Commercial Fire: Durango, CO

Fire Behavior Case Study

CFBT-US
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Introduction

Developing mastery of the craft of firefighting requires experience. However, it is unlikely that we will develop the base of knowledge required simply by responding to incidents. Case studies provide an effective means to build our knowledge base using incidents experienced by others. This case presents an interesting puzzle that will challenge your knowledge and understanding of fire behavior.

Aim

Firefighters and fire officers recognize and respond appropriately to the interrelated hazards presented by building construction and extreme fire behavior in buildings of Type III (Ordinary) construction.

References

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Learning Activity

Review the incident information and discuss the questions provided. Focus your efforts on understanding the interrelated impact of building construction and fire behavior. Even more important than understanding what happened in this incident is the ability to apply this knowledge in your own tactical decision-making.

The Case

This case study was developed using detailed investigative reports (Kaufman,2008; Hanks, 2008) prepared by the Durango Fire and Rescue Authority and NIOSH *Injury in the Line of Duty Report 2008-03* (NIOSH, 2009). Special thanks to Chief Daniel Noonan, Fire Marshal Tom Kaufman, and Fire Investigator Karola Hanks of the Durango Fire and Rescue Authority for their diligence in investigating this incident and sharing the results of their work.

On February 22, 2008 at approximately 1340 hours, the Durango Fire and Rescue Authority responded to a commercial fire in downtown Durango, Colorado. Before this incident was concluded, nine firefighters and officers were transported to the hospital following an explosion. Several of the injured had serious injuries and were admitted and the others were treated for minor injuries and released.

Figure 1. Side A Following the Explosion

Note: Photo by Rachael Piske, AccessDurango.com

Building Information

This incident involved two buildings. One building contained the Seasons Restaurant (764 Main Avenue) and Half Price Ts (Exposure D1, 753 Main Avenue), and the other housed the Rendezvous Swiss Bakery (Exposure D2, 750 Main Avenue) as illustrated in Figure 2. Both buildings were one-story, Type III (Ordinary Construction) and were built in the 1900s. Both buildings had basements. The buildings had brick exterior walls and full dimension wood joists. Exposures B and D3 were two-story buildings of ordinary construction.

Originally, the building housing Seasons Restaurant and Half Price Ts was a single occupancy which was subsequently subdivided into separate occupancies with different owners. While divided, the two occupancies shared a common cockloft. The partition between the restaurant and retail store extended to the underside of the roof and did not provide fire separation. Half Price Ts and the Rendezvous Swiss Bakery shared a parapet party wall, but otherwise were separate buildings.

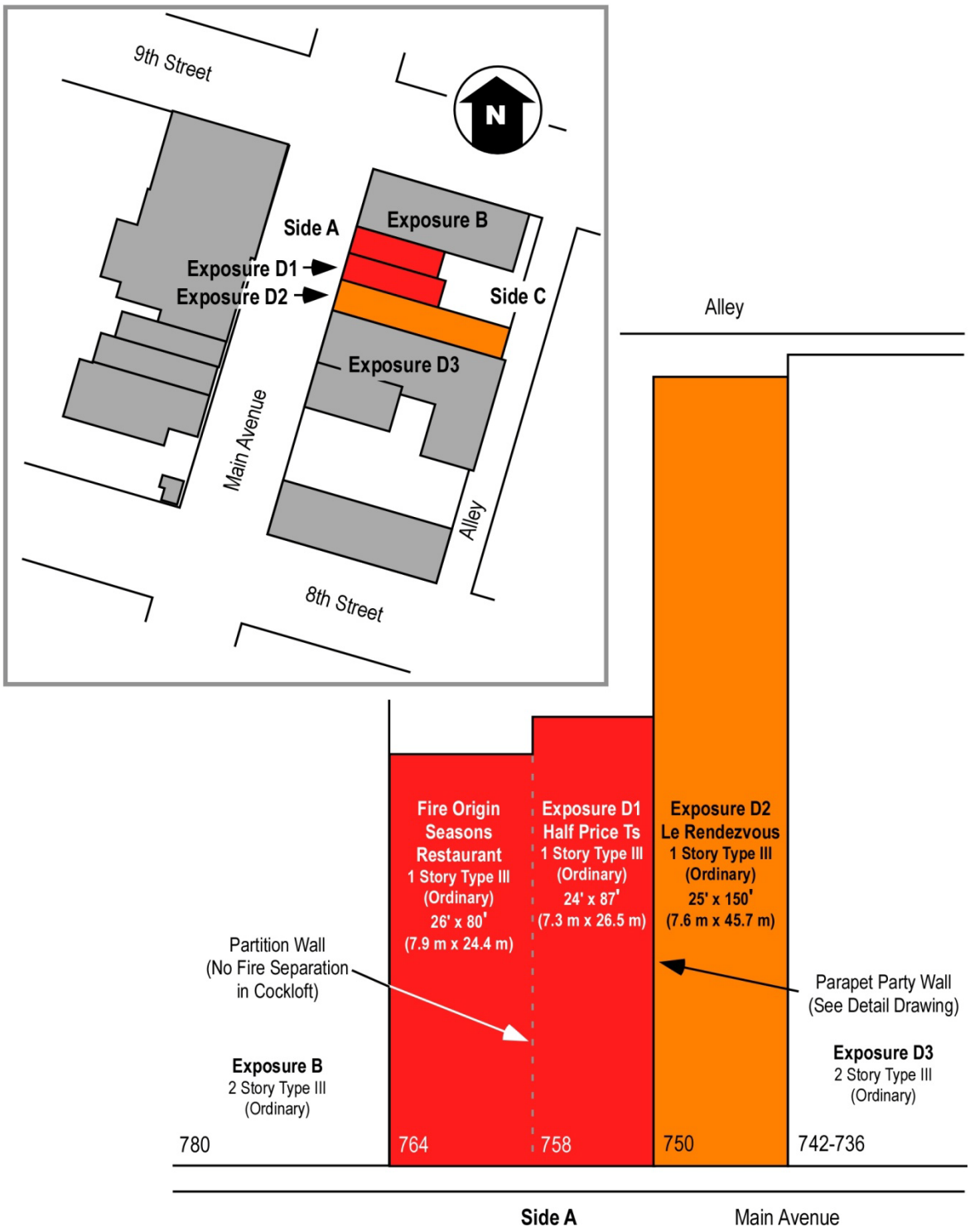
Exposures D1 and D2 were separated by a party wall. Roof joists and ceiling joists supporting the original ceiling were supported in common wall sockets (see Figure 3). Fire investigators discovered that there was a 4" x 4" (102 mm x 102 mm) opening in the wall behind the joists. This wall was also constructed using sand lime mortar which can degrade over time due to contact with water. Loss of mortar between bricks can result in loss of stability and gaps that permit passage of smoke and heat transfer through convection.

Building construction was a significant factor in this incident. In *Building Construction for the Fire Service*, Frank Brannigan (1992) identified a number of important characteristics of older, Type III (Ordinary) Construction:

> As a general rule, there is no effective fire separation within the ordinary construction building, either from floor to floor or within floors. Even where fire separations exist up through the regular floors of the building, they often are imperfect or non-existent in attic spaces (p. 150).
>
> Over the years, most old buildings have undergone extensive modifications. Usually, such modifications have had a detrimental effect on the structure from a fire suppression point of view, creating collapse potential or interconnected voids from which fierce fire can burst out on the unwary (p. 151).
>
> Lowering the ceiling of old buildings is most easily accomplished by constructing a new ceiling. This provides a convenient void for the new utilities, air ducts, and so on. Firestopping is usually non-existent in these situations. Vertical voids connect the horizontal voids so the building is honeycombed with what amounts to one big interconnected non-firestopped void (p. 186)

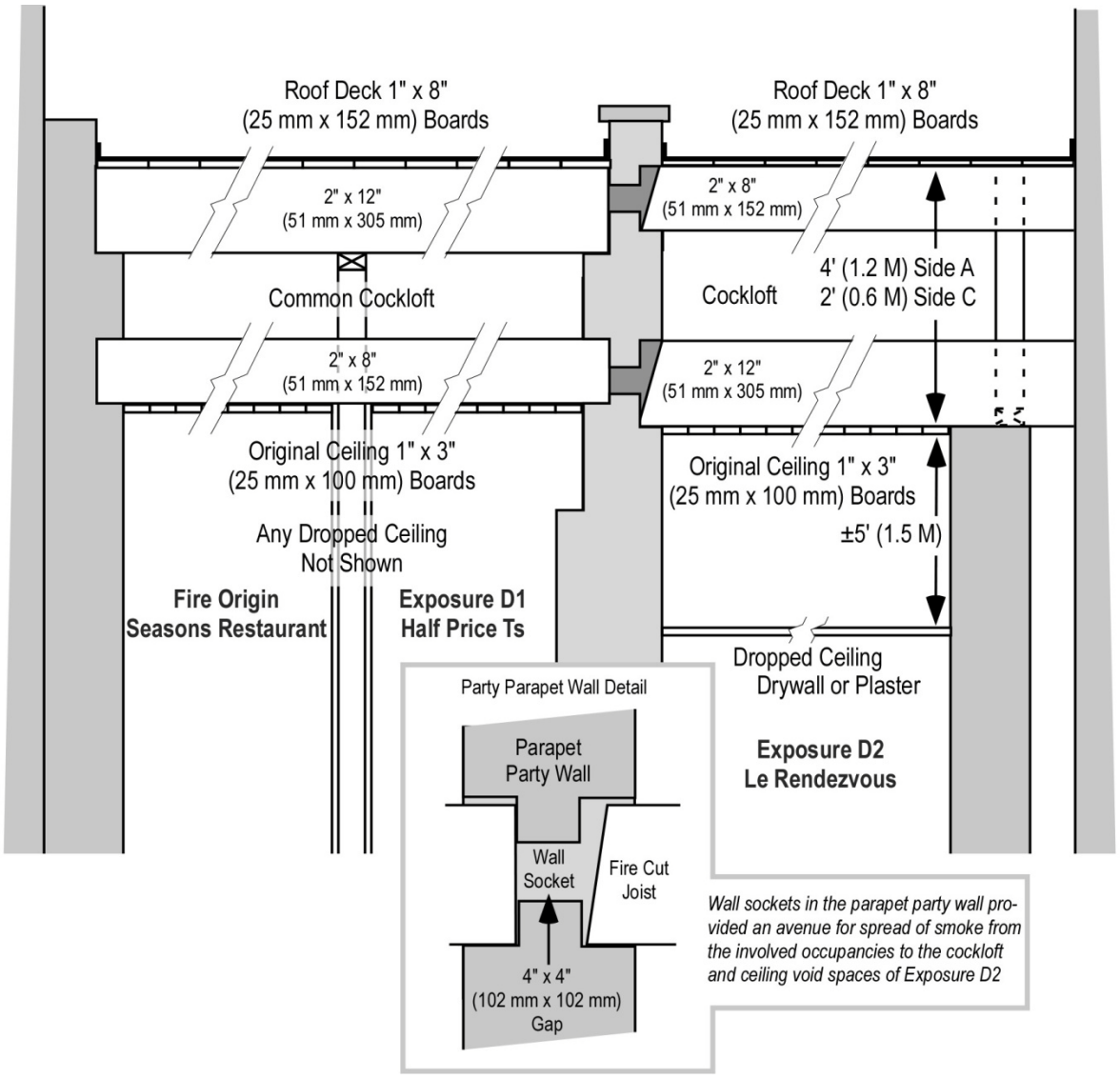
Brannigan (1992) also identified the potential of an explosion resulting from ignition of combustible gases which have accumulated in void spaces within buildings of ordinary construction, providing several examples. However, Brannigan's explanation focuses on carbon monoxide as the principal fuel involved in these explosions and does not clearly distinguish between the phenomena of backdraft and smoke explosion.

Figure 2. Plot Plan of 780-736 Main Avenue



Note: The plot plan and locus map was developed from the City of Durango Geographic Information System and overhead imagery.

Figure 3. Cockloft, Ceiling Voids, & Party Wall Detail



Note: Drawing adapted from from Durango Fire Authority *Fire investigation (explosion) report: Incident # 00001-2008-000718-00*, p. 5, by Fire Investigator Karola Hanks, 2008. Duango: CO: Durango Fire and Rescue Authority

The Fire

The fire originated in the hood system serving the wood fired grill in Seasons Restaurant. The hood system was not constructed to the requirements of the applicable mechanical code and flames extended through a gap in the hood and ignited wood framing within the cockloft void space. Lack of fire separation between Seasons and Half Price Ts (Exposure D1) led to rapid fire spread within the common cockloft above these two occupancies.

The party parapet wall between Exposure D1 and the Rendezvous Swiss Bakery (Exposure D2) slowed fire spread. However, smoke infiltrated through joist wall sockets (and possibly other gaps and

openings) into the cockloft and void space between the original and newer dropped ceiling. Approximately 50 minutes after the arrival of the first company, an explosion occurred in Exposure D2, which caused significant structural damage to the wall on Side A and roof of this occupancy. The explosion injured seven firefighters working on the roof and on Side A in front of Exposure D2

Dispatch Information

At 1340 hours on February 22, 2008, Central Dispatch received multiple calls for a fire at Seasons Restaurant at 764 Main Avenue. Callers reported smoke showing from the building and a thick column of smoke extending to the west, across Main Avenue. The first alarm assignment included three engine companies (Engines 2, 1, and 9), two truck companies (Ladders 2 and 1), advanced life support (ALS) ambulance (Medic 2), non-transport medic unit (EMS 1), and battalion chief (BC 1). The Fire Marshal (Fire 4) and several other staff also responded on the initial alarm.

Figure 4. Smoke Conditions at 1340 hours.

Note: Photo from Durango Fire and Rescue Authority *Cause and Origin Report Incident #08000718*, p. 4, by Fire Marshal Tom Kaufman, 2008. Duango: CO: Durango Fire and Rescue Authority

Weather Conditions

The weather was seasonably cold with a temperature of -1° C(30° F) and variable winds out of the east at 16 km/h (10 mi/h) (as reported by the National Weather Service at Durango La Plata County Airport).

Conditions on Arrival

A Durango police officer arrived at 1344 and reported flames visible on the roof of Seasons Restaurant and that the restaurant was being evacuated. The Durango Fire Authority Fire Marshal arrived a minute later at 1345 to find light smoke showing (no flames).

Engine 2 arrived at 1346 and observed light smoke from the Seasons Restaurant (see Figure 5). The Fire Marshal conferred with occupants of Seasons Restaurant and Half Price Ts (Exposure D1) to determine if all occupants had exited the building. While in Exposure D1, he observed a light haze of smoke with some smoke coming from the basement.

Figure 5. Commercial Fire at 764 Main Avenue, Durango, Colorado

Note: Photo adapted from [annotations added] from *Durango Fire and Rescue Authority Cause and Origin Report Incident #08000718*, p. 4, by Fire Marshal Tom Kaufman, 2008. Duango: CO: Durango Fire and Rescue Authority

The Fire Marshal observed smoke from various areas of the roof above Seasons and Exposure D1, with a larger volume of thicker (optically dense) smoke near the parapet wall separating Exposure D1 and D2. He also observed flames near the base of a roof mounted ventilation fan above Seasons.

Early in the incident, a civilian photographer (identified as Ms. Ellis) took a photograph (Figure 6) of the roofs of Seasons Restaurant and Exposures D1 and D2 from a bathroom window on Side D of Exposure

B. Figure 6 shows conditions on the roof prior to 1345 as seen from Exposure B. These conditions would be similar to those observed by Fire Marshal Kaufman (simply from a different angle and elevation).

Figure 6. Conditions on the Roof Prior to 1345 Hours

Note: Photo by Ms. Ellis adapted from [annotations added] Durango Fire and Rescue Authority *Cause and Origin Report Incident #08000718*, p. 4, by Fire Marshal Tom Kaufman, 2008. Duango: CO: Durango Fire and Rescue Authority

Firefighting Operations

The Durango Fire and Rescue Authority is a combination department serving an area of 325 square miles (842 square kilometers) from 16 stations with a mix of full and part time career and volunteer personnel. Prior to dispatch of companies to Seasons Restaurant, Ladder 2 was refueling (staffed only with an Engineer). Companies responding on the first alarm were augmented by part-time and volunteer personnel who responded directly to the incident in personally owned vehicles (POV) and were assigned to fill out company staffing as they arrived (between 1348 hours and 1356 hours).

Table 1. On-Duty and Additional Unit Staffing of First Alarm Resources

Unit	Staffing	Additional Staffing
Engine 2 (E 2)	Captain Firefighters (2) Engineer	Reserve Firefighter
Engine 1 (E 1)	Captain Firefighter Engineer *Deputy Chief (assigned to L2)*	Reserve Firefighter
Ladder 2 (L 2)	Engineer	Deputy Chief (*Arrived on E 1*) Volunteer Firefighter
Ladder 1 (L 1)	Captain Firefighter Mechanic	
Engine 9 (E 9)	Lieutenant	
Medic 1 (M 1)	Firefighter Paramedic	
EMS 1	Paramedic	
Battalion Chief (BC1)	Battalion Chief	
Crew *No Unit Specified*	*Lieutenant (not identified)*	Firefighter Volunteer Firefighter

Note: This table was developed by integrating data from *Injury in the Line of Duty Report 2008-3* (NIOSH, 2009) and the *Fire Investigation (Explosion) Report: Incident # 00001-2008-000718-00* (Hanks, 2008). Given discrepancies between these two reports, it is likely that Fire Authority staff in addition to those listed in this table were operating at the incident.

At 1347, the crew of Engine 2 deployed a 1-3/4" (45 mm) handline to the front door of Seasons Restaurant. Engine 2 encountered a small volume of light colored smoke in Seasons and Exposure D1. As the hoseline was being deployed Engine 1 staged at a hydrant on the corner of Main Avenue and 7th Street and waited for Ladder 2 to position at the front of the building. Medic 2 arrived at approximately the same time and is assigned to Side C.

At this point smoke is visible from multiple locations on the roof of Seasons Restaurant and Exposure D1. A substantial volume of thick smoke was pushing with moderate velocity from the Exposure D1 roof next to the parapet party wall between Exposures D 1 and D2. A small amount of flame was visible from near the base of the exhaust fan on the roof of Seasons (but this was not visible to the companies on Side A).

Ladder 2 (quint) arrived at 1349 and positioned in front of Exposure D3 and deployed their aerial ladder to Exposure D2 while Engine 1 laid a 5" supply line to Engine 2 (a 5" supply line was hand stretched from

Engine 2 to Ladder 2). The Captain of Engine 1 assumed Command and assigned his crew as the Rapid Intervention Team (RIT). Engine 2 was tasked with investigating conditions in the Seasons Restaurant and Exposure D1.

Figure 7. Ladder 2 Operating on Side A.

Note: Photo by Rachael Piske, AccessDurango.com

At 1352, BC 1 arrived and assumed Command, reassigning the Engine 1 Captain as Operations. Ladder 1 arrived at 1356, positioned on 9th Avenue, just east of Main Avenue and deployed their aerial to the roof of Exposure B and checked for extension in Exposure B. At approximately the same time, the utility company reported that power had been shut off to Seasons and the exposures.

At approximately 1358, Ladder 2 (DC) accessed the roof of Exposure D2 via the aerial ladder and assessed roof conditions on the Exposure D1 and Seasons Restaurant, knocking over a swamp cooler (evaporative cooling unit) on the roof of the restaurant and advised Command (BC 1) that the roof over the restaurant was getting soft. While Ladder 2 assessed conditions on the roof, Engine 2 investigated conditions in Seasons Restaurant and Exposure D1, observing high temperature at the ceiling using a thermal imaging camera (TIC), but was unable to access the fire. Engine 2 advises Command that the fire is in the void space above the ceiling in Seasons and Exposure D1. Dark gray smoke was pushing from the façade at the front of Seasons Restaurant.

Note: Twenty minutes had elapsed and there had been no application of water to burning fuel or hot gases in the void spaces between the ceiling and roof.

Using a chain saw, Ladder 2 (DC and Firefighter) began roof ventilation over Exposure D1. Roof operations are hampered by thick smoke and roof construction and Ladder 2 was unsuccessful in creating an adequate exhaust opening over Exposure D1. A large volume of thick, light brown smoke is pushing from the partially completed ventilation opening. Command reassigns Engine 2 from the interior to support Ladder 2 on the roof with a 1-3/4" (45 mm) hoseline.

Figure 8. Side A at Approximately 1400 Hours

Note: Photo by Rachael Piske, AccessDurango.com

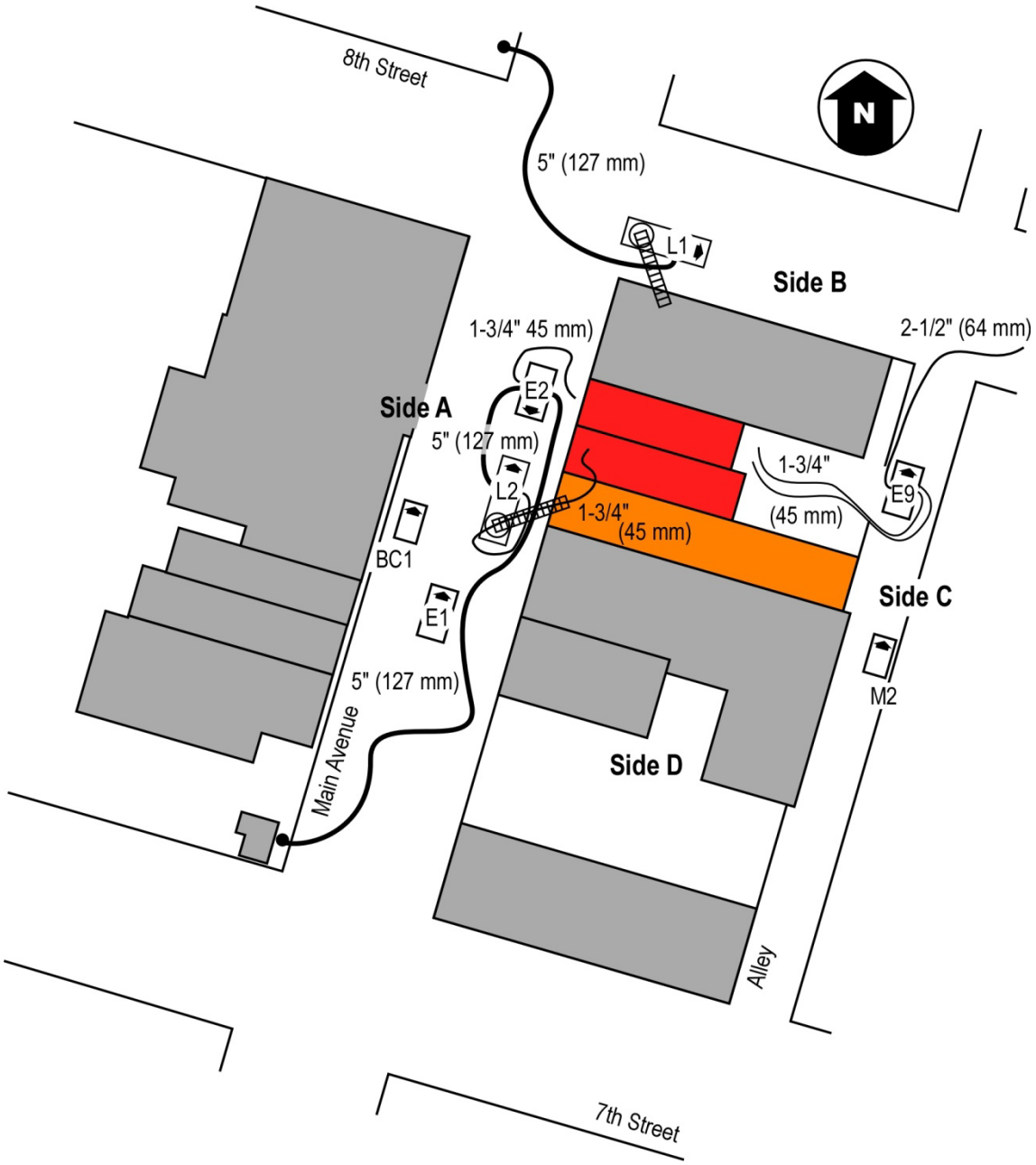
The natural gas service to Seasons was shut off by the utility company at 1402. However, the meters to Exposure D1 and D2 were obstructed by deep snow delaying control of the utilities to the D Exposures. Exposure B is evacuated at approximately 1404 and at 1405, the Incident Commander (BC 1) ordered Central Dispatch to recall all off duty personnel.

Engine 9 arrives at 1409 and was assigned to Side C. The crew of Engine 9 (likely assisted by the crew from M 1) pulls two 1-3/4" lines to protect Exposure B. At approximately 1411, Ladder 1 accessed the roof of Exposure B to check for extension and reported that smoke was venting from an old chimney in the common wall between Seasons and Exposure B. Thick smoke was beginning to accumulate in Exposure D1.

Reassigned from the interior, Engine 2 stretches a 1-3/4" (45 mm) line to the roof of Exposure D1 to protect the crew performing vertical ventilation. The 1-3/4" (45 mm) line was positioned and operated to push the smoke away from the vent crew. At the request of Engine 2, the doors on Side A of Seasons

and Exposure D1 were closed to slow fire development and buy time to complete vertical ventilation. However, the doors on Side C remained open).

Figure 9. Approximate Locations of First Alarm Companies



Note: The location of companies and hoselines was determined using the plot plan provided in *Injury in the Line of Duty Report 2008-3* (NIOSH, 2009) and the *Fire Investigation (Explosion) Report: Incident # 00001-2008-000718-00* (Hanks, 2008), video and photographic evidence.

At approximately 1415, the fire self-vents through the roof above Seasons with flames extending 4'-5' (1.2 M-1.5 M) above the roof. Engine 2 operate their 1-3/4" (45 mm) hoseline on the flames coming from the roof and onto the common wall between Seasons and Exposure B. Ladder 2 relocated on the roof of Exposure D1 and again attempted to cut an opening for vertical ventilation.

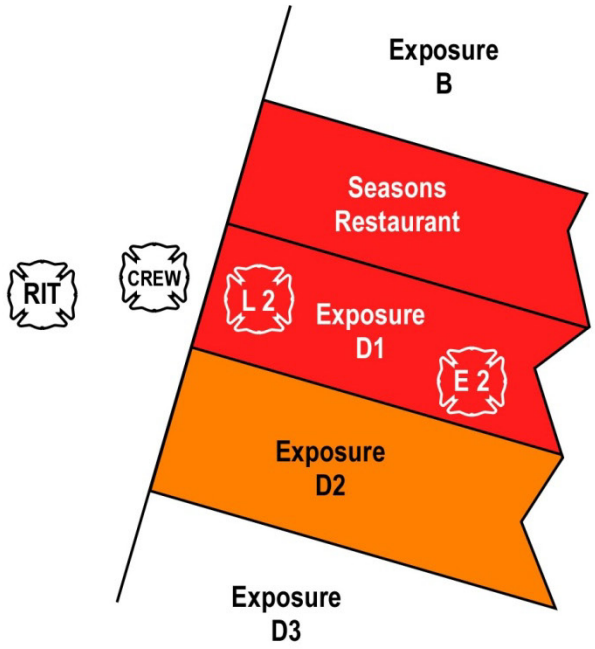
Engine 9 was operating its 1-3/4" (45 mm) lines on Side C to protect Exposure B and at approximately 1420; hand stretched a 2-1/2" (64 mm) supply line to a hydrant at the intersection of 9th Street and East 2nd Avenue to establish a continuous water supply.

Seasons Restaurant and Exposure D1 are now completely smoke logged (the smoke layer extends from ceiling to floor) and condensed pyrolizate is visible on the windows in Seasons and Exposure D1. The velocity of the air track in Seasons is increasing and windows on Side A are shaking. At approximately 1420, glass in the door to Seasons fails.

At approximately 1421, a crew consisting of a Lieutenant and two firefighters (no unit specified) enters Exposure D2 with a 1-3/4" (45 mm)handline to check on conditions and possible fire extension. There is a small amount of smoke at ceiling level, but it is not thick and the TIC shows a ceiling temperature of 92^{o} (33^{o} C). Proceeding towards Side C, the crew encounters an increasing volume of thicker (optically dense) smoke. The Engineer of Ladder 2 takes a hose pack to the roof to extend Engine 2's 1-3/4" (45 mm) handline. The crews on the roof (Engine 2 and Ladder 2) hear a loud pop and feel increased temperature on the roof over Exposure D1.

Ladder 2 vented the skylight over Exposure D2 at approximately 1423, but did not open the sides of the light shaft (venting the interior of Exposure D2, but not the cockloft or void spaces between the ceiling and roof). After the skylight is vented the smoke in Exposure D3 begins to clear and the crew of Engine 9 exits to Side A. On the roof, Deputy Chief Clay (Ladder 2) observes white smoke beginning to issue from the vents on Side C of Exposure D2. The crew of Ladder 2 move to Side A while the crew of Engine 2 remains near the skylight. At this point there are no crews operating on the interior. Engine 9's crew has withdrawn from Exposure D2 and is holding in position on Side A while their Lieutenant confers with Command (BC 1).

Figure 10. Location of Companies/Crews

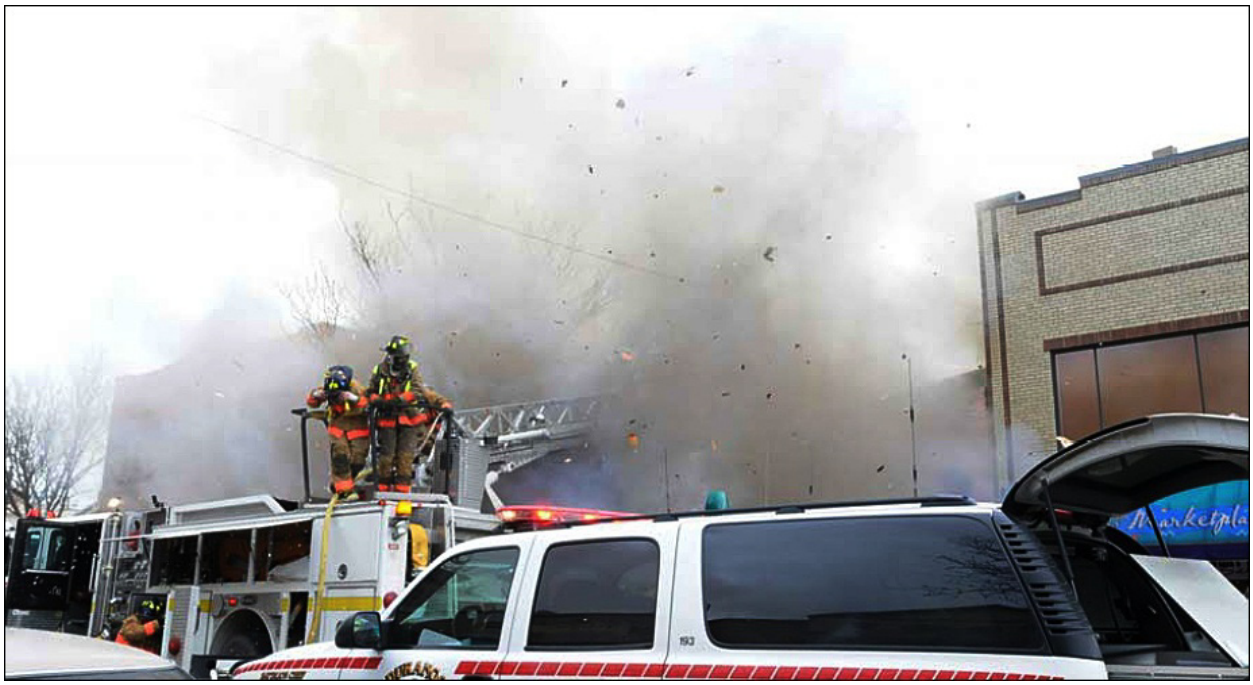


The Explosion

At approximately 1426, a firefighter standing near Ladder 2 (on Side A in front of Exposure D3) heard a loud pop. This was followed by an explosion that lifted the roof of Exposure D2 five to ten feet (1.5 M-3 M) and caused a collapse of the upper portion of the Side A Wall at the level of the cockloft and partial collapse of the roof on Side A. Debris was blown across Main Avenue, a distance of over 40' (12.2 M). The blast was accompanied by release of a large volume of gray to brown smoke, but no visible flames (see Figure 11).

The members of Engine 9 that were positioned at the front of Exposure D2 were trapped by the partial collapse of the wall on Side A. The RIT was struck by flying debris. The Deputy Chief (Ladder 2) was thrown from the roof to the ground on Side A of Exposure D2. The other member of Ladder 2's crew was trapped on a beam several feet below the roofline. The members of Engine 2's crew on the roof of Exposure D2 were knocked off their feet.

Figure 11. Explosion



Note: Photo from Durango Fire Authority *Fire investigation (explosion) report: Incident # 00001-2008-000718-00*, p. 10, by Fire Investigator Karola Hanks, 2008. Duango: CO: Durango Fire and Rescue Authority

Figure 12. Conditions on Side A Immediately Following the Explosion.

Note: Photo by Rachael Piske, AccessDurango.com

Firefighter Rescue Operations

Ladder 2's aerial was repositioned to reach the firefighters on the roof. The firefighter from Ladder 2 was rescued and the members of Engine 2 were able to self-extricate and egress the roof over the aerial ladder.

Nine members were transported to the hospital: The crew from Ladder 2 (DC and Firefighter), the crew from Engine 2 that was working on the roof (3 Firefighters), and four firefighters on the ground that were operating on Side A near the doors of Exposures D1 and D2. Several of these personnel had serious injuries and were admitted to the hospital, the others were treated and released.

Firefighting operations transitioned to a defensive strategy to confine the fire to Seasons Restaurant and Exposures D1 and D2. Command ordered additional companies from Durango Fire and Rescue Authority and Upper Pine Fire District to support extended defensive firefighting operations. Gas service to Exposure D2 was shut off by the utility company at 1440.

Fire Conditions Following the Explosion

As illustrated in Figures 13-15, the force of the explosion resulted in significant damage, but fire development within Exposure D2 was limited to some involvement of the roof (likely due to extension from Exposure D1 after the explosion).

Figure 13. Side A in Front of Exposure D2

Note: Photo by Deputy Chief Tom Aurnhammer, EFO, CFO, MIFireE, CFI, Los Pinos Fire Protection District

Figure 14. Looking North (towards Side B) on Side A In Front of Exposure D2.

Note: Photo by Deputy Chief Tom Aurnhammer, EFO, CFO, MIFireE, CFI, Los Pinos Fire Protection District

Figure 15. Side A Exposure D1 and Seasons Restaurant.

Note: Photo by Deputy Chief Tom Aurnhammer, EFO, CFO, MIFireE, CFI, Los Pinos Fire Protection District

As showing in Figure 15, the fire burning in the void spaces between the ceiling and roof of Seasons Restaurant and Exposure D 1, continued to produce a large volume of thick (optically dense) smoke after the explosion occurred in the void spaces between the ceiling and roof of Exposure D2.

Incident Timeline

The timeline included in the Durango Fire Department Explosion Investigation Report is broken down into ten minute segments and does not include all incident activity due to the difficulty in determining exactly when each activity or event occurred. Tactical documentation did not include time of day and the tactical radio channel used for this incident was not recorded. This timeline is provided to provide a general sequence and flow of operations and may differ slightly from the events as they occurred.

The clock icon is used to identify events for which the Fire Investigation (Explosion) Report identified a specific time. Events which were estimated based on the narrative, photographic evidence, or other information are shown in italic text.

Figure 13. Incident Timeline

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
Smoke was visible from the roof (via web cam) up to one hour before the first 911 call reporting the fire.		
Flames and smoke visible from the roof of Seasons Restaurant. Photos taken prior to the arrival of fire units show a large plume of thick (optically dense) dark gray smoke issuing from the top of the building. The color of the smoke lightened as the plume rose and moved to the west.	1340	Multiple 911 calls to Central Dispatch reporting fire and smoke showing from Seasons Restaurant at 764 Main Avenue.
	1341	E-2, L-2, E-1, L-1, E-9, M= 2, EMS-1, BC-1 dispatched. *Fire 4 (Fire Marshal) also responds on the first alarm.*
	1342	
	1343	
Flames visible on the roof of Seasons Restaurant and occupants self-evacuating (Durango PD)	1344	Durango Police Department officer arrives
Light smoke (but no flames) visible (Fire 4)	1345	Fire 4 (Fire Marshal) arrives and confirms that Seasons Restaurant and Half Price Ts (Exposure D1) are being evacuated.

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
Seasons Restaurant and Half Price Ts are evacuated. Light haze of smoke in Exposure D1 with some smoke coming from the basement area (Fire 4)	1346	E-2 arrives
	1347	*E-2 deploys a 1-3/4" hoseline to the front door of Seasons Restaurant (Side A).*
Light to moderate smoke in Seasons Restaurant (Fire 4)	1348	E-1 arrives and stages on a hydrant at 7th Street and Main Avenue. Medic 2 arrives and assigned to Side C (in the alley).
Smoke from multiple rooftop locations above Seasons and Exposure D1. A substantial volume of thick (optically dense) smoke was pushing with moderate velocity from the Exposure D1 roof next to the parapet party wall between Exposures D1 and D2. A small amount of flame was visible from near the base of a exhaust fan above Seasons. (Fire 4 & Ellis photos).	1349	L-2 arrives and positions on Side A in front of Exposure D3
Light smoke on the first floor level in Seasons and Exposure D1 (E-2)	1350	*E-1 lays a 5" supply line to E-2. E-2 provides a 5" supply line to L-2 (but it is unspecified when this occurred).* *Captain E-1 assumes Command* *L-2 deploys aerial ladder to the roof of Exposure D2.*
	1351	
	1352	BC-1 arrived and assumed command, Captain E-1 assigned as Operations. *RIT assigned to E-1*
	1353	
	1354	
	1355	Charged 1-3/4" (45 mm) hoseline in place on Side A

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
Light smoke in Seasons Restaurant and Exposure D1 (E-2).	1356	L-1 arrived and set up on Side B of Exposure B (Main Avenue and 9th Street). *E-2 makes entry and investigates conditions in Seasons Restaurant and Exposure D1.* *Utility company reports power shut off in Seasons Restaurant and Exposures.*
	1357	*E-2 crewmember retrieves a thermal imaging camera (TIC)*
Roof soft over Seasons (L-2)	1358	*L-2 (DC) accessed the roof via the aerial ladder, assessed conditions on the roofs of Exposures D2, D1, and Seasons. While on the roof of the restaurant, he knocked over a swamp cooler to assist in ventilating the fire occupancy.*
TIC shows increased temperature across the entire ceiling of Exposure D1 to the party parapet wall between Exposures D1 and D2. E-2 reports that the fire is in the void space above the ceiling. Dark gray smoke pushing at low velocity from the façade at the front of Seasons (photograph of the eave line).	1359	
	1400	*L-2 (DC) requests a chain saw to ventilate the roof of Exposure D1.*
	1401	*The L-2 Firefighter goes to the roof with a chain saw and begins roof cutting operations on Exposure D1.* *E-2 is reassigned from the interior to extend a hoseline to the roof of Exposure D1 via L-2's aerial.*
	1402	The Utility Company reports that natural gas service to Seasons is shut off, but the meters for the D Exposures are buried by ice and snow.
	1403	
	1404	*Exposure B is evacuated.*

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
	1405	Command requests recall of off-duty personnel.
	1406	
	1407	
	1408	
Large volume of thick (optically dense) light brown smoke from the partially completed ventilation opening over Exposure D1. (L-2) Optically dense smoke now visible in the interior of Exposure D1. No flames visible from Side C (E-9)	1409	E-9 arrived and assigned to Side C. Two 1-3/4" (45 mm) lines are deployed to protect Exposure B to the rear door of Seasons Resturaunt *Initial cuts made by Ladder 2, but encounter difficulty due to smoke and roof construction.*
Smoke becoming thick (optically dense) and darkening in Seasons and Exposure D1.	1410	Fire Chief Noonan arrives and becomes Liaison.
Smoke venting from an old chimney in the common wall between Exposure B and Seasons Restaurant (L-1).	1411	*L-1 access the roof of Exposure B via an interior stairwell to check for extension.*
	1412	
Seasons and Exposure D1 are completely smoke logged with thick (optically dense) light brown smoke (smoke layer extends from the ceiling to the floor).	1413	
The brown smoke in Seasons and Exposure D1 darkens quickly.	1414	
Flames 4'-5' (1.2 M-1.5 M) in length are visible from the roof of Seasons (L-2)	1415	*E-2 begins flowing water on the flames from the self-ventilated opening in the roof of Seasons and onto the common wall between Seasons and Exposure B.* *L-2 relocates and makes a second attempt to vertically ventilate Exposure D1.*
	1416	
	1417	

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
Condensed pyrolizate is observed on the windows of Seasons and Exposure D1.	1418	*At the request of E-2, the doors to Seasons and Exposure D1 Side A are closed (doors on Side C remain open).* *E-2 operates their hoseline to control smoke movement and protect the crew performing ventilation.*
Velocity of the air track inside Seasons increases and windows are observed to be shaking.	1419	
Glass in the door to Seasons on Side A breaks.	1420	*E-9 hand stretches a 2-1/2" supply line to a hydrant at 9th Street and East 2nd Avenue.* *Natural gas service to Exposure D1 shut off.*
Thin (not optically dense) smoke is observed in Exposure D2, but the ceiling remains visible. Ceiling temperature 92° F (33° C) by TIC.	1421	*A crew (Lieutenant and two firefighters, unit unspecified) enters Exposure D2 and checks ceiling temperature with a TIC.*
Smoke becomes thicker towards Side C of Exposure D2. Roof crew (L-2, E-2) hears a loud pop and feels increased temperature on the roof over Exposure D1.	1422	*The crew (unit unspecified) assessing conditions in Exposure D2 proceeds deeper into the building (towards Side C).* *The L-2 Engineer takes a high-rise pack to the roof of Exposure D1*
Small volume of light colored smoke exits from the skylight at low velocity (L-2)	1423	*L-2 breaks a skylight in Exposure D2 (but does not open the side walls of the light shaft).*
Smoke clears from the interior of Exposure D2 White smoke is visible from the vents on the rear of Exposure D2 (L-2)	1424	*The crew (unit unspecified) assessing conditions in Exposure D2 decides not to go to the basement of Exposure D2 and exits, taking a position outside the door on Side A.* *RIT (E-1) is staged in front of Exposure D2.*
	1425	*On the roof of Exposure D2, L-2 moves to Side A. E-2 remains near the skylight*
A Firefighter (RIT) standing near L-2, hears a loud pop (like someone popping bubble gum, but louder).	1426	

Fire Behavior Indicators & Conditions	Time	Response & Fireground Operations
An explosion lifts a large section of the roof of Exposure D2 approximately 5'-10' (1.5 M- 3 M) and causes a collapse of the upper portion of the Side A wall (at the level of the cockloft) and part of the roof of Exposure D2. Debris is projected across Main Avenue a distance of 9.7 M (32'). The explosion cloud was grey to brown in color and there were no flames visible	1427	*L-2 (DC) is thrown from the roof to the ground in front of Exposure D2. The other member of L-2 on the roof was trapped on a beam several feet below the roof line. The crew of E-2 working on the roof were knocked from their feet.* *The crew in front of Exposure D2 was trapped by the partial collapse of the wall on Side A.* *The Firefighters assigned to RIT were also injured by flying debris.*
	1428	*Following the explosion, the aerial from L-2 was redeployed to rescue the members of L-2 and E-2 trapped on the roof.*
	1429	
Fire developed between the roof and ceiling midway between Side A and Side C in Exposure D2 following the explosion.	1430	
	1440	Natural gas service to Exposure D2 shut off

Contributing Factors

Firefighter injuries often result from a number of causal and contributing factors. NIOSH Report 2008-03 identified the following contributing factors in this incident that led to the injury of the nine Durango Fire and Rescue Authority firefighters and officers.

- Fire growth and accumulation of pressurized smoke in common attic and void spaces.
- Unrecognized building characteristics that contributed to the fire and explosion hazard.
- Ineffective ventilation techniques.
- Execution of offensive operation standard operating procedures (SOP)
- Inadequate staffing

While this list identifies a number of important causal or contributory factors, it fails to identify others.

Questions

The following questions focus on fire behavior, influence of tactical operations, and related factors involved in this incident.

1. What might explain the variation in Smoke, Air Track, and Flame indicators prior to and after the arrival of fire department units?

2. What was the stage of fire development and burning regime when Engine 2 arrived? Think about Seasons Restaurant, Exposures D1 and D2 (e.g., occupied areas, dropped ceiling voids, and cocklofts). Why do you think this was the case?

3. Access to the fire in the void space was a major challenge to fire control. What alternative tactics might have been used to control the fire in the cockloft (note that there may be more than one tactical option)?

4. If Ladder 2 had completed vertical ventilation over Exposure D1, how might this have influenced the outcome of this incident?

5. What was the likely cause of the explosion in Exposure D2? Consider the requirements for a combustion explosion in terms of fuel, air, and a source of ignition. Note that there is more than one possible explanation!

6. What building factors influenced fire development and conditions in Seasons Restaurant and Exposures D1 and D2?

7. What fire behavior indicators were present in the ten minutes prior to the explosion?

B

Building

S

Smoke

A

Air Track

H

Heat

F

Flame

8. Did any of these indicators point to the potential for extreme fire behavior? If so, how? If not, how could the firefighters and officers operating at this incident anticipated this potential?

9. What strategies might have been used to mitigate the risk of extreme fire behavior during this incident?

10. Develop a revised list of factors that are likely to have caused or contributed to the explosion and injuries to the firefighters and officers. Justify your answers!