Wire and Cable

Avoiding Failures in Your Facility

By Jim Degnan, PE
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Facility wire and cable hide behind walls, underground and in conduits; but while they are out of sight, they cannot be out of mind. Wire and cabling systems carry the very lifeblood that powers and controls all of a facility's inner workings. So, it is crucial that the installation and regular maintenance and testing of wire and cabling systems be top of mind for facility maintenance and engineering departments. This article offers important suggestions to help facility managers more efficiently and cost-effectively analyze, maintain and update their facilities' wiring and cabling systems.

Do I Have to Worry about My Facility's Wiring?

Trouble often happens where it is least expected, and problems with wire and cabling are a good example. After all, wire doesn't have any parts that require maintenance, right? True, but that won't stop it from failing. When considering if a facility has the potential for wiring problems, look at the wire's construction, its usage and the load's tolerance for downtime. Modern wiring is available in several very reliable materials, including rubber, thermoplastics, crosslinked polyethylene and others, all of which can be expected to perform reliably for many years in various applications.

When Does Wiring Get to Be Too Old?

A general rule of thumb for electrical equipment is that after 40 years of usage the reliability of the equipment is subject to question, depending on the number of parts, operations and loading. Wiring, however, can be expected to perform well beyond this metric.

There are many, many examples of electrical equipment and wiring that have been in operation twice as long, for over 80 years!

One example of the longevity is seen in residential studies. With electrification occurring in the early part of the 20th century, the wiring in many houses is approaching 100 years old. The National Fire Protection Agency conducted a study on aging house wiring that is available at their Web site, www.NFPA.org. In summary, they found that older house wiring is still in very reasonable condition. Although, if the wire was put in place with pre-1950 rubber insulation, the chances are that it's much nearer the end of its life than a post-1960 thermoplastic insulation.

If Age Isn't a Problem, What Is?

Look at the usual suspects to determine if there is a potential for failure:

Excessive Loading: Overloads are probably the most common cause of wire failure. Too often, load is added to a circuit, panel or switchboard without checking to make sure that the existing load is the real maximum load. Unexpected loading can occur with equipment operated at various times such as seasonal changes, industrial process adjustments or changing facility tenants. Overloads cause excessive conductor temperature and overheat the conductor's insulation, making the insulation become brittle, crack and fail.

Heat: There is an increasing chance of failure if the wire is in an environment that prohibits the wire from dissipating heat or adds heat to the wire. An obvious example is a conduit run above, or connected to, a boiler, oven, heater or other high-temperature sources. Not so obvious might be a conduit on a roof, but with solar radiation, roof temperatures in the southern states can be hot enough to compromise the life of wire. The 2008 National Electrical Code (NEC) added specific provisions for derating wire on rooftops. Another example is wiring run inside of any insulating medium. Wire ampacity ratings are specific to the environment the wire is placed in, mostly expected to be in free air; however, if wiring is run inside of attic insulation, the wire's heat won't be able to get to free air!

Vibration: Wire connected to vibrating equipment should be constructed with multiple strands and flexible

insulation. Otherwise the vibration can cause mechanical fatigue and failure, especially if the vibrating element forces the wire to move up against its travel limits. Typical areas of concern are motors, transformers and generators.

Water: Many modern wire insulations and jackets are rated to withstand water, but some are not. Water can be especially problematic when coupled with environmental changes. A freeze-thaw cycle could force protective jackets to loosen or break off of a wire. Condensation on lightly loaded terminations could eventually lead to chemical by-products, dirt or molds that compromise the integrity of the termination and cause a failure.

Terminations: Poor wire terminations are also a common source of wire failure. If a terminating lug is too large for the cable, it won't be able to provide the correct contact area; if the lug is too small, the wire may have been trimmed to fit and the whole assembly might get too hot. Failure also comes from incorrectly applied terminations, such as the termination not being rated for finely stranded wire and over- or under-tightened lugs.

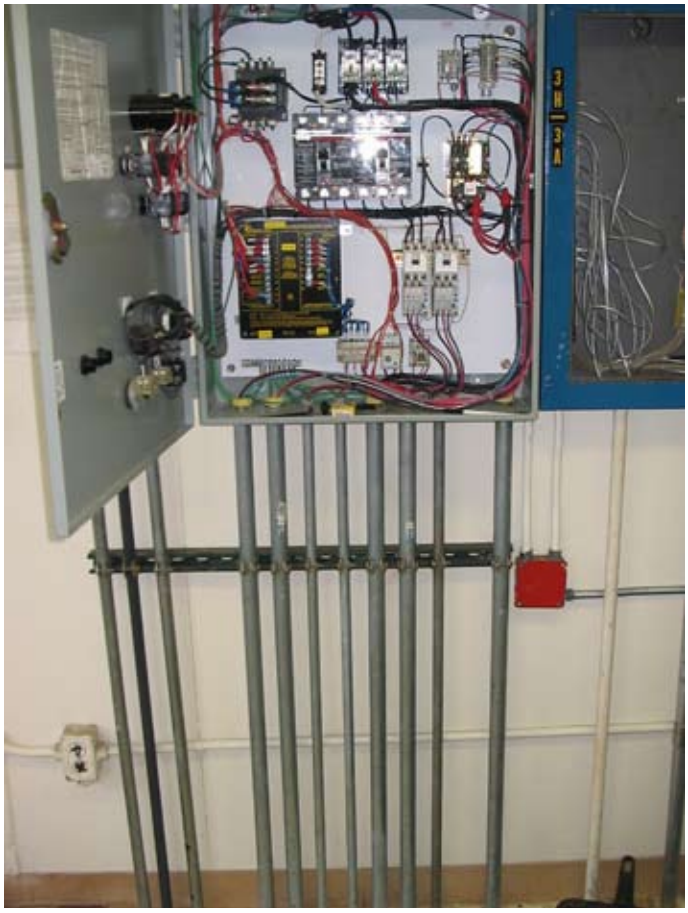
Underground: Underground wiring is susceptible to invasive problems including damage from trenching, rodents and water, as mentioned above.

Mechanical Failure: Conduits and raceways are used to protect wiring from damage, but they often cannot stand up to abuse from vehicles, nail guns and various construction equipment. Lightweight armored cables and tubings may be placed on the underside of a roof, only to have a roofing contractor unknowingly penetrate them with a nail gun, thereby creating a hidden problem that could materialize immediately or only after an unnoticeable trickling failure manifests itself into a complete fault. The NEC takes care to specifically address mechanical protection for emergency systems in patient care areas in Section 517. 30(C)(3).

What Can I Do to Detect Wiring Problems

The best method would be a yearly preventive maintenance program that looks at the usual suspects for potential problems. Loading can be checked with easily obtainable recording ammeters. On critical or heavily loaded cables or cabling where the loading is not readily controlled, consider placing permanent recording ammeters to ensure that the wire is operated within its rating.

The integrity of terminations can be checked visually and with a torque wrench. The best solution is to perform infrared surveys on wiring terminations. Infrared surveys are most useful when wiring is operated at its maximum



load and the terminations are exposed. Exposing live electrical systems is dangerous work and requires a careful approach and understanding of the arc flash hazards that occur during an accident. To prevent injury, those working on live electrical systems should wear the appropriate personal protective equipment, which usually includes flame-resistant attire.

What Else Can Be Done to Prolong the Life of My Cables?

Look to the 2008 NEC, which has requirements for labeling cables at panel boards and junction boxes. If you know exactly what circuit a wire serves, there is less chance of errant connection or misuse.

What Can Be Done to Enhance the Integrity of My Wiring System?

Consider using wire that is able to perform under higher-temperature environments. Common building wire is available with a 90 degree C rating instead of a 60 or 75 degree rating.

Healthcare facilities have specific code requirements for separation of wiring systems so that a fault in a nonessential circuit won't propagate to an essential circuit. Requirements for separation of wiring in healthcare facilities are covered in NEC Section 517.30(C)(1), and accordingly, all Wiring serving life safety and critical branch loads must be isolated in its own raceway systems.

Is There Anything Available For Critical Processes

Consider using one of the new fire-resistant cables. Cables are now available with special insulation that can resist exposure to fire for up to two hours. In fact, usage of the cable is becoming required in high-rise buildings for circuits supporting a building's means of egress.

My Facility Has Medium Voltage Cable; Is There Anything Special I Should Consider?

Wiring on power systems rated over 600 volts has special insulation and shielding to control the higher voltage. The two most common types of medium voltage cable insulation are ethylene propylene rubber and cross-linked polyethylene. The rubber-based cables have a long history of success, but some of the cross-linked polyethylene insulations made before 1990 are subject to premature failure. If you have older polyethylene cables, you may already be experiencing failures. If replacing the cables is an onerous prospect, alternative help may be available through a fluid injection process that sends a fluid through the inside of the cable to fill any developing cracks in the insulation.

One of the most controversial questions is whether or not medium voltage cables should be subject to high-potential (hypot) testing to determine cable integrity. This process places a higher-than-normal voltage on the cable and then monitors the cable to see how well the cable stands up. Its controversial because the higher voltage (potential) may precipitate the very failure that is to be detected! Refer to the cable manufacturer or a trusted medium-voltage electrician for advice. New technologies are now available to analyze the harmonic spectrum of a cable to determine if there are abnormal frequencies present that indicate potential failure, without subjecting the cable to strenuous voltages.

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