

TO: Director, National Institute for Occupational Safety and Health

FROM: California Fatality Assessment and Control Evaluation (FACE) Program

SUBJECT: Two fire fighters die and one seriously injured when an upstairs floor collapses on them during a residential fire in California

SUMMARY

California FACE Report #97CA003

A 29-year old fire fighter (decedent 1), and a 21-year old fire fighter (decedent 2) died and a 42-year old fire captain was injured when a second story floor fell on them while fighting a residential fire. The home's resident was also fatally injured. The municipal fire department received a call at 4:11:35 a.m. from a neighbor of the residence on fire reporting a structure fire. Subsequent calls reported a woman trapped in her home. Two engines, one truck, a battalion chief, a chief's operator and a safety engine were dispatched to the scene. Entrance was made through the single-story structure in the front in order to access the involved two-story addition at the rear. The fire fighters attacked the flames with 1 3/4-inch and 1 1/2-inch hoses in order to attempt the rescue of the trapped resident. While they were fighting the fire, the second story floor collapsed without any warning. The floor, which was twenty-seven feet by 21-feet 8-inches, collapsed as a whole. The CA/FACE investigator concluded that, in order to prevent future occurrences, fire departments should:

- . Address the need for a coordinated attack strategy.
- . Reassess attack strategy when the possibility of rescue has passed and fire damage is significant.
- . Develop a training program that specifically addresses the structural integrity of a fire-damaged structure.
- . Assure that fire department communications protocol is adequate, that it is known to all personnel, and that it is followed.
- . Ensure that fire command always maintains close accountability for all personnel at the fire scene.

INTRODUCTION

On February 6, 1997 at 4:37 a.m. a 29-year old male fire fighter (decedent 1) and a 21-year old male fire fighter (decedent 2) were fatally injured when the second-story floor of a burning residential home fell on them. A fire captain was seriously injured by the falling floor. The fire fighters were fighting a residential fire in which a resident was trapped on the second floor. As they were under the second story floor, it suddenly collapsed on them without warning and trapped them underneath.

The CA/FACE investigator learned of this incident on February 7, 1997 from the FACE principal investigator who learned of the incident on the same day from a television news report. The CA/FACE investigator traveled to the site of the incident on February 11, 1997 and met with the fire department's arson investigator (the incident's chief investigator). The CA/FACE investigator also interviewed a fire captain and a fire fighter who were both present at the time of the incident and met with a state fire marshall who was investigating the incident. Local newspaper articles, the police report, the fire department report and the death certificates for each decedent were obtained.

The municipal fire department had formed in 1850 as a volunteer agency, and reorganized as a paid professional agency in 1888. The department has 258 employees serving a city of 235,000. Decedent #1 had worked for the department for 7 years and had 3 years of prior experience with another agency. Decedent #2 had just completed his municipal fire department academy training and was fighting his first fire. The injured captain had been with the department for 18 years. The State of California requires that fire fighter candidates complete 482 hours of basic training and testing at a fire academy prior to being hired by a fire department. In addition, the municipal fire department required that new recruits, even those with prior fire fighting experience, attend the fire academy operated by the city before fighting their first fire. The city's fire academy is an 8-week long course. After successful completion of the city's fire academy, all city fire fighters are required to train for 2 hours on each shift which averages 25 hours of training per month.

Safety is the responsibility of the fire crew leader, a fire captain, who reports to the command center or the battalion chief. In addition, for the past 1 1/2 years a safety engine (rapid intervention team) has been sent out on all structure fires along with the fire crews. The safety engine crew, which includes a captain, an engineer, and two fire fighters, is responsible for watching for dangers to the fire crews including structure collapse.

INVESTIGATION

The scene of the fire is a home in a residential neighborhood (**exhibit 1**). The home was built in 1942 as a single story structure. In 1952 a two-story addition was added to the rear of the structure. Since it was to be used as a dance studio, the addition was one, large room, approximately 25-feet square, on the lower story with stairs on the west inside wall (**exhibit 2**) leading to an upper story which served as a bedroom. Windows were installed on nearly the entire east wall of the lower story which overlooked the drive way. The second-story served as a master bedroom and bathroom with door leading to a large sundeck on the east side, also overlooking the driveway. The driveway extended the length of the home and had four vehicles

parked in it at the time of the fire.

The first call to the fire department came in at 4:11:35 a.m. from a neighbor of the home involved. The neighbor reported that the structure was on fire. Subsequent calls came in quickly and reported that the resident was trapped in the burning building. The first alarm was sounded and two engines (E-6 and E-9), one truck (T-4), one support unit (SP-2), a battalion chief (BC-2), a chief's operator (OP-1) and a safety engine/rapid intervention team (E-4) were dispatched at 4:12:35 a.m. Each engine, including the safety engine, and the truck was staffed with a captain, and engineer and two fire fighters. The support unit was staffed with a captain and a fire fighter/paramedic. They all arrived within three minutes of dispatch.

First to arrive, engine E-9 fire crews found the rear of the structure involved. E-9's captain saw what appeared to him to be a single-story structure fully involved in the rear of the structure with fire showing through the roof. He immediately called for a second alarm indicating that two houses were on fire and that a resident was possibly trapped. A second alarm was called at 4:17:20 by the Emergency Communications Center. The second alarm dispatched two engines (E-2 and E-11), one truck (T-2), a battalion chief (BC-1), a medic (Medic-72) and all administrative staff. The E-9 captain directed E-9 fire fighters FF-1 and FF-2 (decedent #2) to enter the single-story structure through the front door with a 1 3/4-inch live line. FF-1 forced the front door open and entry was made. The fire fighters were in full turnout gear consisting of a helmet, Nomex hood, full faceshield/respirator, Nomex fire suit, gloves, and a self-contained breathing apparatus (SCBA).

Upon arrival of Engine 6 and Truck 4, the captain from E-6 (injured) directed E-6 FF-2 (decedent #1) to assist their engineer in establishing a supply line for E-9. The captain instructed E-6 FF-1 to use the booster line from E-9 to protect east side exposures (**exhibit 3**). The T-4 captain, T-4 FF-1 and the E-6 captain (injured) checked the east side of the involved home for occupants. The structure was not identified as a two-story structure in the rear at this time because of the heavy flames and, possibly, the large sun deck on the east side giving no appearance of a second story. BC-2 was established as the incident commander (IC) upon his arrival at 4:19 a.m. The command post was established at the intersection of the street on which the involved structure was located and the closest perpendicular street. The IC surveyed the situation and noted what he thought to be a two-story house at the rear of the single story residence. He determined that the two-story structure at the rear, the attic and the garage were on fire.

Meanwhile, E-9 FF-1 and FF-2 (decedent #2), along with their captain, advanced to the rear of the home with the 1 3/4-inch line. As they knocked down the fire, they proceeded to the rear of the structure performing a primary search as the progressed. At 4:20 the IC directed the E-4 crew to protect exposures to the west (**exhibit 4**). The E-4 crew, using a 1 1/2-inch live line from E-9 stationed themselves on the west side of the structure. When the SP-2 crew approached the fire, their captain advised the IC that it would take a larger line to knock down the fire on the east side. The SP-2 crew and FF-1 from E-6 set up a 2 1/2-inch line and began to extinguish the fire in the vehicles, the fence and the garage.

The captain (injured) and FF-2 (decedent #1) from E-6 began to make entry with a 1 3/4-inch line as a backup to the E-9 crew. The T-4 captain, engineer and FF-1 also made entry into

the structure at the same time. FF-2 from E-6 (decedent #1) was positioned at the front door to feed his captain line. E-9's crew had gone toward the west side of the interior and, due to a large amount of fire, E-6's captain (injured) directed his line to the east with the help of the engineer from T-4. At this time FF-2 from E-6 (decedent #1) entered the structure and, apparently, joined E-9's crew.

At 4:23 BC-1, E-2 and T-2 arrived as part of the second alarm. The captain from T-2 ordered his crew to check neighboring houses on the east and west side of the involved structure for fire. Because orders were not requested or received from the IC, T-2's captain gave orders to his crew which duplicated tasks already completed by T-4. The T-2 captain then proceeded to the rear of the involved structure and noted that it was on fire from top to bottom and did not note that it was a two-story structure.

BC-1, E-2 and E-11 located on the street behind of the involved structure to protect the south side (**exhibit 5**). This was done with a 2 1/2-inch and 1 1/2-inch lines. Water was directed on a burning power pole and the involved structure's garage. After approval by the IC, water from the 2 1/2-line was directed on the south side through the second-story window. At the same time SP-2 was directing water onto the second story from the east side as E-4 was playing water on the second-story from the west side. Due to a flare-up, more water was directed onto the second story from the south.

At this time the captain and FF-2 (decedent #2) from E-9 exited to replace their SCBAs. FF-1 from E-9 and, it is assumed, FF-2 from E-6 (decedent #1) remained with the initial attack line. E-9's captain and FF-2 (decedent #2) returned to the attack line to relieve FF-1 from E-9 who exited to change his SCBA. The captain from E-6 (injured) also left to replace his SCBA leaving T-4's engineer and FF-1 on the hoseline. T-4's captain and FF-2 were making a search of the rear of the structure. During this time the interior crews were still not aware that the rear portion of the structure was two stories. They also were not aware that there was an interior stairway leading to the second floor.

The doorway leading from the single story structure to the two-story addition was built in the middle of the common wall (**exhibit 6**). The fire fighters entered through this door to fight the flames. As FF-2 (decedent #2) from E-9 and FF-2 from E-6 (decedent #1) manned the initial attack line, the captain from E-6 (injured) was making his way to the rear of the home to join them. As the captain began to walk through the door, the floor of the second story fell as a whole onto the first floor. As the other firemen continued to refill their air tanks, they heard and felt a low rumble. SP-2's captain stated that it occurred to him that it might have been a collapse of the structure.

The two decedents(FF-2) from E-9 and FF-2 from E-6) were in the middle of the floor of the downstairs area of the two-story structure (**exhibit 7**). The injured captain was in an area near the door opening between the single-story and the second-story structures. T-4's engineer, who was on a hose nozzle, was blown back from the door way onto FF-1 from T-4. As the other fire fighters investigated, they found that the floor of the second story had fallen as a whole onto the first floor.

Since it was known that fire fighters were trapped, rescue efforts began. They were coordinated by the captains from T-2, T-4 and E-11. There were four vehicles in the driveway

which were on fire. They had to be moved so rescue operations could be carried out. Concurrently, three Jaws of Life were brought to the rear of the structure to lift the floor off the trapped fire fighters. The collapse of the second-story floor blew out the flame between the floors. There was still large amounts of heavy smoke and other firemen continued to fight flames in other areas of the structure.

As the Jaws of Life lifted sections of the collapsed floor, the floor was cribbed. Finally, after one hour and seven minutes, the floor was lifted and supported enough to retrieve decedent #1. While others hosed them down the rescuers crawled on their stomachs between the floors to make the rescues. It took another 35 minutes to lift and support the collapsed structure enough to find and retrieve decedent #2. The injured fire captain, who also had to be rescued, suffered second and third degree burns to the right side of his body and broken ribs. The resident's body was found in the rubble more than 5 hours later.

The second story floor was extremely heavy construction for a residential building. It was not supported in any manner except for the outside walls and one 4-inch by 4-inch vertical post located just northeast of the center of the ceiling. Modern building codes would mandate center supports. Additionally, the second floor joist spacing was on 12-inch centers, much closer than required or necessary. The joists themselves were rough sawn and full dimension. They measured approximately 2 3/4 inches wide, 11 1/2 inches deep and 21-feet, 8-inches long. They ran the entire 27-foot width of the addition. The joists were only toe-nailed into the outside walls with no bracing or strapping used. Overlaying the joists were 1-inch by 8-inch flooring placed on a 45 degree diagonal. On top of that, was a layer of 2 3/4-inch by 3/4-inch finished oak hardwood flooring. The first floor ceiling was finished with 1-inch by 8-inch tongue and groove pine. It is estimated that the floor weighed in excess of 4 tons.

When the fire had weakened the walls and, perhaps, the nails that held the second-story floor in place, the walls popped outward and the floor fell as unit. Because the two decedents were in the middle of the floor, they were crushed by the extreme weight of the collapsed floor.

The cause of the fire, which started in the bedroom on the second floor of the rear addition, was most likely electrical in nature. It is probable that an electric blanket or electrical cords powering the blanket were the actual source of the fire since the fire began on the bed. The resident's body, when found, was still wrapped in an electric blanket. Further investigation showed burn patterns of the fire eroding into the floor under the bed causing a hole approximately 6-feet by 8-feet. Fire patterns indicated that the fire was well involved before being reported. After smoldering for an undetermined amount of time, it broke into open combustion and spread rapidly throughout the attic and the remainder of the home.

CAUSE OF DEATH

The death certificates stated the cause of death to be traumatic asphyxia for both decedents.

RECOMMENDATIONS/DISCUSSION

Recommendation #1: Fire departments should address the need for a coordinated attack

strategy.

Discussion: The interior attack crew was never aware that the rear of the structure was two stories, although the exterior crew knew this at least 20 minutes before the collapse. The interior crew also did not know that water was being placed on the second story, the weight of which may have added to the possibility of collapse. The exterior crew also knew there was major damage to the first floor walls which supported the second story. Although the exterior crew was most likely not aware of how the second story was supported on the inside, they should have communicated the condition of the structure to the interior crew who were mopping up and who would have known that the interior support was very minimal because of the lack of vertical support posts. The Incident Commander (IC) could have relayed the information to the interior crew or made a decision to exit, but he had received an insufficient number of necessary status reports. Had the interior crew known that the outside support for the second story was tenuous because of extreme fire damage, they may have made the decision to exit the structure prior to the collapse.

Recommendation #2: Fire departments should reassess attack strategy when the possibility of rescue has passed and fire damage is significant.

Discussion: It was very unlikely that any one within the structure was alive prior to the collapse due to the massive fire damage and smoke. Although one of the most commendable services a fire fighter can perform is a rescue of a person during a fire, the safety of a fire fighter is paramount. A prudent tactic in a hopeless situation would be to consider the removal of interior attack crews. A new strategy could be developed while exterior crews protect all associated exposures and the exterior of the structure itself. At this time the building's structural integrity could be determined prior to further interior fire fighting. Fire fighters would then be protected from unforeseen collapse while the structure fire is held at minimum level.

Recommendation #3: Fire departments should develop a training program that specifically addresses the structural integrity of a fire-damaged structure.

Discussion: In this fire, major structural damage was noted by the exterior crews prior to collapse. In order to satisfactorily analyze a structure which has been damaged by fire to determine collapse potential, a course of instruction should be developed which covers all facets of structural integrity. Older or out-of-code buildings should also be covered. The course objective should be to determine the risk to fire fighters in situations where structural integrity has been compromised. Fireground personnel knowledgeable about structural integrity of fire damaged buildings can then make a decision, based on training, if the risk to fire fighters is too great to make or continue an interior attack.

Recommendation #4: Assure that fire department communications protocol is adequate, that it is known to all personnel, and that it is followed.

Discussion: Communications can be identified as a problem at the scene of many fire fighter fatalities. In this incident, fireground personnel were not actively listening to their radios. It is not unusual for on-scene personnel to be of the mind set that a personal radio is for them to

use for transmission and not for listening.

In addition, standard ICS terminology was not used consistently. This could lead to confusion concerning who is occupying which position and from whom the radio communication is being transmitted or received. Of course, the interior and exterior crews were not in proper communication with one another. All personnel should be trained to use clear and concise communications and the ICS during an incident. All communications should be acknowledged. If no acknowledgment is received, efforts should be made to discover the reason for the failure. Communications regarding the condition of the structure as the fire progresses should be made on an ongoing basis.

In this incident, different decisions may have been made regarding the fire attack strategy had communications protocol been established and fully executed. This is especially true if findings regarding current conditions of the structure, both inside and out, had been regularly reported or requested and communicated to all fireground personnel. It was of paramount importance that all fireground personnel including command and interior crews knew that there was fire showing above the interior crew and that water was being directed onto the fire above them.

Recommendation #5: Ensure that fire command always maintains close accountability for all personnel at the fire scene.

Discussion: Accountability for all fire fighters at a fire scene is paramount, and one of fire command's most important duties. In this incident, accountability was not given the highest priority. After the collapse, it was not known who was trapped and exactly where they were located. The accountability process was not coordinated and the persons assigned to perform it were not trained in the process. Accountability, therefore, was not timely, effective, or complete. After the removal of the final, trapped fire fighter, the accountability process stopped. Some companies at the scene were never checked by the accountability officer. Final accountability, when properly completed, should be disseminated to all fireground personnel to determine if any person is missing or not accounted for.

Although the two fire fighters who died in this incident most likely died within minutes of being trapped, others could have been trapped and saved as was the captain. Moreover, it may not have been clear that interior personnel were under the second-story floor since communications concerning their position were rare. If it was known who was at what location inside of the structure, different decisions may have been made regarding their safety.

References:

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FATALITY ASSESSMENT AND CONTROL EVALUATION PROGRAM

The California Department of Health Services, in cooperation with the Public Health Institute, and the National Institute for Occupational Safety and Health (NIOSH), conducts investigations on work-related fatalities. The goal of this program, known as the California Fatality Assessment and Control Evaluation (CA/FACE), is to prevent fatal work injuries in the future. CA/FACE aims to achieve this goal by studying the work environment, the worker, the task the worker was performing, the tools the worker was using, the energy exchange resulting in fatal injury, and the role of management in controlling how these factors interact.

NIOSH funded state-based FACE programs include: Alaska, California, Colorado, Georgia,

Indiana, Iowa, Kentucky, Maryland, Massachusetts, Minnesota, Missouri, Nebraska, New Jersey, Wisconsin, and Wyoming.

Additional information regarding the CA/FACE program is available from:

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