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Loose Wires Start Fires

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http://www.kennedyelectric.com/SureTest/Suretest-LooseWiresStartFires.htm - Link Now Dead

The NFPA reports [1] that during the period 1989-1993, an average annual total of more than 162,400 fires/year occurred in non-residential structures, resulting in $2.9 Billion of property damage and 205 deaths. **16,600** or 10.2% of these fires were caused annually by Electrical Distribution Systems. Of fires caused by electrical distribution systems, 8,000 were caused by failure within **faulty fixed wiring, receptacles and switches**. In an overwhelming majority of cases the component failed because of loose connections/splices.

Maintenance of electrical system branch circuits is often initiated by specific user problems. Factory equipment or office copiers or computers have recurring problems, or fuses blow (or circuit breakers trip). Degradation of power quality can lead to lost microprocessor data in computers and factory equipment. Increased use of switched mode power supplies in office and factory equipment contributes to the development of harmonics in branch circuits which can cause high neutral currents to develop. In extreme cases fires can result from this condition, or from simply loose connections/splices in the fixed wiring of the circuit or at the receptacle. Reduced voltage resulting from loose connections can cause equipment to malfunction.

The NFPA reports [2] that during the period 1989-1993, an average annual total of more than 162,400 fires/year occurred in non-residential structures, resulting in $2.9 Billion of property damage and 205 deaths. **16,600** or 10.2% of these fires were caused annually by **Electrical Distribution Systems**. The largest portion of fires caused by electrical distribution systems (48%) were caused by **faulty fixed wiring, receptacles and switches**.

Most of these faulty circuits and receptacles could have been previously identified as hazards with a full load test, and the very real probability exists that **several thousands of these fires could have been easily prevented!**

Routine testing of branch circuits under load and early correction of defects can prevent many of these conditions from slowly building to hazardous or troublesome levels. Most hazards are hidden from inspection and cannot be identified with static non-load tests. Static tests such as those performed with simple multi-meters cannot identify hidden defects such as poor or loose connections or damaged conductors - which are the major causes of fires initiating in receptacles or fixed wiring. When current flows through these high resistance defects, heat buildup results at the connections which can cause fires.

However, easy-to-use, safe and cost-effective plug-in testers are now available that test the circuit under a **full load.** This load test can identify certain types of deficiencies in branch circuits, specifically loose connections damaged conductors, and ground faults.

The testers **determine the resistance of the circuit - including the wire and all splices and connections - under a 15 ampere load.** A microprocessor measures the voltage under no load and under a 15 ampere load and calculates and displays the % Voltage drop on the circuit. Excess voltage drop indicates **damaged conductors**, **poor connections/splices, overlong circuits**, and/or **undersized wires**. Not only can the reduced voltage cause damage to or malfunction of equipment (which may cause a fire), but the resistance in the fixed wiring which causes excess voltage drop generates heat - which can be a definite fire hazard - especially if the cause of the excess voltage drop is a point source such as a loose connection.

How much voltage drop is excessive? The **NEC** states that a **maximum total voltage** drop on both feeders and branch circuits to the farthest outlet that does **not exceed 5%**, will provide reasonable efficiency of operations. The **IEEE** recommends that the resistance of any conductor in a branch circuit should **not exceed 0.25 ohms.** A complete circuit of 2 conductors - or maximum total of 0.5 ohms - would yield a voltage drop of **6.2%** under a 15 ampere load on a 120 volt circuit.

For example, assume a circuit has a total voltage drop of 8.3% when measured under a 15 ampere load. Assume further that the circuit's normal wire and connector resistances yield a voltage drop of 5% (the NEC reference for reasonable efficiency), and that any voltage drop in excess of that amount is attributed to a point source of resistance (connection, splice, etc.). The additional voltage drop of 3.3%, or 4 volts in a 120 volt circuit, means that the loose or damaged connection has a resistance of 0.27 ohms, which - at 15 ampere current flow - would generate a point source of heat of 60 watts. A 60-watt point source of heat in prolonged contact with combustible material can cause ignition.

Testing wiring circuits under full load is recommended by the **Occupational Safety & Health Administration** who teaches the use of this test in OSHA safety classes at the OSHA Technical Institute in Des Plains, IL.

After using the Voltage-drop-under-15-ampere-load test for eight months, Steve Scully of the **National Assoc. of Home Builders** Research Center stated ***"Because the tester is able to quickly and safely apply a full load test to the circuit, we can test all circuits in a house for hidden, sometimes deadly flaws within minutes"***. Simple-to-use, the tester **isolates hazards** using simple logic as the inspector moves along the branch circuit.

Based on the ease of application of this test, the **Consumer Product Safety Commission** recommended to the NFPA 73 technical committee - the inclusion of the 15 ampere load test in NFPA 73, the inspection procedure for one and two-family dwellings.

Chuck Barenchi, Insurance loss control inspector for Farmers Insurance in California, says, "*By testing circuits under full-load, I feel a lot more comfortable signing off on the acceptability of a building's wiring system."*

Static tests will also not identify undersized wire. The length of the wire run is sometimes approximated and the required wire size estimated. By testing the branch under load at its last receptacle, the resistance of the entire circuit is determined and can easily confirm whether the wire is sized correctly.

The measurement of ground impedance under load will also identify loose connections or other causes of inadequate grounding, which are not only hazards because of inadequate fault current paths, but an inadequate ground will often render useless the protection of computers and other expensive equipment by devices that rely on a good quality ground.

Routine testing of branch circuits under full load has been proven to be effective at identifying hazards and circuits that are troublesome to plant operations, computer and copier installations and is fast becoming the preferred method of testing. The identification of deficiencies in branch wiring and receptacles and the isolation of hazards such as inadequate grounding, loose connections, and improper wiring can allow you to identify and correct problems in branch circuits before they cause equipment malfunction or fires.

The author is president of Industrial Commercial Electronics, manufacturer of SureTest circuit analyzers at 590 Young Street, Tonawanda, NY 14150. ***(800) 442-3462;***

(716) 692-3061.fax

PRODUCT ROUNDUP: The SureTest ST-1D Branch Circuit Analyzer

The SureTest ST-1D patented circuit analyzer takes only seconds to test each outlet in a branch circuit under a full load. The SureTest ST-1D displays the line voltage under no load, the % voltage drop under both a 15 and a 20 ampere load, the ground impedance in ohms, common mode voltage (voltage between ground and neutral), and estimates the total ampere load on the circuit (calculated from common mode voltage). This instrument also detects incorrect wiring, false grounds (the illegal connection of ground-to-neutral at the outlet), and measures the exact trip point of a GFCI (in ma) - independent of line voltage

variations. *Industrial Commercial Electronics, 590 Young Street, Buffalo, NY 14225.* ***(800) 442-3462; (716) 692-3061.fax***

PRODUCT ROUNDUP: The SureTest ST-THD Branch Circuit Harmonics Analyzer

The SureTest ST-THD provides all the tests of the model ST-1D (see above). As a recording voltmeter it can be left plugged in overnight to monitor branch circuits. The unit will also measure the watts of an imposed load on the circuit to allow easy sizing of UPS systems. The SureTest ST-THD also measures the harmonic content of the power waveform - both total THD and individual odd harmonics (from the 1st-15th) - of both the line voltage and the neutral current. A clamp-on attachment is available for measurement of current harmonics and amperes on 3-phase power distribution lines. *Industrial Commercial Electronics, 590 Young Street, Buffalo, NY 14225.* ***(800) 442-3462; (716) 692-3061.fax***

When Loss Control Personnel are required to inspect a building's wiring as part of their underwriting responsibility, the inspection is usually a visual one only. The age and type of wiring are noted, along with the type of overcurrent protection (circuit breakers/fusing) and the general condition of the main and sub-panels. Any observed code violations and signs of “unprofessional” workmanship are also noted. If there are suspected deficiencies in the wiring as a result of this inspection, recommendation may be made to have an electrical contractor inspect or upgrade the system. Instrument testing of the branch circuits is usually not performed.

The NFPA reports [3] that during the period 1989-1993, an average total of more than 162,400 fires/year occurred in non-residential structures, resulting in $2.9 Billion of property damage and 205 deaths. 16,600 or 10.2% of these fires were caused annually by Electrical Distribution Systems. Although there is no further breakdown of the Electrical Distribution System in non-residential structures, in-depth investigation of 149 residential fires caused by the electrical distribution system showed that the largest portion of these fires (53%) were caused by faulty fixed wiring, receptacles and switches. An article by Smith & McCoskrie [4] summarizes the results of this investigation.

Of the fires occurring as a result of:

1. faulty fixed wiring - poor or loose splices, damaged connectors, improper installation and ground faults accounted for **94%** of these fires.

2. receptacles and switches - loose or poor connections accounted for **59%** of these fires.

Most of these faulty circuits and receptacles could have been previously identified as hazards with a 15-ampere load test, and the very real probability exists that **several thousands of these fires could have been easily prevented!**

Most fixed wiring and receptacle hazards are hidden from inspection, and until recently have been difficult to test for. However, there is now available an easy-to-use, safe and cost-effective plug-in tester that performs a unique **15-ampere load test** which can identify deficiencies in a building's wiring system that static non-load tests cannot.

One of the the tests - under a 15 ampere load - measures the % Voltage drop on a circuit which is caused by resistance in the wire and at point connections and splices. Excess voltage drop indicates **damaged conductors**, **poor connections/splices, overlong circuits**, and/or **undersized wires**. The reduced voltage may cause damage to or malfunction of equipment (which may cause a fire). Also important, excess voltage drop generates heat - which in fixed wiring can be a definite fire hazard - specifically if the cause of the excess voltage drop is a point source such as a loose connection - and is in contact with a combustible material.

How much voltage drop is excessive? The **NEC** recommends that the maximum voltage drop on a branch circuit **not exceed 5%.** The **IEEE** recommends that the resistance of any conductor in a branch circuit should **not exceed 0.25 ohms.** (A complete circuit of 2 conductors - of maximum total of 0.5 ohms - would yield a voltage drop of **6.2%** under a 15 ampere load on a 120 volt circuit.)

If a circuit were assumed to have a resistance equal to the NEC recommended maximum of 5% as a result of normal wire and connector resistances, and any voltage drop in excess of that amount were assumed to be due to one concentrated source (connection, splice, etc), then a loose or damaged connection with a resistance of 0.27 ohms would generate a point source of heat of 60 watts at a 15 ampere current flow. A 60-watt point source of heat in prolonged contact with combustible material can cause ignition. The connection would cause an additional voltage drop of 3.3% or 4 volts in a 120 volt circuit, and the total voltage drop on this circuit would be **8.3%.**

The **Philadelphia Housing Development Corporation** requires contractors to perform the voltage drop under-a-15-ampere-load test prior to insulating existing homes. [5] Prior to instituting the test, smoldering fires were associated with half a dozen installations. The PHDC found that 70% of the homes flunked the 5% threshold on the voltage drop test with “a cluster around 6%”. They arbitrarily established **10%** as an unacceptable voltage drop, beyond which the

contractor must repair/replace the circuit prior to proceeding with the insulation project. PHDC has been using this criteria successfully for 2 years (no fires in 2,500 installations).

Testing wiring circuits under full load is also recommended by the **Occupational Safety & Health Administration** - who teaches this test in OSHA safety classes at the OSHA Technical Institute in Des Plains, IL.

After using the Voltage-drop-under-15-ampere-load test for eight months, the **National Assoc. of Home Builders** Research Center stated ***"Because the tester is able to quickly and safely apply a full load test to the circuit, we can test all circuits in a house for hidden, sometimes deadly flaws within minutes"***. Simple-to-use, the tester **isolates hazards** using simple logic as the inspector moves along the branch circuit.

Based on the ease of use of this test, the **Consumer Product Safety Commission** recommended to the NFPA 73 review committee - the inclusion of the 15 ampere load test in NFPA 73, the inspection procedure for one and two-family dwellings.

The increased use of non-linear loads resulting from increased use of switch-mode power supplies increases the loads to be carried by branch circuits. With this trend and the fact that wiring deteriorates due to aging, the likelihood increases that fires will be initiated by faults in fixed wiring and receptacles.

Another very useful test performed under load by this instrument is the measurement of ground impedance - in ohms. Loose connections or other causes of inadequate grounding not only are hazards because of inadequate fault current paths, but they often render useless the protection of computers and other expensive equipment by devices that rely on a good quality ground.

Insurance loss control inspectors such as those at Farmers Insurance typically say, ***"By performing a full-load test, I feel a lot more comfortable signing off on the acceptability of a building's wiring system."***

The SureTest patented circuit analzer takes only seconds to test each outlet and circuit under a full **15 ampere load** and reads out the line voltage, % voltage drop under load, ground impedance, common mode voltage (voltage between ground and neutral), and estimates the total ampere load on the circuit (calculated from common mode voltage). This instrument also detects incorrect wiring, false grounds (the illegal connection of ground-to-neutral at the outlet), and measures the exact trip point of a GFCI (in ma) - independent of line voltage variations.

The identification of deficiencies in branch wiring and receptacle and the **isolation of hazards** such as **inadequate grounding, loose connections, Improper wiring** can prevent thousands of fires if used routinely by inspection personnel. The SureTest circuit analyzer is manufactured by Industrial Commercial Electronics at 590 Young Street, Buffalo, NY 14225. (800) 442-3462.

Footnotes

[1] Miller, Alison NFPA *U.S. Home Product Report 1988-1992 (Appliances & Equipment)* Aug. 1994

[2] NFIRS and NFPA Survey - *Major Causes of 1989-1993 Non-Residential Structure Fires*

[3] Miller, Alison NFPA *U.S. Home Product Report 1988-1992 (Appliances & Equipment)* Aug. 1994

[4] Smith, Linda & McCoskrie, Dennis "What Causes Wiring Fires in Residences" *Fire Journal* Jan/Feb 1990: 19-24, 69

[5] Kinney, Larry "Assessing the Integrity of Electrical Wiring" *Home Energy* Sept/Oct 1995: 5,6