

NEW JERSEY DIVISION OF FIRE SAFETY

Firefighter Fatality and Serious Injury Report Series

A Firefighter Dies after being Trapped in an Apartment House Fire

Passaic, New Jersey

***Report Issued
March 12, 2003***



STATE OF NEW JERSEY
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INTRODUCTION

The investigation of this incident was conducted by the New Jersey Division of Fire Safety in conjunction with the New Jersey Department of Labor and the New Jersey Department of Health. This report was prepared in accordance with N.J.S.A. 52:27D – 25d, Duties of the Division. The purpose of these firefighter casualty investigations is to report the causes of serious firefighter injuries or deaths and identify those measures which may be required to prevent the future occurrence of deaths and serious injuries under similar circumstances. In some cases new information may be developed, or old lessons reinforced, in an effort to prevent similar events in the future.

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SUMMARY

On May 9, 2001 the Passaic Fire Department (PFD) responded to a working fire in an apartment house at 204 Market Street in the City of Passaic, NJ. Upon arrival, firefighters began fighting the fire and searching for two children who were reported to be in the building. At a point shortly after arrival, FF Alberto Tirado went alone to the third floor to search for victims. He became lost in one of the apartments and subsequently ran out of breathing air and died before rescue crews were able to locate him.

INVESTIGATION

The Incident

On May 9, 2001 at 2037 hours the Passaic Fire Department (PFD) responded to a report of a working fire in an apartment house located at 204 Market Street, Passaic. The building was three stories in height and was of masonry construction with floors, interior walls and roof constructed of wood.

Upon receipt of the reported fire, the PFD, a career department located in Passaic County, responded initially with three engines and a ladder truck. The responding companies were Engines 1, 2 and 3 and Ladder Truck 2. Provisional Deputy Chief Bruce Sinatra also responded in a department owned incident command vehicle.

First to arrive on scene at 2038 hours was Engine 2. This unit was staffed by Lt. Richard Henneberry, FF Ricardo Figueroa, the unit's apparatus operator and FF Elvis Morales.

When Engine 2 arrived, it pulled just past the "A" side of the building in the direction of the "B" side.

NOTE: *To provide for uniform identification of locations and operational forces within an incident scene, the scene is divided geographically into smaller parts which are designated as divisions. Specific areas of the incident scene are to be designated as follows:*

- *Sides of incident scenes shall be identified as letters of the alphabet beginning with the letter "A."*
- *The side of the incident scene that bears the postal address of the location shall be designated as division "A" by the incident commander. Where the incident scene has no postal address, the incident commander shall select any side to designate division "A."*
- *Continuing in a clockwise rotation, the side adjacent to the division "A" side shall be designated as division "B."*
- *Continuing in a clockwise rotation, the side adjacent to the division "B" side shall be designated as division "C."*
- *Continuing in a clockwise rotation, the side adjacent to the division "C" side shall be designated as division "D."*

Ladder Truck 2 pulled in just behind Engine 2 seconds later. Lt. Henneberry radioed to all responding units that there was heavy smoke in the area and confirmed that there was a working fire at the rear (Side C) upper levels of the building. He advised the incoming units that they would need to establish a water supply by connecting to nearby fire hydrants. Henneberry ordered FF Morales to pull a 4" supply line to a fire hydrant approximately 250 feet away. Lt. Henneberry then pulled a 200 foot preconnected 1 3/4" hoseline from the engine and turned toward the apartment building. At this point he twisted his ankle and fell to the ground. FF Morales came to his aid and helped him to his feet and Henneberry continued unassisted in through the front door of the building. He proceeded down the center hallway of the first floor and then up the stairs to the second floor. While Henneberry was making his way into the building, FF Figueroa was engaging Engine 1's pump and was experiencing difficulty operating the units hand throttle due to it being broken. After approximately one minute Figueroa was able to work the throttle sufficiently to charge Henneberry's hoseline. Lt. Henneberry reported that visibility was fairly good on the second floor and at that time, he was on air from his self contained breathing apparatus (SCBA) and standing. When he got to an apartment door (apt. 8) on the "D" side of the building, he opened the door and was met by heavy smoke and high heat. He entered the apartment

and began working to cool the room by applying a fog stream. At about this point, Henneberry was told by other firefighters who had entered the area that there was fire above his head. He immediately turned his hose up to the ceiling and knocked the fire down. Henneberry then began to retreat from the room and noted that there were a few firefighters behind him in the hallway. As he exited the room he noted that there was now an orange glow in the apartment and that unidentified firefighters were bringing a second 1 3/4" hoseline up the hallway.

At about the same time Lt. Henneberry was in the apartment, the crew of Ladder Truck 2 was making entry into the building. Ladder Truck 2's personnel consisted of Captain Scheck, FF Domingo Silvia, the apparatus operator, and FF Alberto Tirado. Upon arrival, Ladder Truck 2's crew was told by civilians and a Passaic Police Officer that there was a possibility that two children were trapped in apartment 7 on the second floor (it was later discovered that the children had escaped without harm). FFs Silvia and Tirado entered the building with a halligan bar, flathead axe and a sledge hammer and proceeded directly to the second floor. As they made their way up the hallway of the second floor, they noted Lt. Henneberry's hoseline in the doorway of Apartment 8. They proceeded to the door of Apartment 7, which was across the hallway from Apartment 8. As they opened the door to Apartment 7 they encountered high heat and heavy smoke. While Tirado stayed at the apartment doorway, Silvia entered the apartment and performed a primary search but found no victims. The two then completed searches in Apartments 5 and 6 and were not able to locate any victims. When the two firefighters returned to the second floor hallway, Silvia told Tirado that he wanted to go outside to get a hand light. Tirado was told by Silvia to stay by the hoseline stretched down the hallway until he returned with the light. Tirado then asked Silvia if the third floor was to be searched. Silvia reported that he told Tirado not to go to the third floor but rather stay where he was until he returned. Silvia then left the building.

At about this time, DC Sinatra, who had arrived at 2040 hours, shortly after Engine 2 and Ladder Truck 2 called for an additional engine to respond, Engine 4, and a short time later Ladder Truck 1 to respond.

Upon his return to the second floor, FF Silvia was told that the second hoseline going down the hallway needed slack, so Silvia assisted in pulling more line to the second floor. At this point Silvia was unsure as to where Tirado was but thought he was probably helping pull the hoseline. It was at 2047 hours when he heard Tirado call on the radio that he was trapped on the third floor. Frantically units on the outside tried to get location information from Tirado. Tirado responded again that he was on the third floor, "up the stairs and to the right." Tirado continued to call for help. He told them he was in the rear apartment to the right. He reported heavy fire and that he couldn't get out.

FF Silvia ascended the stairs to the third floor and called for a hoseline and assistance in trying to locate Tirado. Three other firefighters came up the stairs after Silvia. As Silvia tried to make his way down the third floor hallway, he thought he heard noise coming from

Apartment 11. Silvia tried to break down the door of the apartment but was unable to. At this point, he ran out of air and went back down the hallway and down the stairs to the outside.

At 2053 hours Tirado radioed that he was out of air. This was his last radio transmission.

At about this time Lt. Henneberry became aware that the apartment across the hallway from where he was now was involved in fire. He noted that the crew that was working there had withdrawn and he was alone. There was quite a lot of water on the floor and he felt an electrical shock coming from the water. He also heard people yelling for everyone to get out of the building so he began to retreat. He stated that he felt his duty was to protect the hallway to ensure everyone could get out. He then heard the apparatus airhorns sounding the department's evacuation signal and realized he was nearly out of air since his SCBA low air alarm was sounding. As he retreated toward the exterior, he ran out of air, removed his mask and ran in a crouch to get out of the building. Once outside, he went to get his air cylinder changed and it was then he learned that FF Tirado was missing.

FF Silvia, who was now outside and out of air, enlisted the help of Lt. Raymond Schmitz to raise a ladder to window on side "D" division 3. Silvia climbed the ladder and experienced heavy smoke and heat and was forced to climb down as he could not tolerate the conditions due to being out of air. After changing his cylinder, he joined in the rescue efforts on the third floor and assisted with pulling a 2 1/2" hoseline to that location.

At 2054 hours, DC Sinatra called for mutual aid to report to the incident and act as a firefighter search and assistance team (FAST). While this was going on, there were several attempts to locate FF Tirado on the third floor by firefighters that were already on the scene. Several times they were driven back by fire conditions and attempts to bring the initial 1.75" hoseline up to the third floor and to the rear apartments failed due to the line being too short.

At 2055 hours, the Director of the Fire Department, Anthony Mingo, Jr. arrived on scene. At 2100 hours Chief of Department Lewis Imparato arrived on scene and assumed command. Mutual aid from the City of Clifton arrived at this time also. Soon after, it was reported that the rear of the third floor was heavily involved and a report was received that the rear of the second floor was also heavily involved. A short time later, the roof of the third floor had partially collapsed and Chief Imparato ordered an evacuation of the building once again.

After the structure was evacuated, master streams were utilized to knock down the fire and the FAST, which ended up being comprised of Passaic firefighters already on scene rather than mutual aid firefighters, mounted several attempts to locate FF Tirado. During one of these attempts, Fire Department Director Mingo ordered a ladder pipe to operate on the third floor. It was reported that this caused the FAST to retreat from their search for Tirado.

As conditions in the structure deteriorated, Chief Imparato ordered more evacuations and as conditions improved rescue attempts resumed.

On the fourth attempt, rescuers heard a Personal Alert Safety System (PASS) device sounding in Apartment 12. Upon entry, they found FF Tirado inside the bedroom of the apartment lying face down. This was also the first time a thermal imaging camera was used in the search effort. Tirado was not responsive and was not breathing. Paramedics on scene were called to the third floor where they pronounced FF Tirado dead.

Cause of Death

An autopsy was conducted by the State of New Jersey Regional Medical Examiner's Office which showed that FF Tirado suffered burns to his body and inhaled soot and carbon monoxide. Results of blood tests revealed a level of carboxyhemoglobin of 65%. The official cause of death was listed as asphyxia by smoke and carbon monoxide inhalation. The manner of death was listed as accidental.

Fire Cause Investigation

The fire was investigated jointly by the Passaic Fire Department and the Passaic County Prosecutors Office. The cause of the fire was listed as accidental and was attributed to pre-teen children attempting to light a gas cooking range with a piece of paper that was ignited by a religious candle that was burning in the children's apartment. The gas range did not have a pilot and it was common practice in the household to light it in this manner. While the child was carrying the lit paper from the candle to the stove, it burned her hand causing her to drop it in a pile of clothes which were then ignited.

It was noted that children's parents were not home at the time of the fire.

ANALYSIS

First Alarm Staffing

The first alarm assignment for this incident was three engines and one ladder truck. Each was staffed with an officer and two firefighters. Additionally, a deputy chief responded. All of the first alarm apparatus and personnel arrived on scene in short order due to the short distance from the fire station that the incident scene was located. The incident commander called for additional alarms and for mutual aid companies to respond as the incident escalated, but it must be remembered that only approximately 16 minutes elapsed between the time of the arrival of the first unit on scene and FF Tirado's last radio transmission. For all intents and purposes, operations during the most critical part of the incident were undertaken by the personnel of the first alarm. Due to the number of tasks that were required to be undertaken during the first few minutes of the incident, which included establishing water supply, initial fire suppression and search operations, crews were stretched so thin that firefighters felt it was necessary to operate individually. Additionally, there were insufficient personnel available to assemble a rapid intervention team.

A recommended first alarm staffing number for this type of occupancy is sixteen firefighters and one chief officer responding with three engines and one aerial apparatus.

Coordination between Suppression and Search Operations

The Passaic Fire Department operates with engine companies and truck/ladder companies, meaning that under most circumstances each type of company is responsible for specific but different tasks and operate somewhat independently of each other. Typically, engine companies are tasked with water supply, hose and suppression operations while truck/ladder companies are responsible for ladder work, forcible entry, ventilation and search and rescue operations. This was the case at this incident.

Sometimes this separation of duties can result in a breakdown in the coordination of activities that are to be undertaken. At this incident there was a lack of coordination to some point evidenced by the fact that many firefighters reported they were unsure of the identity of other firefighters in the structure or what company they were from and what their assignments were. This was especially true in the initial stages of the incident. Further, there was a lack of communication between crews inside the structure and between interior crews and the exterior as to the tasks they were performing, what conditions they were encountering, and what additional resources were needed.

Non-use of Thermal Imaging Cameras

At this incident there were initially two thermal imaging cameras on scene. They were located on Engine 2 and Ladder Truck 2. Later, two apparatus arrived with two additional thermal imaging cameras. None of these cameras were utilized for either initial search and suppression operations or for the initial search for the victim.

Safety Officers

Regulations of the Division of Fire Safety N.J.A.C 5:75, Incident Management System mandate the use of a safety officer(s) on all incidents.

Due to limited staffing, there was no dedicated safety officer on scene during the initial stages of this incident. Therefore, in accordance with incident management protocols, the safety officer function was retained by the Incident Commander. Considering the scope of this incident, overseeing fireground operations *and* acting as safety officer was too much of a burden to be placed upon the incident commander.

Personnel Accountability

The Passaic Fire Department did not utilize a formalized personnel accountability system at this incident. Rather, members of each particular company responding on each apparatus more-or-less kept track of each other. Due to the fact that this was a hit-or-miss plan and was not organized and monitored by a person acting as an accountability officer, the concept of accountability of personnel location and function was subject to, and did in fact fail. This resulted in confusion with regard to who was in the building at any particular time and what they were doing.

Freelancing

Freelancing can be simply defined as fire department members acting as individuals without proper authorization from their supervisors rather than as part of a team with clearly defined task assignments provided by a supervisor. Freelancing at incidents often occurs when there is inadequate staff present to perform assigned tasks and to provide adequate supervision of personnel to enforce basic standards of safety. The investigation of this incident was unable to discover conclusively why FF Tirado went to the third floor by himself but it is believed he thought there may have been occupants there. At this incident as is the case at many incidents, freelancing can have disastrous results. This single action more than any other was the major factor that resulted in FF Tirado's death.

It should be noted that freelancing also occurred when fire department Director Mingo ordered a ladder pipe to operate on the third floor without regard to the rescue operations inside the structure being directed by Chief Imperato. As noted previously, this may have caused the FAST to retreat from their search for Tirado.

LESSONS LEARNED

Provision of Adequate Staffing

At this incident, a factor which contributed to the tragic outcome was the lack of adequate staffing. Initially, only twelve firefighters were on scene in addition to the incident commander. Considering that of the twelve, three were apparatus drivers/pump operators, the remaining nine firefighters were tasked with search, suppression and ventilation. A key point to remember is that some members operated by themselves without benefit of a partner. This practice goes against all accepted protocols and should not occur. However, members of this department have been working understaffed for such a long time, it has become common practice. Firefighters reported that if they did not operate in this manner, they would not be able to do any type of operations at all. While their dedication to duty is admirable, the risks they assume are unacceptable.

It has been demonstrated that when staffing levels fall below four firefighters per company, critical fireground operations are not carried out when needed. Tests conducted with the Dallas, Texas Fire Department indicated that staffing below a crew size of four can overtax the operating force and lead to higher losses. Similarly, the National Fire Protection Association (NFPA) in its Standard 1710; Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments notes that engine companies and ladder truck companies each “shall be staffed with a minimum of four on-duty personnel.”

Fire departments and the municipalities they serve need to make a commitment to the adequate staffing of the department in order to allow the most efficient fireground operations in the safest possible manner. Firefighters should not be put in a position due to inadequate staffing that they feel it is necessary to complete tasks by themselves. Additionally, fire department staffing levels must allow for compliance with the two-in; two-out provisions of the PEOSH Respiratory Protection Standard 29CFR1910.134 which state:

- *At least two employees enter the immediately dangerous to life or health (IDLH) atmosphere and remain in visual or voice contact with one another at all times;*
- *At least two employees are located outside the IDLH atmosphere; and*
- *Visual, voice, or signal line communication is maintained between the employee(s) in the IDLH atmosphere and the employee(s) located outside the IDLH atmosphere;*
- *The employee(s) located outside the IDLH atmosphere are trained and equipped to provide effective emergency rescue;*
- *One of the two individuals located outside the IDLH atmosphere may be assigned to an additional role, such as incident commander in charge of the emergency or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident.*

Additionally, in departments that operate engine and ladder truck companies with clearly defined but separate duties, the line between the two types of companies may have to be blurred when dealing with limited staffing. It may be necessary for members of either type of company to be assigned with members of other companies at an incident scene in order

to safely accomplish a given task. Incident commanders and company officers must utilize personnel in ways that may not be in accordance with traditional roles. Firefighters must also be prepared for these “crossover duties” through training provided by the department.

Freelancing and Team Integrity

Fire departments must take all possible measures to prevent freelancing on the incident scene. Company officers and training officers should work within the context of ongoing training programs to create a culture in the department’s ranks that freelancing is never acceptable nor tolerated. Company officers and safety officers on incident scenes need to be constantly vigilant with respect to freelancing and immediately stop it if they see that it is occurring.

Additionally, freelancing at the highest levels cannot be permitted to occur. Command of an incident must be undertaken by one individual, or where more than one agency has jurisdiction or the lines of authority in an organization are not clear, unified command must be established. It is vital that operations are coordinated through the command structure in order to avoid situations where opposing strategies and tactics are employed to the detriment of the overall operation. Such was the case at this incident where Director Mingo acted independently of Chief Imperato who was the Incident Commander.

The concept of team integrity is paramount to ensuring the safety of firefighters and helps to prevent freelancing. Simply stated, firefighters are paired in teams that enter the hazardous area together, perform their assigned task together and exit together. As a team, they formulate tactics that will most efficiently and safely accomplish what is to be done. Through continual training, the concept of team integrity will become second nature and firefighters will understand that working as an individual is neither desirable nor tolerated.

Rapid Intervention Teams

It was discussed previously that fire departments need to provide at least two firefighters outside of the IDLH atmosphere for the purpose of searching for and rescuing lost or trapped firefighters. It is recommended that this concept be taken to a higher level with the establishment of Rapid Intervention Teams (RIT) or Firefighter Assistance and Search Teams (FAST).

These teams, specially trained and equipped to deal with rescue of firefighters under the worst possible conditions, can be composed of departmental personnel or mutual aid personnel. It is important for the incident commander to request a RIT as soon as possible after dispatch to allow for the team to arrive quickly. Some fire departments dispatch a RIT automatically upon receipt of a report of a working fire.

If this concept is adopted by the fire department, it is crucial that the members of the RIT

obtain all necessary training and equipment, and other fire department members are well versed in the duties, responsibilities and operations of the RIT and what needs to be done by fire crews in support of the team.

Search Techniques

It is recommended that teams assigned to primary and secondary search operations that are not equipped with a hoseline be issued and utilize search ropes when searching areas of a structure. Such lines should be reasonably long enough for the normal occupancy encountered by search teams and can be outfitted with carabineers for easy attachment to anchor points. Teams are then able to enter areas to be searched holding the rope as they go and then following the rope back out to the point of entry. There are several systems utilized by various fire departments employing markings or knots at selected intervals in the rope to allow firefighters to gauge how far they are in a space. Fire departments should choose a system that works best for their particular operations.

Use of Thermal Imaging Cameras

Fire departments in New Jersey have a unique benefit in that all were supplied with one or more thermal imaging cameras (TIC) by the state over the last two years. The Passaic Fire Department was the recipient of several of these cameras.

Fire departments that possess these units should routinely employ the use of them during structural firefighting operations. Cameras can be vital especially during search and rescue operations. While TICs must not replace time honored skills, they serve as an important tool to make searches for victims more efficient and result in a higher level of safety for firefighters. Just as firefighters equip themselves with a set of irons and flashlight, they must include the TIC in their cadre of tools every time they enter a situation where visibility is reduced. Further, the TIC must be an integral part of rescue operations for lost or trapped firefighters from the inception of the rescue. The TIC can help speed a RIT to the firefighter saving precious time in locating and removing the victim.

Fire departments must continually train utilizing their TIC in order for all firefighters to become proficient in its use, interpret the images it displays and learn and understand its limitations.

Personnel Accountability

Although not in effect at the time of this incident, the Division of Fire Safety has recently adopted regulations for personal accountability that all fire departments will have to comply with. The standards require that the fire department utilize a two-tag accountability system at a minimum which includes the use of an accountability officer and the use of accountability reports/roll calls, all within the framework of the incident management system that is required to be utilized at all incidents.

The personnel accountability system consists of more than simply handing tags to the designated officer however. It is a system that must be based upon communication

between crews working inside the structure or hazardous area and company officers and the incident commander. Interior crews must continually apprise their company officers regarding conditions, location, and what they are doing. At the same time, company officers responsible for crews must solicit information from their crews and pass it along to the incident commander or planning chief. When proper two-way communication is occurring, everyone on the incident scene is cognizant of what each team is doing and a generally sufficient idea of where they are.

Firefighter Survival Techniques

Since fire incidents are dynamic events and can change drastically at any given time, it is imperative that firefighters be prepared for dire situations should they occur. The best defense against getting into a dangerous situation is to not take unnecessary chances by weighing the risk of an action against the potential and realistic benefit one expects to gain. For example, if a room is fully involved, it is unlikely that an occupant could survive and searching should wait until conditions can be improved by use of ventilation and application of suppression streams.

Firefighters must be aware however that no matter how cautious they are, conditions can deteriorate rapidly and they can become lost or trapped. With this in mind, fire departments need to train firefighters to deal with situations such as these. Through repetitive training, firefighters can learn such emergency survival techniques as “skip-breathing” to conserve precious air supply, entrapment self-extrication techniques, wall breaching techniques, ladder escape “bail-out” methods and so forth. It is also important that firefighters be equipped with small items such as wire cutters, personal flashlights and personal lengths of rope or nylon webbing.

Firefighters must be taught that if they become lost or trapped the most important thing they can do is notify others of their plight and their best guess of their location. For this reason, every interior crew should be equipped with a portable radio equipped with a sufficient number of frequencies for fireground operations as well as a dedicated command frequency. Utilizing their radio, they need to notify the incident commander of their situation using a pre-determined emergency term such as “May-Day.” Additionally, firefighters need to immediately activate their PASS devices manually so as to help rescue crews locate them quickly.

A way of assisting interior crews prior to any emergency is the routine raising of ground ladders, one on each side of the building if possible, in order to provide multiple means of emergency egress.

Above all, firefighters must be conditioned to respond to personal emergencies calmly in order to make reasoned decisions. Many times panic takes over and firefighters do things such as removing their masks that hastens their death. It is difficult to simulate a training scenario where a firefighter actually feels his/her life is threatened but creative, realistic and

safe training exercises can be developed to help prepare firefighters for dire situations.

Safety Officers

As stated previously the regulations of the Division of Fire Safety N.J.A.C 5:75, Incident Management System mandate the use of a safety officer(s) on all incidents.

Safety Officers are needed to observe operations on the fire scene and identify and order the correction of safety hazards to personnel. On major incidents, fire departments must make provisions to have a designated safety officer or at large scale or complex incident, multiple safety officers.

CONCLUSION

The death of Firefighter Alberto Tirado can be directly attributed to the fact that he went to the third floor of the structure by himself, and contrary to all accepted practices as noted in publications such as Essentials of Firefighting and NFPA Standard 1710, as well as the mandates contained in the PEOSH Respiratory Protection Standard 29CFR1910.134.

Other factors contributed in one degree or another to this fatality. Insufficient staffing seemed to have fostered a culture of individualism in the fire department over a long period of time and a lack of supervision due to short staffing made it difficult to address this situation. Additionally, no personnel were available at the onset of the incident to form a rapid intervention team. These circumstances were contrary to what is required in the PEOSH Respiratory Protection Standard and N.J.A.C. 5:75, Incident Management System as well as the recommendations contained in NFPA Standard 1710. Thankfully, no other firefighter casualties occurred as a result of these factors.

In this incident firefighters did not utilize tools that were at their disposal such as thermal imaging cameras nor did they employ safety measures such as the use of ropes to help lead them out of hazardous areas during initial suppression and search operations.

REFERENCES

- N.J.A.C. 5:75, Incident Management System; NJ Department of Community Affairs, Division of Fire Safety, Trenton, NJ.
- Standard Operating Procedures; Passaic Fire Department; 11 Hope Ave.; Passaic, NJ 07055.
- N.J.A.C. 10:100-10 (b) Standards for Firefighters; Respiratory Protection Devices; NJ Department of Labor, Trenton, NJ.
- Rapid Intervention Teams; Fire Protection Publications: Oklahoma State University; Stillwater, Oklahoma 74078-8045.
- Essentials of Firefighting Forth Edition; Fire Protection Publications; Oklahoma State University; Stillwater, Oklahoma 74078-8045.
- Principals of Fire Protection; Arthur P. Cote, P.E.; Percy Bugbee; National Fire Protection Association; Batterymarch Park; Quincy, MA 02269.
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- Investigation Report; NIOSH; 4676 Columbia Parkway; Cincinnati, OH 45226-1998.