of damage or deterioration from overheating. The luminaire (lighting fixture) canopies should be properly fastened in place/secure. Where identified, luminaires (lighting fixtures) must be lamped in accordance with the manufacturers instructions. The lamp installed must not exceed marked maximum ratings on the fixture. One indication of an over lamped fixture is a recessed or damp area fixture that shuts off when left "On" for a period of time. This is generally the thermal protection kicking in. Where a luminaire (lighting fixture) tap conductor or terminals and branch-circuit conductor are identified for polarization, luminaire (lighting fixture) connections must be correctly polarized.

- **Polarization of Luminaires (Fixtures)**

  Where visible, ensure that the luminaire (fixture) is wired so that the screw shell of the lampholder is connected to the same luminaire (fixture) or circuit conductor or terminal. Where the grounded conductor is connected to a screw-shell lampholder, it should be connected to the screw shell. Any open incandescent lamps installed in clothes closets must have required clearance from combustible materials. Luminaire used in closets should be listed for closet use. Most halogen lighting, cable lighting, track lighting are not listed for use in closets.

- **Boxes and Enclosures**

  All visible enclosures should have box covers and the covers should be properly fastened in place with appropriate screws. All boxes, covers, and enclosures installed in wet locations should be specifically identified for use in wet locations. The boxes and enclosures installed in damp locations should be placed or equipped to prevent moisture from entering or accumulating in the enclosure. Any unused openings in boxes or enclosures must be sealed using means that meets or exceeds the characteristics of the box or enclosure. Where an equipment-grounding conductor is installed, any non-current-carrying metal parts that are likely to become energized must be effectively grounded. Where the walls and ceilings constructed of wood or other combustible surface material, all boxes shall be installed flush with or project from the finished surface. Any gaps between the box and the plaster, drywall, or plasterboard surfaces should be no more than 1⁄8" at the edge of the box or fitting. Any gaps that are over 1⁄8" should be repaired.

- **General-Use Switches and Receptacles**

  Verify that the accessible enclosures are properly fastened in place. All receptacles and switches should have faceplates installed. The faceplates should not be damaged or show indications of overheating. Any conductor connections that might be visible should be tight and not show evidence of arcing or overheating. Loose connections may also be evidenced by faceplates that are discolored or warm/hot to the touch. All switches and receptacles should be properly fastened secured and should not exhibit evidence of overheating or physical damage. The safe operation of the switches and receptacles should not be impaired by physical damage. Any switches and receptacles that have been painted or have other coatings applied should be reported and replacement recommended.

  Receptacle wiring should comply with the following:

  1) Receptacles should have proper wiring when tested with a listed receptacle tester. The tester shall provide indications when branch circuit conductors are not connected to the intended terminals on the receptacle.

  2) Where receptacles and branch-circuit conductors are identified for polarization, any installed receptacles must be properly polarized.

  3) All grounding-type receptacles must be properly grounded. Circuits that do not have an equipment-grounding conductor should use a non- grounding-type

receptacle or should have a ground-fault circuit-interrupter (GFCI) protection installed. Any GFCI receptacles installed in ungrounded circuits should be marked "No Equipment Ground" on the faceplate. Any receptacles that appear "loose" or do not appear to make proper contact with the plug blades should be reported and replacement recommended.

4) All switches should be rated for the connected load. Standard dimmers used to control wall receptacles are not generally rated for the maximum load of the receptacle (1800 watts on a 15 Amp circuit) and should be replaced with switches rated for the load. The grounded conductor (neutral) on a branch circuits should not be switched unless both grounded and ungrounded conductors are simultaneously broken. On a standard circuit tester, we may see an open neutral condition when a switched receptacle is in the "Off" position. This receptacle may test properly with the switch in the "On" position. In that case, the neutral is improperly being used as the switched leg of the circuit.

- **Miscellaneous Appliances and Special Equipment; Includes Ground-Fault Circuit Interrupters, Smoke Alarms, Appliances and Utilization Equipment, Arc-Fault Circuit Interrupters, Ceiling-Suspended (Paddle) Fans**

1) CREIA standards exclude testing the Ground-fault circuit interrupter (GFCI) function. The inspector should indicate that GFCI protection is installed where required or recommend appropriate upgrades. Should an inspector make the business decision to test GFCI device operation, this should be done using the integral test function. The manufactures may not recognize external testing devices as appropriate.

2) CREIA standards exclude testing smoke alarms. The inspector should indicate that smoke alarm protection is installed where required or recommend appropriate upgrades. Should an inspector make the business decision to test smoke alarms operation, I suggest that this should be done using the integral alarm test function. Some may disagree with that. However, the internal test is the test recommended by the manufacturer. Some inspectors may generically refer to smoke alarms as smoke detectors. A smoke detector has the ability to sense smoke but no built-in audible alarm function. Smoke detectors are generally found on central systems. A smoke alarm has both the ability to sense smoke and an audible alarm. Smoke alarms that are over 10 tears old should be replaced. Per the California State Fire Marshal, older smoke alarms may test properly using the built-in function but over 20% of the time will fail to respond to smoke in a fire. Many newer smoke alarms have expiration or manufacture dates on the case somewhere.

3) All appliances and utilization equipment should have a disconnecting means within line of sight or use an approved lockout device. The appliance disconnect should be readily accessible and should de-energize all ungrounded conductors. If a protective device rating is marked on an appliance, the branch circuit overcurrent device rating shall not exceed the protective device rating marked on the appliance. All cables entering the appliance/equipment should be fastened

with an approved connector. Any non–current-carrying metal parts should be effectively grounded.

4) CREIA standards exclude testing the Arc-fault circuit interrupter (AFCI) function. The inspector should indicate that AFCI protection is installed where required. Should an inspector make the business decision to test AFCI device operation, this should be done using the integral test function. There are test devices labeled for AFCI testing. None are approved by UL. The inspector should verify the AFCI breakers are rated for the enclosure; i.e. Murray AFCI's should not be installed in a Square-D panelboard. Like early GFCI devices, the current generation of AFCI's is a significant improvement over the first generation products. The inspector may choose to recommend replacement of older branch-feeder AFCI's to the current combination-type AFCI's as a property upgrade.
5) It is important that all ceiling-suspended (paddle) fans be properly supported. Ceiling fans are often installed in existing lighting outlets. Since verifying the adequacy of the fan support is far beyond the scope of a property inspection, I would suggest disclaiming the connections and recommending that they be further evaluated.

While some of the requirements in NFPA 73 are well beyond the scope of a general property inspection, much falls within the scope of the CREIA. No doubt, many of us already do much of this without even realizing it. NFPA developed this inspection protocol by analyzing issues that are known to cause electrical safety problems or fires. By careful integration of this documents recommendations into our own inspection protocol, we stand to significantly increase the effectiveness of our electrical system evaluations and increase the overall safety of the properties we inspect.

About the author:

Skip Walker lives in the SF Bay Area and has performed around 2,200 paid inspections since becoming a CREIA member in 2003. Skip is both a CREIA Master Inspector and an ASHI Certified Inspector. Skip is an ICC Certified Residential Combination Building Inspector and a F.I.R.E. Certified Inspector. Skip is the education chair for the Silicon Valley ASHI/CREIA Chapter and the CREIA Region Three Director. He also holds a California Real Estate Appraisal Trainee License. Skip may be reached at HomeInspection@sanbrunocable.com.