FIRE FIGHTER FATALITY
Biloxi, MS
October 20, 1986

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Tragedy Strikes Biloxi
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On October 20, 1986, an early morning fire of electrical origin caused severe damage to an apartment building at 506 Reynoir Street, Biloxi, Miss., and resulted in the death of two fire fighters.

The two-story, wood-frame building once had been a single family dwelling, but later had been converted into seven apartment units. The building contained numerous combustible concealed spaces, both in the walls and above the second floor ceiling. The building was not equipped with automatic sprinklers, smoke detectors or a manual fire alarm system.

The fire originated in a joint space between the first and second floors, in a location adjacent to a concealed combustible wall cavity. From the area of origin, the fire spread rapidly to the attic, eventually culminating in the total destruction of the second floor.

The severe fire burning in the concealed space created an extremely dangerous condition, which the fire fighters were attempting to remedy. Unknown to others, two fire fighters entered the building without a hose line and subsequently died in a second floor bedroom. Both were equipped with full protective clothing and self-contained breathing apparatus (SCBA).

The building

The large, two-story wood frame structure at 506 Reynoir Street originally had been a single family dwelling. It was built around the turn of the century and was converted to an apartment building several years later. There were seven living units in the building—four on the first floor and three on the second. (See Figures 1 and 2.) Except for apartment I, all units were occupied at the time of the fire. Eight persons occupied the first floor—four in apartment A and two each in apartments B and F. Three persons occupied the second floor—one occupant each in apartments C, D and E.

An open stairway in the center of the house connected the first and second floors and provided the only escape route for second floor residents. With the exception of apartment B, all first floor units had exits opening directly to the outside. The living areas were approximately 2280 sq. ft. for the first floor and 1300 sq. ft. for the second. The building had no fire alarm system, automatic sprinklers or smoke detectors.

The structure’s balloon frame construction contained vertical channels that had no fire-stopping. Numerous combustible concealed spaces were present inside the walls, the attic, and between the inside and outside walls of the second floor. The majority of interior wall and ceiling finishes were of 1-by-3-inch tongue and groove, southern pine boards. Floors were finished in a variety of materials including carpet, vinyl, and wood.

First floor ceilings were 12 feet in height except in some bathroom and kitchen areas, where 8-foot-high suspended ceiling systems had been installed. Ceilings throughout the second story were 8 feet, 10 inches high.

The building was heated by unvented, natural gas space heaters located within each of the seven living units. A central heating system with associated ductwork was present but was not being used at the time.

About 25 minutes before the bodies of the deceased fire fighters were discovered, fire fighters move in to complete extinguishment.

Fire fighters and others pay tribute to one of their fallen comrades.
The building was supplied through two electrical services. The first service was supplied from a normal utility service drop to the meter on the building. The second service was tapped from the load side of two separate meters on an adjacent building owned by the same individual that owned 506 Reynoir. The tap conductors were run underground to the fire building to supply window air conditioner and some lighting.

Public protection

Biloxi, Miss., is a city of 53,000 people located on the Gulf Coast. The city covers an area of approximately 26 square miles. The Biloxi Fire Department is one of three divisions in the Department of Public Safety. The Fire and Life Safety Division has a fully paid force of 78 career fire fighters operating six engine companies and two truck companies out of six fire stations.

Fire discovery

The couple in apartment F on the first floor were awake as usual during the early morning hours of October 20, 1986. Both husband and wife had risen at 2:00 a.m., to prepare to leave for work. At approximately 2:50 a.m., they saw smoke discharging from a heating duct in the living room ceiling. They also could hear a sound described as a scratching or crackling noise. The apartment was filling with smoke, and since they had no telephone, the wife ran next door where a neighbor called the fire department. The husband left the apartment, went around the outside of the building, and began pounding on the door to apartment B to awaken the occupants. Having notified them of a fire, he and a next door neighbor went up the stairway to the second floor, yelling for everyone in the building to leave immediately because of fire.

Just before he was warned of the fire, the occupant of apartment D woke up coughing because of smoke in his room. He jumped up and opened the door to the hallway in an attempt to determine where the fire was. He saw people coming up the stairs shouting for everyone to get out, and he quickly dressed and left the building. The second floor occupants of apartments C and E were wakened by the warnings and quickly left the building as well.

At that time, only a light haze of grey smoke was present in the stairway, hall, and apartment D on the second floor. On their way out, at least three persons saw smoke coming from a heating duct adjacent to the stairway in a wall separating the kitchen of apartment B and the main entrance foyer.

At 2:54 a.m., an off-duty Biloxi fire fighter driving by in the area detected an odor of something burning. Then he observed smoke coming from the rear of the house at 506 Reynoir Street. He drove away in search of a public telephone, but he met a police officer who was responding to the reported fire. He followed the officer back to the house, and together they began a search of the apartments. They were soon joined in the search by a second police officer.

Fire fighting

First-in Engine 3 arrived on the scene at 2:55 a.m. and reported no smoke showing. Moments later, Engine 1 and a battalion chief arrived and notified the dispatcher of the presence of smoke.

The building's electrical meter was pulled, de-energizing only a portion of the circuits as indicated by the continued illumination of some lighting. Later, the public utility disconnected the service drop to the building, which also failed to cut off all of the power. Sometime later, the tap conductors running underground from an adjacent building were dis-
covered and disconnected from the meters that fed them.

At 2:56 a.m., a police officer reported to the battalion chief, who was functioning as fire ground commander at that time, that all occupants were out of the building. The battalion chief's size-up determined the presence of fire at the rear, northeast corner of the structure, in the area where the roof intersected the top of the exterior wall. The fire involved roof rafters that extended into the attic.

Engine 3 connected to a hydrant in front of the building with a 4-inch supply hose. Two 1½-inch hose lines were stretched along the south side of the house and positioned to the outside rear. Initial fire suppression efforts began at position 1 (see Figure 3). Fire was spreading to the attic, and fire fighters set up a ground ladder there to reach an attic vent on the roof peak. From position 1, a fire fighter applied water to the attic area continually, in an attempt to stop the rapidly spreading fire.

Soon after, fire crews set up another ground ladder at position 2, adjacent to the north porch. They removed facia boards to expose burning roof rafters and then put a second hose line into operation, directing water into the involved area in an effort to stop the advancing fire. With two outside lines operating, the overall effect on slowing the progress of the fire was minimal, according to incident accounts.

To this point, fire had not involved the first floor. The fire burned through the tongue-and-groove pine ceiling in apartment 1, directly under the area of fire origin, causing hot embers to fall onto an upholstered chair below. After apparently smoldering for some time, flaming ignition of the chair occurred and quickly spread fire to other room furnishings and to the combustible walls and ceiling. By the time fire fighters became aware of the situation, apartment 1 was engulfed in flames. Quick action by fire crews stopped further involvement of the first floor. They mounted an interior attack from the north entrance to apartment 1, and rapidly extinguished the first floor fire.

A request for additional forces brought Truck 1 and Engine 2 to the scene. At approximately 3:10 a.m., the captain from Engine 1, accompanied by fire fighters A and B (the fatalities), had completed a preliminary search of the building for occupants and had reported to the fire ground commander that no one was inside.

After obtaining an attic ladder, the three fire fighters re-entered the building in an effort to find access to the attic. They were wearing full protective clothing and SCBA, but they did not have a hose line in their work area. The smoke was light to moderate and no noticeable heat was present.

The second floor smoke layer was from approximately 7 feet above the floor to the ceiling. There was an 18-by-21-inch attic scuttle hole inside the closet between the hall and the front dormer, but the fire fighters could not locate it. All three men left the building and exchanged their SCBA air cylinders, as their two previous trips inside had used up the air supplies.

Fire continued to spread inside the concealed spaces of the attic. After involving the rear portion of the building, fire began moving toward the front and growing in intensity. Fire fighters remained at position 1 (see Figure 3), but the crew at position 2 relocated to position 3 in an effort to stop the spread of fire in the concealed spaces. However, the fire continued to spread despite these efforts.

Upon arrival, Truck 1 was positioned adjacent to Engine 3 in front of the building. A 4-inch line from Engine 3 supplied the 1000-gpm spray nozzle located on Truck 1's platform. Fire fighters hand-stretched 250 feet of 4-inch supply hose through a vacant lot to Engine 1, to provide water for two 1½-inch exterior handlines that were deployed to the west and north sides of the building. Subsequently, Engine 4 was ordered to respond to the scene to provide extra personnel.

At approximately 3:38 a.m. fire extended from concealed spaces into habitable portions of the second floor. The interi-
ing through the roof. For safety considerations, fire fighting at position 1 was discontinued while the master stream was in operation. As with the handlines, the master stream was ineffective in extinguishing the fire because water was not being applied to the seat of the fire.

Because of another fire alarm at a high-rise apartment building a short distance away, Engine 2, staffed by two fire fighters, was dispatched directly from the fire scene, at 3:45 a.m. An engine and a truck from their respective stations also were dispatched to the high-rise alarm.

Shortly before 4:00 a.m., apartment E, at the northwest corner of the house, began burning. As Truck 1 continued to apply water from above at a rate of 1000 gpm, fire fighters put a 1¾-inch handline into operation from the ground at position 4. This directed water through the kitchen window of apartment E. Shortly thereafter, crews positioned a ground ladder at that window to allow fire fighters better access for stream penetration.

As suppression efforts continued, fire suddenly erupted from the bedroom window of apartment E (see position 5, Figure 3). Fire crews stopped their attack at position 4 and directed streams through the window from the ground. At about this time, Truck 1 began directing its master stream into the front dormer, which also was beginning to burn.

Engine 2 returned to the scene at 3:53 a.m., from what had been a false alarm at the high-rise apartment complex. At approximately 4:45 a.m., three fire fighters went up the ladder at position 5 and pushed the air conditioner from apartment E’s bedroom window into the room.

The fire now had extended into apartment C, and the entire second floor was burning. Large portions of the roof were collapsing, with the worst damage occurring over the stairway and apartment D.

Fire fighters entered apartment E through the bedroom window and succeeded in extinguishing the fire there. Then they directed their efforts toward the fire in the hallway and inside apartment C.

By this time, another crew had placed a ground ladder at position 6, at the front of the building. From that ladder, fire fighters could direct water onto the fire in the front dormer. Eventually, they entered the second floor, fighting fire as they went. Working in a coordinated effort, the two crews eventually pushed the fire toward the rear of the house, where they accomplished final extinguishment.

At approximately 5:05 a.m., when small spot fires were being extinguished and smoke conditions had lightened, crews discovered the bodies of two fire fighters in the bedroom of apartment E. Although a crew had passed through that room during interior fire suppression activities, the bodies had gone unnoticed for almost 20 minutes. This is attributed to smoke and fire conditions, the depth of water on the floor, and debris in the room.

Fire damage

Fire damage was extensive. The second floor was gutted, and most furnishings were consumed or severely damaged. Most of the roof collapsed, except in the front of the building and on the one-story addition in the rear. The floor/ceiling assembly between the first and second floors received severe structural damage adjacent to the stairway and in the area of fire origin. Apartment 1 sustained moderate damage, caused when burning debris fell from the ceiling and ignited the room furnishings and interior finishes. Although no struc-

The room in which the deceased fire fighters were found.

tural damage occurred on the first floor, there was considerable smoke and water damage. The estimated property loss to the building and contents was $90,000.

Casualties

The scene was preserved for investigators who were summoned immediately. They examined the premises and made the following observations about the fatalities.

Both deceased fire fighters were equipped with protective coats, protective trousers, and protective hoods. Other equipment included boots, gloves, fiberglass helmets with faceshields, and 30 minute positive pressure SCBA. Neither fire fighter was wearing a helmet or protective hood when discovered.

Fire fighter A was found lying on his side on the floor between the dresser and bed (see Figure 4). The SCBA was being worn and the facepiece was tightly sealed on the face. The breathing tube was not connected to the regulator, but was found near the victim’s hand. Burned debris was present on top of the body but not beneath it. His helmet was located approximately four feet away, near the bedroom window.

Fire fighter B was found lying on his back on the floor.
against the south end of the bed. The SCBA was being worn
and the facepiece was fitted loosely to the face. The breath-
ing tube was connected to the regulator. Burned debris was
present beneath the bed as well as on top of it. His helmet
was found close by, next to the bed.

After the fatalities were transferred to the Medical Examin-
er’s Office, the SCBA of each fire fighter was transferred
carefully to a case of the type provided by the SCBA manu-
ufacturer. Each case was sealed and subsequently was
shipped to the National Institute for Occupational Safety and
Health (NIOSH) for examination and testing.

Testing conducted on November 20, 1986, included the
remaining service life indicators (low pressure warning) of
the fire fighters’ SCBA for conformance to Title 30, Code
of Federal Regulations, Part 11. The NIOSH report indicated
that the low pressure warning of the SCBA worn by fire
fighter A did not function during the test and also cited other
significant findings on each apparatus examined. Further,
the report states NIOSH has no evidence or opinion as to
whether any or all of these problems were the result of fire
scene exposure. The report did recommend, as a precaution-
ary measure, that all of Biloxi’s SCBA be given a thorough
examination for proper assembly and performance. (The
complete NIOSH report, dated November 21, 1986, is enti-
tled, “Examination of SCBA from Biloxi, MS.”)

Medical Information
The Harrison County medical examiner conducted post-
mortem examinations on both fire fighters. The Gulf Coast
Community Hospital, in Biloxi, performed toxicological
analyses.

The cause of death for fire fighter A was determined to be
carbon monoxide poisoning due to the inhalation of smoke.
The autopsy revealed sooty material in the upper and lower
respiratory tract.

The cause of death for fire fighter B was determined to be
upper respiratory tract burns due to the inhalation of hot air
and smoke. Medical authorities believe that the inhalation of
super-heated air induced a bronchospasm, immediately re-
sulting in the cessation of breathing.

Cause and origin
Investigators from the Biloxi Department of Public Safety
have determined the cause of the fire to be electrical in
origin.

The original wiring in the structure, when it was occupied
as a single-family dwelling, was “knob and tube” type of
wiring. Several years later, when the building was converted
into seven apartment units, additional wiring was necessary
as bathroom and kitchen facilities were added. It most likely
was during this period when nonmetallic-sheathed cable
was spliced to the original wiring to expand the electrical
system. The splices were made by twisting the nonmetallic
sheathed cable wire around the bare knob and tube wiring.

Splices of this type are not uncommon; however, they are
required to be soldered, and these splices were not. Poor
electrical contact of copper conductors can cause the con-
nection to overheat. While a load is connected, the overhe-
ating may cause the twisted conductor to expand. When the
load is disconnected, the conductors cool off and contract.
The contact at the connection will deteriorate because of this
thermal cycling.

Section 110-14(b) of NFPA 70, The National Electrical
Code*, has specific requirements for splices, such as the
following:
Conductors shall be spliced or joined with splicing devices suit-
able for the use of or by brazing, welding or soldering with a fusible
metal or alloy. Soldered splices shall first be so spliced or joined
as to be mechanically and electrically secure without solder and
then soldered. All splices shall be covered with an insulation
equivalent to that of the conductor or with an insulating device
suitable for the purpose.

<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>2:50 a.m.*</td>
<td>Discovery of fire.</td>
</tr>
<tr>
<td>2:52 a.m.</td>
<td>Alarm received by fire department.</td>
</tr>
<tr>
<td>2:54 a.m.</td>
<td>Police officers and off-duty fire fighter arrive on scene and begin to search building for occupants.</td>
</tr>
<tr>
<td>2:55 a.m.</td>
<td>First fire apparatus arrives on scene.</td>
</tr>
<tr>
<td>2:56 a.m.</td>
<td>Police officer reports all occupants out of the building.</td>
</tr>
<tr>
<td>3:10 a.m.*</td>
<td>Fire department completes preliminary search for occupants.</td>
</tr>
<tr>
<td>3:11 a.m.*</td>
<td>Fire crew begins search for access to attic.</td>
</tr>
<tr>
<td>3:13 a.m.</td>
<td>Truck 1 and Engine 2 arrive on scene.</td>
</tr>
<tr>
<td>3:27 a.m.*</td>
<td>Fire fighters A and B leave the building and have their air cylinders changed.</td>
</tr>
<tr>
<td>3:29 a.m.*</td>
<td>Fire ground commander notified that attic access could not be located.</td>
</tr>
<tr>
<td>3:38 a.m.*</td>
<td>Fire fighters leave floor blocked by fire.</td>
</tr>
<tr>
<td>3:43 a.m.*</td>
<td>Engine 2 leaves scene to respond to another reported fire.</td>
</tr>
<tr>
<td>3:43 a.m. to 3:53 a.m.</td>
<td>Operation of truck 1 master stream begins.</td>
</tr>
<tr>
<td>3:53 a.m.</td>
<td>Engine 2 returns to fire scene.</td>
</tr>
<tr>
<td>4:00 a.m.*</td>
<td>Fire is observed issuing from apartment E bedroom window.</td>
</tr>
<tr>
<td>4:06 a.m.</td>
<td>Engine 5 arrives on scene.</td>
</tr>
<tr>
<td>4:45 a.m.</td>
<td>Fire fighters enter bedroom window of apartment E with hose line and begin fighting fire.</td>
</tr>
<tr>
<td>5:05 a.m.*</td>
<td>Bodies of fire fighters A and B discovered.</td>
</tr>
</tbody>
</table>

* Indicates approximate time based on available data and the best judgment of the investigator.

Table 1

<table>
<thead>
<tr>
<th>Conditions of SCBA when found</th>
<th>Fire fighter A</th>
<th>Fire fighter B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Facepiece</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Facepiece hose attached to regulator</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Air supply remaining</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Blood CO (carbon monoxide) (normal: &lt; 1.5%)</td>
<td>73.6%</td>
<td>15.0%</td>
</tr>
<tr>
<td>Blood ethanol (normal: &lt; 0.1) (lethal: &gt; 0.5)</td>
<td>0.17mg/dL</td>
<td>0.05mg/dL</td>
</tr>
</tbody>
</table>

According to investigators, an unsoldered splice was lo-
eated in a joist space between the first and second floors in an
area, directly below a concealed combustible wall cavity. While
connected to a load, the poor electrical connection
apparently heated and ignited combustible materials in the
concealed space.

Discussion
Fire began to involve the void space created by 12-inch
tongue-and-groove boards attached above and below the 2-
by-6-inch floor joists, spaced 24 inches on center.
Fire eventually burned through the ceiling of apartment I,
directly under the area of fire origin, causing hot embers to
fall onto an upholstered chair below. The smoldering chair
generated a large quantity of smoke in the room over a period of
time. Forced air heating ductwork connected apartment I,
the foyer, and apartment F to the furnace room adjacent to the north porch. Although the furnace was not in use, smoke traveled through the ductwork and into apartment F, where the occupants were awake and could respond quickly to the emergency.

The fire also burned through the wood decking over the floor joists and spread to the concealed combustible wall cavity above. The concealed space, formed by the sloping roof rafters and a knewall from apartment D, ran for a distance of approximately 35 feet along the north side of the building. Because there was no fire-stopping at the top of the knewall, fire traveled to the attic and, once inside, involved the entire space.

The fire department was on the scene within three minutes of notification. At arrival, all occupants were safely outside the building.

Problems associated with cutting the electricity off to the building were encountered due to power being supplied from an adjacent building. This condition hampered fire ground operations and was in violation of Section 230-2 of NFPA 70, The National Electrical Code®.

Approximately 15 minutes after fire department arrival, the captain of Engine 1 with fire fighters A and B had completed a preliminary search for occupants and had reported to the fire ground commander that there were no occupants inside.

Of the five crew members initially available to the fire ground commander, two were deployed to the rear of the structure to make an exterior attack, and three were sent inside to search for occupants and to find an attic access.

Approximately 40 minutes after fire department arrival, the entire attic space was burning. Fire crews positioned on the north side of the building were ineffective in stopping fire spread. They had to reposition continually to follow the fire as it progressed toward the front of the building.

By approximately 3:38 a.m., 43 minutes after the fire department arrived, fire had extended onto the second floor, blocking the stairs. Apparently, fire fighters A and B were trapped in the front portion of the second floor at that time, with no hose line and with windows as the only avenue of escape. Between 3:43 a.m. and 3:53 a.m., fire broke through the roof and Truck 1 began operating the master stream.

At some point during the fire, fire fighter A apparently disconnected his facepiece hose from the regulator. He died of carbon monoxide poisoning due to smoke inhalation. Because burned debris was found on top of his body but not underneath, it is believed this victim was on the floor prior to roof involvement.

Fire fighter B was found on his back in a prone position, close to the other fire fighter. It is possible that fire fighter B was standing up and attempting to help fire fighter A when fire and super-heated gases entered the bedroom. He died of upper respiratory tract burns due to the inhalation of hot air and smoke. The presence of burned debris beneath as well as on top of his body indicates that fire fighter B collapsed to the floor after fire fighter A.

Fire fighters A and B were last seen at approximately 3:27 a.m., when others helped them change their SCBA air cylinders. Nearly an hour and forty minutes later, their bodies were discovered during final fire extinguishment. They were not missed during that time.

One of the two fire fighters who manned Engine 2 when it responded from the scene to the false alarm at the high-rise building was not normally assigned to the engine. Given this situation, keeping track of individual fire fighters admittedly was difficult. Engine 2 and its crew returned to the fire scene at 3:53 a.m., about one hour and twelve minutes prior to discovery of the fatalities.

Summary

Fires that begin inside concealed combustible spaces create special problems for fire fighters. These fires can grow and spread rapidly throughout a structure and can be difficult to attack. It is not easy to apply water directly on the fire unless openings are made. The quickest method of getting at a concealed attic fire is to open up the top floor ceiling while a charged hose line is standing by.

In his textbook, Fire Command, Chief Alan Brunacini of the Phoenix Fire Department has the following to say on the subject:

Command and interior sectors cannot be timid during the size-up of a concealed space fire. Initial hesitation to open up will usually force everyone to chase the fire. Access, as a form of support, requires good size-up to be at the right spot, quick decisions to be on time, hard work to get inside, and good coordination to balance access with attack. The fire ground commander must:

Forecast fire travel; get fire fighters ahead of the fire; open the structure; cut off the fire; and complete extinguishment.

The key lesson in this fire fighter fatality incident is the need for continuous command and control of fire fighters and for attention to safety on the fire ground.

The essence of fire ground control by the fire ground commander involves the on-going ability to know where fire fighters are located and to direct what they are doing. In a very practical sense, if the fire ground commander initially can place his fire fighters, move them, and change what they are doing, he has the most important level of control.

To accomplish that level of control, sector officers often are assigned to manage specific areas or functions. In this incident, fire fighters did not remain with their officers, but were assembled from different companies, making accountability most difficult. The false alarm further worsened the situation.

A major responsibility of any fire department is to provide for fire fighter safety. Nowhere is compliance with safety practices more important than at the fire ground. This is where many fire fighter fatalities occur. Establishing clearly defined standard operating procedures (SOPs) ensures uniformity, streamlines operations, reduces confusion and promotes accountability and safety.

When crews or individuals are operating outside of the structured "game plan," they have a negative impact on control efforts and also on their personal safety and welfare. Accountability is necessary to promote teamwork and to ensure safe, efficient operations. It requires the cooperation of everyone on the fire ground, including fire fighters and fire officers.

Footnotes