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ELECTRICAL FIRE FACTS

Electrical fires are a leading cause of property damage. Each year, approximately 40,000 reported home fires are attributed to issues with the electrical distribution system. It is estimated that the dollar losses for residential electrical fires are double those of losses for non-electrical fires.

This electrical-system fire rate equates to more than 100 per day nationwide, with a total annual cost by some estimates approaching $1 billion dollars. Outside of fires of incendiary or suspicious origin, "issues with the wiring system" is the leading cause of residential property damage in dollar terms.

Almost half of these fires have been attributed to issues with "fixed wiring". This includes in-wall wiring, and associated devices such as switches, receptacles, and outlets. It is estimated that fires of this type are the cause of hundreds of deaths and thousands of personal injuries annually.

In reference to specific devices, the CPSC states that (in 2003), 5,300 fires were attributable to electrical receptacles, wherein 40 lives were lost and 110 injuries were caused. In addition, CPSC states that 3,900 injuries, that require an emergency room visit, are associated with receptacle outlets each year. Further, CPSC finds that electrical switches and outlets comprise the largest single category of product-related electrocution deaths.

The CPSC data also indicate that in 1998, fire losses amounted to $1.68 billion, with $680 million attributable to residential electrical distribution systems and equipment.

Among construction / specialty trade contractors, in 2006 there were 882,000 electricians employed in the U.S., a year where there were 118 fatalities and 279 non-fatal injuries among electricians. Among electrical workers involved with the construction trades, 34% of deaths by electrocution occur to electrical workers, with 58% of electrocution deaths due to contact with electrical wiring and related equipment. In terms of lost time among electrical contractors in the construction industry, in 2006 there were 12,900 nonfatal injuries involving days away from work, with a portion of these associated with contact with electrical equipment. In the construction / extractive industry category, in 2006 there were 360 events / exposures involving contact with electrical wiring and other electrical components.

Although each individual device in a typical home wiring system may be designed to a high degree of reliability, the sheer number of installed devices approaches two billion in the U.S.

The fact that each of these items is somewhat craft-sensitive (in that installation and maintenance practices influence their performance), lends added reason for concern.

Additionally, home wiring systems have a finite life. They are subject to degradation, and show decreased performance with age. As a result, the life expectancy of a home wiring system is normally less than that of the dwelling. Unfortunately, home wiring components are infrequently inspected, replaced, or upgraded.

Serious problems can develop with home wiring over long periods of time. This type of issue is generally 'silent', and frequently remains hidden until it is too late. Critical workings of most wiring and associated devices are hidden within the walls of a structure.

Most homes in the U.S. are more than 25 years old, with about one-third built more than 50 years ago. Age, usage, environmental conditions, overloading, and other factors account for much of the deterioration in home electrical systems.

The NFPA estimates that nearly 5,000 fires originate at switches, receptacles, and outlets each year. These devices attach to electrical house wiring either by screws or springs.

In the 1930's, there was little demand for electricity in homes outside of a few lights and a radio. Typical usage for an early electrified home might have been on the order of a few hundred watt-hours per day. Prior to 1935 there were no requirements to have wall outlets in a residence. Up to about 1950, wiring systems were comprised mostly of two wires (no ground), with receptacles accepting two-bladed plugs. Standards in the 1950's were to have one outlet every 20 feet along a wall, and permitted non-metallic (sheathed) cables.

The advent of numerous household electrical appliances and the widespread adoption of air conditioning in the 1960's and 1970's drove increased demand for electric use in homes. In the 1970's, standards continued to evolve, and specifying heavier 12 gage wiring in place of smaller 14 gage, mandated the installation of GFCI's, and utilized 3-wire (grounded) systems.

In a parallel development during a 1965-1974 period, numerous structures were wired with aluminum conductors. These were quickly identified as problematic – and were found to be the cause of numerous fires. Aluminum wiring connections were found to be 55 times more likely to become a fire hazard as compared to their equivalent copper counterpart.

Improved standards certainly helped – in the 25-year period to the mid-1990's, electricity consumption doubled, while the rate of accidental electrocutions decreased by half. By 2002, electrical codes specified the use of AFCI's on bedroom outlets with further enhancements made in 2005, including increased outlet density to one every 12 feet of wall space.

Trends are clearly toward increased safety, significantly with the aid of detection and control devices, concurrent with increasing demand for electricity. It is common for many new, full-featured homes to utilize 100,000 watt-hours of electricity per day during peak demand seasons.

Higher electrical demand, combined with the fact that electrical components are craft-sensitive and deteriorate with use, underlines the importance of detecting dangerous conditions before they become critical.

Although installation and device standards recommend (and commons sense indicates) turning off the power before working on electrical wiring components, many electricians reportedly work on wiring systems 'live'. Qualification requirements for electricians vary widely between areas, with some states and municipalities not requiring that electricians be licensed. Various states and areas have no electrical codes.

Various homeowners take it upon themselves to perform work on, or make modifications to, their home electrical system. These alterations can be made with inadequate knowledge and may not be professionally inspected to accepted national standards.

During installation and servicing, installers commonly hold switches and outlets at the top and bottom of the thin metal plate. Often this plate has sharp edges, and is oriented such that it is difficult to apply sufficient torque when tightening the termination (binding-head) screws. As a result, there is a tendency to either insufficiently tighten the screws, or to grip the device closer to where the torque is applied to the screw. In the one case, poor termination may result, and in the second case, hand puncture or laceration injuries may result from slipping screwdrivers, or worse, electrical shock, due to contact with live metal parts.

Not all electrical hardware components are created equal. A quick survey of switches and outlets available via national retail home improvement chains reveals a wide range of grades (and prices). Generally, the higher-priced devices are designed to be more robust, are found to perform over a longer time period, and work better under harsh operating conditions. Unfortunately, motivations of homeowners and installers may not always be toward the highest quality, most reliable products.

Similar to recommended periodic smoke-detector performance checks, electrical outlets and switches (including their wiring connections) should be continually monitored for any early signs of degradation. Suspected components should be tightened, or replaced / upgraded when found.

The need for a device to aid the inspection, installation, and maintenance of switches and outlets is very clear.

Frequent handling of many switches and outlets, and their often-stiff wiring, can fatigue the fingers and hands. As a result, tired muscles may lead to decreased quality of installation and increases the chance of physical injury.

The immediate proximity of exposed metal parts on switches and outlets, including termination screws and electrical wiring, combined with the propensity of many persons to work on the devices 'live', creates a potentially hazardous condition.

Due to often-encountered confined working conditions, poor lighting, physical fatigue, a general hesitancy due to working under 'live' conditions, lack of clearance in small wiring boxes, stiff wires, and a host of other possibilities, electrical workmanship can and does vary.

It is often difficult to properly place a wire under, and tighten, many binding-head screws. It is all too easy to only partially capture a bare wire under a screw head, accidentally trap wire insulation or other contamination under a screw head (due to insufficient stripping or dirt), reverse the wire 'wrap direction' around the screw, or to very lightly fasten a screw onto the wire.

Correct switch and receptacle installation includes creating a sufficiently stripped, clean copper wire end, wrapped free-end clockwise around, and fully captured by and securely tightened under the head of, the proper (color coded) binding screw.

Users have a need for a safety device, assist tool, indicator, or the like that aids proper switch and outlet installation. One that helps to identify the condition of existing components, and aids when servicing already-installed parts offers enhanced value.

A device that combines the advantages of reduced fatigue, incorporates visual indications, assists mechanical leverage to assure joint tightness, offers tactile feedback, reduces the time required to do work, and improves working clearance to potentially 'live' parts offers an electrical technician many advantages.

Even if electrical systems met the needs of typical home usage when they were installed decades ago, the demands placed on many homes today simply exceed the ability of older electrical systems to safely deliver the needed power.

Home electrical systems and wiring devices can deteriorate for any number of reasons: frequent usage, abuse, physical disturbance or damage, improper plugging, overloading, overheating, over-insulating, improper installation, humidity, lack of maintenance, aging, insects and rodents, exposure to weather, among others.

Indications of a deteriorated condition in the electrical system may not always be present, but the following signs may indicate a need to take action: the presence of smoke or odors, arcing / sparking, popping or buzzing sounds, frequent open circuits, discoloration, melting, overheating, exposed metal parts, loose or broken parts.

The key mechanism by which problems in the electrical wiring system leads to structure fires is that of excessive heating, combined with the presence of combustible materials.

Excessive heat is frequently caused by inadequately tightened, or loosened, fasteners that are used to attach wires to a receptacle or switch. Heat can also be generated by inadequate plug retention due to worn receptacle springs, or in the case of a switch, to excess bulb wattage. Very high heat levels (10,000 degrees F) can be generated by localized arcing, that can occur between wires and insufficiently tightened fasteners on a switch or outlet.

Either of these causes may act gradually to deteriorate parts of the electrical system over extended periods of time. Shorts and other wiring faults can cause immediate and rapid heating of wiring and components, and may even lead metal parts to melt and explode. Flying molten metal (having a temperature of more than a thousand degrees F) causes severe burns and will readily ignite combustibles.

Construction materials such as dry wood, wallboard paper, vapor barriers, and others readily combust in the presence of high levels of heat or molten metal. Importantly, common wire insulation may readily combust, especially if it has been previously heated.

Common household materials such as draperies, linens, carpets, furniture coverings, foams, cardboard, and paper, can readily combust in the presence of localized heating.

A practical definition has been proposed for “excessive heating”, that sets actionable guidelines in the case of an electrical device. Namely, the guidelines suggest ‘taking action’ if a device is hotter than a ‘like’ component operating under similar conditions by more than 27 degrees F, or if a given device is hotter than surrounding (ambient) air by more than 72 degrees F.

It is clear that older wiring systems can pose a real hazard through potentially bad connections and general degradation. New wiring systems and components can also pose a threat if not properly installed and verified. Issues need to be identified before they become critical, and either upgraded or replaced.

In a direct effort to decrease home fires due to arcing conditions, in 2002 the electrical code required the installation of arc-fault (AFCI) devices in bedrooms for new construction. AFCI’s are intended to address fire hazards due to arcing conditions, particularly ‘across-the-line’ (or parallel arcing). Other devices (GFCI’s) may not adequately protect in the event of arc faults. Reportedly, 82% of the 73,500 electrical fires in the period of 1994-1998 were attributable to arcing. These accounted for 591 deaths, 2,247 injuries, and more than $1 billion in property damage.