Electrical Emergencies

by Battalion Chief Frank C. Montagna and Terry Bellew, Con Edison

You are an engine Lieutenant responding to a report of an explosion and fire on a utility pole and your unit is the first one to arrive at the scene. On the pole, flames are leaping out of the top of one of three transformers. You open the cab door and step out onto the street. You notice that one of the overhead electric wires is hanging off the pole and lying across a metal fence. It is neither arcing nor whipping. Is it live? Is it dangerous? What should you do?

Do you know enough about overhead wires and transformers to keep yourself, your Firefighters and the curious residents of the area safe at this overhead electric incident? What are the hazards present at this incident? Which wires carry high voltage? What actions should you take? What actions must you not take? Who is at risk here--Firefighters, civilians or both? This article will describe the overhead electric system, point out its hazards and explain what Firefighters can do to mitigate these incidents.

Both the LIPA (Long Island Power Authority, which is currently managed by National Grid) and Con Edison overhead electric systems are designed and constructed in a similar fashion, although some of the equipment differs. The information included in this article holds true for both systems.

The overhead electric system is comprised of a network of wires and transformers, mounted on poles made of wood, cement or fiberglass. It also includes some ground-based transformers. The poles may support both primary and secondary wires. Primary wires carry voltages of 4kV, 13kV, 27kV and 33kV and secondary wires carry voltages of 120V/240V. The poles are supplied with primary voltage wires from substations via underground primary cable. (See Photo #1.) These primary cables are routed up the side of poles inside metal or plastic risers. These risers also can supply secondary electric to the overhead system. The wires inside the riser are insulated and protected by the riser. If the riser is damaged--from a car crashing into the pole--the riser and insulation can be damaged, resulting in the car being charged by the high- or low-voltage wires in the riser.

Where are high-voltage lines located on the pole?

Firefighters always have been assured that the high-voltage wires are located on the top of the pole. This is a safety precaution that keeps the high voltages far away from people and vehicles. There is, however, an important exception to this rule and Firefighters must be aware of it. Called aerial cable, it is located below the secondary wiring on the pole and often is mistaken for cable TV wires. Aerial cable can be encased in lead, aluminum or poly vinyl shielding, is attached to a supporting cable by hangers and can carry 4000V, 13,200V, 27,000V or 33,000V. That is right, there are high-voltage lines hanging below the secondary wires on utility poles. (See Photo #2.)

Are overhead wires insulated?

The primary wires, found on the top of the pole, are not insulated. They may be covered with an abrasion-resistant protective covering, but it is not insulation and will not protect Firefighters from electrocution. The secondary wires may or may not be insulated. If they are insulated, Firefighters cannot rely on the insulation to protect them. It may have been damaged, deteriorated by age or it may be missing. Firefighters can't tell by looking at a wire if the insulation or covering is intact or if it will provide protection. Treat all of these wires as if they are live and not insulated.

Are the wires live?

Primary voltage is designed to trip out once there is a fault or over-current in excess of 900 amps. That means a downed high-voltage wire may trip out if it breaks and falls. A high-voltage wire that trips out automatically will try to reset itself three times. This is known as three trips to lockout. Unfortunately, it also might not trip out. There are many variables that affect how much electricity will flow from a broken wire. If the 900 amp-level is not achieved, it will not trip out, but instead remain live. Firefighters cannot tell if a downed primary voltage wire is live by looking at it. Always assume the wire is live.

Photo #1--Riser pole is supplying high-voltage lines (arrow).

Aerial cable, as previously mentioned, is insulated, but if it is damaged or on the ground, the insulation may be

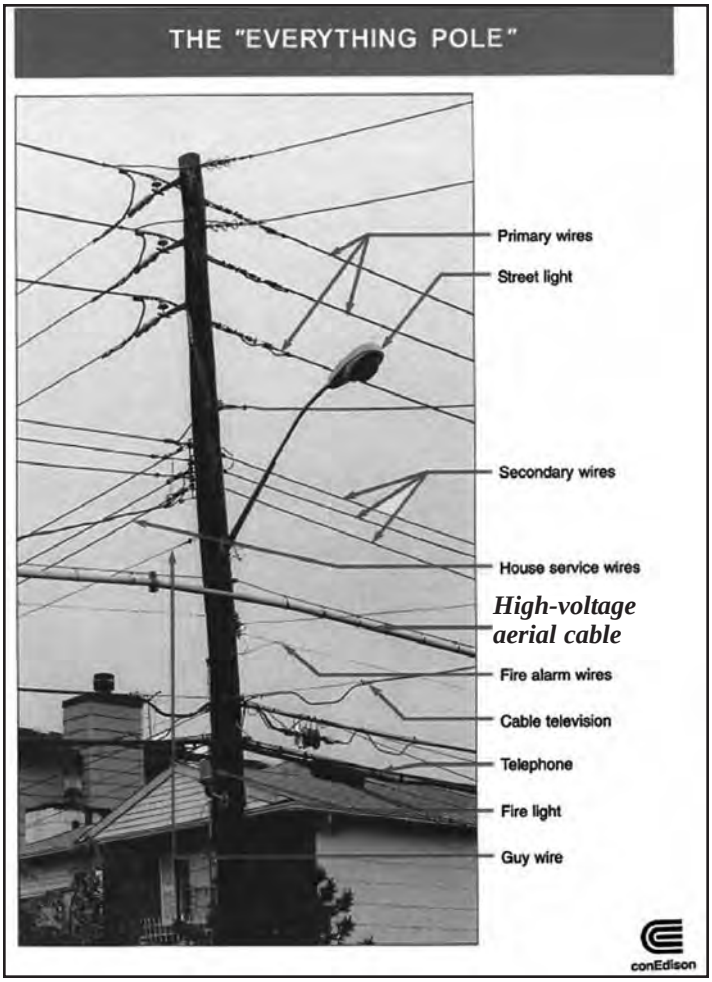

Photo #2--High-voltage aerial cable is located below both the primary and secondary lines on this pole.

Photo #3--4kV transformer supplying secondary risers.

Photo #4--Pad transformer.

Photo #5--Silo transformer.

compromised. Always treat downed aerial cable as live and dangerous.

Secondary voltage is not designed to trip out. A downed secondary wire will be live if it is still connected to the pole. Since the secondary wires are located much lower on the pole, they account for the majority of electrical injuries and electrocutions. Again, Firefighters cannot tell if it is live by looking at it.

What is inside pole-mounted transformers?

Transformers serve to raise or lower voltage as needed throughout the overhead electric system. Pole-mounted transformers (see Photo #3), found in all boroughs except Manhattan, can contain 30 to 50 gallons of dielectric fluid, an insulating oil. While this oil should be PCB-free, there is the possibility that it could be PCB-contaminated oil. Thus, FDNY treats all transformers as PCB-contaminated until they are tested and proved to be PCB-free. A round blue label attached to the side of the transformer means it has been tested and is clear of PCBs. New transformers have a non-PCB marking stencil on them.

There are two other types of transformers used in the overhead electric system that will not be found on poles. Both pad-mounted transformers and silo transformers are ground-based transformers that are typically non-PCB-contaminated--but must be treated as contaminated--until tested and proved otherwise. Pad-mounted transformers contain 50 to 200 gallons of dielectric fluid and can be found in all five boroughs, but are most common in Staten Island. (See Photo #4.) Silo transformers contain 30 to 50 gallons of dielectric fluid and can be found in Brooklyn, Queens, the Bronx and Staten Island. (See Photo #5.)

Unlike the transformers in the underground system, the pad-mounted and silo transformers do not pose an immediate carbon monoxide hazard when involved in fire. The wiring from these transformers does not pass through underground conduit on its way to supplied structures. Instead, the wires are directly buried into the ground and, as a result, do not offer the easy passage of CO-laden smoke into the building. CO, however, can migrate through the ground and surrounding structures still must be checked for CO infiltration when these transformers or their associated cables burn.

Downed power line incidents pose multiple hazards

Ground gradient--Direct contact with a downed line can result in electrocution. In fact, just walking close to the wire can be deadly. As electric current passes into the ground, decreasing irregular circles of ever-lessening electric potential radiate out from the wire's point of contact. (See Diagram #1.) This phenomenon is known as ground gradient and a Firefighter walking into this area could be electrocuted as one foot is in one potential zone and the other foot is in another. The result of walking into the ground gradient would be electrical current entering your body through one foot and exiting from the other. Many factors, including ground composition and moisture, affect step potential and there are no visible signs of ground gradient's presence. It can radiate out 100 feet from a downed high-voltage line.

Standing water--If a downed wire is in a puddle of water, the entire puddle could be electrically charged. Anyone entering the puddle could be electrocuted. Water flowing in a stream or from a fire hose also can conduct electricity.

Charged fences, wires and structures--A live downed wire can charge an entire metal fence, stair railing, aluminum siding, cable TV wires, telephone wires or any conductive structure, including metal curb strips, light poles, aluminum siding, cars, fire apparatus and metal ladders. Certain types of traffic stripes on the roadways can conduct electricity. Even poles, trees, fire hoses and wood and fiberglass ladders can conduct high-voltage electricity, especially when wet. A high-voltage wire contacting a structure's service line, ground wire or secondary wires on the pole can result in high voltage being delivered into buildings, resulting in fire. The truth is, if the current is high enough, most anything will conduct electricity.

Gas line damage--A charged high-voltage line can burn down through pavement and concrete to damage a buried natural gas line and ignite the gas leak it creates.

Tactics

Wires down with life in danger:

- The first-arriving unit should notify the dispatcher that life is in danger, specifying the location of the downed wires and requesting forthwith power removal and priority response by the utility company with an ETA.
  - * Request that a Battalion Chief respond. On arrival, the Battalion Chief should transmit any additional details to the dispatcher.
- If the wires are Con Edison's and the given ETA is unsatisfactory, the Battalion Chief should contact the Utility Company Electrical Operations Center directly by cell phone, using the telephone numbers found on the Con Edison notification cards, stating that life is in danger and stressing the need for a priority response.
  - * ***Note:*** Con Edison does not supply electricity to Broad Channel and the Rockaways in Queens. That area is supplied by LIPA and managed by National Grid.
- Caution civilians trapped in a vehicle with a downed electrical line over it to remain in their vehicle until the wires are de-energized by the utility company.
  - * ***Note:*** FDNY does not have any approved method for moving a live wire. Policy states that Firefighters must wait for the utility

Members are urged to review the following references:
- *All Units Circular* 266.
- "Electricity and the Fire Service...Simplified," by then-Lieutenant Frank Miale, in the 2nd/85 issue of *WNYF*.
- *Training Bulletin*, Emergencies 3, Basic Emergencies, section 8.

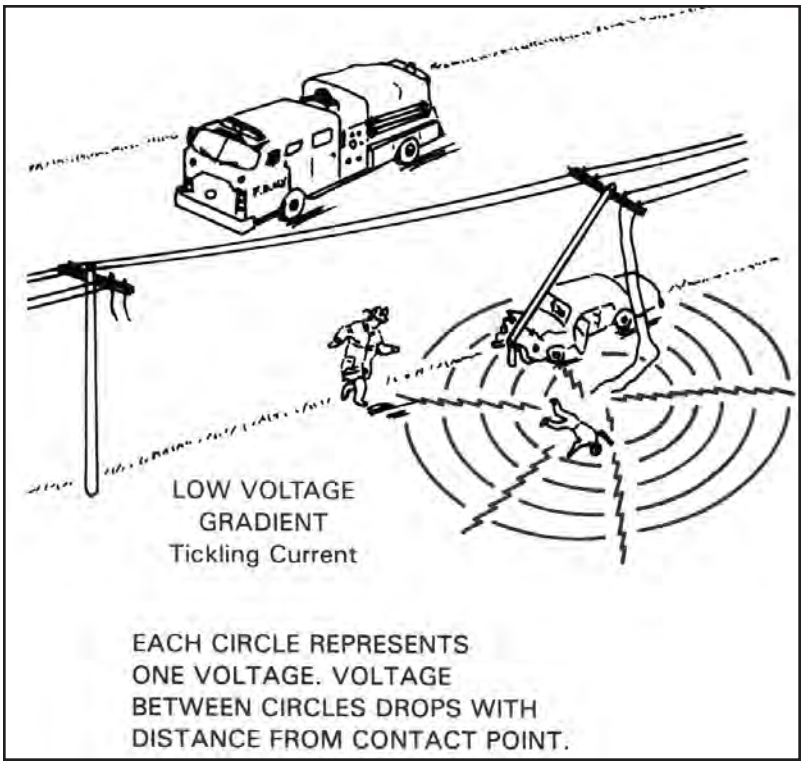

Diagram #1--Ground gradient diagram from Chief Frank Miale's article.

to remove power before assisting people trapped in a car by a fallen wire or a victim in the street onto whom a wire has fallen.

* If it is necessary for the vehicle's occupants to exit, they must jump free, never contacting both the vehicle and the ground at the same time. Failure to take this precaution could result in electrocution.

Wires down with or without life in danger

- Isolate the area.
  * Don't park under overhead wires or over electric manholes.
  * Keep apparatus, Firefighters and civilians away from the area, don't congregate under the overhead wires and keep civilians out from underneath them.
- Monitor nearby buildings for heat in the fuse/breaker box using thermal imaging cameras (TIC). Using the TIC is a safety precaution meant to avoid thermal burns and electrocution.
  * Heating wires can generate carbon monoxide gas in the service box.
  * Opening or closing breakers could result in an explosion.
- Secure the area and await the arrival of the electric utility.
- If necessary to use water, use a fog stream and stay at least 25 feet away from any downed wire.
- Always try to locate both ends of a downed wire. One might be lying on the ground, while the other is dangling unnoticed in the air.
- Anything that the wire is in contact with may be electrically charged. A fence or seemingly harmless cable TV wire can be charged by a downed electrical wire.
  * Avoid puddles, metal gratings, manholes, fences, wet grass and other objects if they could be electrically charged.
- High-voltage wires often whip and snap while producing high-temperature arcs. Stay back at least one pole span in either direction and tape off the area where a downed wire is lying or hanging. Illuminate the area if needed and post a guard to warn Firefighters and civilians away from the danger area.
- Do not place heavy objects on downed high-voltage wires to keep them in place. This can cause the wire to make substantial contact with the ground and result in high-temperature arcing and whipping, as well as producing a ground gradient where none existed before.
- If a high-voltage wire is down and arcing, notify the gas utility to respond and evaluate the likelihood of the wire compromising the gas line.
  * If you smell gas at a downed wire incident, notify the gas utility.
- Look to see if the overhead wires are connected to the underground by a riser on the pole. If so, it is possible for the underground system to become involved.
- If telephone or cable wires are down, try to determine if any electric wires have been disturbed and might be in contact with the downed telephone or cable wires.

Pole-mounted transformer fire

- Notify the dispatcher of the exact location of the transformer using the pole numbers and/or an address.
- Protect exposures to prevent fire extension from the burning transformer.
- Do not extinguish the burning transformer until requested by utility personnel unless life is in danger.
  * Use a 30-degree fog stream to extinguish the burning transformer from at least 25 feet away. Stay out from underneath any overhead wires while operating.
  * Water entering the transformer might splash burning oil out of the transformer and onto whatever is below.

After responding to an overhead electric incident, Firefighters are responsible for site safety and must await the arrival of the electric utility personnel. Secure the area and check and monitor the surrounding buildings, keeping everyone away from the downed wires. After the utility arrives and makes the area safe and the Incident Commander (IC) is satisfied that the hazard has been mitigated, FDNY members can take up.

These incidents, though frequently uneventful and seemingly routine, quickly can become hazardous. The precautions mentioned above always should be employed and all members operating at the scene should be informed of the location of the downed wires and the potential hazards. Warnings and safety precautions may have to be repeated to newly arriving units and re-emphasized if it is a prolonged incident.

It is important that FDNY work with the utility representatives at these incidents. At overhead electric incidents, members should consult with and often must rely on utility workers to make the incident scene safe for Firefighters to operate. Additionally, members should take time after an incident is concluded to do a quick debriefing with the utility supervisor on the scene. Working closely with the utility will enhance safety for FDNY members, utility personnel and the people served by both entities.

About the Authors...

Battalion Chief Frank C. Montagna *(left) is a 38-year veteran of the FDNY, the past 22 years of which have been as a Chief Officer. He is assigned to Battalion 58. Currently, he is working in the Bureau of Training, where he is responsible for curriculum development for Officers. He holds a degree in Fire Science from John Jay College, where he has taught fire science courses. He is a member of the editorial advisory board of* Fire Engineering *and has published articles in that publication and contributes regularly to* WNYF. *He is the author of* Responding to "Routine" Emergencies. ***Terry Bellew*** *(right) has been in Electric Operations with Con Edison for 36 years. Currently, he is assigned as an Instructor with the Overhead Training facility at The Learning Center in Long Island City. His experience includes overhead line construction and emergency operations. He is the brother of Lieutenants John Bellew, Ladder 27 (killed in the line of duty at the Black Sunday fire in the Bronx on January 23, 2005) and Daniel Bellew (retired from Battalion 16) and the uncle of FF Daniel Bellew, Ladder 28.*