Utility Emergencies & Foam Student Manual

New Hampshire Department of Safety
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Supplemental Reading Key

The following sections of the text, *Fire Fighter Skills second edition*
by Jones & Bartlett,
correlate to materials presented in this program.

Pages 521 to 525 of Chapter 16

Pages 632 to 637 of Chapter 21

Pages 787 to 794 of Chapter 28

Pages 864 to 878 of Chapter 32

Other reference materials, by product, may be found may be found on the following pages:

Electrical	33, 129-130, 183, 279-280, 347, 557, 636-637, 657, 726, 756
Gasses	141-142, 279-280, 636, 657

Preface

This class is designed to increase awareness of the possible hazards associated with typical utility systems based on the products they transport. The class will explain the basic concepts of the various utility systems and what typical responder solutions may be used to solve common malfunctions. A discussion of firefighting foam and its applications round out the classroom presentation. The student will need an understanding of the ICS System, basic fire fighting concepts, and Hazardous Materials Operations. The practical evolutions reinforce the tactics discussed in the classroom.

This program must be understood to be an introduction and not a detailed study of any one utility system or product. There are much more detailed programs that cover individual utilities, and the best information will be obtained from the utility operators in the community within which you will be working. The most important point that one must be aware of is, that if you do not know how something operates or are not fully aware of the possible hazards of a system, DO NOT TOUCH OR INTERFERE! Do not attempt to save that which is already lost! First responders tend to forget that it takes more time to notify, assemble, and transport utility personnel and equipment than it takes us to respond. For that reason we should be notifying the utility as one of our first actions when we discover we have a utility incident.

UTILITY SYSTEMS

Before we look at problems with utility systems, we will need to understand just what a utility is. The dictionary definition states that a utility is "Something useful to the public". This gives our imaginations quite a wide area in which to roam. In general, we will be talking about the transportation of commodities in large quantities over some expansive system of distribution. Examples may be electrical generation and distribution or natural gas gathering and distribution. Other utilities may include but are not limited to steam, oils, propane, water, and wastewater. As you see, we can include a wide range of items. We may also include public transportation systems as utilities. We will not talk about incidents with public transportation, as they become vehicle crashes with the possibility of adding a mass casualty incident to make them interesting. Other parts of your training address those types of incidents.

We should be aware that utilities have controls placed upon them by government and other safety agencies. These safeguards control how employees are protected, rate structures, construction standards, and operational methods. Some of these controls are spelled out in the Code of Federal Regulations known as CFR's. These laws cover a wide range of rules governing how the various utilities may operate. The Department of Energy, OSHA, and others impose additional controls. These may range from operational controls and restrictions to employee welfare. Voluntary compliance with consensus standards, which are developed by the utilities themselves, adds even more levels of safety and control. Examples of these standard-making bodies would be the American Gas Association and the American Petroleum Institute.

Expanding on our definition, it appears that utilities are in the business of transporting goods through a vast network to consumers. Some of the goods transported may be electricity, gasses, chemicals, fuels, steam, potable water, wastewater, people, and data. It is the actual transportation system that is the key component of a utility. Any transportation system needs a good support network for construction and maintenance. That component becomes a portion of the utility system. Another component is an infrastructure of cost controls and collection. This adds the need for a system of measurement and accounting for the product entering and exiting the system. Most utilities end at the point of delivery to the end consumer. Yet the movement of the product may continue on in similar infrastructure on the consumer property. Depending on the user and the size of the property, this system may be as complex as that of a true utility. The problems that may occur may be as large as those in a small true utility system. Many utility companies will assist with problems past the transition point if by no more than terminating product flow at the interface connection.

Any fault in a utility system will most likely release a large uncontrolled amount of energy. This release usually will pose harm to both property and people. It is in the utility system's best interest to control this release as soon as possible to reduce liability and costs. In most cases special skills and equipment will be needed to manage such a release, and the utility operator will have both of these. In some cases the system may be controlled from a remote location, but more than likely you will need a utility representative on the scene to ask for this type of shutdown.

Most utility systems will have these common components:

1. A way of either producing or gathering the transported materials.
2. A processing or transforming facility.
3. A distribution and metering network to transport the material long distances.
4. Possibly a secondary processing or transformation location. (This may be in multiple locations.)
5. Local distribution network and metering.

Along with these common components may be other specialized components that are more specific to either the product or the means of transport. In some cases individual components are by differing ownership.

We may compare this infrastructure with the purchase of an automobile:

- The manufacturer (utility co) collects and assembles parts from many locations (gathering).
- The car is produced (processing) and then shipped (distribution) to a dealer location.
- The dealer prepares the car (secondary processing) and delivers the car to you, the end user (local distribution).
- You pay the dealer for your car (metering).

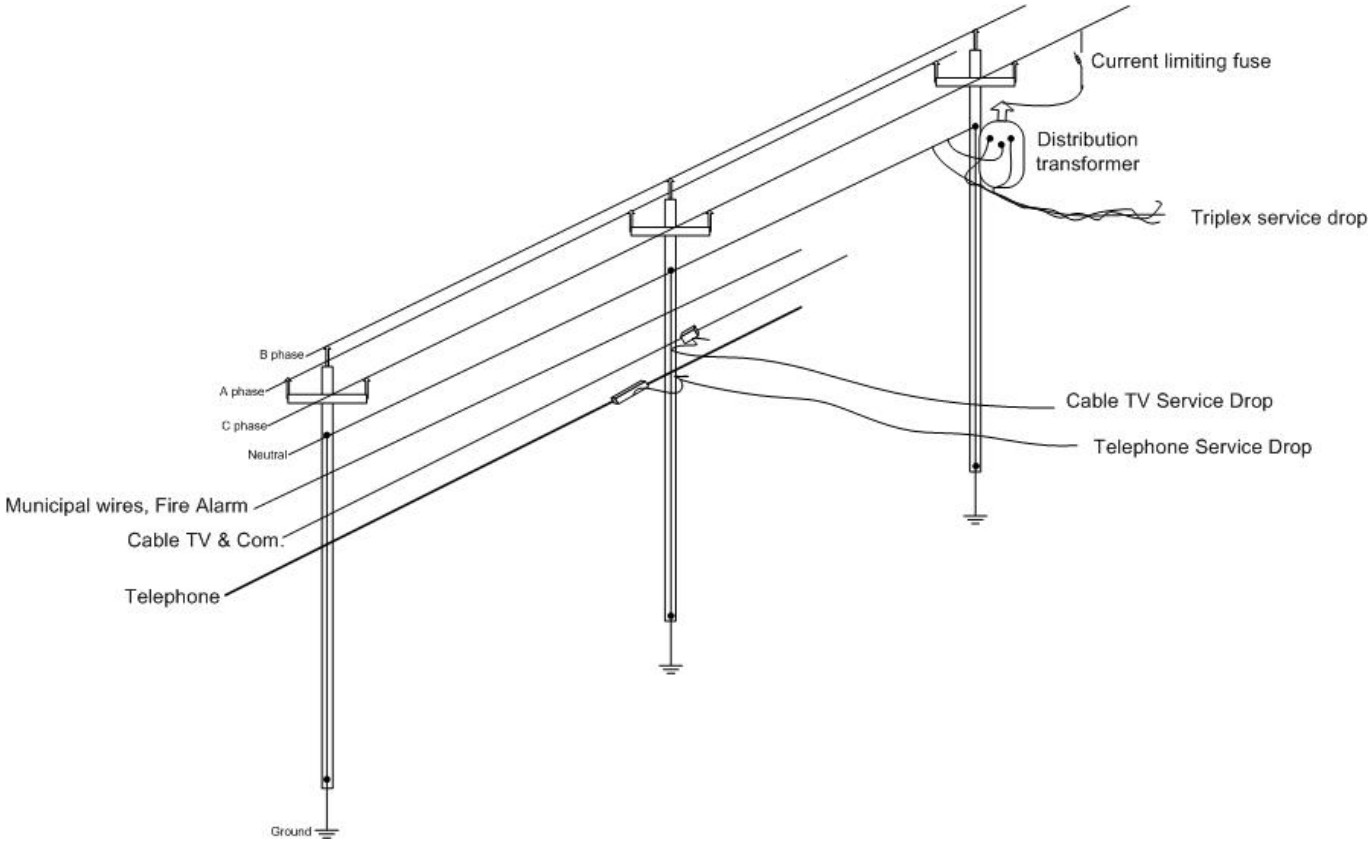
While this process is not exactly the same as a utility operation, it does illustrate the idea of the general process involved in utility systems. We will look at products and components of some common utility systems. By knowing the individual product and some of the possible components involved in its transport, we will be more able to control an incident.

Electric Utilities

We will start with a look at the electric utility. A typical system starts with the generation of electrical energy. In New Hampshire that is principally done by steam turbines connected to generators. Steam is produced by coal, natural gas, trash, wood and nuclear energy. However, we also have some small hydro (water) turbine plants. The typical commercial power plant generators operate in the range of 2,400 to 13,800 Volts. This power is then sent outside the power plant to a switch yard and stepped up to voltages in the range of 69,000 to 1,500,000 Volts (69kV to 1500kV in industry terms) for cross country transmission. The transmission grid is interconnected with all commercial power producers in the US and Canada. Transmission lines are generally operated by an entity other than the local serving utility company. However, your local utility will assist with incidents involving transmission lines to the extent of their training and available support equipment. They also have direct contact with the operator of the transmission line, which speeds solution to a malfunction.

At the receiving end of the transmission line, substations are used to reduce the voltage to a level safe for local distribution in the ranges of 2,400 to 34,500 volts. This is the voltage that may be on the poles of a typical city street or country road! At each user location additional distribution transformers are used to reduce this voltage to the level needed by the end user devices. This is typically 120/240 volts for a residence. Commercial and industrial users will have voltages of 120/208 or 277/480 V. Some large industries or small plants with large usage will have their own substations. In addition some industrial plants will have internal distribution systems and substations operating at the same street voltages of 2,400 to 34,500 volts. The most common internal voltages are 4,160 and 7,200.

Small generators, wind turbines, and hydro plants are connected to the distribution system and “back feed” power back to the grid. There are strict controls imposed on these systems to prevent energized lines without utility knowledge. During periods of power outages, some people attempt to power their structures from portable generators by plugging a cord into the generator and then into an outlet in the structure. This is a very dangerous practice as it will back feed power into the power grid and may be transformed up to distribution voltages on downed wires. This can be a lethal threat to both you the responder and to utility crews working to restore power.



This drawing shows a three-phase distribution pole line. Typical voltage would be 34,500 between the combinations of A & B, B & C, or C & A. Between A or B or C and the neutral, the voltage is only 19,920. These wires are the top most wires on the pole and have heavy insulators to which they are attached. The bare wire below the cross arm is the neutral wire and is shared with both the primary top phases and the lower secondary service wires. This neutral wire is connected to a wire that goes down the pole to a copper plate attached at the base which acts as a connector to the earth. Thus the neutral is "GROUNDED". Neutral conductors are grounded at all available locations in the system. At customer location one, two, or three transformers are attached to the pole. Each Primary wire is connected to the transformer through a current limiting fuse. This fuse is to protect the distribution wires and not the transformer or load. It will provide some protection to the transformer if there is a fault on the primary side within the transformer. The secondary connections on the transformer feed the service drop wire to the customer. Most residential and small commercial service drops will be triplex or quad wire. This consists of a steel strand wrapped with aluminum conductors to make a bare neutral. Around this wire are wrapped insulated aluminum conductors to carry the energized or "hot" power. The neutral wire is connected to the earth through the primary neutral connection. We will talk more about the "hot" wires later in the presentation. About 30" to 48" below the primary/secondary neutral is space on the pole for municipal wires. Usually these are Fire Alarm but could be traffic signal or other control circuits. In some cases the voltage could be lethal!

About 12” below the municipal space is cable television and 12” below that are telephone cables. If the cable has an orange outer sleeve, it denotes a fiber optic assembly and carries light not electricity. While the fiber cable cannot electrocute you, it can destroy your eyes by looking into the end of an open cable! On some poles there could be multiples of any of these circuits.

In order to control a problem with an electric utility, we should know the dangers associated with the transported material. That is electricity. The following is an MSDS for electricity.

Material Safety Data Sheet MSDS for Electricity

SECTION 1 - PRODUCT IDENTIFICATION AND USE

PRODUCT IDENTIFIER:
Electricity

PRODUCT IDENTIFICATION NUMBER (PIN): Is everywhere - does not have one

PRODUCT USE:
Electricity is a form of energy that surrounds us in many forms and from many sources. There are the naturally occurring sources (i.e., static electricity and thunder and lightning storms). There is also a network of the power supply system. This system includes generating stations, transmission lines, transformers, distribution lines and residential fuse boxes and/or breaker panels. Local power utilities play an important role in harnessing electricity into usable energy. As usable energy, electricity can be used to complete certain tasks and run different machines and equipment.

MANUFACTURER'S NAME:
Electricity is generated by power utilities.

SUPPLIER'S NAME:
Depending on your geographical area, different utility distributors exist.

STREET ADDRESS:

CITY:	**STATE:**	**COUNTRY:**
Concord	NH	USA

EMERGENCY TELEPHONE NUMBER:

SECTION 2 - HAZARD INGREDIENTS

HAZARDOUS INGREDIENTS: Electricity is a form of energy. As such, it has the potential to do many good things, but it also has the potential to do harm. Electricity is created when particles become charged. Some are negatively charged (electrons), some are positively charged (protons). Unbalanced charges between the protons and electrons are part of what is necessary to create an electric current. However, the flow of electric current cannot take place until the circuit is completed.

SECTION 3 - PHYSICAL DATA

PHYSICAL DATA: Electricity is invisible to the naked eye. It is neither acid nor base. As a form of energy, it is colorless, odorless, and does not have the usual types of physical properties that can be easily described.

SECTION 4 - FIRE AND EXPLOSION DATA

FLAMMABILITY: Electricity does relate highly to fires and explosions. As a form of energy, electricity has the potential to be the fuel source for an electrical-based fire. It also has the potential to ignite other types of fires. Many a fire has been started by the combination of combustible fumes and gases and an electrical spark or discharge. Fires that involve electricity are known as Class "C" fires and must be handled in a certain way. Special types of extinguishers are required for fires involving electricity.

SECTION 5 - REACTIVITY DATA

REACTIVITY DATA: Electrical current flows when there is a difference of voltage between two points. Electricity flows through different substances in different ways. Insulators have a high degree of resistance to electrical current and tend to hinder the flow of electricity. Conductors transmit electricity very well and have a very low resistance. Some materials are sort of between insulators and conductors. These materials are called semi-conductors and have some characteristics of the two classifications. It is important to remember that VERY FEW materials are non-conductive when voltage is extremely high. Although it is true that electricity will take the easiest path to ground, in fact, electricity takes ALL paths to ground, not just the easiest path.

SECTION 6 - TOXOLOGICAL PROPERTIES

TOXOLOGICAL PROPERTIES: Electricity does not enter the body through inhalation, ingestion or absorption through the skin or eyes. Electricity enters the body as a path to ground. It is merely in transit. The bottom line with exposure to electricity is that you never want external electrical current flowing through you. Your body is not designed to conduct current and, when it does, many negative things can happen. There are many different signs and symptoms of electrical injury. The scope of signs and symptoms experienced by the victims of electrical injuries might include: burns at the entry and exit sites of the electricity, visual disturbances, muscle tenderness / twitching, restlessness or irritability, fractured or dislocated bones, seizures, respiratory distress or arrest, irregular heartbeat or cardiac arrest. Usually internal damage is far more than shown on the exterior

EXPOSURE LIMITS: Very small amounts of electricity can do a lot of damage to the body. Caution should always be heeded when working and dealing with electricity as you may not get a second chance next time.

CARCENOGERICITY: When it comes to electricity, carcinogenicity is actually the least of your worries. If you are not careful with electricity today, you will not be around tomorrow to worry about developing any long-term effects.

SECTION 7 - PREVENTATIVE MEASURES

PREVENTIVE MEASURES: Preventive measures typically encompass personal protective equipment, guarding and grounding. Electricity surrounds just about everyone and we all have a part to play in being on the lookout for potential hazards and taking action to prevent accidents before they occur. *Distance is your best friend!*

SECTION 8 - FIRST AID MEASURES

SPECIFIC FIRST AID MEASURES: It is essential that before any treatment for electrical injury commences, the cause of the electrical injury must be removed. Once the source of electricity has been isolated and the victim is clear of the source, it is then safe to commence with the standard first aid examination, assessment and treatment. Regardless of the apparent extent of injury, ALL victims of any type of electrical injury should be transported to the nearest medical facility for a thorough assessment. This list details some of the common effects of electrical injuries:

- Electrical injury often causes a person to stop breathing. If the victim's breathing has stopped, immediately start rescue breathing (artificial respiration) and give oxygen if available;
- Exposure to electricity may cause cardiac arrest or ventricular fibrillation. In either case, cardiopulmonary resuscitation should be started and maintained until a normal cardiac rhythm is attained;
- It is important to immobilize and cover the victim and treat for shock. Treatment for shock involves trying to maintain a balance, not giving anything to eat or drink, having the person lay down and maintaining a normal body temperature;
- Where electricity enters and leaves the body it will leave burns. These are known as the entrance and exit wounds. It is best to not attempt to treat entrance and exit wounds, but instead to cover them with clean dressings and have them dealt with at the emergency health care facility.

SECTION 9 - PREPARATION DATE OF MSDS

PREPARED BY : New Hampshire Fire Academy

DATE: 12/19/2008

As you can see electricity can be very harmful if not fatal. The following chart shows current levels of voltages usually found in residential and commercial spaces and the expected effect on the average body. Muscle mass, fat, & water content will change the points up or down. We measure electron flow in units of Amps. A 150 watt light bulb uses 1.25 Amps at the normal household Voltage of 120. The outlet it is plugged into will be protected by a 15 or 20 Amp. over current device. The figures in the chart are in milliamps, which is 1,000 of an Amp. The individual body, the level of voltage, the length of time the voltage is contacted, and many other factors will determine the extent of injuries. While the external damage may seem small, the internal damage will be very large. Very few people survive contact with voltages greater than 220 Volts. There are cases where people have been killed by voltages as low as 49 volts.

- **1 milliamp (mA) is just perceptible by most people.**
- **5 mA slight shock (0.5 watt LED lamp). This is the threshold cutoff of a GFCI outlet required in bathrooms and kitchens.**
- **6-30 mA painful shock, loss of muscle control, may not be able to let go.**
- **50-150 mA extremely painful shock, respiratory arrest, severe muscle contractions, death is possible!**
- **1,000-4,300 mA (1-4.3 A) Ventricular fibrillation occurs. Muscles contract; nerve damage occurs. Death is likely.**
- **10,000 mA (10 A) Cardiac arrest & severe burns occur. Death is probable.**
- **15,000 mA (15 A) Smallest normal over current device.**

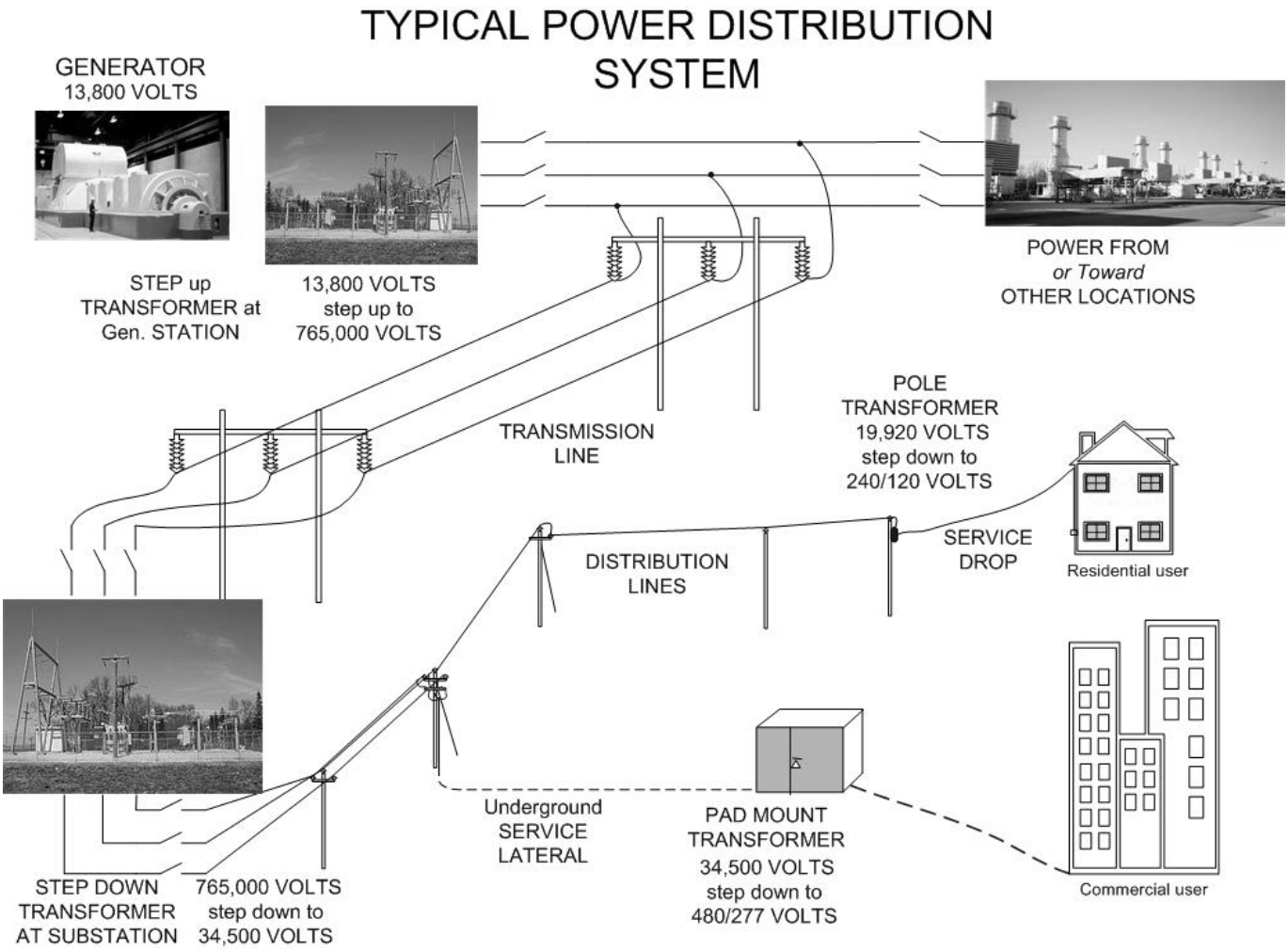
An electric arc produces temperatures as high as 35,000 degrees F. Molten particles of the equipment will be projected as far as 10 or 20 feet. This heat wave will melt synthetic clothing and burn the skin and respiratory tract. The intense ultraviolet light will burn the eyes at great distances. The sudden ionization of the air surrounding the arc will produce a shock wave similar to a blast of TnT. Most residential electric services are rated for an interrupting current of 10,000; 22,000; or 65,000 amperes. A remote rural electric service could have an available short circuit current as high as 8,000 amps while a residential service in a densely populated area could have short circuit currents as high as 20,000 amperes. Commercial and industrial services will be in the higher ranges of available current in a fault situation. Just because it is a residential service does not mean that there is not enough energy available to do severe damage to you, the structure, or the electrical equipment under fault conditions. As electricity travels at the speed of light, you cannot outrun it!

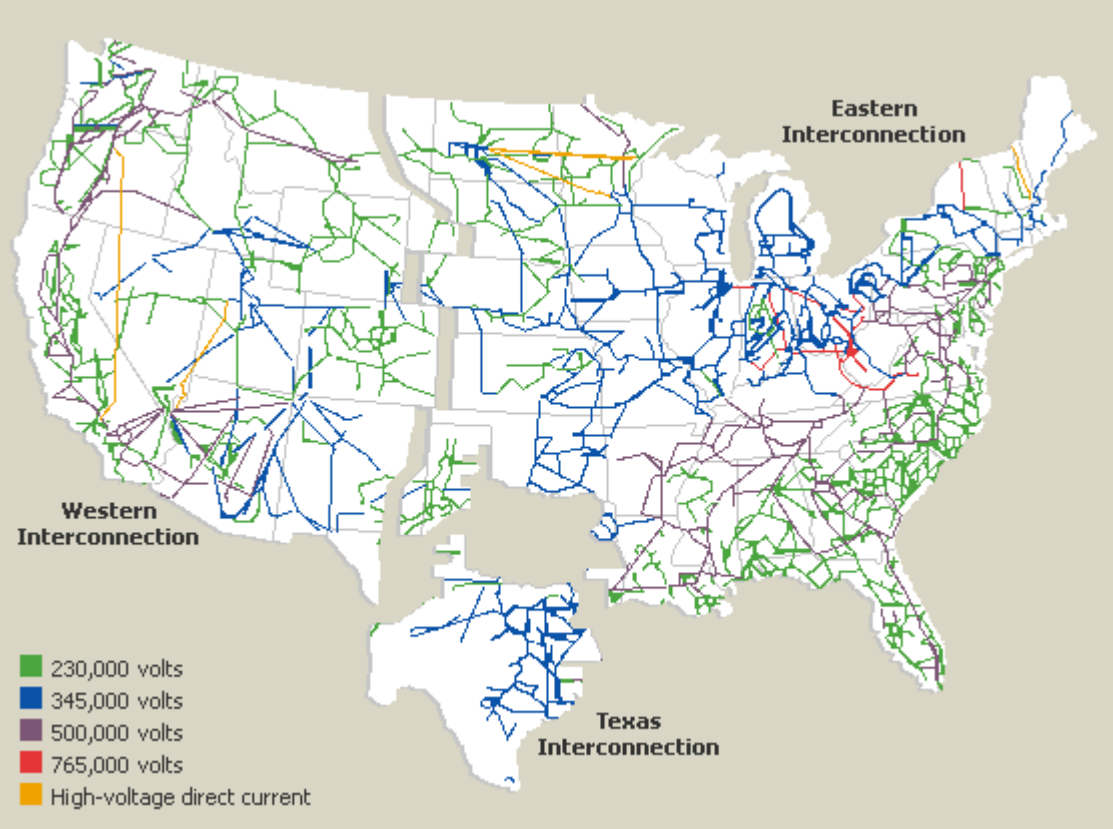
Downed power lines are a great danger, as we cannot tell if they are energized or not. Even if we see them arcing and the arcing stops, do not believe that the line is now not energized. The capacitance of the line may still retain a voltage sufficient to cause harm. This may be equated to the charge in a battery after the charging system is disconnected. Also, power lines are designed to fault tolerant and burn away minor interferences. Circuit protective devices are set to open a circuit if the fault current exceeds the maximum short time capacity of the equipment, which may be many times the actual normal operating levels. Also, in an attempt to keep the majority of a system operating, some protective devices will open the circuit for a short time and then reclose on the fault in an attempt to burn the fault away from the power line. This may occur several times before the protective recloser will lock open and need to be reset manually. Generally, this setting is for three attempts but may be more or less as selected by the designers of the system. This makes a downed power line a great danger because if people do not see an arc, they may assume the line is not energized. We also must be aware of the dangers of "Step Potential". Because the earth is not a uniform mass or does not have even moisture distribution, it is also not a uniform conductor. When a power line contacts the ground, the point of contact will be close to the same voltage as the wire. In an effort to equalize the voltage, electrons will try to follow the most direct route to the closest grounded connection. As the electrons flow through the earth, they produce heat as in a lamp or toaster. This uses up voltage the same as friction loss in fire hose reduces pressure. For each unit of distance the electrons travel, the voltage will decrease until the voltage is equal to the grounded conductor of the system. If a person steps between two adjacent areas of voltage change, there will be a difference that is bridged by the body and not the earth. As the body is a better conductor than the earth, the current will flow through the body and do damage. If a tingling is felt near an electrical problem, slide the feet together. Exit the area by sliding one foot away then the other not passing the heel or toe of the other foot. Wires in contact with trees, vehicles, and other objects will impose the same voltage on the object and the same voltage dispersion gradients will be around the object and the earth where they contact.

If a power wire is down on a vehicle, you should have the operator stay in the vehicle. If they are able to move the vehicle away from the wire, do so. Do not let anyone touch the vehicle and the ground at the same time. As a last resort, you may instruct the occupants to exit the vehicle by jumping clear without touching the vehicle and the ground at the same time and have them try to land on both feet as close together as possible.

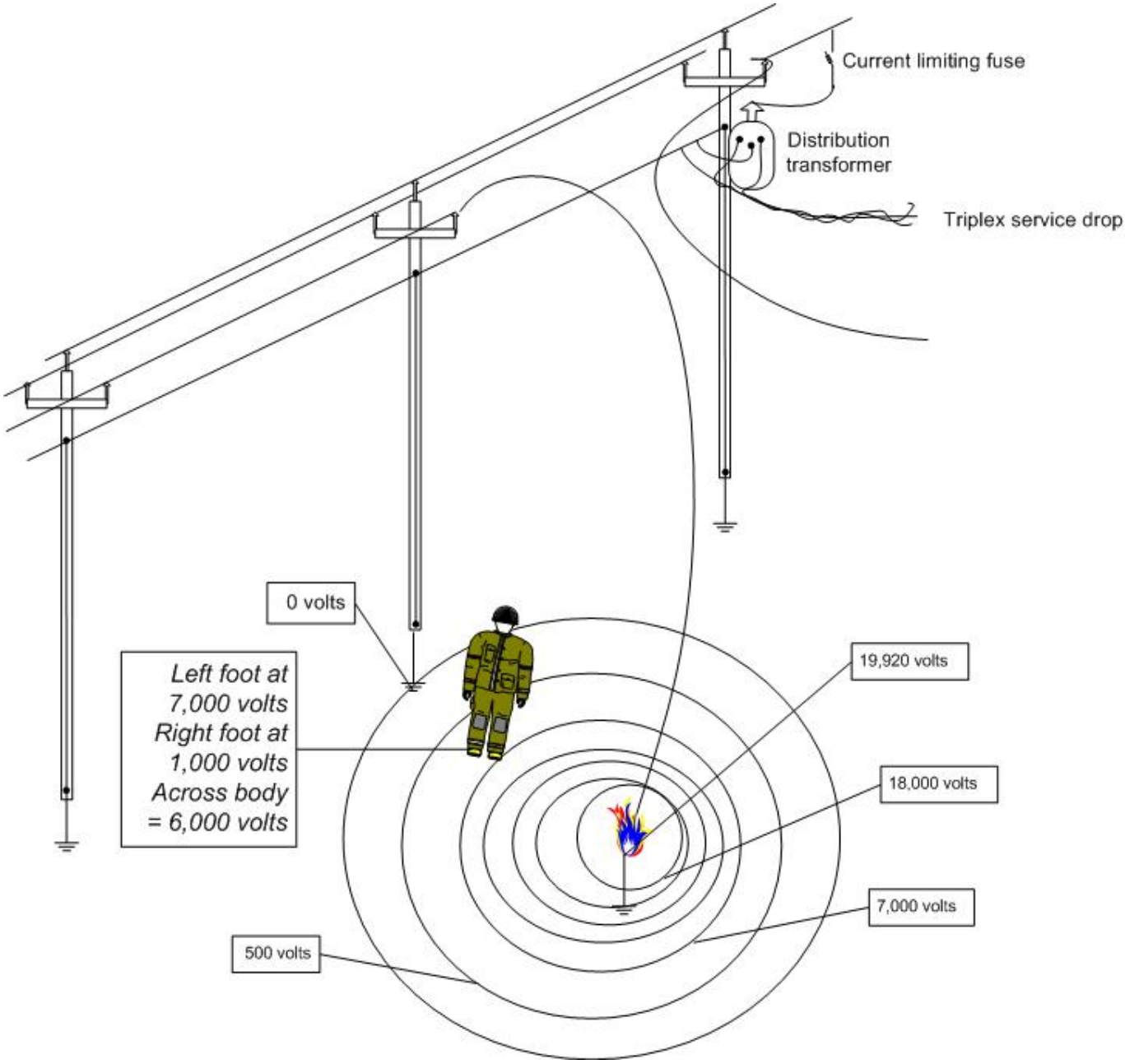
The drawing on page 16 illustrates the step potential effect.

The drawing on this page shows the electric distribution system in graphic terms. The drawing on page 15 is a map of the interconnect grid within the United States.



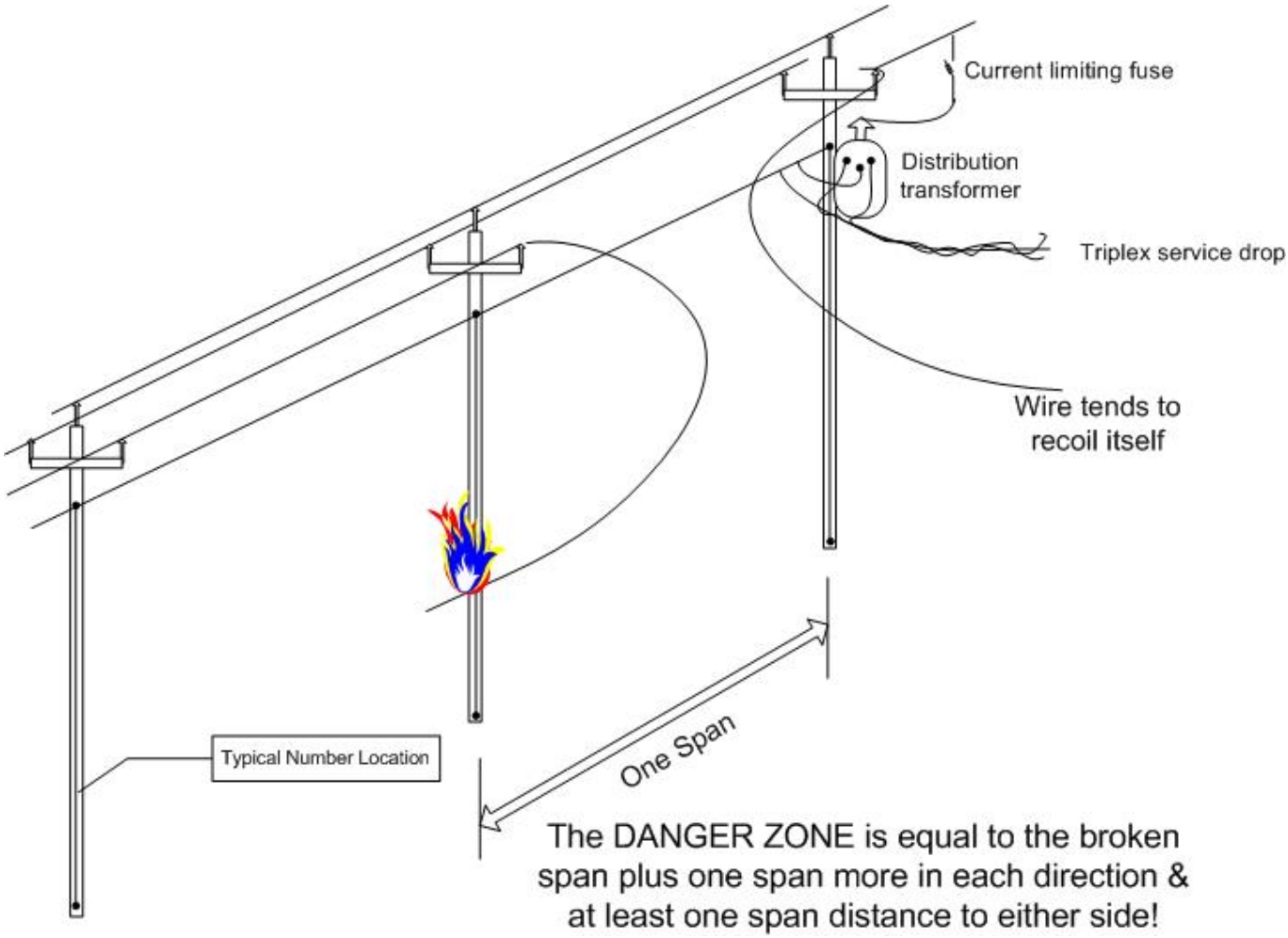


This map shows the size of the interconnected electric grid within the United States. Be aware that the grid also extends into Canada.



Another danger is the mechanical dynamics of the construction and materials used in the construction of power lines. There are mechanical forces that need to be addressed in the construction of the power line such as wire weight and changes of direction, which put the wires under mechanical tension. This is why the utilities put guy wires at poles where wires change direction to counteract these forces which could pull poles out of a vertical plane. The wire itself is constructed of a steel strand wrapped with an aluminum conductor. This adds mechanical strength to the less structural but more conductive aluminum. This is called ACSR (Aluminum Conductor Steel Reinforced). When using this type of cable, we must be aware of the fact that the cable will want to revert to its as shipped shape as it was wound on the shipping reel. In other words, cables will try to recoil and whip back in the direction of the applied forces when broken or released from under a load such as a tree limb as it is

removed. Be aware that communication cables also use the steel support strand and will whip in similar ways but with more force. The following drawing illustrates why we must stay at least one pole span away from a utility line fault. This applies to lines still intact but under loads or arcing, as we have no idea when they may fail. When reporting utility line problems, you should try to get the identification information on the tags attached to the pole at about eye level as well as the physical location.



As communication cables may share poles with power lines, we should use extreme caution with these utilities as well. A downed power line may energize the communications equipment with voltages well above that normally carried by these utilities. Communication cables may also carry laser light on glass fiber. These pose a threat only if you look directly into the end of the glass fibers. While you may not see visible light, the light levels will damage your eyes in a very short time frame.

As you can see by the very nature of electric utilities, there is not much we can do in the event of an incident without assistance from the utility personnel. Any downed wire must be treated as if it is energized until you have confirmation from the utility personnel that the line is safe. Do not touch anything that is in contact with a downed line as that object is also energized. With today's voltages we, as first responders, have nothing in our tools or PPE that will withstand high voltages! The videos within the slide program will bring this point home. We will go into more depth on how to handle these emergencies after we look at the other types of utilities.

Pipelines

The next largest utility we will look at is the pipeline industry. As with electricity, we must gather or manufacture the product. In most cases this is done by companies other than the pipeline company. You may have gathering pipelines from oil and gas wells that will send the raw product to a processing plant or refinery. From these locations the product is inserted into a transportation pipeline that is like a railroad or a truck on a highway, in that many products by many different producers may be transported long distances in the same pipes. The pipeline operators will have compressor or pump stations to push the product to the exit location. At that point it may be distributed by a local pipeline or further stored or processed by a new company.

Local utilities that transport water and sewerage are shorter pipeline systems dedicated to transportation, processing, and distribution just like oil and gas pipeline systems. They may only encompass a small area or they may cover long distances, as do the water systems in the far western part of the country. Most potable water systems start with well water or water from a river or stream. The water is collected, filtered, and treated to remove biological hazards. Gravity or pumps move the product via transmission lines into the distribution piping. The distribution piping is usually set up in a grid to make it easier to isolate a break and to assure adequate flows at a reasonable infrastructure cost. Pipe sizes range from ¾” to as great as 60” with pressures of 20 to 125 PSI. As with any emergency, larger volumes and pressures will cause greater risks and challenges. Waste water systems range in size between 2” to 20’ depending on the expected flow. Most systems flow by gravity, but there are both large and small force mains (Pumped) in both rural and urban locations. A wastewater break causes more concern than a fresh water break because of the health risks. They can also be a rescue challenge. With water pipeline emergencies, the tasks will normally be isolation, rescue, and property conservation. Flooding of structures will also cause problems with other utility systems and the potential of structural collapse.

Steam is an energy source used for heating and cooling in many large buildings. Many communities have central steam plants and an infrastructure to distribute this energy source to multiple buildings. This may be a system dedicated to a small campus of one-owner buildings to massive systems that cover the area the size of Manhattan, NY. Pressures in these systems may range from 60# to as high as 160#. The big danger with steam is the escape of superheated water that will cause extensive burns to anyone that may be in the way of such a leak.

Pipelines may carry any gas, liquid or fine solids long and short distances as part of a dedicated facility or as a common carrier. As with any pressurized system, pipeline emergencies will have structural damages to the pipeline and equipment as well as any equipment or structures in the vicinity of such a break. In pipelines that carry fuels, there is the added risk of explosive force ignition of the product and the continued fires that will remain until the pipeline rupture may be isolated. There may be tens of thousands of gallons of product in the pipeline between isolation valves. New Hampshire has few pipelines that carry refined petroleum. Most of these serve our airports with jet aviation fuel. The one exception is an oil pipeline system owned by Portland Pipe Corp. that runs east to west and connects to other lines in the distribution grid.

This system takes crude oil from the port of Portland to Montreal and Ontario. At peak throughput, the system is capable of transporting 525,000 barrels a day. In addition to the actual pipelines, there are pump stations located in Lancaster and Shelburne, NH. This pipeline was first constructed in 1941.

Transmission of natural gas is increasing in our region. Other regions also have liquid Propane (LP) or liquid Natural Gas (LNG) pipelines. Many upgrades and enhancements have been made in the last ten years to the grid in the southeastern corner of New Hampshire. All of these transmission lines operate at about 1000 Psi. The Pittsburg-Gorham Line is 24" in diameter. A second 30" line runs from Plaistow to Newington and on into Maine. Both these lines are owned or shared by *Portland Natural Gas Transmission System*. The other co operator of the southern line is *Maritimes & Northeast Pipeline LLC.* The second Plaistow to Newington line is operated by *Granite State Gas Transportation Co.* The Pelham to Concord line is operated by *The El Paso Pipeline Group, Northern Division* a part of *Tennessee Gas Pipeline an El Paso company.* At least one of the Newington lines is bidirectional. Without talking to the operator, you will have no idea which direction the gas is flowing. Also, none of these lines have had any reportable incidents since 1998. That is the earliest reporting period on file to the present. However, an incident with any one of these lines will be a major challenge. A quick search of reported accidents in the US will give you an understanding of the extensive damage that may result from a failure of one of these pipelines. A smaller intrastate line runs from Concord to Tilton by way of Loudon, Canterbury, and Belmont.

Control of a rupture of one of these large high pressure gas lines will be a major disaster, and the only measures we as first responders will be able to do is evacuate those endangered and attempt to control the fires on the edges. Once the gas is contained by the pipeline operator, we will be able to extinguish the remaining fires as the gas burns off. While most incidents are not as destructive as they may be with these large pipelines, you must use care when controlling small incidents. We must not extinguish a fire fed by a gas or by a liquid that change to a gas under normal atmospheric conditions. As we do not see the escaping gasses, it is better to let them burn in a controlled location in place of flowing to an unknown ignition source.

Other Utilities

As we stated earlier, we will consider other means of transport as utilities for our purposes of emergency control. These can be stand alone propane systems, transport trucks, railcars, and ships or barges. In essence they are merely a contained section of a pipeline. The materials transported are the same, and the control measures will be the same. The quantities will be small, and we now have the possibility of entrapment of operators within the wreckage of this "pipeline".

Petroleum products for New Hampshire originate at terminals in the Portsmouth, Rochester, Claremont, Boston, Portland, or the Albany areas. These terminals may receive the bulk product by pipeline, ship, rail, or in some cases truck. At the terminal the product is stored in giant tanks and pumped into trucks that ship the product to local distributors. In the case of gasoline, the ethanol is added at this stage as it causes problems when shipped by pipeline. In the case of LPG, the odorant is introduced at this time. To this point LPG has no noticeable odor.

The distributor then takes the product to their storage tank or directly to the consumer. Much of the gasoline and diesel fuels go to local filling stations and is stored in underground tanks. These tanks use either pumps located within the dispenser, or in most cases, pumps within the tank to push the product through the meter and the filling hose to the consumer tank. These dispensers have special "break away couplings" at grade level to seal off the product pipe if the dispenser is knocked over or pulled off its base. As the dispenser also has electric power, usually the product that is trapped within the open piping or spilled on the ground is ignited if the unit is dislodged from the base. The shear valve keeps the fire and product in the below grade piping from meeting. These valves also have a thermal latch to close the valve if involved in fire but not sheared.

Let's look at the commodities that do not require pressure to remain a liquid. Most are received by ship at a local terminal or transported by rail or truck from remote processing facilities. The most common products on our roads would be gasoline, diesel fuel, heating oils, hot road oil, and many chemicals. The silhouette drawings in your ERG's depict the type of tanker that would be used to transport these items. Most are then stored in tanks above and below ground that are vented to the atmosphere. The majority of below grade tanks must be of a double wall design to protect the environment. The products are moved from various containers by a system of pipes, hoses, and pumps. These may be at fixed land based facilities or mounted to transport vehicles. The same collection, processing, and distribution system is utilized as that with pipelines but using containers on water, rails, or roads in place of pipes. Incidents within a terminal or large distribution facility will require a large response and, in most cases, will be a facility that has been preplanned by your department and with the operator and in some cases with mutual aid companies. Incidents within rail cars or ships will have special challenges that we will not get into in this program. Incidents at user facilities and on transport vehicles are the most common.

Oxygen, Carbon Dioxide, Nitrogen, Neon, Xenon, and a host of other minor gasses are a few of the common gasses that are transported and used in industry and research facilities. Quantities may be in small cylinders or large transport trucks. The properties of the material and the quantity will play a key role in determining how the incident is handled.

Each of these needs to be contained within a tank under some amount of pressure. The second difference in these is that some are transported as a gas and others are transported as a liquid.

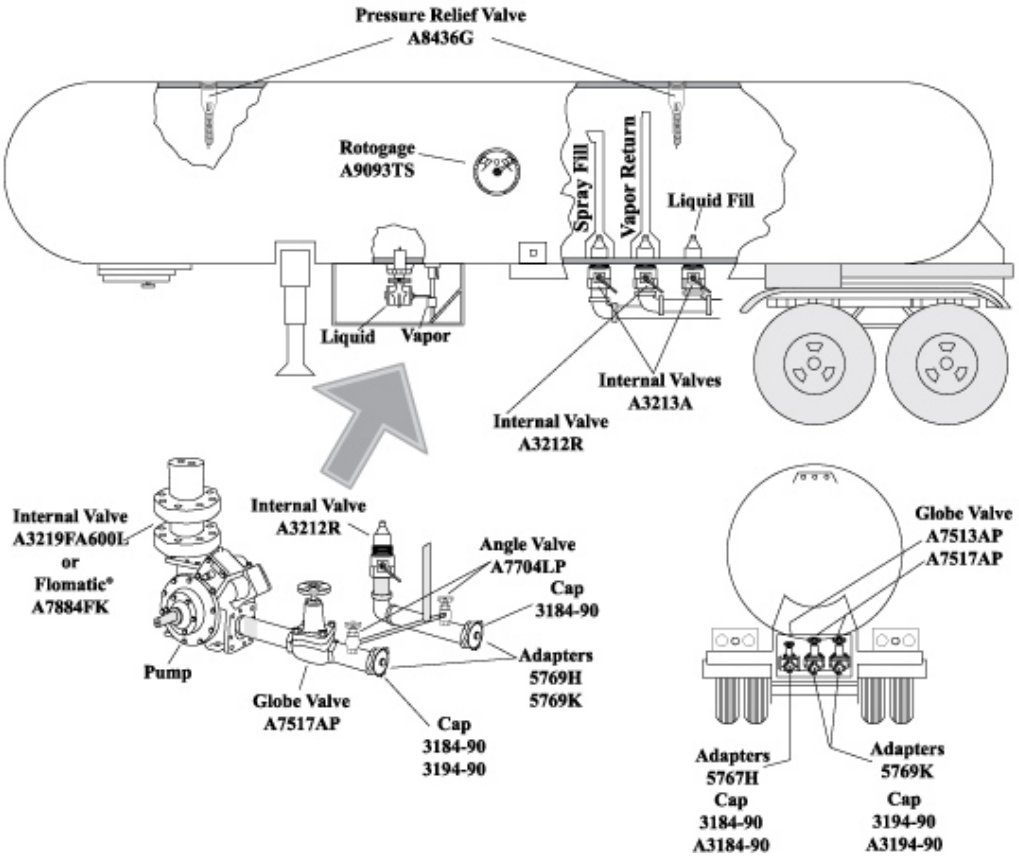
Of concern to most responders is any vapor cloud emanating from any cylinder or transport vehicle. In the case of Liquid Nitrogen and Liquid Oxygen transport systems, a small vapor cloud is normal. This is because the transport system uses a small quantity of the gas to be expelled through a special heat exchanger in order to keep the transport vessel cold.

In this program we will concentrate only on the flammable gasses. Your Haz-Mat training will guide you with most of the others. The most common flammable gas is Propane which is transported as a liquid under about 125# pressure. As pressure is reduced the liquid boils to produce gas and rebuild the pressure and stop the boiling. This equilibrium is disturbed when we release the liquid at atmospheric pressure and the result is a release of a large quantity of gas. For each cubic foot of liquid the resulting gas quantity will be 270 cubic feet of vapor. Just by turning a leaking propane tank so that the leaking valve is in the vapor space, you can reduce the hazard by a factor of 270! Propane enters our state at distribution centers in Newington, Rochester, Claremont, and from terminals in Boston and Albany.

Most transport and delivery trucks are required to have certain safety devices. These are designed to limit out flow of product if a pipe or hose is broken, or if the piping is broken from the opening of the tank. Just as in gasoline dispensers, these valves are designed to shear on impact but leave the actual closed valve within the container. The outlet valves also must self close if subjected to high heat as in a fire and to have remote closure operators on the vehicle. Normally, these remote controls are on the driver front and the curb rear of the tank frame. Additionally, all pressure vessels must have approved pressure relief valves to vent product if the tank pressure rises above a safe level. If such a valve is operating and product is escaping, most likely it is from an external fire which will also ignite the escaping product. If the sound of that escaping product increases in pitch and intensity, it is a good indication that the tank relief is approaching the point at which it cannot release enough product to keep the tank at a safe pressure. If you cannot rapidly cool the tank to reduce the sound, *it is time to retreat*! Smaller tanks may have fusible plugs that serve the same purpose. The drawing on the next page shows these safety features.

Bulk Transport Trucks

Drawing Courtesy REGO PRODUCTS



A **BLEVE** is our worst nightmare! This is when a pressurized flammable liquid is suddenly released into normal atmospheric pressure and explodes violently. The acronym stands for **B**oiling **L**iquid **E**xpanding **V**apor **E**xplosion. If one cubic foot of propane is allowed to escape from 100# pressure to atmospheric pressure, it will immediately boil off into 270 cubic feet of vapor. This expanding vapor is just looking for a heat source to become an instant bomb. A container or closed pipe will weaken at any point of heat or flame impingement. This will be accelerated in areas of a container that are not covered with liquid so any cooling by hose streams must cover all vapor space areas of the container. Any pipe that is closed at both ends by valves or any other obstruction becomes the same as a transport container and will have the same BLEVE possibilities. Fires involving gases should be controlled but not extinguished until the supply of the gas is stopped and the entire vapor is consumed. Containers that have any flame impingement MUST be cooled by a continuous bath of water on ALL surfaces. This is especially a requirement for all spaces that are only contacted by vapor within!

Systematic Control

Most utility systems will be well versed in using the **N**ational **I**ncident **M**anagement **S**ystem. They wish to have the same outcome at an incident as you do so will do everything they can to achieve that outcome. You will need to use unified command, as you will need many different players to control a major utility incident. By using a stepped approach, you break the incident into manageable portions that are easer to deal with.

The **first** concern is to limit access to the site and to remove or limit the persons that could be endangered. This includes first responders. We must resist the candle moth syndrome and rush in where only fools will tread. Keep you and your personnel safe as your first action.

Second: we must identify the actual problem. What is escaping or may escape? What is broken and can it be fixed. What are the possible dangers at this time and in the expanded time we will need to act.

Third: evaluate current risks and hazards. Project future risks and hazards accounting for set up times, equipment and or supply accumulation times, and control time. Failure to account for these time constraints may place everyone in an unacceptable position of risk.

Fourth: select what protective equipment and PPE is appropriate to the incident at hand. Evaluate if you have such equipment or how long it will take to get the equipment. Most importantly are the people on hand trained at a level to use the equipment properly. Reevaluate step 3.

Fifth: assemble the required equipment, supplies and, trained personnel. Reevaluate step 3.

Sixth: implement your plan and constantly monitor and evaluate the results. If things go well, keep going. If your actions do not appear to be controlling the situation, go back to step one and formulate a new plan. In most cases you will only have one chance to do it correctly so make sure the first steps are acceptable to all of the unified command staff. Keep in mind that the utility representative knows more about the product and systems than we do. You may have to write off structures, equipment, and people that are beyond help. The utility will scrap any equipment that was involved so it does no good to attempt to save equipment that places you in danger.

Seventh: as the incident is controlled, you may decontaminate and regroup. This allows for rotations of personnel, release of mutual aid, and restoration of normal civilian operations. Depending on the incident, this decontamination phase may last several days and may be done by contractors. It may also take days to replace utility equipment and restore civilian normalcy depending on the extent of the damages. Emergency personnel may have a minimal presence during this phase of the operation and command may shift several times through several agencies or contractors.

Eighth: terminate and evaluate the incident. Take time to document all that was done and keep accurate records of times. Also take the time to convene all the responders to have a critique of the incident. Make sure this is not a finger pointing session but one of mutual respect and learning.

In essence this is a combination of all your training both in the fire sciences as well as any life experiences you have had in the past. We control most any incident in the same way. We will need to combine our hazardous materials training, incident command, fire fighting knowledge and other life experiences to control these incidences as we do with any incident. Pre incident discussions with all the utility entities in your response district as well as mutual aid response districts will make a utility incident relatively routine. Prior knowledge will save lives and effort on your part.

Extinguishing Agents

In order to be most successful in extinguishing utility fires, we may wish to use other materials than just plain water. We have touched on the properties of both water and auxiliary agents in our fire extinguisher classes. In industrial & special situations, these materials may be used with built-in protection systems to protect from the event of fire. In the utility industries, these systems will be in places of high risk or value. Examples would be large switch yards and switching stations of electric and communication utilities, tank farms and loading racks of Petroleum distributors. Keep in mind, that as we learned with extinguishers, an electrical fire reverts to a class "A" or "B" fire after the power is disconnected. While water is relatively inexpensive and abundant, it may not be where you need it; therefore, it becomes a challenge to provide the necessary cooling capacity for large petroleum fires in remote locations. Your knowledge of water relays or tanker shuttles will be taxed to the limit in some extreme fires. We are fortunate that in cold or dry seasons we are able to get to water. Some sections of the country do not have that luxury.

Loading racks and utility equipment and buildings may have very specialized detection and suppression systems. You will need to understand their operation and how to support the suppression system and not to work in opposition to the system. Opening spaces with gaseous deluge systems or applying water to foam systems will defeat what the system has accomplished. You need to understand the system capabilities and limits.

In general, if we are to suppress a raging utility fire, we will need copious amounts of finished foam. We should never start using foams and then revert to plain water, as we will defeat what we have accomplished with the foam. This is a very expensive mistake.

There are several types of foam concentrate used by the fire service and even more used in specialized industrial systems. Foam usage began to bloom during WW II. Development has since increased to the magic potions we use today. One major advance was the development of what we call "Class A Foam". This material is designed to make attack of common Class A materials more efficient. The first characteristic is that the concentrate reduces the surface tension of the water molecule. This allows the water to get into fine crevices and pores of the material burning. The fine bubbles hold water on the surface to help cool, and when broken, release more water into the material. In higher concentrations the bubbles may be produced to act like sticky glue and be used to place an insulating blanket on a vertical surface for radiant heat protection. Class A Foam concentrates are usually mixed in the rage of .1 to 3% ratio to the water. They do not work on petroleum products and do not mix with other types of foam. Mixing classes of foam concentrate in most cases will produce a gel that is nearly impossible to get out of the equipment.

Class B Foam concentrates are designed to control petroleum fires. There are five general types designed for special applications:

- (AFFF) "A Triple F" is the most common and has wide use. It is a liquid concentrate that is made from fluorochemical and hydrocarbon surfactants combined with high boiling point solvent and water with suitable foam stabilizers.
- (PT) Regular Protein Foam was used for almost all aircraft fire fighting before the 1970's. Due to its corrosiveness, no self-sealing ability, and other limitations, PF is no longer widely used. It may still be used in some special industrial applications.

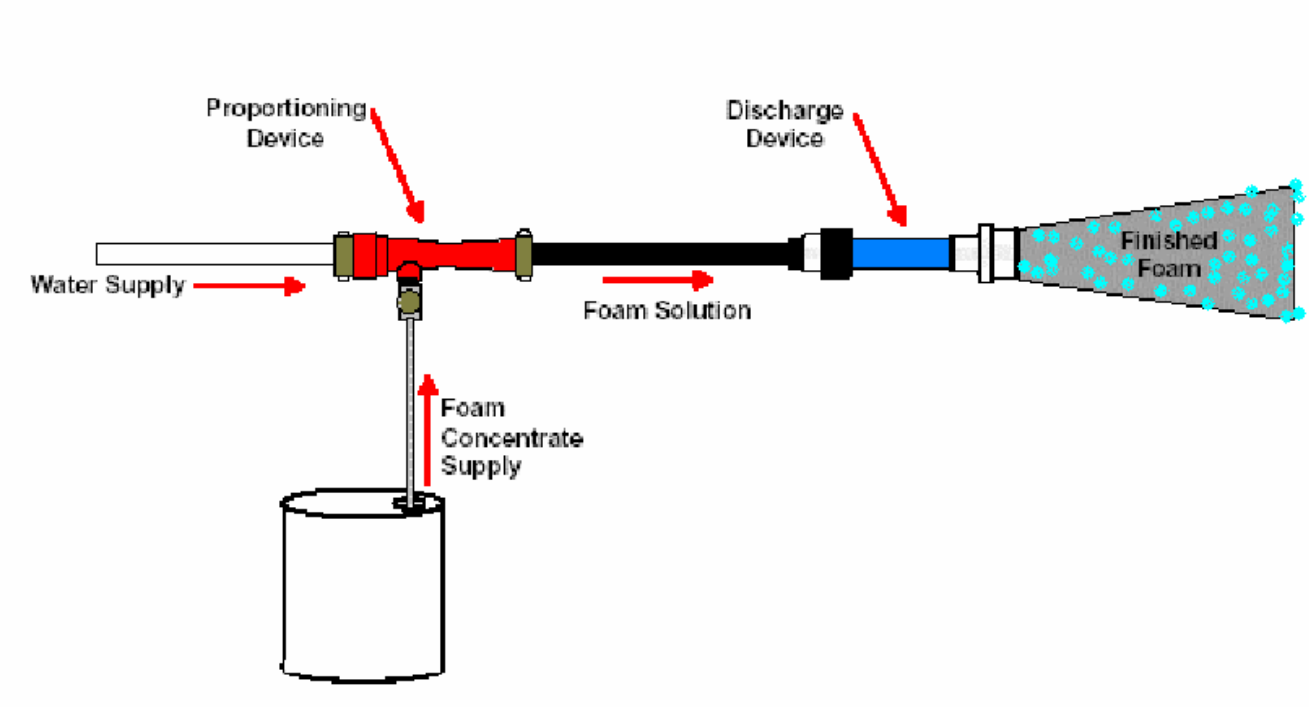
- (FPF) Is widely used in protecting fuel tanks and petroleum facilities because its unique fuel shedding qualities make it highly desirable in sub surface injection applications.
- (FFFP) Fluoroprotein foam technology with aqueous film forming foam capabilities provide the benefits of AFFF with the long lasting heat resistance of FPF.
- (HX) High Expansion foams have applications in concealed spaces, fire extinguishing systems for specific industries such as aircraft hangers, rolled or bulk paper storage, etc, and have expansion ratios of 200:1 to 1,000:1. HX is usable on class "A" materials.

We must be aware that more and more fuels are containing polar solvents. That is a chemical that has an attraction for water. This attraction will break down the foam structure very rapidly. If a fuel with a polar solvent is suspected, we must use foam that is resistant. This will have a label and concentration rating for polar solvents or be labeled as AR for alcohol resistant. In most cases the mix ratio will also be higher. If normal application is 3%, the AR rating will climb to 6%. The most common polar solvent fuel is gasoline containing a percentage of alcohol. Check the product MSDS or an *Emergency Response Guide* if in doubt. While always using the higher percentage would not hurt operations, you are using twice as much concentrate, and if not required, are making more work and expense.

The fire service has selected AFFF and HX as the most commonly used for general application. One must keep in mind that we do not mix different kinds or brands of foam concentrate. The one exception is the same kind of concentrate may be mixed with other brands if it meets the same MIL. specification. Finished foam acts on the fire in three ways. The first is to separate the fuel from the surrounding environment by placing a thin coating on the fuel. The second is the suppression of the vapors by this same blanket. The third is cooling the fuel by the evaporation of the water as the foam bubbles break. As the bubbles hold the foam on top of the fuel, we will need to reapply foam as the bubbles break in the cooling mode to maintain the suppression and separation functions.

To produce finished foam we must combine 4 ingredients. The first is foam concentrate, the second is the correct % of water, and the third is the introduction of air, while the fourth is agitation. Remove any one part and you do not get usable finished foam. There are several methods used to measure the correct amount of foam concentrate added to the water stream. The most common is by the use of a proportioner. This device is inserted in the water stream either on the apparatus or in line with the discharge hose to the nozzle. We select the percentage of desired foam to water, and a venturi action reduces the pressure in the pick up tube to something below atmospheric pressure so foam concentrate is forced into the water flowing through the device. Turbulence in the hose stream mixes the concentrate with the water. Discharge through a fog nozzle will add the necessary air to produce finished foam. A standard fog nozzle will add enough air in a ten degree power cone setting to allow for good reach and sufficient aeration of the foam mixture. After the fire is extinguished or if we wish to suppress vapors, we may add an aerator tube to the fog nozzle to enrich the bubble amount of our foam solution for better staying power.

Below is a drawing of a portable proportioning device in operation.



It is important to match the eductor and the nozzle flow and pressure rates to get proper operation. One must also match the required inlet pressure and the maximum outflow hose length, as these are critical to maintaining the correct mixtures. In this example, we need 200 PSI at the inlet of the eductor and a maximum of 250' of 1 3/4" hose to a 100 psi, 95 GPM fog nozzle on the outlet. This rating is for a pickup tube setting of 3 to 6%. Settings of 1% and below will allow an additional 100' of discharge hose. Reduced inlet pressure will affect nozzle pressure and will result in an increase in foam to water ratio. The eductor manufacturer's information should be consulted for each different eductor nozzle combination you use. If you have a built in system on your apparatus, you need to understand the directions for that particular system, as there are many variations available. After use of any foam system, it is important to flush the system with clean water to remove any concentrate residue that will dry and plug the system.

High expansion foam is used to fill spaces where we cannot place a firefighter or to flood spaces with high value equipment or products. Examples are aircraft hangers and rolled paper storage. These are generally fixed systems. Portable systems may be used for basement or attic fires where access is a concern. The large volume of foam both cools and smothers a fire within the filled space. Special equipment and HX foam concentrate are needed in order to make good foam. As with apparatus systems, you need to know the systems you may be using to get the best results.

CAFS (Compressed Air Foam System) has been used in structural attack situations with mixed results. The ability to change the foam concentrate level and the uniform bubble production as well as lighter attack line weight are advantages.

Some people would never go back to normal water operations, while others do not feel that the advantages outweigh the disadvantages, which include more likelihood of kinked hoses. Again, you must be familiar with any system you may use to get the best results.

The foam concentrate selection will dictate the use of an aspirating or non-aspirating nozzle. Many structural trucks will be equipped with the ability to deploy class "A" or "B" foam. Some may be set up to be able to use either class A or B foams. Common fog nozzles will normally be the choice of applicator. Possessing the add on foam tube for these fog nozzles gives one the advantage of making a selection in the field based on the need. As an example, we may attack a flaming fuel spill with class "B" AFFF foam and the standard fog nozzle. This will provide an expansion ratio of about 4:1. After the fire is extinguished, we may add the air tube to lay a vapor suppressing blanket over the remaining fuel. This tube will bring the expansion ratio up to about 12:1. Dedicated foam nozzles may reach expansion ratios of 25:1 using AFFF.

While correct proportioning and expansion ratios are important, application will make or break the entire operation. If we plunge a foam stream into a pool of fuel, all we do is agitate the fuel and release more vapors which intensify the fire. Using hand lines, we have three basic ways we may place foam on the fuel. The key word is to **place** the foam gently, as close to the fuel surface as possible for the most efficient operation. The first method is to direct the foam stream on the ground in front of the flaming fuel and **sweep the blanket** produced over the fuel. This will work if the spill is small and you can get to all sides.

The second method is to bounce the foam off an object such as a tank side or structure so that the foam **banks down** over the fuel. This will work if you have a spill adjacent to objects of enough size to break up the hose stream within reach of all of the flaming fuel.

The last method is to open the fog stream to about a 10 or 15 degree cone and eject the foam in a horizontal line over the flaming fuel. The closer you can keep the stream to the fire surface the faster this will work. Be very careful not to tip the stream down into the fuel, as you will disturb the blanket you are making. This gives fast knockdown and sufficient reach to keep you back from most of the radiant heat. This is called the **Seat of the Fire Method**. It is an improvement of the *rain down method* which had the stream tipped up at a 45 degree angle in relation to the ground. This resulted in the loss of about 50 to 75% of the foam into the thermal column without affecting the fire. Do all that you can to not move or agitate the flaming fuel. Any disturbance will open the foam blanket and allow vapors to escape and burn. Stepping in the fuel area should be avoided as you contaminate your PPE and open the foam blanket which will allow flames to occur around you. If it must be done, you need a backup crew with a charged foam line to protect you!

Summary

As you can see, utilities present an exciting challenge, and each incident will be different. We have a system containing an immense amount of energy just waiting to escape. Special equipment and training is needed to control this energy. Utility personnel are best equipped to control most incidents. In an incident we must use a logical, controlled approach to think out the solution to a safe outcome. Our safety comes first with others a close second. Do not attempt to save something that is already lost. Utilities will usually scrap any equipment, as it is cheaper to replace than repair. Utilities will be happy to help preplan and explain their systems, so use that time to get to know the people you may be working with in an emergency.

Firefighting foam is a complex science of which we have just scratched the surface. You will need to study the foams and equipment that you will be using to get the best outcomes. Manufacturers will assist you with information and training on the systems you have.

Additional Resources

Propane Emergencies by Michael S. Hildebrand & Gregory G. Noll, Red Hat Publishing Company, Inc., ISBN 0-9656565-4-3

Responding to Utility Emergencies by Michael Callan, Red Hat Publishing Company, Inc., ISBN 1-932235-02-7

Pipeline Emergencies by Gregory G. Noll & Michael S. Hildebrand, Red Hat Publishing Company, Inc., ISBN 1-932235-08-6

Electricity Recognizing and Avoiding the Hazards, DVD by AGEIS Insurance Services, Inc., 10 Exchange Place, Jersey City, New Jersey 07302 Tel: 201.521.4581

Fighting Flammable Liquid Fires: Fire Engineering January, February & March 1993

Propane Gas association of New England, PO Box 859, Moultonboro, NH 03254, Tel: 603.544.2226

PRINCIPLES OF FOAM FIREFIGHTING GLOSSARY

ADHESIVE QUALITIES—The ability to bind together substances of unlike composition. When a foam blanket clings to a vertical surface, it is said to have adhesive qualities. This is required to prevent vapor release from a tank shell, for example.

AFFF (Aqueous Film Forming Foam)—A foam liquid containing fluorocarbon surfactants that control the physical properties of water so that it is able to float and spread across the surface of a hydrocarbon fuel.

AERATION—The introduction of air into a foam solution to create bubbles that result in finished foam.

BANK-DOWN METHOD—This method of foam application may be employed when an elevated object is near or within the area of the burning pool of liquid. The object may be a wall, tank shell, or similar structure. The foam stream is directed off the object, allowing the foam to run down onto the surface of the fuel.

BATCH-MIXING—The making of foam solution by pouring an appropriate amount of foam concentrate into a water tank.

BURNBACK RESISTANCE—The ability of a foam blanket to resist the destructive effects of heat radiated from any remaining fire from the liquid's flammable vapor or any hot metal wreckage or other objects in the area or direct flame impingement such as would be evident in a partially extinguished petroleum fire.

CAFS—Abbreviation for Compressed-Air Foam System

CHEMICAL FOAMS—Foams produced as a result of a reaction between two chemicals.

CLASS B FOAM—Foams designed to be used on fires or spills of flammable or combustible liquids.

COHESIVE QUALITIES—The ability to bind together substances of like composition. A good foam blanket is held together by its cohesive qualities.

COMBUSTIBLE LIQUID—Liquid having a flash point at or above 100 degrees F and below 200 degrees F.

DRAINAGE TIME—The amount of time it takes foam to break down. Also called Drainage Rate and Drainage Dropout Rate.

DRY FOAM—Foam that has a very high air-to-foam solution ratio. This foam will cling to horizontal surfaces.

EDUCTOR—Portable proportioning device that injects a liquid, such as foam concentrate, into the water flowing through a hoseline.

EXPANSION RATIO—Amount by which foam solution expands when mixed with air. Low expansion up to 20:1, Medium Expansion 20:1 to 200:1, High Expansion 200:1 to 1,000:1.

EXPLOSIVE LIMIT—See Flammable Limit

EXPLOSIVE RANGE—See Flammable Range

EXPOSURE PROTECTION—Covering any object in the immediate vicinity of the fire with water or foam.

FINISHED FOAM—Extinguishing agent formed by mixing a foam concentrate with water and aerating the solution for expansion; for use on Class A and Class B fires. Foam may be protein, synthetic, aqueous film forming, high expansion, or alcohol type.

FLAMMABLE LIMIT—Percentage of a substance in air that will burn once it is ignited. Most substances have an upper (too rich) and lower (too lean) flammable limit. Also called Explosive Limit.

FLAMMABLE LIQUID—Any liquid having a flash point below 100 degrees F and having a vapor pressure not exceeding 40 psi absolute.

FLAMMABLE RANGE—The range between the upper flammable limit and lower flammable limit in which a substance can be ignited. Also called Explosive Range.

FLASH-BACK—Re-ignition of flammable liquid caused by exposure of its vapors to a source of ignition such as a hot metal surface or a spark.

FLASH POINT—Minimum temperature at which a liquid gives off enough vapors to form an ignitable mixture with air near the liquid's surface.

FLUOROPROTEIN FOAM LIQUID—A foam based on natural protein and modified with a selected fluorinated surfactant, which is loosely bonded to protein and gives the foam oleophobicity (ability to shed oil-like products)

FOAM—A stable aggregation of small bubbles of lower density than oil or water and shows tenacious qualities for covering horizontal surfaces.

FOAM CONCENTRATE—The raw foam liquid as it rests in its storage container prior to the introduction of water and air.

FOAM PROPORTIONER—Device that injects the correct amount of foam concentrate into the water stream to make the foam solution.

FOAM SOLUTION—The homogeneous mixture of water and foam concentrate in the correct proportions.

FOAM STABILITY—The relative ability of a foam to withstand spontaneous collapse or breakdown from external causes, such as heat or chemical reaction.

FINISHED FOAM—Foam solution mixed with air or aerated.

FUEL RESISTANT—Tolerance and the ability to minimize fuel pick-up so that the foam does not become saturated and burn.

HYDROCARBON—Organic compound containing only hydrogen and carbon and found primarily in petroleum products and coal.

HYDROPHOBIC—Water hating; having the property of not mixing with water

HYDROPHILIC—Water liking; mixes readily with water

LEL—Abbreviation for Lower Explosive Limit.

LIFE OF FOAM—The period of time that the foam blanket remains in place until more foam must be applied.

MSDS—Acronym for Material Safety Data Sheets.

OLEOPHOBIC—Oil hating; have the ability to shed gasoline, oil and similar products.

POLAR SOLVENT—Flammable liquids that have an attraction for water, much like a positive magnetic pole attracts a negative pole; examples include aldehydes, alcohols, amines, esters, ethers, ketones, and lacquers.

POLYMERIC MEMBRANE—A thin, durable, cohesive skin formed on a polar solvent fuel surface, protecting the foam bubbles from destruction by the fuel; a precipitation which occurs when a polar solvent foam comes in contact with hydrophilic fuels such as isopropanol, ethanol and other polar solvents.

PROPORTIONING—The mixing of water with an appropriate amount of foam concentrate to form a foam solution.

PROTEIN—Complex nitrogen containing organic compounds derived from natural vegetable or animal sources. Hydrolysis products of protein provide exceptionally stable, cohesive, adhesive, and heat-resistant properties to foam.

QUARTER-LIFE—The time required in minutes for one-fourth of the total liquid solution to drain from the foam. Also referred to as 25% drainage time.

RAIN-DOWN METHOD—This method of foam application directs the stream into the air above the fire and allows the foam to float gently down onto the surface of the fuel.

ROLL-ON METHOD—This method of foam application directs the foam stream on the ground near the front edge of the liquid pool on fire. The foam then rolls across the surface of the fuel.

SEAT OF THE FIRE METHOD--- This method of foam application directs the stream above the fire in a horizontal path using a 10 degree fog pattern. This allows the foam to float gently down onto the surface of the fuel with the advantage of greater reach. The application should be done as close to the surface of the liquid as possible to prevent loss in the thermal column.

SOLUBILITY—Degree to which a solid, liquid, or gas dissolves in a solvent (usually water).

SPECIFIC GRAVITY—Weight of a substance compared to the weight of an equal volume of water at a given temperature

SURFACE TENSION—The effect of a surfactant on the water/concentrate solution. It allows the water to spread more rapidly over the surface of Class A fuels and penetrate organic fuels.

SURFACTANT—A chemical that lowers the surface tension of a liquid.

SYNTHETIC FOAM—Foam concentrate derived from detergents and other chemicals.

UEL—Abbreviation for Upper Explosive Limit.

VAPOR DENSITY—Weight of a given volume of pure vapor or gas compared to the weight of an equal volume of dry air at the same temperature and pressure. A vapor density less than one (1) indicates a vapor lighter than air; a vapor density greater than one (1) indicates a vapor heavier than air.

VAPORIZATION—Passage from a liquid to a gaseous state. Rate of vaporization depends on the substance involved, heat, and pressure.

VISCOSITY—A liquid's thickness or ability to flow.

VOLATILITY—The ability of a substance to vaporize easily at a relatively low temperature.

Excavator Manual

A Guide To Safe Excavation Practices in Massachusetts, Maine, New Hampshire, Rhode Island and Vermont

Dig Safe System, Inc.

It's Smart. It's Free. It's the Law.

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Preface

The purpose of this document is to provide you with a basic understanding of your responsibilities as set forth in the "Dig Safe" law of your state concerning safe excavation practices and the protection of underground facilities.

This document is not intended as a legal reference. It does not contain the complete text of the "Dig Safe Law," and is not intended to be a guide for dealing with specific utility companies or products.

You may download copies of this manual at digsafe.com, as well as complete copies of the state laws and rules for MA, ME, NH, RI and VT.

State Regulatory Agencies

The following state agencies regulate and enforce the "Dig Safe Law."

- **Massachusetts Department of Public Utilities**
  One South Station, Boston, MA 02201
  617-305-3500, www.mass.gov/dpu
- **Maine Public Utilities Commission**
  242 State Street - 18 State House Station
  Augusta, Maine 04333-0018
  207-287-3831, www.maine.gov/mpuc
- **New Hampshire Public Utilities Commission**
  21 South Fruit St, Suite 10, Concord, NH 03301-2429
  603-271-2431, www.puc.state.nh.us
- **Rhode Island Public Utilities & Carriers**
  89 Jefferson Blvd, Warwick, RI 02885
  401-941-4500, www.ripuc.org
- **Vermont Department of Public Service**
  112 State St. - Drawer 20, Montpelier, VT 05620-2601
  802-828-2811, www.state.vt.us/psd

What is Dig Safe®?

Dig Safe® is a call center, serving as a link between you – the excavator, and member utility companies. We are a private, not-for-profit organization established to collect information about your upcoming excavation project and notify the appropriate member utilities in the area of excavation. The utilities mark the location of their lines, or use sub contracted private locating companies to mark their lines. This is a free service for anyone to use. ***Note: Dig Safe is a call center and does not mark lines!***

Hours of Operation

Dig Safe is open from Monday through Friday from 6:00am to 6:00pm for both regular and emergency locate requests. Online ticket entry for non-emergency work is available 24 hours a day. During off hours, weekends and holidays, Dig Safe's off hours call center processes only emergency locate requests. See page 9 for a list of observed holidays.

Call Center Operation

After you have given all of the appropriate information to a Dig Safe Customer Service Representative (CSR), he or she will repeat the information back to you. Please listen carefully to verify its accuracy.

Write down the list of member utilities notified for the mark-out request so you may verify their response on the job site.

You will be given an eleven digit Dig Safe confirmation number, or "ticket" number. Please keep this number for your records.

Remember, not all utilities and municipalities are required by law to participate in the Dig Safe system. It is your responsibility to notify any non-member facility owners directly.

Call Before You Dig

1. It is the law!
2. You must call for a utility mark-out request at least 48 business hours in advance in Rhode Island and Vermont, and at least 72 business hours in Massachusetts, Maine and New Hampshire. (Excluding weekends and holidays.)
3. In Massachusetts and Maine, you must call regardless of where the excavation is. In New Hampshire, Rhode Island and Vermont, you must call when working within 100 feet of underground utility facilities, including private property.
4. You must call for most earth penetrating activities, even small jobs. See the definition of "Excavation" on page 5.
5. Don't rely on old marks or faulty information… call.
6. Mark out the area that you plan to excavate with white paint, flags or stakes. Include the name or initials of your company.*
7. When state regulators inspect an excavation site or investigate a damage prevention incident, they will check to see if you have a valid Dig Safe permit.
8. Review the Locate Request Form so that you will know what information you need when calling Dig Safe. (See page 24.)
9. In an emergency, notify Dig Safe at 888-DIG-SAFE with the location of the emergency excavation as soon as possible.

An emergency is a sudden or unexpected occurrence which poses a threat to public safety, life, health, property or essential utility service.

** Although it is recommended, premarking is not required in Rhode Island.*

What is “Excavation?”

Massachusetts: “Excavation” means an operation for the purpose of movement or removal of earth, rock or the materials in the ground including, but not limited to, digging, blasting, auguring, backfilling, test boring, drilling, pile driving, grading, plowing in, hammering, pulling in, jacking in, trenching, tunneling and demolition of structures, excluding excavation by tools manipulated only by human power for gardening purposes and use of blasting for quarrying purposes. (Chapter 82, Section 20)

Maine: “Excavation” means any operation in which earth, rock or other material below the ground is moved or otherwise displaced, by means of power tools, power equipment or explosives and including grading, trenching, digging, ditching, drilling, auguring, tunneling, scraping and cable or pipe driving, except tilling of soil and gardening or displacement of earth, rock or other material for agricultural purposes. (Title 23, MRSA 3360-A)

New Hampshire: “Excavate”,” excavating”, or “excavation” means any operation conducted on private property or in a public way, right-of-way, easement, public street, or other public place, in which earth, rock, or other material in the ground is moved, removed, or otherwise displaced by means of any tools, equipment, or explosive, and includes but is not limited to drilling, grading, boring, milling, trenching, tunneling, scraping, tree and root removal, cable or pipe plowing, fence or sign post installation, pile driving, wrecking, razing, rending or moving any structure or mass material but does not include the tilling of soil for agricultural purposes, landscaping and maintenance or residential property performed with non-mechanized equipment, landscaping activities performed with mechanized equipment that are intended to cut vegetation, including lawn edging,

Continued on the next page.

What is “Excavation?” - Continued

aeration and de-thatching, excavations permitted or grandfathered under RSA 155-E, or replacement of department-of-transportation-installed delineator posts in the same location. (RSA 374, Section 48)

Rhode Island: “Excavation” means an operation for the purpose of movement or removal of earth, rock or other materials in or on the ground, or otherwise disturbing the subsurface of the earth, by the use of powered or mechanized equipment, including but not limited to digging, blasting, auguring, back filling, test boring, drilling, pile driving, grading, plowing in, hammering, pulling in, trenching, and tunneling; excluding the movement of earth by tools manipulated only by human or animal power and the tilling of soil for agricultural purposes. (Chapter 1.2, Section 39-1)

Vermont: “Excavation activities” means activities involving the removal of earth, rock or other materials in the ground, disturbing the subsurface of the earth, or the demolition of any structure, by the discharge of explosives or the use of powered or mechanized equipment, including but not limited to digging, trenching, blasting, boring, drilling, hammering, post driving, wrecking, razing, or tunneling, within 100 feet of an underground utility facility. Excavation activities shall not include the tilling of the soil for agricultural purposes, routine home gardening with hand tools outside easement areas and public rights-of-way, activities relating to routine public highway maintenance, or the use of hand tools by a company, or the company’s agent or a contractor working under the agent’s direction, to locate or service the company’s facilities, provided the company has a written damage prevention program. (VSA Title 30, Chapter 86)

Guide to Marking Proposed Excavations

The following is only a guideline. Refer to the current Common Ground Alliance (CGA) Best Practices for complete details at www.commongroundalliance.com.

These illustrations are examples of how excavators should 'premark' the area of proposed excavation. Use white marking products (paint, flags, stakes, whiskers or combination) to identify the excavation site. Using florescent pink is recommended to premark on snowy terrain.

Single Point Excavation Markings

Full Line | Radius or Arc | Four Corner | Dash Line

Premark the proposed area of excavation by using: a continuous line, dots marking a radius or arc, dashes marking the four corners of a project, or dashes outlining the excavation project. Make the dash about 6" to 12" in length and 1" in width. Space them between 4' to 50' apart. Make the marks close together enough to be seen by utility locators. Dots of about 1" in diameter are typically used to define arcs or radii and can be placed at closer intervals instead of the dashes.

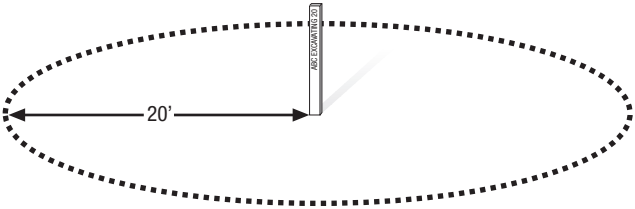
Continued on the next page.

Guide to Marking Proposed Excavations - Continued

Using a Single Stake to Mark the Center Point of Excavation Site

When an excavation site is contained within a 50’ radius or less, you can mark it with a single stake positioned at the center of the proposed excavation. If you choose this way of marking, you must tell the Dig Safe CSR that you have marked the excavation site with a single stake at the center and include the radius of the site.

The stake should be white, and have this information on it: Excavator’s name, abbreviations or initials, and the radius of the excavation site in black letters on the stake, or a note attached to the stake.



Wait the Required Time

1. Before you begin any non-emergency excavation, you must call Dig Safe at least 48 business hours in advance in Rhode Island and Vermont, and at least 72 business hours in advance in Massachusetts, Maine and New Hampshire. (Excluding weekends and holidays, see the observed holidays list below).
2. Do not start excavating before your legal start date and time!
3. If your excavation has not started within 30 days from the date the Dig Safe permit was obtained, the Dig Safe permit expires and must be renewed. Renewals require the same advance notice as new permits.
4. In Maine, New Hampshire, Rhode Island* and Vermont, Dig Safe permits expire every 30 days from the date of issue. In Massachusetts, if the excavation has started within 30 days from the date of issue, the Dig Safe permit is valid for the life of the excavation, provided that the excavator maintains the marks.

** For exceptions, refer to the Rhode Island "Dig Safe" Law, which is available at digsafe.com.*

Observed Holidays

New Year's Day • M.L.K. Day • President's Day • Patriot's Day (MA,ME only) • Memorial Day • Independence Day • Victory Day (RI only) • Labor Day • Columbus Day • Election Day (NH only) • Veteran's Day • Thanksgiving Day • Christmas Day

Respect The Marks

1. You are responsible for maintaining the marks placed by member utility companies at your site.
2. Before you begin your excavation, walk through the site to familiarize yourself with the markings and the locations of buried utilities.
3. Pay special attention to any changes in direction that the underground facilities take.
4. If your excavation causes the removal or disturbance of the markings, establish offset marks in order to maintain a reference point for those underground facilities.
5. Make sure that everyone involved in your excavation is aware of any offsets that have been established, any marks that have been compromised, or any other information regarding facility locations.
6. Don't put spoil piles over markings. Avoid driving machinery over stakes and flags. Paved areas should be swept periodically so that painted marks remain visible.
7. If marks have faded or been compromised to the point where proper and safe excavation is no longer possible, contact Dig Safe to request a re-mark. Refer to the "Laws at a Glance" section on page 23 for advance notice requirements for re-mark requests.
8. If you refresh the markings at the site, make sure that you use the uniform color code and identification letters to avoid any confusion. (See the Color Coding System on the back of this manual).
9. Once the project is complete, it is recommended that you remove any marks as best you can. This will reduce the likelihood that future excavators will mistake them for marks provided in response to their own excavation notice, or assume that they do not need to provide notice of intent to excavate.

Guide to Utility Marks

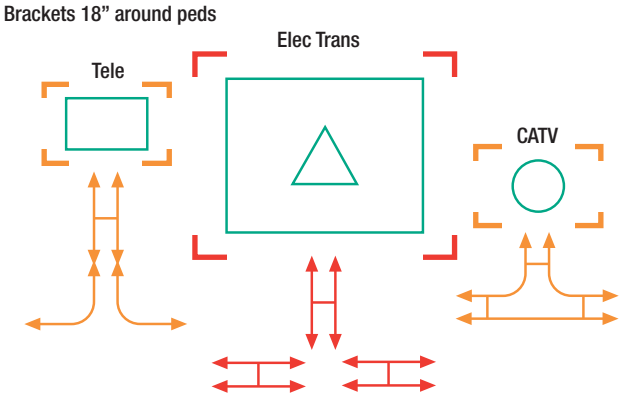
The following is only a guideline. Refer to the current Common Ground Alliance (CGA) Best Practices for complete details at www.commongroundalliance.com.

1. Utility lines should be indicated by markings using the current APWA color codes (see back cover). Markings should be 18”-24” in length and 2” in width.
2. The owner of a facility should be indicated by initials or by company name in letters 6” high at the beginning and end of the locate. On long locates, the facility owner should be indicated every 100’.
3. For operators with multiple facilities within an excavation area, for example bundled or stacked facilities, the total number of lines within the ground should be indicated when known.
4. If a facility is known to be present but the total number of lines for a facility cannot be determined, a corridor marker may be used indicating the approximate length of the facility.
5. When known, the size of the line being located should be indicated. Line size should indicate the outside diameter of the pipe or structure.
6. Conduit or duct structures, whether single or multiple conduits or ducts, should be indicated by the conduit symbol indicating the approximate depth of the structure.
7. When known, the pressure of a the facility should be indicated.
8. When known, termination points, dead ends and stub outs should be indicated.
9. Offset marks should be used when there is a likelihood that the markings may be destroyed if placed directly over the facility.

Guide to Utility Marks - Continued

The following is only a guideline. Refer to the current Common Ground Alliance (CGA) Best Practices for complete details at www.commongroundalliance.com.

Using Brackets Around Pedestals, Transformers and Poles



Markings start outside of brackets. Dig by hand inside the marked area.

Dig With Care

1. Before you excavate within the Tolerance Zone (See page 14), you must:

   Verify the location, type, size, direction-of-run and the depth of the facility.

   For gas and liquid petroleum lines, verification must be by means of hand-dug test holes or vacuum excavation.

   The location of other utilities must also be verified by means of hand-dug test holes or vacuum excavation unless otherwise agreed upon with the facility operator.

2. Do not assume that buried facilities will be at a certain depth.

   Facilities may have been originally installed at a prescribed depth, but later erosion or grade changes cause them to now have a shallow or deep cover.

3. Verification by a hand-dug test hole or vacuum excavation requires the facility to be exposed to view.

   If after a diligent search the facility cannot be verified in this manner, notify the facility operator.

4. Vacuum excavation is an accepted means of verifying the location of marked facilities.

5. Powered Equipment may be used for removing pavement, but only to the depth of the pavement.

6. If the excavation is going to cross a Tolerance Zone, dig a test hole to expose the facility at the point of crossing.

7. If the excavation is going to parallel a utility, you should dig test holes at any marked change of direction, elevation and at tee's.

8. For relatively straight excavations parallel to a utility, a test-hole should be dug approximately every 20 to 25 feet.

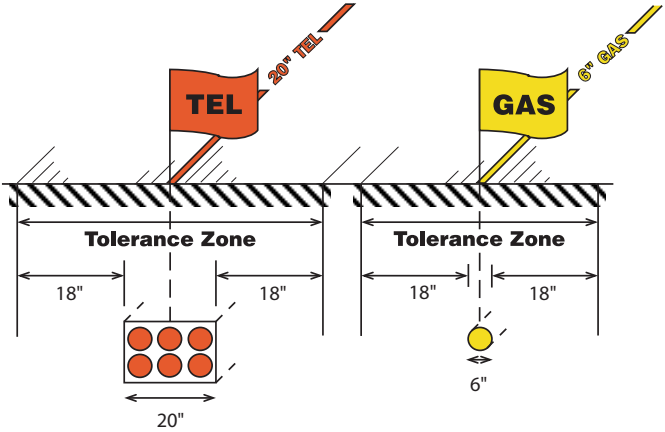
9. If you find an unmarked or unknown facility, notify the facility owners or contact Dig Safe.

Tolerance Zone

The Tolerance Zone (in most states) is a zone designated on the surface by the use of standard color-coded markings, which contains the width of the facility plus 18 inches on each side of the facility.

For exceptions, refer to your state's "Dig Safe" law which may be downloaded at digsafe.com.

Measuring the Tolerance Zone



Excavation After Verification

1. When excavating close to an underground facility, it is a good practice to have a spotter assist and guide the machine operator.
2. After you have verified the location of a facility by hand digging test holes, or by vacuum excavation, you must use due care when excavating around a facility with any type of equipment.
3. If the excavation work requires significant spans of the facility to be exposed, support them to prevent sagging or collapse.
4. Take care not to damage the protective coating or tracer wire of a facility. If you do, leave the damaged facility exposed and immediately call the facility operator.

Reporting Emergencies

In the event to an emergency involving danger to life, health or property as a result of damage to an underground facility, the excavator shall:

Immediately notify 911, the operator of the affected facility, and the appropriate state regulatory agency (See page 2) of the exact location and nature of the emergency.

If a Facility Is Contacted or Damaged

1. If you damage a facility, you must immediately call the operator whose facilities have been damaged, even if you only scrape the protective coating. Left untreated, this type of damage can lead to a catastrophic failure.
2. You should keep the emergency number of your local facility operators at hand.
3. If you are in doubt about whose facility it is, call Dig Safe to send a message to all member facility owners in the area.

Steps To Take If You Break….

A Natural Gas, Petroleum or Propane Line:

1. Stop work and evacuate the site.
2. Call 911.
3. Call the appropriate facility operator.
4. Don't do anything that could cause a spark.
5. Alert everyone on the premises.
6. Keep the public and traffic away.
7. Tape, rope or place cones around the area.
8. Stay upwind of blowing gas.
9. Do not try to fix a gas pipe.
10. Do not try to extinguish a gas burning fire, unless there is a threat to life.

An Electric Line:

1. Stop work immediately and warn all persons in the vicinity, including emergency and rescue personnel, that the ground and objects near the excavator, and equipment around the point of contact, may be energized.
2. Contact the electrical utility operator and fire department immediately if a radio or phone is at hand. Otherwise, remain still and signal for help to relay a call for utility and emergency assistance.
3. The operator should remain on the excavator.
4. Personnel on the ground near the excavator or point of contact should remain still with both feet together. Don't touch the excavator, nearby equipment, structures or material.

Continued on the next page.

Steps To Take If You Break - Continued

5. Evacuate the excavator and the area near the point of contact only after an official of the electric utility deems it is safe to do.
6. If immediate evacuation is required due to threat of serious injury from fire, explosion or other hazard:
   - Jump – not step – clear of the equipment and land with both feet together
   - Move a safe distance away (at least 25 to 30 feet) using short hops or shuffling steps to keep both feet together at all times.
   - Do not take normal, walking steps
7. Do not resume work until an electric utility official confirms the site is safe.

A Telephone or Fiber Optic Line:

1. Stop excavation and secure the area for public safety.
2. Notify facility owner of the potential damage to copper/fiber cable.
3. Do not examine or stare into broken/severed/disconnected fibers/fiber cable.
4. Move a safe distance away from a damaged fiber system (always assume that a laser signal is present).
5. Place warning or barricades around the fiber damage location to protect the public and other workers from exposure.
6. Do not view broken fiber cables with any optical instruments.

Suggestions & Reminders

Do report immediately to 911 and the facility operator any damage that poses a risk to public safety.

Do follow the special instructions regarding their lines.

Do keep a minimum of an 18-inch Tolerance Zone between any underground facility and the cutting edge of any powered equipment.

Do protect and preserve the color-coded markings until those markings are no longer needed for a proper and safe excavation.

Do call for a re-mark if the markings are destroyed, or removed before excavation is complete.

Do be sure that someone other than the equipment operator (i.e. the spotter), is there to look for any sign of an underground facility.

Do conduct the excavation near the underground facility carefully. Excavate by hand to be able to tell the exact location of the line and to prevent damage.

Do report any damage to the facility operator. For example, cracked conduit, gouges, dents or breaks to the coatings, cable sheathes and cathodic protection anodes or wiring that may pose problems now or in the future. Allow the underground facility operators time to make repairs.

Don't notify Dig Safe unless you plan to start the excavation within 30 days.

Don't assume that a pipeline or cable runs straight, or is centered between permanent marker posts.

Don't assume the depth of a utility. Never assume that an underground facility is at the same depth throughout the entire route of an excavation.

Don't excavate within the Tolerance Zone with mechanized equipment prior to verification.

Don't phone in emergency locates that are not really emergencies.

Don't work under anyone else's Dig Safe request unless you are listed as a sub contractor on another party's permit.

Gas Leak Recognition and Response

A gas leak is usually recognized by smell, sight or sound.

Smell: Natural gas is colorless and odorless. A distinctive, pungent odor is added so that you'll recognize it quickly. Not all transmission lines are odorless.

Sight: You may see a white cloud, mist, fog, or bubbles in standing water, or blowing dust. You may also see vegetation that appears to be dead or dying for no apparent reason.

Sound: You may hear an unusual noise like roaring, hissing or whistling.

What to do if you suspect a gas leak:

- Move to a safe environment.
- Call the pipeline operator – they are available 24 hours a day, 7 days a week.
- Provide the exact location, including cross streets.
- Let them know if sewer construction or digging activities are going on in the area.
- Do not smoke or operate electrical switches or appliances. These items may produce a spark that might ignite the gas and cause an explosion.
- Do not assume someone else will report the condition.

Continued on the next page.

Gas Leak Recognition and Response - Continued

Hazard Awareness & Prevention Measures

Like all forms of energy, natural gas, propane and petroleum must be handled properly. Utility operators work very closely with industry and government agencies and stay abreast of new technologies and security methods to ensure the highest levels of service and safety. Despite an excellent safety record, a leak caused by damage to a pipeline may pose a hazard and has the potential to ignite. A variety of measures are used to ensure pipeline safety including: *Coordination with One Call Centers, Inspection programs, Design and construction practices, Workforce qualifications, Industry safety practices and government oversight, Pipeline markers and facility mapping, and Public education programs.*

Gas Pipeline Locations

Since pipelines and other utilities are underground, line markers are sometimes used to indicate their approximate location along their route. The markers display the material transported in the line, the name of the utility operator, and the telephone number where the operator can be reached in the event of an emergency. Markers only indicate the general location of an underground line and cannot be relied upon to indicate the exact position. The presence of markers does not negate the requirement to notify Dig Safe prior to excavation.

National Pipeline Mapping System

For information about the pipelines and pipeline operators that might be located in your community, contact the National Pipeline Mapping System at www.npms.rspa.dot.gov.

The Perfect Excavation

Here are some simple steps to the perfect excavation:

1. The excavator visits the site, and marks out every place he may be excavating with white paint, flags, or stakes.
2. The excavator fills out all the information about the excavation on a Locate Request Form (See page 24), then calls in the stake-out request to Dig Safe.
3. The Dig Safe Customer Service Representative takes the information, and gives the excavator a Dig Safe Permit Number and a list of member facility owners notified.
4. The excavator then notifies any non-member facility operators if known. Non-member companies are not notified by Dig Safe.
5. Each member facility company, or its private locating company, marks out the facilities it owns or maintains in the area of excavation. (See the Color Coding System on the back of this manual).
6. While working, the excavator takes care to find and maintain any markings that have been placed.
7. When digging near a buried facility, the excavator observes the tolerance zone around that facility.
8. If exposing a facility, the excavator provides proper support and protection for it so that the facility will not be damaged.
9. When the excavation is complete, the excavator provides proper backfill for any facilities that have been exposed, and removes all utility markings.

Get Dig Safe® Permits Online!

Haven't tried Quick-Ticket?
Enjoy the benefits of applying online:

- Notify Dig Safe member utilities directly from your own PC.
- Spend less time on the phone.
- Apply at your own convenience…Quick-Ticket is available 24/7!
- A printed confirmation makes record keeping easy. It lists the Dig Safe permit number, excavation location, legal start date/time, and the member utilities notified.
- Quick-Ticket makes multiple entries easy. After completing the first ticket, most of the significant information you entered is carried over to each subsequent ticket, saving time.
- Renew existing Dig Safe permit numbers using Quick-Ticket.
- On-site tutorials are available upon request, and Dig Safe's staff is happy to help over the phone if you have trouble using Quick-Ticket.
- Dig Safe's Quick-Ticket online service is free.
- Apply for a Quick-Ticket password now! Go to digsafe.com and click on Quick-Ticket Password.

Laws at a Glance

This guide is designed for quick view only and is not all-inclusive. To download a complete copy of Dig Safe state laws and rules, please go to digsafe.com – "Laws & Enforcement."

	Massachusetts Statute Chapter 82, Section 40	**Maine** Title 23 MRSA Section 3360-A	**New Hampshire** Statute RSA 374, Section 47-56	**Rhode Island** Statute Chapter 39-1.2, Section 1	**Vermont** VSA Title 30, Chapter 86
Who is required to provide notification?	All excavators	All excavators (using mechanized equipment only)	All excavators	All excavators (using mechanized equipment only)	All excavators
What excavation areas require notification?	Public ways and private property	Public ways and private property	Within 100 feet of underground utilities	Within 100 feet of underground utilities	Within 100 feet of underground utilities
Who is required to participate in the system?	Gas, Electric, Telephone, Cable Television and Private Water Companies	Gas, Electric, Telephone, and Cable Television	Gas, Electric, Telephone, Cable Television and Public Water Companies	Gas, Electric, Telephone, and Public Water Companies	Gas, Electric, Telephone, and Cable Television
Notification time requirements*					
Minimum	72 Hours (except weekends and holidays)	72 Hours (except weekends and holidays)	72 Hours (except weekends and holidays)	48 Hours (except weekends and holidays)	48 Hours (except weekends and holidays)
Maximum	30 Days	30 Days	30 Days	30 Days	30 Days
Emergencies	ASAP	ASAP	ASAP	ASAP	Immediate
Response time by utilities	72 Hours	72 Hours	72 Hours	48 Hours	48 Hours
Notification time for unanticipated blasting - after initial notification	4 Hours	4 Hours	4 Hours	4 Hours	• • •
Remark notification	24 Hours	24 Hours	• • •	24 Hours	48 Hours
Violation penalties:					
First offense	$1000	Up to $500	$500	$200	Up to $500
Subsequent offenses	$5000 to $10,000	Up to $5000	Up to $5000	$500 to $1000	Up to $5000
Gas Related					Up to $100,000
Premarking requirement	Yes	Yes	Yes	No	Yes

LAST UPDATE: 5/12/08

Locate Request Form*

Today's Date _____/_____/_____

Dig Safe Number _____

Caller Details

Contr I.D. _____

Caller Name _____

Title _____

Phone # _____

Fax # _____ Alt # _____

Email address _____

Business Hours _____ to _____

Company Name _____

Address _____

City _____ State _____ Zip _____

Location Details

State: (check one) ☐ MA ☐ ME ☐ NH ☐ RI ☐ VT

City/Town _____

(optional) Latitude _____ Longitude_____

Address/Intersection _____

Buffer Distance (Please circle):
500' 600' 700' 800' 900' 1000' 1100' 1200' 1320'

Cross Street 1 _____

Cross Street 2 _____

Additional Information _____

Type of Work_____

Area (i.e. St to house, in the st, sidewalk area, right side of house on private property)

_____

Premarked? (check one) ☐ YES ☐ NO

Start Month _____Day _____Year _____

Time (military) _____ : _____

Excavator Doing Work (if not same as above) _____

Members Notified:_____

** These forms are available for download at digsafe.com - Downloadable Forms.*

Color Coding System

Color coding is used to identify the type of underground facilities.

RED	Electric Power Lines, Cables, Conduit and Lighting Cables
YELLOW	Gas, Oil, Steam, Petroleum or Gaseous Materials
ORANGE	Communication, Alarm or Signal Lines, Cables or Conduit
BLUE	Potable Water
GREEN	Sewers and Drain Lines
PURPLE	Reclaimed Water, Irrigation and Slurry Lines
PINK	Temporary Survey Markings
WHITE	Proposed Excavation

1-888-DIG-SAFE
(888-344-7233)
digsafe.com

DATE OF LAST REVISION 1/09

CDC

Workplace Safety and Health

NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH

HAZARD ID

HID 15 • January 2002

Fire Fighters Exposed to Electrical Hazards During Wildland Fire Operations

Description of Hazard

Among the various hazards fire fighters face are electrical hazards during wildland fire suppression activities. The National Fire Protection Association (NFPA) reports that 10 fire fighters died from contact with electricity during wildland fires between 1980 and 1999 (this figure does not include lightning strikes) [NFPA 2001]. As part of the National Institute for Occupational Safety and Health (NIOSH) Fire Fighter Fatality Investigation and Prevention Program, NIOSH investigated two separate incidents in 1999 in which fire fighters died or were seriously injured from exposures to electricity while fighting wildland fires [NIOSH 1999a,b].

Fire fighters performing fireground operations near downed power lines may be exposed to electric shock hazards through the following means [NWCG 1998; IFSTA 1998b]:

- Electrical currents that flow through the ground and extend several feet (ground gradient)
- Contact with downed power lines that are still energized
- Overhead power lines that fall onto and energize conductive equipment and materials located on the fireground
- Smoke that becomes charged and conducts electrical current
- Solid-stream water applications on or around energized, downed power lines or equipment

DEPARTMENT OF HEALTH AND HUMAN SERVICES
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

NIOSH

CASE STUDIES

Case 1

On June 23, 1999, a 20-year-old male volunteer fire fighter was electrocuted while fighting a grass fire [NIOSH 1999a]. The volunteer fire fighter was one of a crew dispatched to a grass fire where a power line was reported to be down. The volunteer fire fighter arrived and immediately helped the Deputy Chief and a fire fighter/paramedic extinguish the fire on the east flank. The volunteer fire fighter then walked toward a smoldering pile of brush near the downed power line. As he pulled a charged, 1-inch line over the uneven terrain, he apparently tripped and fell onto the 6,700-volt, downed power line. Other fire fighters on the fireground used a nonconductive tool to pull the line from under the victim. He was moved to the street, received cardiopulmonary resuscitation (CPR), and was then taken to a local hospital, where he was pronounced dead.

Case 2

On October 4, 1999, a 20-year-old male volunteer fire fighter was electrocuted and two other fire fighters were injured when they contacted an energized electric fence while fighting a grass fire [NIOSH 1999b]. Central Dispatch notified the fire department of a fire that was started when a downed power line ignited the surrounding grass. The Chief arrived first, followed by Engine 1 and two fire fighters. The Chief indicated to Central Dispatch and to the responding fire fighters that the electric fence bordering the area was energized by the downed power line. The driver of Engine 1 and the three fire fighters crawled underneath the bottom wire of the electric fence. They positioned themselves approximately 50 feet from the downed power line and attacked the primary fire. After the fire was extinguished, the three fire fighters crawled under the fence a second time. The two surviving fire fighters do not remember the injury event. However, it is believed that when one of the survivors was crawling on her back under the electric fence, a hook from her bunker coat might have contacted the bottom wire of the fence. It is believed that the other two fire fighters were shocked while trying to help the fire fighter who was still energized. All three were removed from the energized area, and basic first aid procedures were administered until the ambulance arrived. One of the injured was transported by helicopter to an area hospital, and another was transported by ambulance to the local hospital and later to the burn unit of an area hospital. The third fire fighter was pronounced dead on arrival at a local hospital.

Recommendations for Prevention

To minimize the risk of electrocution, electrical shock, and electricity-related burns while fighting wildland fires, NIOSH recommends that fire departments and fire fighters take the following precautions [IFSTA 1998a,b; NWCG 1998; NFPA 1997; 29 CFR* 1910.332(b); 29 CFR 1910.335(b); Brunacini 1985]:

Fire departments should do the following:

- Keep fire fighters a minimum distance away from downed power lines until the line is de-energized. This minimum distance should equal the span between two poles.
- Ensure that the Incident Commander conveys strategic decisions related to power line location to all suppression crews on the fireground and continually reevaluates fire conditions.
- Establish, implement, and enforce standard operating procedures (SOPs) that address the safety of fire fighters when they work near downed power lines or energized electrical equipment. For example, assign one of the fireground personnel to serve as a spotter to ensure that the location of the downed line is communicated to all fireground personnel.
- Do not apply solid-stream water applications on or around energized, downed power lines or equipment.

**Code of Federal Regulations*. See CFR in references.

- Ensure that protective shields, barriers, or alerting techniques are used to protect fire fighters from electrical hazards and energized areas. For example, rope off the energized area.
- Train fire fighters in safety-related work practices when working around electrical energy. For example, treat all downed power lines as energized and make fire fighters aware of hazards related to ground gradients.
- Ensure that fire fighters are equipped with the proper personal protective equipment (Nomex® clothing compliant with NFPA standard 1500 [NFPA 1997], leather boots, leather gloves, etc.) and that it is maintained in good condition.
- Ensure that rubber gloves and dielectric overshoes and tools (insulated sticks and cable cutters) for handling energized equipment are used by properly trained and qualified personnel.

Fire fighters should do the following:

- Assume all power lines are energized and call the power provider to de-energize the line(s).
- Wear appropriate personal protective equipment for the task at hand—Nomex® clothing compliant with NFPA standard 1500, rubber gloves, and dielectric overshoes and tools (insulated sticks and cable cutters).
- Do not stand or work in areas of dense smoke. Dense smoke can obscure energized electrical lines or equipment and can become charged and conduct electrical current.

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