BEFORE THE WASHINGTON UTILITIES AND TRANSPORTATION COMMISSION

BNSF RAILWAY COMPANY Petitioner, v. THE CITY OF MOUNT VERNON Respondent, SKAGIT COUNTY, WASHINGTON; and SKAGIT COUNTY FIRE DISTRICT #3; and WASHINGTON STATE DEPARTMENT OF TRANSPORTATION; and WEST VALLEY FARMS, LLC Intervenors.	)	DOCKET NO. TR-070696 WRITTEN TESTIMONY OF: LARRY RABEL

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Q. Please state your name and business address.

A. My name is Larry Rabel and my address is 1136 57th Place SE Auburn, Washington 98092

Q. By whom are you employed and what is your position?

A. I am an independent consultant and an employee of the City of Kent as a Fire Captain and Liaison to King County Fire Protection District #37.

Q. How long have you held the position of Fire Captain with Kent Fire Department?

A. I have held my current rank of Captain since December of 2004,

Q. What are the general nature of your duties and responsibilities in your position as Fire Captain and consultant?

A. In my role as Fire Captain, I lead the Information & Strategic Services unit of the Kent Fire Department. The Kent Fire Department is a full time paid department with 150 full time firefighters, a population of 137,000 and a service area of 51 square miles. The department demographics consist of three distinct areas, Urban, Suburban and Rural. Our Suburban and Rural areas have similar characteristics of the area that would be effected by the Hickox Road crossing closure in Skagit 3. My responsibilities in the Information and Strategic Service unit are focused on response data analysis, resource deployment and long

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term planning for the Department. I also coordinate land purchases for future fire station sites and from 2003 – July of 2007 I also coordinated fire station design and development.

As a consultant, my work has focused on mitigating the fire service impacts of development that effect response times.

Q. Prior to becoming Fire Captain for the Kent Fire Department what administrative or supervisory positions and experience have you had in providing fire protection and emergency medical service, beginning with your position immediately prior to become Fire Chief?

A. From February 2000 to December 2004 I served as Lieutenant in the Kent Fire Department. My main responsibilities during this time was as Liaison for King County Fire District 37. As Liaison I developed the District's Growth Management Policies and Level of Service Mitigation Policies. I obtained my Emergency Medical Technician certification (EMT) with a manual defibrillation endorsement in 1990 and completed my re-certification as a King County EMT in August of this year. From 1990 to 2004, I maintained my certification as a manual de-fibrillation tech and from 2004 to present I am certified in the automatic defibrillation technique. In total, I have served as an EMT-D for 17 consecutive years. From 1996 to 2000 I served in the Kent Emergency Management office as a Project Manager, and as Emergency Operations Center Coordinator. My fire and EMS experience in Emergency Management focused on command training, preparedness and mitigation planning for large scale fire and EMS incidents and City wide training on how the Kent Fire

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Department and City of Kent would provide fire and EMS services in large scale events. From 1990 to 1997 I served as a line firefighter. I was both engine and ladder company certified with the Kent Fire Department. Prior to my employment with Kent Fire I held the position of firefighter in the rural community of Wyoming Minnesota from 1982 to 1986, I left the department as the Assistant Training Officer.

Q. Have you had any experience as a Fire Fighter or Emergency Medical Services provider? If so, where and for how long?

A. See previous answer

Q. What education and training have you received for your career in the fire service?

A. In 1983, I received my Firefighter I certification from the State of Minnesota. In 1990 I completed the Washington State Fire Service Academy training and went on to complete the Kent Fire Departments 6000 hour apprenticeship program in 1993. I hold both Firefighter I and Firefighter II certificates. I am also certified in numerous levels of the National Incident Management System and as fire scene Safety Officer. In 1997 I was selected as a Department representative to the Emergency Medical Service Committee. This committee studied the impacts of a growing community on the outcomes of EMS delivery and toured several cities around the country to compare service delivery modules and how other agencies were mitigating growing service demand with limited resources. In 1998 I completed the King County Training Officers, "Officers Development Academy" and in

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1999 I completed the "Professional Development Series" of classes for Emergency Managers, a FEMA based training program. My fire service deployment training began in 1997 when I was selected as a Department representative to participate in Accreditation Training through the Commission on Fire Accreditation International. This group is now known as the Center for Public Safety Excellence (CPSE). This training involved methods to objectively examine the effectiveness and performance of fire departments with a focus on defining community risk, and properly allocating resources to those risks. I was an active participant in the Departments Accreditation program that was certified in 2004 and I am now a key player in maintaining accreditation through my Information & Strategic Services unit. The unit provides the performance and deployment measures required for Accreditation and compliance with chapter 52.33 RCW. In 2005, I followed up my 1997 training with two other courses offered by CPSE, Standards of Cover I & II. These courses focused on measuring deployment effectiveness and planning for future deployment based on the local risk factors of the service area.

Q. Have you taught any courses or seminars relating to providing fire suppression or emergency medical services?

A. Yes, both internally and externally. For the past two years I have delivered internal classes to the Kent Fire Department's 150 Officers and Firefighters on the deployment models established by CPSE and how the Department's Standard of Cover works to review, measure and maintain or improve service. Externally, In February of 2007,

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I delivered a seminar on Growth Management Strategies for Fire Service Providers in Washington State at the Washington State Fire Marshals Education Forum held in Graham Washington. In October of 2007, I was co-presenter on Growth Management for Fire Districts at the Annual Fire Commissioners Seminar in Pasco Washington. I am also an instructor for the Community Emergency Response Team (CERT) program and teach classes on Disaster Medical techniques.

Q. Have you authored, in whole or in part, any publications relating to providing fire suppression or emergency medical services?

A. Yes. Relating to fire suppression and medical services in a disaster setting: The 1998 & 2004 Comprehensive Emergency Management Plans for the City of Kent. The Comprehensive Emergency Management Plan for the City of Covington, King County's Regional Disaster Plan and the Lake Young's Dam, Flood Inundation Plan. Relating to strategic direction: The 2001 Kent Fire & Life Safety Strategic Plan. Relating to fire services delivery: Seven years as author and 5 years as editor of the "37 Dalmatians" a quarterly newsletter sent to the citizens of Fire District 37. Relating to growth management & fire and EMS delivery for the fire service: The King County Fire District 37 Concurrency Management Plan, this plan is the 2007 recipient of the Emerging Technologies Award from the Washington State Association of Planners and focuses on identifying the impacts of increasing populations and associated traffic impacts caused by community growth. Two articles in the national publication of Arc User, "Covered" an article published in the

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October-December 2006 issue relating to developing a Standard of Cover or in lay terms, properly deploying fire service resources. The second article was published in the July – September 2007 issue of Arc User titled "Priming the Pump." This article continues to build on properly deploying fire service resources.

Q. Are you a member of any professional organizations? If so, please identify them.

A. Yes, the International Association of Firefighters and the Washington State Council of Firefighters.

Q. Have you testified as an expert witness in any court or administrative hearings? If so, please identify the court or administrative body, and the general nature of your testimony.

A. Yes, as consultant to King County Fire Protection District #17 at a Land Use Hearing regarding a proposed development within District 17's response area. The nature of my testimony was the effects of growth on response times and how response time standards are based on intervening in a fire phenomenon called flashover and brain death in a non-breathing patient.

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Q. What is the general organization and structure of Skagit County Fire District No. 3?

A. Skagit County Fire Protection District No. 3 is a two station volunteer department covering approximately 50 square miles of service area. The demographics of the District can best be described as rural blending to suburban at its northern borders.

Q. What is a "response time," as you use that term in the Fire District?

A. Response time is the amount of time that elapses from the time a person in need of assistance calls 9-1-1 until arrival of fire department resources. The term "response time" is often misunderstood even in the fire service because it is made up of three distinct components of time. These three components consist of:

(1) The time a call is received at a 9-1-1 center until a dispatcher can alert fire service resources of the need for service. This first component has a national standard for performance of 1 minute or less. This standard is found in the National Fire Protection Association's (NFPA) standard number 1221. Fire departments often leave this component off of their reported response times as identified in Chapter 52.33 RCW which defines "response time" as travel time.

(2) The time it takes for fire service personnel to disengage from their activities or arrive at a fire station, don appropriate protective clothing and position themselves in a fire

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apparatus with seat belts fastened. This second component of response time is referred to as turnout time and ends when wheels of the fire apparatus begin to turn.

(3) Wheels turning begins the third component of response time and is referred to as "drive time."

The combined elapsed time of all three of these components makes up "response time." It is important to mention that response time does not include "set up time" or "at patients side." These two time frames each take place after a fire apparatus arrives at the curb of the address dispatched. Set up time is the time it takes firefighters to secure a water source, deploy hoses and don self contained breathing apparatus in preparation for a fire attack. Set up time is dependant upon the number of personnel on scene of an incident. All tasks can be completed simultaneously if adequate personnel are on scene. At patient's side refers to the time it takes fire personnel to arrive at curbside, gather appropriate EMS supplies including a de-fibrillator and walk to a point where they find the patient in need of EMS services. This can be very quick for patients of auto accidents but can take several minutes within large commercial or multi-family structures.

Q. Is the "response time" important to providing fire suppression services, and, if so, why is it important?

A. Yes! Fire will at least double in size every minute and non-fire service people witnessing or experiencing a structure fire are usually astonished by how fast a fire can grow and move outside of its room or area of origin. This fire movement outside of the fire's

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room of origin happens with almost explosive force and is referred to as "flashover." Flashover is feared by all firefighters. The NFPA establishes response time standards and goals based on two criteria. First, is the time to fire flashover, the point in fire behavior when a room or other area becomes heated to a temperature where flames flash over, and involve all combustibles in the room. When flashover occurs, it is no longer possible to survive anywhere within the fire compartment and the fire becomes a major threat beyond the room of origin. Flashover will cause glass to break out and non-fire rated residential doors will quickly burn through. Flashover is a significant killer of firefighters and has often resulted in multiple life losses at fires[1]. The attached figure, "Fire Growth verses Reflex Time[2]," (Figure 1) shows fire growth over time, and the sequence of events that may occur from ignition to suppression of fire without the intervention by firefighters.

The NFPA Handbook on page 7-311 of the 19th edition states; *"Nothing is more important than the element of time when an emergency is reported. Fire growth can expand at a rate many times its volume per minute. Time is the critical factor for the rescue of occupants and the application of extinguishing agent.*

The time segment between fire ignition and the start of fire suppression activities is critical and has a direct relationship to fire loss. The delivery of emergency medical services is also time critical. Survival rates for some types of medical emergencies are

[1] FLASHOVER – a firefighter's worst nightmare! Paul Grimwood, www.firetactics.com Attached as Exhibit A.
[2] Figure 7.21.1 from NFPA's Fire Protection Handbook Nineteenth Edition, Volume 1

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dependent on the rapid intervention by trained emergency medical personnel. In most cases, the sooner that trained fire or emergency medical rescue personnel arrive, the greater the chance for survival and the conservation of property."

Q. Is the "response time" important to providing emergency medical services, and, if so, why is it important?

A. Yes! See also the end of my answer to the question above.

The second criteria used by the NFPA for response time is the patient's chance for recovery after breathing has stopped. The attached figure, "Response Time/Intervention Verses Survival" (Figure 2) is derived from the Fire Protection Handbook[3] and survival rates from King County EMS. This figure points out that patient survivability is directly related to time. The faster an intervention is made the better the chance for survival.

The District is aware that response times to some areas of the service area effected by the Hickox road closure already diminishes chances of survival of a non-breathing patient. However, time is still critical here. The Skagit Medic-1 program makes a significant effort to provide public education and instruction on cardio pulmonary resuscitation (CPR). Citizen initiated CPR buys time for responding fire crews to arrive. CPR is a very physically strenuous undertaking that can easily exhaust a single person delivering it and any delay in emergency response can mean the difference in a futile attempt at CPR by a family member or a successful one.

[3] Chapter 21, figure 7.21.3

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CPR is now known to be only one component of successful response to a cardiac patient. Research now shows that fibrillation, (the quivering of heart muscle in cardiac arrest patient) must be converted. The District's firefighters are trained in de-fibrillation and they carry de-fibrillation units on four of their front line apparatus. According to the American Heart Association's web site http://www.americanheart.org/presenter.jhtml?identifier=4481 *Brain death and permanent death start to occur in just 4 to 6 minutes after someone experiences cardiac arrest. Cardiac arrest can be reversed if it's treated within a few minutes with an electric shock to the heart to restore a normal heartbeat. This process is called defibrillation. A victim's chance for survival are reduced by 7 to 10 percent with every minute that passes without CPR and defibrillation.*

Q. What is the Fire District's experience with "response time" to emergency call out?

A. Skagit 3's response times seem to be typical of a volunteer fire department. Stations seem to be adequately spaced for appropriate drive times but the turnout time of volunteer forces extends the overall response time, or customer service interval. Service to the area to be affected by the Hickox Road closure has historically recorded actual response time averages of 13 minutes which is within the goals established by NFPA 1720 for volunteer fire departments.

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Q. Does the Fire District have any concerns that closing the Railroad Grade at Hickox Crossing will affect the District's response time for providing fire suppression and emergency medical services in the area?

A. Yes, drive time studies of the closure reveal significant increases in overall response time and bring up four significant concerns. Increased response times, Increased risk to firefighters from larger and more dangerous fires, a decrease in available firefighting water and an increased risk to property.

First, in addition to the concerns described previous, an increase in response time ensures that firefighters from Skagit 3 will be faced with a much larger fires than would occur without the closing. As I stated earlier, fire grows quickly and at least doubles in size as each minute passes. The fact that Hickox Crossing closure will increase drive times by 2 to 4 minutes means that fires they respond to have the potential to be 4 to 16 times larger than they would have been with the crossing still open.

Larger fires directly relate to increased risk to firefighters. High heat from larger fires increases the chances of flashover, backdraft (see attached FLASHOVER article Exhibit A), the chance of spread to other structures and the duration of firefighting efforts. All of these events contribute directly to an increase in firefighter injuries.

Large fires tend to move both up and out and require large water flows. Many of the properties that will be at risk because of the Hickox road closure will be the numerous farms along Hickox road and the northern reaches of the Dike and Britt roads. It is likely that

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any fire at many of these farms will involve multiple buildings because of the delay in response. The fire flow needed for any fire can easily be calculated by established methods. As a rule of thumb, fire scene commanders multiply length times width of the fire area and divide by three. A 10 by 10 room fire would require about 33 gallons per minute to extinguish. Delay water application by 2 minutes and the fire would grow from 100 square feet to 400 square feet requiring 133 gallons per minute to extinguish. A delay in water application of 4 minutes and the fire would be 1600 square feet and would require 500 gallons per minute to extinguish. Now, add 50% more water for each side of a structure that has another structure nearby and 1600 square foot fire requires 1,500 gallons per minute of fire flow. The District's first in fire engine to this area is only capable of flowing 1,000 gallons per minute and carries 2,500 gallons. Water supply will be depleted in two and a half minutes and because not enough water can flow to match the size of the fire, it will be ineffective at extinguishment until an adequate and sustained fire flow can be achieved. At best, tender run fire operations can only sustain approximately 300 to 400 gallons per minute of fire flow and this can occur only when multiple water tenders are operational.

To further complicate the water supply issue, the closing of the Hickox road will block access to a 12 inch water main capable of quickly filling the Districts large 3500 gallon tender.

This leaves the District with two options for fire flow, they can make the 15 minute round trip Tender drive to a nearby fire hydrant on Britt Road capable of approximately 400

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static gallons per minutes or take the 28 minute round trip drive time to reach the large flow hydrant blocked by the siding closure. Net turnaround time to Britt road including 10 minutes positioning the tender, setup and disconnecting and 10 minute flow time will be 35 minutes. Net turnaround to the high flow, top fill hydrant on Hickox road will take five minutes to position, setup and disconnect hoses and 4 minutes flow time for a total round trip of 37 minutes. Add another 5 minutes for set up and dumping the tenders load back at the fire scene and 40 minutes have elapsed for the Britt road fill and 42 minutes for the Hickox road trip which will bring just 3,500 gallons of water (about 85 gallons per minute) to the fire scene. Using five minutes to originally set up the tenders drop tank, 40 minutes for the round trip of the tender's refill, and the original volume of water that was delivered to the fire scene by the tender and the engine, they are capable of continuously flowing just 211 gallons per minute.

Timely arrival and quick application of water in the initial stages of a fire is the only defense the District can provide citizens against fire. They simply cannot deliver the water needed for the larger fires that will result from the delay in responses caused by the siding closure.

Last is the concern for property risk. As outlined above, closure of the Hickox road and lack of water, significantly increases the risk to fire for the properties on the other side of the siding closure. This increased risk may also affect the Districts fire rating and potentially raise insurance rates to the property owners.

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Q. What is the basis for the District's concerns?

A. In my opinion, the Districts concerns should be based on the same platform that the National Fire Protection Association bases its standards and which have been adopted by the District. *Nothing is more important than the element of time when an emergency is reported.* [sic] Closing the siding at Hickox Road will produce irreparable harm to the health safety and welfare of the citizens of the District unless an appropriate mitigation can be achieved.

Q. Why is the presence of "farm machinery" on Dike Road and Stackpole road a factor which would influence response time?

A. Since the general use of the land in this area is agriculture, agricultural traffic is common during the growing and harvesting seasons. (March-November) The presence of impedances such as large machinery and its ability to block or slow traffic is the precise reason why the International Fire Code calls out for a minimum clear fire lane of 20 feet to exist. When farm machinery travel Dike or Stackpole road, they block fire access and delay response. Appendix D, of the International Fire Code calls for secondary access roads when any structure greater than 62,000 square feet exist or when 30 or more one or two family dwellings exist. This code standard was developed to be used in cases where fire access can be limited by local conditions. Appropriately, the District is concerned about this frequent agricultural traffic.

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Q. In addition to the agricultural area, what is the general nature of the other structures in that geographical area, and what is your experience with the type of emergency service provided?

A. Chief David Skrinde describes the area to contain farms, residential areas and some business operations.

Farms tend to produce a need for EMS services as a result of industrial accidents related to the heavy machinery involved in farming. Other risk factors produced by farms are an increased fire risk due to the likelihood of welding and cutting often required to self maintain farm equipment. Farm structures usually are exempt from fire code enforcement and as a result are built to burn. That is, they do not normally have the built in fire protection as buildings that are required to follow fire codes. Farm structures are therefore more likely to produce larger fires and tend to involve other nearby structures. Farming also involves various chemicals including fertilizers, pesticides, herbicides, and compressed gases. All of these products increase the risk and likelihood of emergency response. I would most closely link a farms need for emergency response to my experience with commercial/industrial areas which typically produce a call for service in the Kent area at a rate of 0.03 calls per thousand square feet of structure and storage structures that typically produce less than one call per thousand square feet. Upon reviewing the area utilizing GIS imagery, there could be as many as 2 million square feet of agricultural structures. At least 90% of these structures seem to be devoted to storage leaving 200,000

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square feet to apply to the call rate of 0.03 calls per square foot. Six calls per year can be expected.

It is my experience that demand for fire and rescue services in residential areas can be predicted by population and population can be generally predicted by the number of residential structures. A rule of thumb is 2.7 people per home and one emergency call per year for every 10 people. Chief Skrinde states that there are 60 plus homes in the area affected by the siding closure. Using my rule of thumb formula with the estimation of homes present, 16 calls will be generated annually from the 60 homes.

Businesses in the area seem to be blended with the agricultural use providing no more service demand than already estimated. In total, up to 22 calls per year can be expected to occur in the area affected by the proposed siding closure. Based on my experience with data analysis of fire responses, at least one call per year will be a fire response, 14 calls will require medical assistance and, four medical calls will be life threatening. One call will likely be related to hazardous materials related to farming operations and the remaining 6 calls will consists of other service related calls including severe weather and false alarm related calls for assistance.

Q. Are you concerned that if the rail crossing remains open, there is some risk that District personnel operating aid or fire equipment would disregard warning devices such as lights, bells, or gates at the railroad crossing, and attempt to cross the railroad tracks despite the warning? What is the basis of your answer?

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A. Refer to Chief Skrinde's testimony. I agree with his statement. Traffic accidents are the second largest killer of firefighters nationwide. Firefighters are trained in accident prevention while navigating traffic. Rail crossings are stationary, well known to local emergency responders and pose little risk to firefighters and do not rank highly in the types of accidents firefighters are involved in.

Q. Based upon your education, training, and experience, and as a consultant with 20 years of fire service experience, do you have an opinion as to whether or not closing the Rail Grade Crossing at Hickox Road will directly and substantially jeopardize the health and safety of the citizens residing, working or visiting within the area affected by the closure?

A. Yes, I do.

Q. What is your opinion?

A. As a volunteer fire department, Skagit County Fire District 3 already has difficulty in achieving meaningful response times to the area. The closure of Hickox Road rail crossing complicates their ability to provide service on multiple levels as I have already stated. Any increase in response time in this area jeopardizes the health safety and general welfare of the citizens of this area.

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Q. If there were an ultimate decision to close the Hickox Road crossing, are there any actions or conditions which would mitigate the risk of harm to persons and property? If so, what are they?

A. Yes. But first let me say that it appears that the closure of this crossing was not well thought out and did not consider up front the impacts that Hickox Road has on emergency response. Roads both to the north and south have much less effect on the public safety. Mitigation in the form of an alternate closure keeping Hickox Road open should be considered.

In the event Hickox Road is closed, mitigation should offset the harm to emergency response. The closure will impact both fire and EMS responses. Nothing can mitigate the time lost to a life threatening emergency medical incident. The appropriate mitigation here is the relocation of volunteer EMS resources capable of responding to the area affected by the closure.

Fire flow mitigation should also occur, mitigation should include the restoration of the Districts ability to provide fire flow to the affected area. Extension of the water system along Dike Road and Hickox Road capable of flowing at least 1,000 gallons per minute should be a required mitigation.

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CERTIFICATION

I, Larry Rabel, do hereby declare under penalty of perjury of the laws of the State of Washington that the foregoing DIRECT WRITTEN TESTIMONY is true and correct to the best of my information, knowledge and belief.

SIGNED AT Des Moines, WA, this ____ day of _____________, 2007

See Attached

Larry Rabel, Principal
Deployment Dynamics Consulting
Auburn Washington

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SIGNED AT Des Moines, WA, this 5 day of NOVEMBER, 2007

Larry Rabel, Principal
Deployment Dynamics Consulting
Auburn Washington

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FIGURE 1

Response Time / Intervention vs. Survival

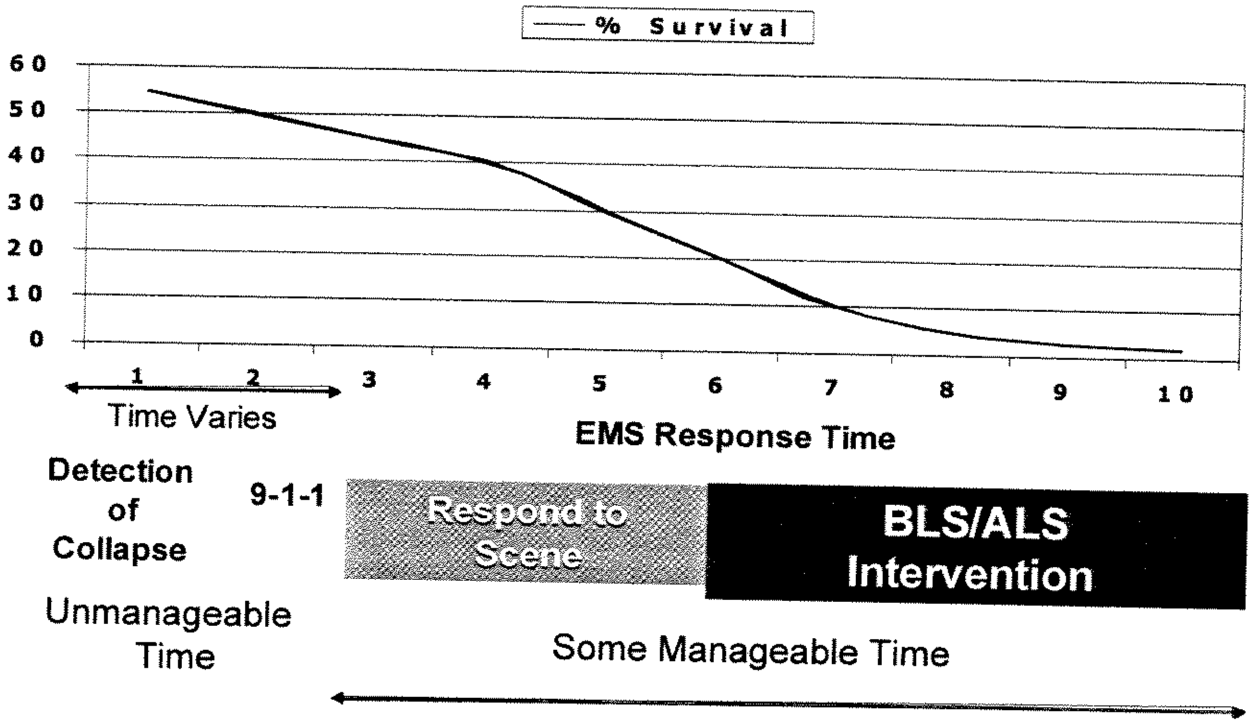

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FIGURE 2

CHAPTER 21

Locating Fire Stations

SECTION 7

Robert C. Barr
Anthony P. Caputo

One of the primary responsibilities of a fire department is the delivery of fire and rescue services The delivery of these services normally originates from fire stations that are placed throughout the area to be protected To provide effective service, crews must respond in a minimum amount of time after the incident has been reported and with sufficient resources to initiate fire, rescue, or emergency medical activities. This chapter discusses the basic elements and means by which fire station locations can be identified for the timely and efficient delivery of fire and rescue services

Robert C Barr is president of Firescope, Inc , a fire protection consulting firm located in Hingham, Massachusetts Anthony P Caputo, P.E , is president of Pyrotech Consultants, Inc , a fire protection consulting firm in Sandwich, Massachusetts

TIME CONSIDERATIONS

Criticality of Time

Nothing is more important than the element of time when an emergency is reported. Fire growth can expand at a rate of many times its volume per minute Time is the critical factor for the rescue of occupants and the application of extinguishing agent.

The time segment between fire ignition and the start of fire suppression activities is critical and has a direct relationship to fire loss The delivery of emergency medical services is also time critical. Survival rates for some types of medical emergencies are dependent on the rapid intervention by trained emergency medical personnel In most cases, the sooner that trained fire or emergency medical rescue personnel arrive, the greater the chance for survival and the conservation of property.

There are a number of factors that determine when flashover may occur (Figure 7 21.1). These include the type of

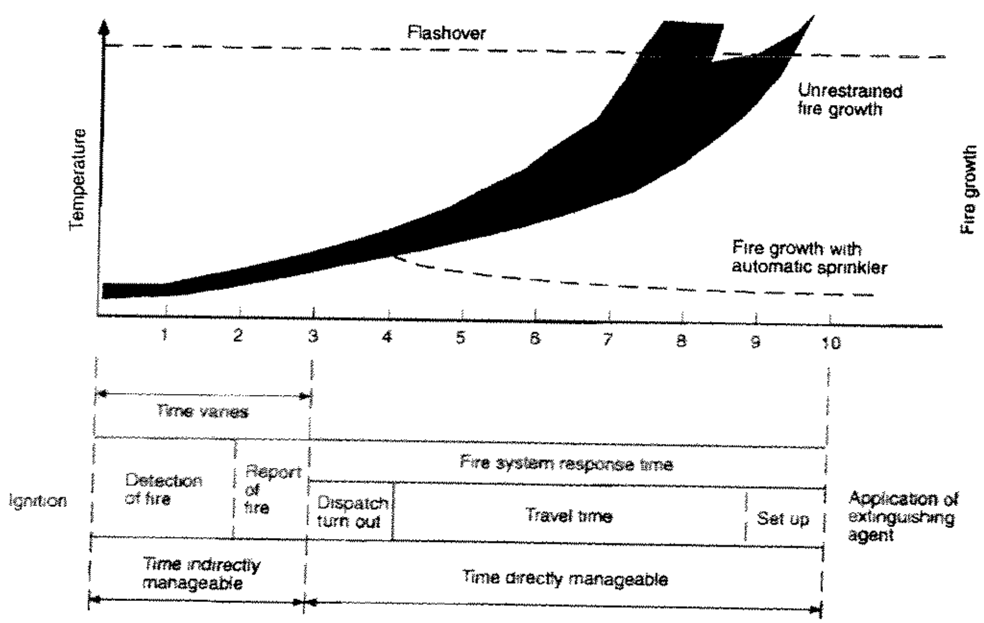


FIGURE 7.21.1 *Fire Growth Over Time and Sequence of Events That May Occur from Ignition to Suppression*

EXHIBIT A

FLASHOVER - a firefighter's worst nightmare!

Paul GRIMWOOD

'Then conditions abruptly changed. I'd never seen anything like this. I've fought a lot of fires in different kinds of buildings, in all kinds of weather, with all kinds of combustibles. I thought I'a seen a lot. I thought I'd seen enough that I could deal with whatever happened and I could take care of my crew. But, as I said, this thing abruptly changed. To this day, I'm still amazed that this happened.

In the darkness, I could see little orange flickers around me. The heat was unbelievable. Unbelievable!.... The heat from this flashover was like a blast furnace, and that causes you to turn into an instinct-driven animal. I've seen people in videos jump out of windows several floors up, and I thought, "What the hell were they thinking? We could save those people." Now I know. The pain from the heat and the feeling of being trapped is overpowering. If I was on the ninth floor, I would have jumped.

Unfortunately, John Lorenzano and Woodie Gelenius died in the fire. There were found in separate locations on the third floor. I don't know how John and I got separated. I was the last one to talk to John; I was the last one to see Woodie. Why did I get rescued and they died? I don't know. It's a thought that will always be with me'.

Captain Mike Spalding on the Indianapolis Athletic Club Fire 1992

The phenomenon of 'flashover', in its generic sense, is a significant killer of firefighters. In the USA, NFPA statistics recorded between 1985 and 1994 demonstrated a total of 47 US firefighters lost their lives to 'flashover'. Of 87 firefighters killed since 1990 that reportedly died of smoke inhalation whilst operating inside structures, the major causes of injury were - *became lost inside the structure* and *ran out of air* (29 deaths); *caught by the progress of the fire, backdraft or flashover* (23 deaths); and *caught in structural collapses* (18 deaths, 10 of which were in floor collapses). All but one of these 70 victims was wearing self-contained breathing apparatus. (The one exception was a firefighter rescuing family members from a fire in his home.) Of 31 US firefighters who reportedly died of burns inside structure fires since 1990, 14 were caught or trapped by rapid fire progress; *backdraft or flashover* and 12 were caught in structural collapses (NFPA). Three firefighters were killed when an Oregon auto-body shop roof collapsed in 2002 but witnesses reported hearing an explosion. seconds before the roof collapse. Was it a backdraft or smoke explosion that caused the collapse? The Fire Chief on scene also reported that when firefighters tried to carve an opening in the building's ceiling, trapped gases that had heated found the oxygen they needed to flash into a blaze. The ceiling, floors and walls combusted immediately, causing roof supports to collapse.

'Flashover' (rapid fire progress) has often resulted in multiple life losses at fires. In 1981 a 'flashover' in the Stardust Disco in Dublin, Ireland caused the deaths of 48 young people. In 1982 two Swedish firefighters were killed in a smoke explosion. Following this incident the Swedish fire service developed Compartment Fire Behavior Training (CFBT) programmes to advance firefighter safety. Also in 1982 there were 24 deaths in the Dorothy Mae apartments flashover in Los Angeles. In 1987 thirty-one people, including a fire officer, lost their lives as fire gases ignited in the heart of London's underground railway (Metro) network and in 1991 eight Russian firefighters died in corridor flashovers that occurred during a major hotel fire in St. Petersburg. In 1994 three New York City firefighters died in a stair-shaft when a backdraft occurred as firefighters forced entry into an apartment on fire. In 1996 there were seventeen deaths as a flashover occurred in a Dusseldorf airport terminal fire. In 1997 three UK firefighters were killed in flashover related incidents and the UK fire service followed this with training updates and CFBT programmes. In the new millennium several firefighters have lost their lives to 'flashover' during live training burns in 'real' structures, notably in Denmark and the USA, and in 2002 five Paris firefighters died trapped by two 'flashover' related incidents. We may well ask - how many more must die unnecessarily?

However, is the generic use of the term flashover to be encouraged and should firefighters gain a clearer understanding of other related phenomena?

FLASHOVER AS AN EVENT

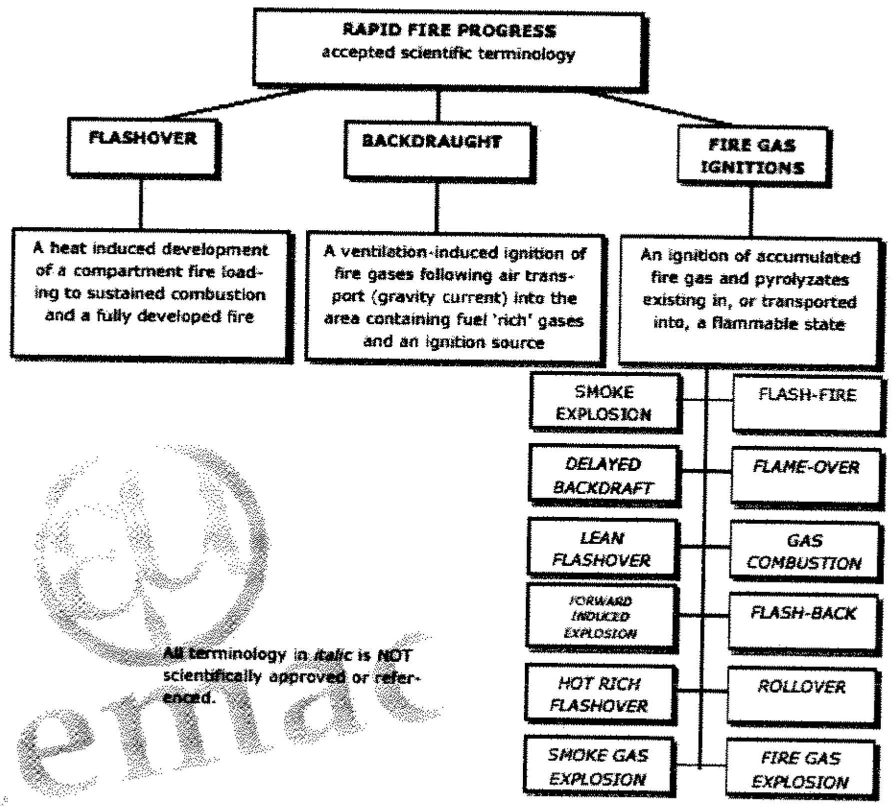
The term 'flashover' was first introduced by UK scientist P.H. Thomas in the 1960s and was used to describe the theory of a fire's growth up to the point where it became *fully developed*. Customarily, this period of growth was said to culminate in 'flashover', although Thomas admitted his original definition was imprecise and accepted that it could be used to mean different things in different contexts. Thomas then went on to inform us in UK Fire Research Note 663 (December 1967) that there can be *more than one kind of flashover* and described 'flashovers' resulting from both *ventilation* and *fuel-controlled* scenarios. Thomas also recognized the limitations of any precise definition of 'flashover' being linked with *total surface involvement of fuel* within a compartment (room) where, particularly in large compartments, it may be physically impossible for all the fuel to become involved at the same time.

Throughout the period 1970 to 2002 there had been widespread use of the term flashover. and various attempts were made to redefine the terminology associated with such phenomena. It was also apparent that firefighters had failed to grasp a clear understanding of the various events that could occur at fires and the NFPA opted to record such occurrences simply as **Rapid Fire Progress**. There are many terms that are used by various authorities to describe .flashover related phenomena. Some have scientific origins and are referenced universally whilst others have been introduced to the language by authors to describe events they have personally experienced at fires. It is common for different terms to sometimes mean the same thing. It is also a fact that English terms often fail to translate into other languages with the same meaning and terms have been amended to allow for this. However, this can cause further confusion when those terms are then re-introduced back into English in different formats! This can occur where scientific or training documents are translated back into English and new terminology appears.

It is perhaps more convenient to list such phenomena under three specific headings, describing universally accepted definitions; detailing case histories of interest; and demonstrating countering and preventative actions (defenses) that can be used by firefighters, as follows.

RAPID FIRE PROGRESS

1. **FLASHOVER**
2. **BACKDRAFT**
3. **FIRE GAS IGNITIONS**



FLASHOVER - DEFINED

'In a compartment fire there can come a stage where the total thermal radiation from the fire plume, hot gases and hot compartment boundaries causes the generation of flammable products of pyrolysis from all exposed combustible surfaces within the compartment. Given a source of ignition, this will result in the sudden and sustained transition of a growing fire to a fully developed fire.......This is called 'flashover'......'

It is a significant feature of a 'flashover' that this transition to a state of total involvement is sustained. It has become further established that 'flashover', in it's true form, is totally reliant upon variables such as thermal influences where *radiative and convective heat flux* are assumed to be the driving forces, although ventilation conditions, compartment volume and geometry, fire location and the chemistry of the hot gas layer also serve to influence any potential for a compartment fire progressing to flashover. Generally, such an event is physically defined as having been reached through flames exiting windows or door openings; gas temperatures of 600 deg.C at ceiling level; and heat flux to exposed items at floor level reaching 20 kw/m2. It is worthy of note that *'rollover'*, as an event that is seen to precede flashover by a few seconds, may also meet such criteria. As a scientist Thomas recognized the limitations of any precise definition of 'flashover' being linked with *total surface involvement of fuel* within a compartment (room) where, particularly in large compartments, it may be physically impossible for all the fuel to become involved at the same time. The spread of fire, in such a way, is generally linked with phenomena such as *flash-fires or flameover.*

In it's generic sense the term 'flashover' is still used by many firefighters to describe a range of events that culminate in rapid escalation of the fire - rapid fire progress - or even an explosion with accompanying pressure wave that breaks windows or pushes walls down. Such generic In effect, flashover is generally a **heat-induced development** of a compartment fire. A fire that rolls 'lazily', although sometimes with great speed, across the ceiling, generally supports the event. It is rarely explosive although a pressure and combustion wave may break windows. It should be noted that there is potential for 'flashover' to be induced by an increase in compartmental ventilation where the *heat loss rate increases* as more heat is convected through the opening. use of the term should be discouraged. There is a point beyond stability where ventilation may cause more energy to be released in the compartment than can be lost through openings and this condition of 'thermal runaway' may lead to 'flashover'.

FLASHOVER CASE-HISTORIES

1. In the December 2002 edition of Firehouse magazine USA a company engine officer described how his crew attended a one-room house fire that had vented itself out of a rear window. Heavy fire was seen issuing from the window - the fire was post flashover. As the fire crew forced entry at the front they took out two windows either side of the entry door. As they advanced towards the fire they encountered moderate heat so they took out another window from the interior. At this stage the fire found them! At the same time the exterior officer ordered an immediate evacuation of the structure over the radio due to rapidly escalating fire conditions. Such were conditions inside the structure that they had to urgently evacuate out of It must be remembered that fire will often head for an air supply - if that is behind you then you are in trouble! The more windows you take out behind you the more likely this is. Also remember that flashover conditions can be created or worsened by taking out windows, causing *thermal runaway*. If a window is to be vented it should be **ahead** of the hose-line being advanced, exterior wind conditions permitting! the window they had just vented!

2. A team of five firefighters arrived on-scene at a house fire and opted to place the primary search ahead of the fire attack as a tactical objective. As the fire progressed unchecked for several minutes, without any form of isolation or confinement strategy, it developed beyond flashover and trapped two firefighters on the floor above. They survived but with serious burns.

BACKDRAFT - DEFINED

'Limited ventilation can lead to a fire in a compartment producing fire gases containing significant proportions of partial combustion products and unburnt pyrolysis products (under-ventilated fire). If these accumulate then the admission of air when an opening is made to the compartment can lead to a sudden deflagration. This deflagration moving through the compartment and out of the opening is a backdraft (backdraught).'

In 1992 C. Fleischmann reported on the phenomena of backdraft - The purpose of his project was to develop a fundamental physical understanding of backdraft phenomena. The research was divided into three phases: exploratory simulations, gravity current modeling, and quantitative backdraft experiments. The term gravity current is used scientifically to describe two fluids of differing densities interacting in such a way that a vertical interface exists between the fluids, the resulting motion consists of the heavier fluid flowing horizontally beneath the lighter fluid. Such a flow is said to form a gravity current. Gravity currents are widespread in nature, and their common characteristics are observable in avalanches, heavy gas releases, turbidity currents, fresh and salt-water exchange, and sea breezes. However, the role they play in backdrafts is related to the movement of air into an under-ventilated fire compartment and is often referred to as an air-track by firefighters. It can often clearly be seen where smoke is pushing out of an opening or doorway with a clear interface below which clear air is entering the compartment or structure. The velocity of the air-track or the speed that the smoke is seen issuing is often a reliable sign as to the extent of under-ventilated conditions. However, a gravity current is not always distinct where heavy smoke exists down to the floor and a 'twister' may sometimes be seen in the smoke at an entry point where a swirling pattern about the size of a soccer ball seems to be sucking air in through and along its path. In effect a backdraft is a ventilation-induced ignition of the gases or combustion products. The event can result in a 'whooooompf' or a 'bang' and can be violently explosive and damaging to structural elements. It generally produces a large fireball to the exterior of the building as fire gases are able to burn off in a plentiful supply of oxygen.

In the January 2000 edition of Fire Engineering magazine Brian White, a Captain with FDNY, put forward his own theory of a phenomena he termed - high-pressure backdraft. It was Mr. White's belief that wind effects upon buildings sometimes enabled excessive pressures to form within, as air entered through various openings on the windward side of a structure. He further suggested that when an opening was created elsewhere in the structure, the sudden unleashing of pent-up pressure sometimes worsened the effects of any rapid fire development as it stirred a large mass of high-velocity air-movement through the structure. He described several scenarios where rapid decompression of a structure occurred as windows failed, or vented, causing major increases in the burning-rate that were greater than normally anticipated *'fanning' effects* created by wind movement alone. Grimwood also discussed these phenomena in his book Fog Attack (1992) and through his own article, *momentum & inertia theory*, at www.firetactics.com

BACKDRAFT - CASE HISTORIES

1. At 1739 hours on 26th February 1994 London firefighters responded to a fire in a private cinema club in the central city area. On arrival four persons were seen trapped at a third storey window and one man had already jumped from this window prior to their arrival. As a ladder was sited for the rescue a further three men jumped from the window and another three were eventually assisted out and down the ladder. With reports of additional people trapped inside the structure firefighters in SCBA advanced a hose-line towards the interior stairs. As they reached the stairs a 'very loud roaring and intense fire' escalated in the stair-shaft and the crew were beaten back. A total of three people had jumped from the third storey and portable ladders and an aerial tower ladder were used to rescue a further 17. An additional six men died in the third storey cinema area. The classic 'roaring' sounds experienced by firefighters attempting to reach the upper floors

by the interior stair-shaft demonstrated a backdraft situation where fire gases were burning off in the shaft as air rushed in from the access doorway.

2. On 1st February 1996 in Blaina, Wales, a fire involved the ground floor kitchen at the rear of a two-storey house during the early hours. The initial crew of six firefighters were faced with the predicament of children reported missing and trapped upstairs. The building was heavily charged with smoke, which was seen to be issuing from the eaves on arrival. They chose to attempt the rescues first and in doing so, no *interior fire attack* or *fire isolation strategy* was undertaken. Two hose-lines (19mm hose-reels) were laid to the structure but neither was brought into use prior to the backdraft occurring five minutes after arrival. Flames were seen issuing from the rear kitchen window and the compartment fire had developed to a post-flashover stage. However, a distinct gravity current was in progress with heavy volumes of thick black smoke exiting at the front entrance doorway. A resulting backdraft took the lives of two firefighters as the fire developed unchecked for several minutes.

3. Just three days later another firefighter (female) was killed by an ensuing backdraft that occurred in a large super-market in Bristol. As four firefighters (including the victim) entered through the main entrance to tackle the fire the heavy black smoke layer was seen to be in motion, continually rising and falling. Just five minutes after entry an intense 'howling wind' was seen to enter the main entrance doorway causing flames to bend inwards. The resulting ignition of the fire gases moved across the wide expanse of the store both under and within the suspended fibre-board ceiling at an estimated five metres per second (high velocity gas combustion). The accompanying pressure wave knocked one firefighter off his feet. Should firefighters have entered these conditions in the first place? The continuous rise and fall of the smoke layer is most likely a result of the *pulsation cycle* caused by brief ignitions (oscillatory combustion) in the fuel-rich gas layers. This may also be linked to the 'puffing' phenomena noted by Sutherland. As these ignitions occur intermittently the repeating thermal expansions of fire gases may cause the smoke interface to rise and lower and such a process must be viewed as a classic warning sign for backdraft.

4. On March 28, 1994, the New York City Fire Department (FDNY) responded to a report of smoke and sparks issuing from a chimney at a three story apartment building in Manhattan. The officer in charge ordered three- person hose teams to make entry into the first- and second-floor apartments while the truck company ventilated the stairway from the roof. When the door to the first-floor apartment was forced open, a large flame issued from the apartment and up the stairway, engulfing the three firefighters at the second floor landing. The flame persisted for at least 6½ minutes, resulting in their deaths. The FDNY requested the assistance of the National Institute of Standards and Technology (NIST) to model the incident in the hope of understanding the factors, which produced a backdraft condition of such duration. The CFAST model was able to reproduce the observed conditions and supported a theory of the accumulation of significant quantities of unburned fuel from a vitiated fire in an apartment, which had been insulated and sealed for energy efficiency. This demonstrated that backdraft is not always, as commonly believed, a transient event involving short, possibly violent, releases of energy from the fire, which are not *normally* sustained!

5. A fire department was using PPV in a pre-attack mode, in a house fire, to assist firefighters in locating the fire. The exhaust exit (window) in use was too small and a backdraft occurred as the fire gases ignited along the interface of the rich/lean mix.

FIRE GAS IGNITIONS - DEFINED

There is a wide range of events that can be conveniently grouped under the heading Fire Gas Ignitions (FGI's) and such phenomena can generally be defined as - *'an ignition of accumulated fire gases and combustion products, existing in, or transported into, a flammable state'*. Any such ignition is usually caused by the introduction of an ignition source into a pre-mixed state of flammable gases; or the transport of such gases towards a source of ignition; or the transport of a fuel-rich mixture of gases into an area containing oxygen and an ignition source. The ignition is not reliant on the action of airflow/oxygen in the direction of an ignition source, which is clearly recognised as a backdraft event.

There have been several scientific studies into the phenomenon of **smoke explosion** with the most recent by B.J. Sutherland of University of Canterbury in Christchurch, New Zealand (1999). An explosion is defined in this study as the rapid propagation of a flame front with an accompanying pressure wave (Croft, 1980). Croft suggests that pressures as high as 5-10 kPa could be produced during a smoke explosion. Pressures this high are large enough to break windows. It is the velocity of the flame front that determines the magnitude of the pressure wave. If the pressure wave is not formed or is negligible, then the phenomenon is known as a **flash-fire**, and not an explosion (Wiekema, 1984). This excellent report describes how smoke/gas layers may descend onto sources of ignition; how ignition sources may ascend into the gases and how a process termed 'puffing' may precede smoke explosions. This effect is thought to be similar to that of pulsating smoke - noted as a warning sign for 'backdraft'! The author also noted detached flaming in the overhead as a pre-cursor to some smoke explosions.

At the Indianapolis Athletic Club fire in 1992 it was suggested that the events that led to the firefighter and civilian deaths and injuries did not fit the accepted definitions of 'flashover' and further suggested that some form of flash-fire or flame-over was responsible for the rapid-fire development. This fire also demonstrated how flames might head towards new air supplies, at window openings, made or existing behind advancing fire crews. The term **flame-over** is used to describe the effect of flames, generally at ceiling level, travelling at high-speed across super-heated surfaces giving off flammable gases. This phenomenon is, in effect, not dissimilar to a flash-fire and is also sometimes confused with rollover, which is detached and sporadic flaming extending from the main fire plume in the overhead, often seen to precede flashover.

Floyd Nelson (USA) introduced a further definition for a term he referred to as **Forward-induced Explosions**. In effect, this definition described the ignition of pockets of fire gases as they transported throughout a structure/compartment. The phenomena differed from that of backdraft in that fresh air (oxygen) is the moving force in a backdraft whilst the gases themselves are the moving force in a 'forward-induced' explosion as they move towards a supply of air. This can occur in many ways inside a fire-involved structure, for example, where a collapsing ceiling forces fire gases to transport outwards from the area of collapse. On mixing with pockets of air they may come into the flammable range and can ignite with varying explosive effects. Mr Nelson also discusses the effects of high velocity gases that may gain momentum in large spaces, corridors or shafts within a structure. Where the movement and ignition of super-heated fire gases are accelerated through narrow openings or corridors or are deflected the effects can be dramatic. The deep levels of burning (referred to in the UK as a *local deepening*) will cause unusual patterns of burn as if an accelerant has been used to increase fire intensity. On occasions, where high-velocity gases escape to the outside without being deflected, their flow is such that they may cross an entire street creating a flame-thrower effect from a window or doorway.

FIRE GAS IGNITIONS - CASE HISTORIES

1. Firefighters were turning over debris after a small fire occurred in a cupboard involving some plastic and cardboard boxes. As they lifted a pile of debris a source of ignition was uncovered that ignited an accumulation of gases. The resulting explosion blew one firefighter into the hallway!

2. Whilst a PPV fan was being used to clear the smoke following a one-room house fire, the constant fanning effect from the PPV, after the main body of fire had been suppressed, caused a fast smouldering fire to occur in the debris and wall linings, resulting in an accumulation of fuel-rich 'under-ventilated' combustion products in the structure. The resulting explosion was caused as an ember or spark was convected up into these gases!

3. A fire in a Stockholm warehouse in 1986 had been extinguished but a heavy smoke layer in the large expanse of overhead went unnoticed above the firefighters heads. As debris was overturned an ember floated up into the smoke layer and a massive smoke explosion occurred with several firefighters receiving severe burns.

4. A fire in a warehouse caused two smoke explosions - firstly the un-vented smoke layer was fast approaching floor level when it came into contact with the flaming fire source. This ignited the smoke layer, which had formed into a flammable mixture. The second explosion occurred as a ceiling collapsed, pushing a fuel-rich-mix of fire gases outwards into other areas of the warehouse where there was a plentiful supply of air/oxygen. As the fuel-rich gases were diluted they came into contact with the fire and a further explosion occurred.

5. In 1973 a team of London firefighters was attempting to gain access into a basement area serving multiple occupancies in a six-storey building. The fire was in an under-ventilated state in the basement but all windows were intact. As the door was opened the gases auto-ignited on meeting fresh air. The fire burned above the firefighters heads for several seconds, trapping them in the open basement area outside the structure. They were not in immediate danger and were able to observe the gases burning off outside the compartment in free-air without any burning apparent inside the hallway. This effect may appear similar to that experienced at the NYC Watts Street fire (above) - if super-heated gases meeting fresh-air at a point of exit then cause the ignition it is not a backdraft. However, if the ignition occurred inside the compartment first, as air entered, burning off in a fireball outside the compartment (Watts Street) then it is a backdraft - an ignition induced by ventilation. The two events may appear similar as they present themselves.

6. In 1997 a team of nine South Yorkshire (UK) firefighters responded to a fire in a car auto spares store. The building was tightly sealed with steel doors and windows boarded with timber and steel sheet. As the firefighters forced entry at the front of the store the conditions demonstrated moderate heat with only minor smoke issuing from the doorway. A water spray was directed into the overhead prior to entry. However, at this moment the doorway 'turned orange' and a fireball was seen heading out into the street. The explosion took out the entire storefront and buried several firefighters in front of the store in the street. Eight firefighters were taken to hospital - three of them seriously injured. It is most likely that the fire had burned for some time inside the sealed compartment and the fire gases and products of combustion had formed into an explosive mixture. On forcing entry a burning brand may have risen into the gases in the overhead causing a subsequent violent explosion. This was a difficult structure to ventilate due to re-inforced steel doors to the rear and boarded windows. The floor above served as a seperate occupied residency. The introduction of water droplets into the overhead failed to suppress the smoke explosion in this instance. The lesson to be taken from this experience is to treat the frontage of such a structure as a shotgun barrel! This point was made in Fog Attack in 1992 where entry is being forced into a 'sealed' structure it is advisable to operate with the least number of firefighters in the danger zone as possible, using points of cover when able. At the time of this explosion all eight firefighters were situated directly in front of the building, just a few feet from the doorway.

7. Deputy Chief Thomas Dunne (FDNY) presented a most interesting account of an event he termed *'delayed backdraft'*. He described how firefighters approached a fire in a two-storey and basement, 50' x 100' brick and wood-joist structure, in the Bronx. First arriving firefighters were faced with smoke (but no fire) issuing from the ground floor of a tire repair facility, which was the end one of three occupancies in the building. Initial actions were to lay 2 ½" hand-lines and open up all three occupancies at ground level, where it became obvious that the fire was restricted to the tire repair occupancy. Fire was located and almost suppressed in the basement of this part of the structure and adjoining occupancies continued to show clear of smoke or fire conditions. In fact a substantial firewall existed between the fire involved occupancy and the adjoining mattress store. However, smoke issuing from the tire store suddenly started to increase rapidly and extended to the adjoining mattress store, causing the curtailment of interior firefighting operations. By this time a very large quantity of rubber tires were burning in the basement of the repair facility. An explosion (reported as a backdraft or smoke explosion), occurred some 45 minutes after first arriving crews had applied water to the fire. Immediately following the explosion a heavy amount of fire was seen to involve the ground floor level. As the fire continued to spread throughout the structure an exterior operation progressed through the night. Deputy Chief Dunne then went on to explain that whilst firefighters are trained to recognise 'classic' warning signs of backdraft conditions on arrivial, perhaps there is insufficient emphasis placed on the fact that such events can occur quite some time after fire suppression efforts have begun, possibly whilst the structure is occupied by firefighters. He advised that two incidents of this type had occurred recently in his assigned division and that firefighters should be wary of any enclosed space that is issuing heavy smoke and remains insufficiently vented. The term *'delayed flashover'* was first introduced in Swedish firefighting training texts during the early 1980s and referred to situations where any likely ignition sources were isolated from accumulating flammable gas layers. This could occur where a smouldering fire existed in the same compartment as the fire gas accumulation or potentially where the gases were building in compartments adjacent to, or some way from, the fire compartment itself. The resulting explosion, when ignition source met with accumulated fire gases, was defined as a delayed action flashover. Later, during the mid 1990s, the same event was redefined in UK training texts as a *'delayed backdraught'*. However, in both cases the definitions were incorrect in that these events are more correctly termed *fire gas ignitions* or *smoke explosions*. Experience has shown us however, it is perhaps more prudent to place greater emphasis on the fact that ALL events associated with rapid fire progress, be they flashover, backdraft or fire gas ignition, may occur quite sometime after initial firefighting operations have been initiated. Therefore the term *delayed*, along with the potential for delay, is applicable to all forms of rapid fire progress although perhaps even greater emphasis is needed in terms of fire-gas and smoke accumulations forming in adjacent or nearby compartments, rooms, voids or attics etc (*smoke explosion*). This form of explosion rarely presents itself with any form of warning signs whatsoever and is perhaps the firefighter's greatest hazard. Such explosions often occur when fire-gas accumulations form at their stoichiometric point - In terms of flammability limits of gas/air mixtures the stoichiometric mixture is the 'ideal' mixture that will produce a most complete combustion - ie; it is somewhere between the UEL (upper) and LEL (lower) explosive limits, and an ignition at the stoichiometric point may result in the most severe deflagration, in relation to those near the upper and lower limits of flammability.

8. A particular type of smoke explosion has been commonly associated with fires in saunas. This often occurs with some *delay* as a sauna is designed to retain heat! If a fire occurs inside the sauna, it is a *compartment within a compartment* if located inside a main building. Such fires progress extremely slowly in under-ventilated conditions, producing large amounts of smoke. The smouldering combustion process weakens the timber sauna structure and when firefighters

direct a powerful stream of water at the sauna the structure fails and releases the ignition source into the surrounding atmosphere, which is most likely in a highly flammable state. The resulting explosion or ignition of the accumulated fire gases comes without warning and is often *delayed* until firefighters are occupying the space. This situation demands some form of tactical venting action prior to any attack on the fire taking place.

Paul Grimwood
www.firetactics.com
February 2003

BEFORE THE WASHINGTON UTILITIES AND
TRANSPORTATION COMMISSION

BNSF RAILWAY COMPANY, Petitioner, v. CITY OIF MOUNT VERNON, Respondent. SKAGIT COUNTY, WASHINGTON STATE DEPARTMENT OF TRANSPORTATION, WEST VALLEY FARMS LLC, and SKAGIT COUNTY, Intervenors	)	DOCKET NO. TR-070696 DECLARATION OF SERVICE

Nancy Catalano declares I am a citizen of the Unites States of America, over 18 years old and competent to testify to the matters herein. On November 5, 2007, I served by email and first class mail, postage prepaid, a true and correct copy of the foregoing document on the following:

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