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Photo By: Steve Spak

CELLAR FIRES

Cellar fires can be deadly. On November 30, 2003, Massachusetts's firefighter Martin McNamara died fighting fire in a cellar of a burning building; March 7, 2002 two firefighters from Manlius N.Y., John Ginocchetti and Tim Lynch were killed in a basement of a private

house after a floor collapsed. In the past five decades 30 FDNY firefighters have died in cellars, killed by fire, explosions, collapse, drowning, and toxic fumes. Some cellar fires are more dangerous than others. Is it the crawl space, the basement, a cellar or a sub-cellar, that is most dangerous? Fire officers should know which below grade areas are most dangerous, and why?

A crawl space is defined as a small space beneath the lower floor of a structure that allows access for wiring or plumbing. The crawl space area between the underside of the first floor and the unexcavated ground is not large enough for a person to stand upright.

A basement, on the other hand, is a full story below grade, which has one half its heights, or less above grade level. When calculating the height of a building, the basement is counted as the first floor.

A cellar is different. It is a below-grade area that has more than half its height below grade.

A sub cellar is an under-ground level below a cellar. It is possible for a structure to have all three below-grade levels: a basement, a cellar and a sub cellar.

The degree of fire extinguishing effort is related directly to the depth below the street level of the below-grade area. The deeper under-ground the cellar, the greater the difficulty of fire extinguishment. This is because firefighting access, extinguishment of flames with hose streams, ventilation of smoke and rescue of trapped victims will be more difficult the deeper you go below grade.

Firefighter friendly cellar

Some cellars are more difficult to extinguish than others. A cellar that is below grade, at the front of the building, but above grade at the sides and rear is not a true cellar and is not as difficult to extinguish a fire, as a cellar that is totally below grade. The cellar of a building that has had the sides and rear yards excavated will have many windows and several doors available to firefighters for access, ventilation and rescue. By excavating the rear yard and designing side alleys around a building, 50 percent or more of a cellar can be above grade.

Below grade cellar

A cellar that is totally below grade front, side and rear will have only one or two stairways and may have no windows. Because access and ventilation during a fire will be difficult to

extinguish. Deadly toxic gases can build up quickly, explosions of flammable gases can occur easily and large quantities of water will be used for extinguishment due to smoke and limited access.

Only a sub cellar presents more problems to a fire officer's strategy than a below-grade cellar. A sub cellar will have only one interior entrance and no windows. A sub cellar usually is found in old commercial and storage buildings and modern high-rise buildings. A fire in a sub cellar is the most difficult below-grade fire extinguishment problem encountered in the fire service.

Interior attack strategy

One of the dangerous jobs a firefighter must do is taking a hose-line down into a burning cellar stairway. Upon arrival of the first companies, the cellar stairway is usually the only vent to the underground fire. Smoke, heat and flame rise up out of the opening where firefighters must advance the hose-line. Besides having great courage, fire-fighters taking the hose down cellar stairs under these conditions must accomplish three dangerous maneuvers: First, they must drive back the flames lapping up out of the cellar opening while still at the top of the stairs. Then, they must descend the stairs through the heat and flame barrier rising up and attempt to get below the heat and flame level in the cellar. Finally, the firefighters must pull the hose-line across the smoke- and heat-filled cellar floor to the seat of the fire. To do this, they often must crawl through a maze of narrow aisle space or climb over piles of paper or collapsed storage boxes.

The firefighters advancing the hose-line down into a cellar could be trapped and killed immediately if the heat level has banked down to the cellar floor and there is no clear space below the flame and smoke. After several minutes in the cellar, if they become lost, disoriented or if a concealed fire cannot be found quickly and extinguished, the flames and heat venting up the cellar stairs above the heads of the firefighters can completely fill the cellar stair-the only vent. If this occurs, the firefighters' only escape back up the stairs will be blocked and they will be trapped in the burning cellar. When the hose line attack fails the fire officers should consider defensive outside attack, protect exposures and an indirect firefighting strategy. The use of high

expansion foam may be the last option when the interior hose line can not be advanced to the seat of the fire.

Enclosed cellar stairs

The design of a stairway leading down to a cellar determines the likely hood of an interior attack strategy success. For example, a fire-retarded stairway enclosure with a self-closing door at the cellar floor level is the best design for firefighting. Firefighters descending cellar stairs of this kind can take the hose-line down to the cellar in a smoke-free stair enclosure, start water in the hose, check their masks and safety equipment and then slowly open the door to the cellar. They are already below the level of heat and flame banked down from the cellar ceiling. If the heat is banked down to the floor and there is no survivable area below the flame, the door is closed and the firefighters are still safe in the stair enclosure. The firefighters may be withdrawn and strategy changed to a defensive attack. After closing the door at the cellar level, they climb the stairs to the first floor in a smoke and heat free environment... The door at the bottom of the stair enclosure acts as a protective barrier for the firefighters, keeping the cellar stair enclosure free of deadly flame, heat and smoke. Firefighters are withdrawn before the strategy is change to defensive attack or indirect attack.

Photo By: Steve Spak

Sidewalk cellar entrance

Some cellars have an entrance that is a pair of steel trap doors, flush with the sidewalk located in front of a building. The cellar entrance leads to a concrete or wooden stair leading down from the sidewalk to a cellar area. This cellar entrance has no fire retarding enclosure at the bottom of the stairs. Any flame and heat in the cellar will flow straight up out of the sidewalk cellar entrance, and there is a good possibility the wooden stairs leading to the cellar have burned away or been weakened prior to the arrival of the firefighters. A sudden collapse of a cellar step

could cause several firefighters directing a hose stream, to lose their balance and tumble into a burning cellar. Under ordinary conditions, the outside sidewalk cellar entrance stair is used more often to send boxes or cartons down to the cellar for storage than by people to enter the cellar. So the cellar stairs may be covered with package chutes or rollers designed to slide packages and boxes down over the steps leading to the cellar. These slippery chutes or roller ladders sometimes are left on top of the stairs after a delivery of stock has been stored in the cellar. During a fire, if firefighters attempt to descend the smoke-filled cellar stairway and step on a chute or roller, they will slide into the burning cellar.

Open stairs or trap door ladders

Another cellar opening which may be used to attack a cellar fire during the initial stages of a fire is one found inside a store. This one leads to a cellar through a trap door in the floor. A wooden trap door made of the same material as the floor boards, which opens at one side by a hinge and has a wooden ladder leading to the cellar, is sometimes found in stores and storage buildings. This wood trap door creates a concealed three- by six-foot section of floor deck that is unsupported by floor beams below. These wooden trap doors usually are located in an aisle or passageway so stock or boxes will not cover access to the cellar. Firefighters may use these trap doors and interior cellar stairs to search or advance a hose-line when a fire is small. However if the fire has gained headway before the arrival of the first units these trap doors cellar stairs should not be used to advance hose lines down to extinguish a fully involved cellar. The flame and heat flowing up out of the trap door may burn the wood cellar access stair resulting in a stair collapse after the firefighters descend with the hose line. After the stairs collapse firefighters are trapped in the cellar.

Elevators

In many modern commercial buildings there are no trap doors or unenclosed cellar sidewalk cellar stairs leading to below-grade areas. Some buildings have interior enclosed stairs leading to the cellar and elevators. Today, when firefighters respond to a report of a minor fire, building employees sometimes offers to take them to the cellar or sub cellar in the elevator. Firefighters should realize the danger of this means of entry. If they are taken to the cellar by elevator

operator for an odor of smoke or a reported small fire, by the time they arrive at the cellar level the minor fire may now be a major blaze. If firefighters do not know the location of the exit stairs because they were taken below grade in the elevator; and the they cannot get the elevator to return to street level they will die in the below-grade area. Use the stair when locating a cellar fire not an elevator.

Cellar storage

If the interior attack strategy on the cellar fire is successful and firefighters descend a cellar stairs and get below the heat barrier in the cellar, they must then advance the hose-line through the cellar to the seat of the fire. Storage materials such as boxes, cartons, packages and furniture can make the hose line advance dangerous and difficult. Large quantities of combustible merchandise or unused furnishings are stored in cellars. This combustible material is stored as high as possible, usually right up to the underside of the cellar ceiling. Also, there is usually only one narrow aisle through the stored material that leads to the utility supply and shut offs. This improper storage in a cellar creates dangers to firefighters advancing an attack-line: It obstructs the reach of the hose stream, preventing water from hitting the flames. Large stacks of storage in a cellar can also conceal the exact point of fire origin, causing firefighters to remain for long periods in an oxygen-deficient cellar. The safety factor provided by a hose stream reach of 30 or 50 feet which allows firefighters to remain a safe distance from the flames and heat of a fire during extinguishment is eliminated in a cellar with storage material stacked up to the ceiling.

When a hose stream cannot be swept across the underside of a cellar ceiling because of storage, firefighters must crawl up close to extinguish the blaze. A space of three feet or more between the top of the cellar storage material and the under-side of the ceiling is necessary for the effective use of a hose stream. Flames spreading through a cellar will be seen quickly in this three-foot space and the hose stream could drive the flames back, at a safe distance, if this three foot space is kept above cellar storage material.

Cellar Content collapse

Another problem caused by storage in a cellar is storage material collapse. When cardboard boxes stacked on top one another are burning or wet by a hose stream, they collapse. If firefighters advance a hose stream through a narrow aisle between cardboard cartons and the cartons collapse behind them, they may become disoriented or trapped in the cellar. The hose-line, often used by firefighters to feel their way back to safety in a smoky cellar, is covered over with collapsed cartons of merchandise. Additionally, the narrow aisle, the path back to the cellar exit, is no longer present. There is just a pile of wet, burned, collapsed storage cartons

Fire concealment

Finally, another danger caused by cellar storage material is fire concealment. A fire in a cellar must be located before it can be extinguished. The exact point of origin of a fire may be hidden and smoldering behind boxes or furniture stored in a cellar. Firefighters may have to remain in the oxygen-deficient cellar atmosphere for an hour or more searching for the concealed fire. Large amounts of storage may have to be removed from the cellar to get at the fire origin and completely extinguish the flames. In some instances, a serious, rapidly spreading fire may be discovered behind storage material, piled up to a ceiling in a cellar. If there is no way to temporarily contain the flames and if the fire is beyond control of the hose stream on hand, there will be no time to wait for a back-up hose-line to be stretched to the cellar. The flames and heat will spread rapidly throughout the cellar over the heads of the firefighters and rise up out of the cellar exit. The firefighters will have to abandon the hose stream and try to get up the cellar stairs before the flames and heat cut off the only escape.

Explosion

Confinement increases chances of combustible gas explosion. A cellar is the most confined space in a building because there are fewer windows and doors leading to fresh air. The chances of an explosive mixture developing when gas escapes is increased. Also, there are many combustible liquids and gases that can form an explosive mixture. For example, a central heating system uses kerosene or fuel oil; a hot water heater uses piped gas; flammable liquids often are found in a cellar. During a cellar fire, a ruptured flammable liquid container or broken gas pipe

may release a flammable gas. If mixed with air and ignited by the fire, a violent explosion will occur. Firefighters may extinguish the cellar fire and then be killed by the explosion. The definition of an explosion is the rapid ignition of a combustible gas/air mixture that results in shock waves, structural collapse and heat release. If there were no shock waves or structural collapse, it would be called a reflash or flash fire. Explosion in cellars during firefighting operations have blown street-level, plate-glass windows into the faces of firefighters standing on the side-walk, blasted firefighters back up cellar stairways out onto the sidewalk, buried firefighters beneath collapsing masonry walls in the cellar and seriously burned firefighters near the explosion.

Listed below are the destructive effects caused by explosion pressures:

Effect of Explosion	Destructive Peak Pressure
Glass shattering	0-5 psi
Firefighter knock down	1 psi
Wood partition collapse	1-2 psi
Cinder block wall collapse	2-3 psi
Brick wall collapse	7-8 psi
Firefighter lung damage	15 psi
Threshold for fatalities	35 psi
50% fatalities	50 psi
99% fatalities	65 psi

Armed with the above information regarding the destructiveness of an explosion, a firefighter could reduce his chances of serious injury when a cellar explosion is suspected: Stand clear of any windows that may suddenly explode outward. Avoid standing near the entrance opening that will vent the pressure or shock wave of the cellar explosion. Do not use a cinder-block or masonry wall for protection against the force of the explosion. Most important, wear all protective clothing, helmet, mask, gloves, boots and turnout pants and coat. Even if a firefighter survives the explosive shock waves in a cellar, there will be a flash fire of extremely high temperature, created by the rapid combustible gas ignition.

Gas leaks

After a cellar fire is "knocked down", firefighters making a primary search may discover a small gas flame near a melted connection of a gas meter, or a broken gas pipe burning. This should be reported immediately to the officer in command in the cellar, and the flame should not be extinguished. The flaming gas should be allowed to burn freely. The hose stream should cool the surrounding combustible material but not the flame. The gas supply to the broken meter or pipe should be shut off from a distant street or tank valve. Even after the gas supply has been completely shut off, flame will continue to burn at the broken meter or pipe until the remaining gas in the system has dissipated. Do not extinguish this residual gas flame. Stand fast and allow it to burn out. Explosions have occurred in cellars from small amounts of residual gas, even after the gas supply was shutoff. A flammable gas/air mixture confined to less than 25 percent of a room or cellar enclosure can cause an explosion. Based on this fact, it would be an error to assume a flammable gas/air mixture must fill a cellar completely before an explosion, can occur. An explosive mixture in one corner of a cellar could destroy an entire below-grade area, killing and injuring firefighters throughout the entire cellar, as well as those about to enter.

Sometimes after extinguishing a cellar fire, a broken gas pipe is discovered leaking gas that is not burning. This is more serious than a burning broken gas pipe and fast action is necessary. The leaking gas pipe break should be plugged quickly with rags or bar of soap while the supply is shut down. The hose-line should extinguish any smoldering fire in the vicinity of the gas leak; the cellar area should be completely vented to prevent an explosive gas/air mixture from developing, **Water accumulation**

If a cellar fire is not extinguished with the first-attack hose-line and high expansion foam is not available, large amounts of water must be discharged into the cellar using cellar pipes, distributors and hose streams through the cellar entrance stairs. In some instances, water may be flowed across the first floor above a cellar fire, according to Edward McAniff in Strategic Concepts in Firefighting. Called "flowing the floor," it is used when the first floor becomes too dangerous for firefighters due to smoke or collapse. The objective of this tactic is to cover a porous floor in an old building with several inches of water in the hope the water will drip

down and enter the cellar ceiling and fire area. It is a defensive, last resort effort, used when firefighters have been withdrawn to a doorway, and outside defensive streams have not yet been put into operation. However, after any cellar fire has been extinguished, it is not uncommon to discover several feet of water in a cellar. Water accumulation is a danger. A firefighter collapsing in a water-filled cellar will drown. On an upper-floor fire, if a firefighter falls unconscious, he will be discovered quickly and removed to safety. In a water-filled cellar, if a firefighter falls unconscious, he will sink out of sight below the water and drown. There are many ways firefighters have been knocked unconscious and drowned in water-filled cellars: Firefighters have walked into low-hanging pipes or beams in cellars and struck their heads. Firefighters have been overcome by carbon monoxide, lack of oxygen or oxygen depletion and collapsed. Firefighters have fallen into water-covered sumps or oil burner pits and struck their heads on objects. Firefighters have been struck on the helmet by heavy sections of spalling concrete. Firefighters have fallen into cellars through holes in the first floor and struck their heads on the edge of the floor opening. Firefighters have fallen through collapsing terrazzo first floors and been knocked unconscious when hitting the water-filled cellar floor. Water accumulation in a cellar after a fire must be considered more than a nuisance. Water accumulation is a deadly hazard of cellar firefighting.

Electrocution

In addition to drowning, water on the cellar floor after a fire can cause electrocution. If the water level has reached the electrical supply servicing the building and a firefighter enters the cellar, the electrically charged water will render the firefighter immobile and slowly shock him to death. Unable to cry for help or move, the firefighter will collapse into the cellar water and either drown or die from cardiac arrest caused by electrocution. Electric and gas supply should be shut off from the street before firefighters enter a water filled cellar.

Asphyxiation Firefighters often are asphyxiated fighting cellar fires. This is because the ability to vent a below-grade cellar is limited and sometimes impossible. To vent a cellar, firefighters may only be able to prop open one small, cellar entrance or door or cut a small hole in the first

floor directly above the fire with a power saw. But this takes time. However, in many buildings, the first floor is constructed with brick, concrete or terrazzo and can be penetrated only by air hammers. This takes even more time. Before this venting can be accomplished, firefighters usually have entered the cellar for several minutes, either searching for the fire origin or directing hose streams on the blaze. Asphyxiation or suffocation is a great danger to firefighters in the cellar. Deadly carbon monoxide most often is stated as the danger in a cellar death, but actually asphyxiation can be caused by other products of combustion. For example, heavier-than-air toxic gases such as sulfur dioxide may have accumulated in the cellar. Also, the oxygen in the cellar may have been replaced by carbon dioxide generated from complete combustion, or the oxygen may have been replaced or reduced to dangerous levels by steam, generated when the water stream strikes the flames. If a firefighter dies from lack of oxygen in a cellar, it is a tragedy. Self-contained breathing apparatus always should be worn before entering a cellar regardless of the size of the flames or the amount of smoke present. SCBA should also be worn during overhauling operations in an unvented cellar, because asphyxiation deaths and injuries to fire-fighters in cellars occur most often at the beginning and end of a fire operation. Firefighters are not asphyxiated in cellars during actual hose-line advance and fire extinguishing operations. The following examples of firefighter deaths and injuries in cellars illustrate this statement best: Three firefighters were killed in a cellar when shutting off utilities after a fire was extinguished. At another fire, a fire officer was pulled out of a cellar, unconscious. He was almost asphyxiated by toxic gases while searching for the fire location in a light haze. A sprinkler had extinguished a small fire in plastic materials. At another fire, two fire-fighters overhauling in a cellar became dizzy, staggered to the street and collapsed at the command post.

Floor collapse

. When searching the first floor for the fire origin unsuccessfully for a long period of time, think cellar fire. Continue to search the first floor, but send a fire-fighter down to the cellar to search for fire, too. The blaze could be below, sending smoke and heat up to the floors above. A cellar

fire burning undetected for a prolonged time can destroy wood floor beams supporting the first floor, causing it to collapse into the cellar. This hazard increases when the first floor is constructed of a terrazzo, finished cement laid on top of an old wood beam floor deck. Terrazzo floors consist of highly polished marble chips set in several inches of cement. This terrazzo floor increases the dead load supported by the floor and also conceals a cellar fire. Smoke and heat from the cellar fire will not rise up through the terrazzo floor as it will on a wood deck floor. The cellar fire first will burn away the wood beams supporting the terrazzo-finished floor above them. There will be no sagging, springy or spongy feel to the terrazzo floor to indicate collapse. After the wood beams are burned away, the floor load will be transferred to the terrazzo cement and then there will be a sudden collapse of the terrazzo floor into the burning cellar. Any firefighter on the terrazzo floor will fall into the cellar. Terrazzo cement floors often are found on the first floor of churches, restaurants, hallways, lobbies, bathrooms and stores. The presence of a first-floor terrazzo floor above a cellar fire should be considered a collapse danger. It is not possible to detect the weakening of a terrazzo floor from fire, nor is it possible to detect weakening of the wood support beams below just by looking at them. However, in some instances, a small amount of water from a hose stream sprayed across the terrazzo floor will evaporate quickly or turn to steam in the area heated by a fire below. This may indicate intense heat from the cellar fire below, conducting up through the cement and marble chips. On October17, 1966, 12 FDNY chiefs, company officers and firefighters died when a terrazzo floor they were standing on collapsed into a burning cellar fire.

Lessons learned

1. When a fire company enters a burning cellar, down an interior open stair, one firefighter with a portable radio should be stationed at the top of the stairs leading down to the cellar. This firefighter should warn the firefighters in the cellar to evacuate the below-grade area if heat and smoke rising up out of the cellar increase in intensity to the point where it might prevent the escape of the firefighters.

2. Self-contained breathing apparatus should be worn before entering a cellar even if there is only a light haze of smoke. Carbon monoxide and other toxic gases are colorless and odorless. They can be present in deadly quantities in a cellar even without smoke.

3. When entering a cellar to shut off utilities, wear self-contained breathing equipment and notify your officer.

4. Most incidents of firefighters being overcome in cellars occur after the fire is out and overhauling has begun. Toxic gases build up in a smoldering cellar during overhauling because heat from the smoldering fire and hot concrete walls create a positive pressure in the area.

This heated, pressurized air expands and rises out of all the below-grade area vent openings and prevents fresh air and oxygen from entering the heated cellar through these openings. Two openings are required to ventilate a below-grade cellar: one opening to eliminate smoke, one opening to allow fresh air into the cellar. Positive pressure ventilation should be used to vent the cellar. As soon as the fire is extinguished and there is not a danger of reigniting the blaze. One fan should be used to remove smoke from one cellar opening, and another fan to force fresh air into another cellar opening.

5. At several fires where firefighters have died or been overcome in cellars, there has been a light smoke condition and a sprinkler discharge controlling the fire. Do not let the presence of an operating sprinkler give you a false sense of security. Wear your SCBA.

6. Never enter a cellar to shut off utilities without notifying your officer.

7. When a call for help is received for a firefighter "down" in a cellar, do not at-tempt a rescue without SCBA or you will add to the problem. Don a mask and get to the firefighter

Quiz for Newsletter

1. True or False

The definition of a cellar is a below grade area that has more than one half of its floor height below grade.

Answer_____

2. Which one of the answers is most correct regarding high piled carton and boxes in a cellar?

A. Obstructs the reach of the hose stream

B. Conceals the fire origin

C. Collapse and blocks escape

D. All of the above are true

Answer_____

3. Why is an explosion more common in a cellar?

A. It is an unconfined space

B. Presence of a central heating unit

C. Unbroken gas pipes after a fire

D. All of the above

Answer_____

4. When discovering a flame coming from a broken gas pipe after a fire has been "knocked down" firefighters should not do which one of the following?

A. Quickly extinguish the small fire

B. Shut the gas supply off at the source

C. Allow the fire to burn

D. Notify the officer

Answer_____

5. Which one is not a danger present at a cellar fire?

A. Drowning

B. Electrocution

C. Asphyxiation

D. Falling objects

Answer_____

Answers to Quiz:

1. T; 2. D; 3. B; 4. A; 5.D