OSHA FactSheet

Electrical Safety Hazards of Overloading Cable Trays

According to the 2005 National Electrical Code® (NEC), a cable tray system is "[a] unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways." Cable trays support cable across open spans in the same manner that roadway bridges support traffic. Cable trays are not raceways, and are treated as a structural component of a facility's electrical system. Cable trays are a part of a planned cable management system to support, route, protect and provide a pathway for cable systems.

Cable trays feature flexibility unmatched by conduit, as cables are easier to mark, remove and find in cable trays. Cable trays are available in a number of different configurations, including ladder, ventilated trough, ventilated channel, solid bottom, wire mesh, single rail, and other similar structures. They are manufactured in steel, aluminum, and fiber reinforced plastic (FRP), although aluminum accounts for about 70% of the cable trays used in industry today.

Overloading cable trays

Cable trays come in a wide variety of sizes. The appropriate size and number of cable trays depends directly on the number and size of conductors intended and the allowable fill area as specified in the NEC. Also, since cable trays offer flexibility for modification and expansion, engineers and designers should plan cable tray systems to be sized and designed to anticipate both current and future needs.

Cable tray fill is addressed in the 2005 edition of NEC Sections 392.8, 392.9, 392.10, and 392.12. The type of cable tray (e.g., solid, ventilated), ampacity requirements, and the type and voltage rating of cable used determines the allowable fill for each cable tray — ventilated cable trays provide for the greatest allowable fill due to increased airflow. A generic guideline provided by The Cable Tray Institute indicates that cable trays should not be filled in excess of 40-50% of the inside area of the tray or of the maximum weight based on the cable tray specifications. The NEC provides specific and more detailed requirements for cable tray fill. In any case, the best strategy is to review and follow the rules set out in the NEC and the manufacturer's installation guides when installing cables in cable trays.

Hazards associated with overloaded cable trays

Overfilling and improperly securing wires in cable trays can lead to a number of serious hazards. Weight is one issue; all cable trays and their associated supports are rated for a specific maximum weight, based partly on the allowable fill area and the spacing of the cable tray supports. Overloading cable trays can lead to a breakdown of the tray, its connecting points, and/or supports, causing hazards to persons underneath the cable tray and even leading to possible electric shock and arc-flash/blast events from component failure when the cables are suddenly no longer supported. Additionally, cables in trays can be damaged by improperly securing and installing other cables and wires in the same cable tray.

The NEC requirements for cable tray fill also consider the heat buildup in conductors while current flows. When cable trays are overloaded, excessive heat buildup in and around live conductors can cause the insulation to break down, leading to potential shock hazards or fires. Fires can occur either in the cable tray (which may provide a fire path) or in combustible materials near the cable tray. Furthermore, the improper use of flexible cord could lead to the spread of toxic fumes if a fire were to occur.

Grounding of cable tray systems is essential for personal safety and protection against arc-

ing that can occur anywhere in the wiring system. Proper grounding must be done before cables are installed and tested before cables are energized. In addition to these general requirements, metallic cable tray systems supporting electrical conductors must be electrically continuous and effectively bonded as per the requirements of the 2005 edition of NEC Section 392.7.

Recognizing overloaded cable trays

Recognizing overloaded cable trays is not difficult. The fill values for cable trays specified in the 2005 NEC range from a single layer to roughly a 50% fill of the cross-sectional area of the cable tray. If visual observation reveals a cable tray that is completely full and/or overflowing with cables, chances are that the cable tray is in violation of both the National Electrical Code and OSHA requirements. One of the major culprits associated with overloaded cable trays are abandoned cables within the tray. These abandoned cables should be removed; and in fact, section 590.3(D) and various sections in Chapter 8 of the 2005 NEC specifically require removal of abandoned temporary wiring and communication cable installed within a cable tray.

Wiring methods permitted in cable trays

Any wiring methods used in cable trays must be listed by a Nationally Recognized Testing Laboratory as suitable for use in cable trays and in the environment in which it is installed. Table 392.3(A) of the NEC and OSHA's 1910.305(a)(3)(i) provide corresponding lists of conductors and raceways permitted in cable tray systems. Additionally, NEC Section 392.3(B) and OSHA's 1910.305(a)(3)(i)(B) allow other specific conductors in industrial establishments where maintenance and supervision assure that only qualified persons will service the cable tray systems. Flexible cords are not currently listed for use in cable trays (NEC Article 400, OSHA, 1910.305(g)) as they are prohibited as a replacement for the fixed wiring of a structure. The insulation on flexible cords can break down and become brittle over the years, which can lead to shorts and fires containing toxic fumes.

Standards and regulations that apply to cable trays

Cable trays were first covered in the 1965 edition of the NEC, under Continuous Rigid Cable Supports. Today, the use and installation of cable trays is covered by Article 392 of the NEC, and by OSHA regulations in 29 CFR 1910.305(a)(3) and 1910.399, or comparable standards promulgated by States operating OSHA-approved State plans. Specific permitted uses of cable trays are covered by the 2005 edition of NEC Section 392.3 and OSHA's 1910.305(a)(3)(i); uses not permitted are addressed in NEC 392.4 and OSHA's 1910.305(a)(3)(ii). Other sections and articles of the NEC are referenced throughout Article 392 for specific installation and use issues. The National Electrical Manufacturers Association (NEMA) also publishes three standards that apply to the proper manufacture and installation of cable trays: ANSI/NEMA-VE 1-1998, Metal Cable Tray Systems; NEMA-VE 2-1996, Metal Cable Tray Installation Guidelines; and NEMA-FG-1998, Nonmetallic Cable Tray Systems.

For more information

National Electrical Code®, (2005 Edition) Article 392 (See also NEC Handbook).

OSHA 29 CFR 1910.305(a)(3) and 1910.399.

Cable Tray Institute (http://www.cabletrays.com).

The Cable Tray Manufacturer's Installation and Use Instructions.

This is one in a series of informational fact sheets highlighting OSHA programs, policies or standards. It does not impose any new compliance requirements. For a comprehensive list of compliance requirements of OSHA standards or regulations, refer to Title 29 of the Code of Federal Regulations. This information will be made available to sensory impaired individuals upon request. The voice phone is (202) 693-1999; teletypewriter (TTY) number: (877) 889-5627.

For more complete information:

OSHA Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov

(800) 321-OSHA

DSTM 03/2006

OSHA® FactSheet

Working Safely Around Downed Electrical Wires

Electrical hazards multiply for workers involved in cleanup and recovery efforts following major disasters and weather emergencies. Life-threatening danger exists around downed and low-hanging electrical wires which can still be energized following a storm.

Safety First

Always consider all electrical equipment, lines and conductors to be energized. If you notice downed wires or damaged electrical equipment, contact appropriate utility personnel if you can. Circuits do not always turn off when a power line falls into a tree or onto the ground. Reloaders automatically try to reset circuits and restore power when it is interrupted. Even if electric lines are not sparking or humming, fallen electric lines can electrocute you if you touch them or the ground nearby.

Energy

Downed wires can energize other nearby objects, such as fences, water pipes, bushes and trees, buildings, and telephone/CATV/ fiber optic cables. Even manhole castings and reinforcement bars (rebar) in pavement can become energized by downed wires. During storms, wind-blown objects such as canopies, aluminum roofs, siding, and sheds can also be energized by downed wires.

Backfeed

The improper connection of portable generators to a building's electrical system is one way hazardous backfeed conditions are created! Backfeed is a hazardous condition created when temporary sources of electricity (such as a generator) are connected to the damaged permanent system causing electricity to flow inside and outside a structure through connected lines and equipment. In emergency conditions, portable generators should only be used as standalone sources of power, and (except for properly wired by-pass or isolation connections) not connected to a building's electrical system. If a generator is connected to a building's electrical system, it must be done with a properly installed main breaker bypass to prevent electricity from flowing out of the building and into downed power lines.

Some other sources of backfeed include:

- Circuit ties/switch points
- Lightning
- Downstream events

Always ensure that proper lockout/tagout procedures are followed to avoid connecting two electrical sources to the same circuit.

Rules to Live By

- Do **not** assume that a downed power line is safe simply because it is on the ground or it is not sparking.
- Do **not** assume that any wire is a harmless telephone, television, or fiber-optic cable, and does not carry lethal current.
- Treat everything electrical as energized until tested and proven to be de-energized.
- Never go near a downed or fallen electric power line.
- Electricity can spread outward through the ground in a circular shape from the point of contact. As you move away from the center, large differences in voltages can be created.
- Never drive over downed power lines. Assume that they are energized.
- If contact is made with an energized power line while you are in a vehicle, remain calm and do not get out unless the vehicle is on fire. If possible, call for help.
- If you must exit any equipment because of fire or other safety reasons, try to jump completely clear, making sure that you do not

touch the equipment and the ground at the same time. Land with both feet together and shuffle away in small steps to minimize the path of electric current and avoid electrical shock. Be careful to maintain your balance.

Workers' Rights

Workers have the right to:

- Working conditions that do not pose a risk of serious harm.
- Receive information and training (in a language and vocabulary the worker understands) about workplace hazards, methods to prevent them, and the OSHA standards that apply to their workplace.
- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

For additional information, see OSHA's Workers page (www.osha.gov/workers).

How to Contact OSHA

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing safe and healthful workplaces for their employees. OSHA's role is to ensure these conditions for America's working men and women by setting and enforcing standards, and providing training, education and assistance. For more information, visit www.osha.gov or call OSHA at 1-800-321-OSHA (6742), TTY 1-877-889-5627.

U.S. Department of Labor

OSHA® Occupational Safety and Health Administration

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OSHA® FactSheet

Working Safely with Electricity

Working around live electricity is a serious hazard. Engineers, linemen, electricians, and others who work with electricity directly, and workers who work with electricity indirectly may be exposed to serious electrical hazards.

Generators

Generators are commonly used as a replacement source of electricity when electrical power is lost. Most generators are gasoline or diesel powered with internal combustion engines which turn an alternator to produce electricity. One of the hazards from gasoline or diesel powered engines is carbon monoxide (CO). Carbon monoxide is a colorless, odorless gas produced during the operation of gasoline powered generators. When inhaled, the gas reduces your ability to transport oxygen. Symptoms of carbon monoxide poisoning include headache, nausea and fatigue that can lead to unconsciousness and ultimately prove fatal. The following information is a list of best practices to identify hazards when operating around power lines and electrical equipment.

- DO NOT operate a generator indoors. Generators should be placed outdoors in a location where the exhaust gases cannot enter a home or building. Good ventilation is key to operating a generator safely.
- Be sure the main circuit breaker is OFF and locked out prior to starting any generator. This will prevent inadvertent energization of power lines from backfeed electrical energy from generators and help protect utility line workers from electrocution.
- Turn off generators and let them cool prior to refueling.

Power Lines

Overhead and buried power lines are especially hazardous because they carry dangerously high voltage. Fatal electrocution is the main risk, but burns and falls are also hazards.

- Look for overhead power lines and buried power line indicators.
- Stay at least 10 feet away from overhead power lines and **assume they are energized**.
- De-energize and ground lines when working near them.
- Use non-conductive wood or fiberglass ladders when working near power lines.

Extension Cords

Worn cords can expose the wires within, or loosen the connections on the plug end. Extension cords that are not 3-wire type, not designed for hard-usage, or that have been modified are not as durable. These conditions can increase the risk of electric shock.

- Use equipment that is approved by a nationally recognized testing laboratory.
- Do not modify cords or use them incorrectly.
- Use factory-assembled cord sets and extension cords that are 3-wire type.
- Use cords, connection devices, and fittings equipped with strain relief.
- Remove cords from receptacles by pulling on the plugs, not the cords.

Equipment

Due to the dynamic, rugged nature of construction work, normal use of electrical equipment causes wear and tear that results in insulation breaks, short-circuits, and exposed wires. If there is no ground-fault protection, it can cause a ground-fault that sends current through a worker's body.

Use ground-fault circuit interrupters (GFCIs) on all 120-volt, single-phase, 15- and 20-ampere receptacles that are not on an existing building's permanent wiring, or have an assured equipment grounding conductor program (AEGCP).

- Use double-insulated tools and equipment, distinctively marked.

- Visually inspect all electrical equipment before use. Remove from service any equipment with frayed cords, missing ground prongs, cracked tool casings, etc.

Electrical Incidents

If the power supply to the electrical equipment is not grounded or the path has been broken, fault current may travel through a worker's body, causing electrical burns or death. Visually inspect electrical equipment before use. Take any defective equipment out of service.

- Ground all power supply systems, electrical circuits, and electrical equipment.
- Frequently inspect electrical systems to ensure that the path to ground is continuous.
- Do not remove ground prongs from cord- and plug-connected equipment or extension cords.
- Use double-insulated tools and ground all exposed metal parts of equipment.
- Avoid standing in wet areas when using portable electrical power tools.

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- Review records of work-related injuries and illnesses.
- File a complaint asking OSHA to inspect their workplace if they believe there is a serious hazard or that their employer is not following OSHA's rules. OSHA will keep all identities confidential.
- Exercise their rights under the law without retaliation, including reporting an injury or raising health and safety concerns with their employer or OSHA. If a worker has been retaliated against for using their rights, they must file a complaint with OSHA as soon as possible, but no later than 30 days.

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Electrical Safety

Electrical hazards can cause burns, shocks and electrocution (death).

- Assume that all overhead wires are energized at deadly voltages. Never assume that a wire is safe to touch even if it is down or appears to be insulated.
- Never touch a fallen overhead power line. Call the electric utility company to report fallen electrical lines.
- Stay at least 10 feet (3 meters) away from overhead wires during cleanup and other activities. If working at heights or handling long objects, survey the area before starting work for the presence of overhead wires.
- If an overhead wire falls across your vehicle while you are driving, stay inside the vehicle and continue to drive away from the line. If the engine stalls, do not leave your vehicle. Warn people not to touch the vehicle or the wire. Call or ask someone to call the local electric utility company and emergency services.
- Never operate electrical equipment while you are standing in water.
- Never repair electrical cords or equipment unless qualified and authorized.
- Have a qualified electrician inspect electrical equipment that has gotten wet before energizing it.
- If working in damp locations, inspect electric cords and equipment to ensure that they are in good condition and free of defects, and use a ground-fault circuit interrupter (GFCI).
- Always use caution when working near electricity.

For more information:

OSHA® Occupational Safety and Health Administration

U.S. Department of Labor

www.osha.gov (800) 321-OSHA (6742)

OSHA 3294-04R-13

OSHA® DATOS RÁPIDOS

Seguridad eléctrica

Los riesgos eléctricos pueden causar quemaduras, choques eléctricos y electrocución (muerte).

- Sepa que probablemente todos los cables aéreos están energizados (vivos) a voltajes fatales. Nunca asuma que se puede tocar un cable de manera segura aún si está fuera de servicio o parece que está aislado.
- Nunca toque una línea de energía eléctrica que se haya caído. Llame a la compañía de servicio eléctrico para reportar líneas eléctricas caídas.
- Manténgase al menos 10 pies (3 metros) alejado de los cables aéreos durante limpiezas y otras actividades. Si está trabajando desde alturas o manejando objetos largos, antes de comenzar a trabajar evalúe el área para detectar la presencia de cables aéreos.
- Si un cable aéreo cae sobre su vehículo cuando esté guiando, manténgase dentro del vehículo y continúe guiando, alejándose del cable. Si el motor de su vehículo se detiene, no salga del vehículo. Adviértale a las personas que no toquen el vehículo o el cable. Llame, o pídale a alguien que llame, a la compañía local de servicio eléctrico y a servicios de emergencia.
- Nunca opere equipos eléctricos mientras esté parado sobre agua.
- Nunca repare cables o equipo eléctrico a menos que esté calificado y autorizado.
- Antes de energizar el equipo eléctrico que se ha mojado, haga que un electricista calificado lo inspeccione.
- Si está trabajando en áreas húmedas, inspeccione los cables y equipo eléctrico para asegurarse que estén en buenas condiciones y sin defectos, y use un interruptor de circuito con pérdida a tierra (GFCI, por sus siglas en inglés).
- Siempre tenga cuidado cuando esté trabajando cerca de electricidad.

Para más información:

OSHA® Administración de Seguridad y Salud Ocupacional
Departamento de Trabajo de los EE. UU.
www.osha.gov (800) 321-OSHA (6742)