Enlightening Elyria Firefighters in the Hazards of Lightweight Building Construction

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CERTIFICATION STATEMENT

I hereby certify that the following statements are true:

1. This paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

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ABSTRACT

The problem was that building materials and their use in construction may affect Elyria Fire Department (EFD) operations and strategies.

The purpose of this research project was to gather information to aid fire ground command officers and firefighters in combating fires in modern lightweight constructed occupancies.

The author utilized a survey as well as evaluative and analytical research methodologies to answer the following questions:

What has changed historically in building construction, from conventional heavy timber type to modern lightweight construction?

What are the hazards of lightweight construction in relation to firefighting?

What programs, training, changes, and/or adjustments in fire ground tactics are available to assist the EFD in operating in buildings of lightweight construction?

The procedures consist of a literature review utilizing textbooks, magazines, journals, and the internet. A survey was conducted of Ohio fire firefighters asking of their experience with lightweight building construction issues. The results revealed that most firefighters are comfortable with their training and can distinguish the inherent problems with lightweight construction. The fire service organizations have not authorized procedures that will notify or alert firefighters of the presence lightweight construction.

Recommendations included an ongoing training program following established fire service training curriculum for building construction. A reevaluation of reference materials utilized in promotional examinations. Work with various city officials to establish an ordinance mandating exterior building markings to alert firefighters of construction methods in a building.

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INTRODUCTION

On July 2, 1988 the Hackensack, New Jersey Fire Department responded to a working fire at the Hackensack Ford car dealership. While operating on the interior, the wood bowstring truss roof failed, it collapsed, trapped and ultimately killed five firefighters.

On the afternoon of December 26, 1992 the Memphis Fire Department responded to a working fire in a church. The fire claimed the lives of two firefighters when the wood truss roof above where they were operating, collapsed approximately seven minutes after their arrival.

On February 15, 1999 Lake Worth, Texas suffered the loss of three firefighters when the roof they were operating under collapsed within minutes after their arrival.

Nearly one year to the date of the Lake Worth tragedy, in the early morning hours of Valentines Day 2000, the Houston, Texas Fire Department responded to a fire in a McDonald's restaurant. The fire began in a small office area in the center of the building. The fire spread up above the false ceiling and attacked the lightweight wood trusses. Within 10 minutes after arrival two Houston Firefighters were killed.

On March 17, 2005 two Yellowknife, NWT (Northwest Territory) Canada firefighters were killed when a storage shed constructed with lightweight trusses at a Home Depot collapsed while they were on the roof ventilating the structure.

What do the examples above have in common? All of the buildings involved utilized lightweight truss construction to support their roofs. Whereas lightweight construction is a good economical option for the building industry and building owners, trusses do not maintain their integrity when involved in fire and seldom give any kind of warning of collapse. The fire service needs to better identify the buildings with this type of construction. Additionally, they must

develop tactics and strategies to implement when combating fires in buildings supported by lightweight trusses manufactured with both metal and wood.

In the City of Elyria, Ohio, there is a re-vitalization taking place in the downtown area. Many of these buildings were built between the late 1800s and early 1900s. The buildings constructed then utilized what is called heavy timber or ordinary construction. The materials utilized to hold up floors and roofs were large pieces of lumber. These buildings now are being remodeled utilizing smaller, less expensive lightweight construction.

In addition to the downtown area revitalization, the City of Elyria is going through a steady growth of new construction in the far Southeast area. Residential and commercial buildings are filling up what was once farmland. The Southwest area is where the majority of the city's mercantile buildings are located. Those buildings are all constructed of lightweight materials, with new buildings going up almost daily.

The Elyria Fire Department needs to evaluate its process of educating members in the hazards of lightweight construction as well as identifying the buildings which utilize that construction.

Through analytical, historical research, and surveys, this study will gather relevant information on lightweight truss construction and gauge the awareness level of Elyria Fire Department members concerning lightweight construction. The goal is that through education, the department can identify and successfully mitigate fires involving buildings utilizing lightweight construction safely.

Statement of the Problem

The problem this study will address is the lack of practical understanding of firefighters and officers regarding lightweight building construction as it relates to the fire service, and how

fire ground commanders conduct fire attack. Elyria can be described as an old Midwest industrial city. It has several buildings 75-125 years old. The construction techniques used in these buildings utilized heavy timber construction with a lot of mass. Fire attacks could be conducted in these buildings for an extended period without a fear of collapse.

Today, construction techniques incorporate lightweight engineered systems with an emphasis on speed and economics. Tests have shown these buildings can and have failed in as little as five minutes of fire involvement.

Purpose of the Study

The purpose of this study was to gather relevant information and educate Elyria firefighters on lightweight construction to aid in the risk management of interior fire attack.

Research Questions

The following questions will be answered:

1. What has changed historically in building construction, from conventional heavy timber type to modern lightweight construction?
2. What are the hazards of lightweight construction in relation to firefighting?
3. What possible new programs, improvements in training, changes and/or adjustments in fire ground tactics are available to assist Elyria Fire Department members relative to operating in buildings of lightweight construction?

BACKGROUND AND SIGNIFICANCE

The City of Elyria is located in Lorain County, in Northeast Ohio. The population according to the 2000 census is 55,953 the city is 21 square miles, with a tremendous mix of residential, commercial, and industrial occupancies. The Elyria Fire Department currently operates four stations and has a minimum daily staffing of 17 firefighters on duty, one of which is a dispatcher. Each station houses an engine company, with the downtown station additionally housing a ladder, heavy rescue and shift commander vehicle. The department does not provide ambulance service to the community, but does provide emergency medical first responder service. The department employs 70 firefighters all of which are trained to the level of Emergency Medical Technician.

Many of the older commercial buildings especially on Elyria's main thoroughfare, have been rehabilitated from old, run down vacant buildings to new apartments and condominiums.

Located on Elyria's Northwest side is a large retail area called the Midway District. This location, once farm land in the 1960s has now become a bustling retail and commercial district with many new strip malls and large "box type" stores, all utilizing lightweight construction.

In June of 2006, construction began on a large retail center in Elyria's far Southeast corner. Once that is completed it will house one of the largest Wal-Mart stores in the country and several strip malls.

Elyria's Southeast side has also sprouted several new housing developments within the last 20 years. These include numerous single family dwellings, condominium complexes and large garden style apartment complexes. While each incorporates their own styles of architecture, they all have one item in common, lightweight construction. The Elyria Fire Department is confronted on a daily basis of trying to design and prepare multiple training

programs with a limited amount of funding, to assist firefighters in combating the effects of fire in both new and old occupancies, constructed with every type of construction possible for the last 200 years.

Early commercial construction methods utilized heavy timber construction. Heavy timber is defined as being buildings constructed with noncombustible or limited combustible exterior walls and floors made of large dimension combustible materials, also known as Type IV construction (Brannigan & Corbett, 2007). Early 20th Century residential construction, while using heavy timbers, lacked any type of fire stopping between floors. The heavy timber construction held fires in check due to the sheer mass of the wood.

Firefighters today can no longer rely on the building industry and architects to design buildings which will stand up to the destructive forces of fire. Today's construction consists of smaller, less expensive lighter weight materials and fasteners.

Because of the age of the city, Elyria's firefighters have extensive experience in fighting fires in heavy timber or ordinary constructed structures. Dunn (2007) stated fire attack in these buildings is straight forward unless it is an advanced fire. Then the proper attack is an aggressive offensive attack on the interior of the building, coupled with vertical ventilation of the roof to remove the heat and smoke.

Norman (1998) stated the following:

> The most common structures that we operate in, houses and other residential occupancies, as well as many smaller commercial buildings, are most often either wood-frame or brick-and-wood-joist (ordinary) construction. These buildings were built with relatively large floor and roof joists, typically two-by-eight-inch and larger. The 20-minute rule of thumb applies to this type of construction: If the fire is not under control in

> 20 minutes, you should probably begin withdrawing your personnel and shift to exterior operations. Of course, this is only a guide and even as such it must be applied carefully and with some modifiers.

With new construction, fire ground commanders must rethink the time allowed for firefighters to remain inside to conduct a fire attack:

> The twenty-minute rule said that if we were fighting a fire for twenty minutes, we should consider the collapse potential of the structure. There are several problems with this rule. An obvious question is: when does the twenty minutes start? Another problem with this rule is that it treats all types of structures and construction features the same. Lightweight trusses may collapse in less than five minutes under fire conditions. The truth is you cannot predict collapse time (Bingham, 2006).

Fire attacks in an ordinary constructed building, due to the overall stability, fires in ordinary constructed buildings can be extinguished safely with an offensive attack (an exception would be fire attacking lightweight structural components) (Smith, 2002).

The experience mentioned previously regarding Elyria's firefighters in these buildings can cause a problem when the same tactics and strategy is utilized when a building is constructed of lightweight construction.

Fortunately, Elyria has never had a firefighter killed in a lightweight building collapse. However, the fire department has experienced several close calls with the collapse of lightweight roofs during fire attack operations. All commercial buildings constructed in Elyria since 1987 have utilized some type of lightweight truss construction. Some of these types are the wood truss, lightweight metal, parallel chord wood truss, and plywood I-beam (Lahetta, personal communication, July 28, 2007).

Not only are these materials being used for roof construction, they are also utilized for floor construction in multi-story buildings as well as support of a first floor when a basement is found in the building.

Another problem being found in the City of Elyria is the increase in construction of rain roofs. A rain roof is a new permanent, lightweight roof structure built overtop of the original roof. These are a common remedy in the repair of leaking or damaged roofs. If the building was originally constructed with heavy timber, firefighters may not recognize the new hazard in the lightweight construction created. A rain roof system under fire conditions is an ambush waiting to be triggered. For all responders, the key is recognition and caution (Smith, 2007).

A noted authority on building construction as it relates to the fire service, Mr. Frank Brannigan (1989) stated, "When a combustible structure is involved in fire, no code provision however well written and however well meaning, provides real personal safety for the firefighter. We must know that the building is the enemy; and we must know the enemy."

The potential impact the study will have on the Elyria Fire Department is the increase in knowledge and recognition of potential hazards on lightweight building construction as it relates to the fire service. This knowledge will provide for a safer fire ground, perhaps reducing injuries or fatalities caused by the effects of fire on lightweight building construction.

LITERATURE REVIEW

Today in the City of Elyria, many new single family housing developments are sprouting up as well as many new commercial developments especially on the Northeast side. The construction is vastly different to that of houses and commercial buildings constructed in the city 50 to 100 years ago.

In describing the genesis of lightweight construction techniques Smith (2007) stated:

> After World War II the need for housing outstripped the lumber industry's ability to supply the wood needed for all the housing requirements. Additionally, the conventionally framed heavy timber building required many craftsmen to construct it. To alleviate the above mentioned problems, technology stepped in and engineers were able to calculate the loads delivered to the various framing members and then design patterns involving geometry and physics to construct a wooden or steel member that would support the same load with smaller component parts.

Mittendorf (2006) explains that conventional construction (2X6-inch or larger) derives its strength from the size of its members, and generally employs independent members. The advantages of conventional construction as compared to lightweight construction are enhanced fireground time, partitioning of fire, and potential partial collapse.

The reason lightweight construction is being utilized increasingly by the building industry is its ability to offer a cost savings to builders and the ease it provides when running utility lines and ventilation duct work. The lightweight construction allows for the support of larger spans without the need for vertical columns (Pindelski, 2007)

Pindelski also discussed, a test prepared by the building industry comparing the difference in actual build time when constructing a 2,600 square foot house using conventional

wood timbers and lightweight constructed trusses. Pindelski acknowledged the test results indicated that the lightweight constructed residence took only 148 labor hours while the conventional heavy timber wood constructed residence took 401 labor hours. The lighter weight materials also utilized 26% less lumber compared to a conventional heavy timber constructed home.

In describing the cost vs. benefit factor during firefighting operations, Dumas (2004) stated:

> The problem is the construction industry is changing at an extremely rapid pace. It is a multibillion dollar industry that is focused on making the best, most structurally sound, and most affordable products for its ultimate consumer—oftentimes, a homeowner. We acknowledge that most of these newer products are superior to older methods of construction. Superior, that is, until it burns. For firefighters, mass equals time, for the building industry, mass will equal money.

Elyria's firefighters need to be diligent students in all aspects of firefighting in many different types of construction. One needs to know the construction of the Fortress mentioned earlier as well as new lightweight constructed homes and businesses. In discussing the correlation between fire spread and collapse:

> Rapid fire spreads and early structural collapses are two primary hazards to firefighters during fires in all types of construction, particularly in modern construction methods or modern contents. Even if structural components are protected with drywall, poke-throughs are common and the drywall or a suspended ceiling may be suspended below the structural members allowing a large void space for fire travel (Clark, D., Jaehne, R., Norman, J., McCastland, J., Smiths, D., 2007).

Brannigan (2003) authored the following about conventional vs. lightweight wood:

> Solid-sawn wood contains *fat* — wood not necessary to carry the imposed load. When only this part of the wood is burning, roof strength is not greatly affected. As it continues to burn, however, the beam gradually weakens, and the roof becomes spongy. This may or may not warn firefighters to get off the roof in time to avoid disaster.

In interpreting the NFPA (National Fire Protection Agency) Standard 251, Standard Fire Exposure Test, Brannigan (1995) stated that the testing concluded that solid-sawn beams lasted about five minutes per inch of thickness. Brannigan emphasizes that the standard should not be used as a rule of thumb:

> Today's fires deliver fire loads more intense than the standard test. The fireground commander is rarely aware of how long the beams have been burning. The intermittent impact load of a working firefighter will almost certainly stress the structure more than the distributed static load applied in the typical fire test.

In analyzing the constant conflict between new construction methods and fire suppression tactics, Mittendorf (1998) makes the point that new construction methods are not usually in harmony with fire suppression operations. Considering the cost of labor, equipment, and building materials, it is not economically feasible to construct a structure in the same manner as in the 1900s. Heavy timbers have been replaced by 2X4s and petrochemical-based compounds have replaced conventional building materials regardless of building type or size.

In describing lightweight construction materials referred to as open web bar joist, Pressler (1997) stated the following:

> One of the most common types of roofs you may encounter is a steel bar joist truss assembly covered with a corrugated metal roof, commonly known as "Q" decking. The

metal bar joists can be used to span distances greater than 50 feet and are usually found spaced four to six feet apart (larger spacing is possible, depending on how the entire roof was designed). This roof assemblies' lack of fire resistance provides little or no protection for operating forces. The roof's rating comes from the type of roof covering installed and the type of ceiling tile installed under the roof. Do not rely on lightweight steel trusses to withstand any amount of fire.

Clark et al., (2007) concluded that part of the concern with modern construction stems from the perception that the structural fire resistance of conventional wood-frame construction provides a much greater degree of safe working time than for modern construction. As a practical matter, no two fires are the same and a structure's fire endurance and mode of failure under real fire conditions is unpredictable.

Clark et al., (2007) acknowledged that actual time on the fireground can quickly be forgotten and firefighters may not be able to determine if this time has already been exceeded when they arrive. They believe that there needs to be a rethinking of tactical procedures and guidelines for fighting fires in these newer structures or newer contents. Using the same tactical methods as firefighters would use in heavy timber construction will not be practical.

The use of plywood I beams (figure 1) is another commonly found building component in today's buildings. Kirsch (2007) described their structural integrity under fire conditions as follows, "In 1986, the Illinois Fire Service Institute at the University of Illinois tested five types of floor systems to determine their structural stability. Included in this testing were wooden I-beams set at 24 inches on center. Of all the floor systems, the wooden I-beams failed first at 4 minutes and 40 seconds."

Figure 1. Plywood I beam. Photo by: Kirsch (2007)

Norman (1998) on the hazards of plywood I beams stated the following:

> One particularly dangerous entry is the plywood I beam. The marketers of this product are quick to assure owners that they will never be disturbed by squeaky floorboards again. This parallel chord beam, while not a truss, poses the same dangers inherent to any lightweight system, mainly a lack of mass. It consists of a top and bottom chord of 1 ½ inch by 2 inch plywood with a web of 3/8" plywood. Does anybody in the lumber industry have any idea how fast 3/8 inch plywood burns through completely?

McLaughlin (2007) describes a newer type of construction called the metal "C joist" (Figure 2). C joists are lightweight, 12 to 14 gauge, cold-formed steel, approximately 1/16-inch thick formed in a "c" shape, when exposed to fire these joists lose their integrity and fail rapidly.

Dietrich Industries (2006) advertised that C-Joist components provide an economical, lightweight alternative to open web trusses, bar joists, engineered lumber, cast-in-place or hollow core floor assemblies.

Figure 2. Metal C Joist.

Dugan (2007) describes another problem with new construction now being seen in Elyria utilizing gypsum. Dugan defines gypsum as having excellent insulation characteristics. Those characteristics make it a concern to firefighters as the gypsum may hide any evidence of fire attacking lightweight construction materials used to support the roof.

The hazards of gypsum are so great that the New York City Fire Department prohibits its firefighters from performing roof cutting operations on it (Fire Department, City of New York Safety Bulletin 85, 2001).

Additionally, a concern in Elyria is the remodeling of existing older buildings using newer, lighter weight construction methods. In his book, Smith, states that, "the construction industry has the ability to mimic or replicate almost any type of construction aesthetic desired" (Smith, 2007).

Rain roofs illustrated in Figure 3 are also a problem for today's firefighter. As buildings continue to get older their existing roofs begin to show their age by allowing the elements into the building. One way to stop this is by building an entirely new roof utilizing lightweight materials onto the original roof. This type of construction hazard under fire conditions led to the deaths of six New York City firefighters on August 2, 1978 (Dunn, 1998).

There are several buildings located in the City of Elyria which include a rain roof over an existing roofing system. Currently the only way a firefighter in Elyria knows these exist is by word of mouth or the study of a building inspection report if such a hazard is noted.

Figure 3. Photo on the right shows the exterior of a rain roof located on an Elyria building. The photo on the left illustrates the new roof's interior lightweight construction. File Photo.

In discussing the need for preplanning rain roofs Smith (2007) stated, "Once the installation has been completed, it is difficult to know that a rain roof system exists, Pre-planning is paramount, when it is discovered that a rain roof has been installed in your area, the address should be tagged."

It is important to remember that the building stock in your community represents a collection of structures built under a variety of regulations or no regulations at all. Most building code regulations are not retroactive, meaning that buildings do not have to comply with the most current regulations in your community. They are "existing, nonconforming" buildings that may contain a multitude of hazards (Brannigan & Corbett, 2007).

As architects and the building industry continue to create structures that vary in type, design, materials and methods of construction, the fire service must stay familiar with both older

concepts and newer trends. Although certain types of building construction are currently popular with architects, modern practices will inevitably be replaced by newer, more efficient, more cost effective methods (Mittendorf, 1998).

The current practice of designing buildings of lighter materials and substituting geometry for mass has brought about significant strides in the architectural field; it has also brought about significant problems in the field of firefighting (Brannigan & Corbett, 2007).

The change in construction from wood to unprotected lightweight steel in low rise, large area buildings may have the advantage of reducing the fuel contributed to a fire by the structure; however, it may have the disadvantage of increasing the incidence of burning building collapse (Dunn, 1998).

Vincent Dunn (1982) describes how fire effects the metal plates called gussets as follows:

> The metal gusset plate fasteners used in lightweight construction can incorporate wooden members which are 2" wide and 4" deep these wood pieces are connected by a surface fastener called a gusset plate or gang nail. This connector, which is critical to the integrity of the lightweight truss system during a fire, is a piece of sheet metal with many "v" shaped nailing points punched through it. These "v" shaped nailing points fasten only the surface of the 2" x 4" wood truss members.

Dunn further states that during a fire when a gusset plate heats up, it conducts heat to the "v" shaped points which will cause the wood to expand. The wood is then destroyed by pyrolysis, which causes the gusset plate to fall out as shown in Figure 4.

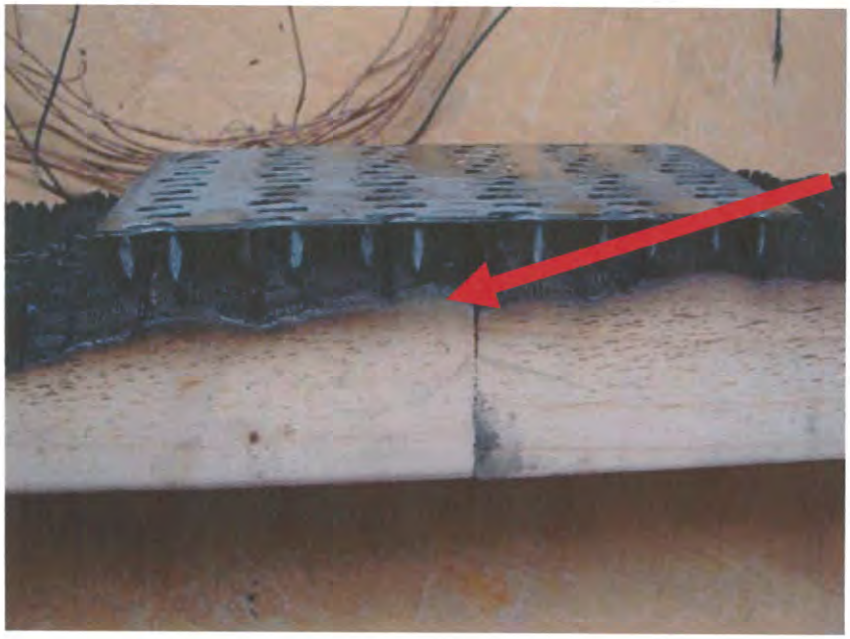

*Figure 4.D*epicts the "v" prongs of a metal gusset plate impinged by fire.

Photo Courtesy of NIST (National Institute of Standards and Technology)

The lightweight wood truss system is being used in the construction of homes and apartment houses throughout the nation at an increasing rate. However, according to engineering calculations and practical firefighting experience, lightweight trussed rafters can be expected to collapse within about 10 minutes (Dunn, 2002).

Elyria has currently gone through a period of growth in the last six years. Many new commercial buildings and residential housing units constructed with lightweight materials have been built since 2000, 66 commercial buildings, 781 single family houses and 100 multi-family garden style apartment buildings have been constructed. (Lahetta, personal communication, May 2006).

Company tours and inspections indicate to Elyria firefighters buildings being built today in Elyria amalgamate some type of lightweight construction to a degree. Firefighters who in the past studied the five classes of building construction now must also add the factor of lightweight

building materials used in those five types, and how they perform under fire conditions (Elyria, Ohio 1999-2006).

Firefighters must remain highly aware of their surroundings, conditions change rapidly and they must recognize the danger signs—fires burning in attics or basements, indications of potential collapse, and respect them (NFPA, 2002).

The following three recommendations mentioned below were just a few of the many detailed by the National Institute of Occupational Safety and Health (NIOSH) in a firefighter fatality investigation report involving a wooden lightweight construction collapse (NIOSH, 2000):

1. Ensure that firefighters are trained to identify truss roof systems.
2. Ensure that firefighters use extreme caution when operating on or under a lightweight truss roof and should develop standard operating procedures for buildings constructed with lightweight roof trusses.
3. Ensure that firefighters performing fire fighting operations under or above trusses are evacuated as soon as it is determined that the trusses are exposed to fire.

Firefighting victims of structural collapse were part of several age groups, experience levels, and ranks and were involved in several activities such as advancing an attack hose line or search and rescue (Brassel & Evans, 2003).

Brassel and Evans (2003) also deducted that 65.08% of duty deaths studied (180 total, not including the 343 Firefighters lost on September 11, 2001 at the collapse of the World Trade Center Towers), were the result of advancing an attack hose line into a building. Firefighters pride themselves for conducting an interior attack, or in other words, stretching a hose line into

the building and extinguishing the fire hopefully, head on. This method of attack has been the standard for departments, especially in the last 40 plus years; since the creation of self contained breathing apparatus which allow firefighters the ability to breathe clean air supplied in a tank on their backs.

Firefighters are trained to protect life and property. To do this requires quick and correct placement of hose lines, and if the condition dictates, this is done by going inside a structure and cutting off the fire before it harms any unburned area of the structure or victims still savable.

Brannigan and Corbett (2007) in discussing risk analysis and why fire fighters go into a building: "When reports of fire fatalities from any type of building are studied, certain questions keep coming to the fore: "Why were those fire fighters where they were? What was the potential benefit from the risks undertaken?" Too often the answers were completely truthful, it might be learned that the real reason was an antiquated macho attitude on the part of fire fighters. This must be changed. Firefighters have been injured and have died unnecessarily in many fires. Taxpayers have been saddled with unnecessary expenses because firefighters were operating in buildings that could not possibly be saved. It may provide a good feeling to say, "We made a fine stop," when fire fighters extinguish a fire in an already half-destroyed structure. However, fire departments are organized to provide a service, not to make people feel good."

> Experts have a firm belief that firefighters, at all levels must be informed professionals:
>
> If the fire service is to be regarded as truly professional, analysis of the relationship between risk incurred and benefits obtained must be undertaken. There are many unavoidable risks in firefighting, and they are all the more reason for the fire officer, who must consider the lives of the firefighters, to be well informed about construction features

of buildings that have been available for study for many years (Brannigan & Corbett, 2007).

A firefighter dies every 18 months in the collapse of a burning building constructed of lightweight wood construction. Additionally, architects and engineers are looked at by firefighters as promoting lightweight construction's use in today's society. (Dunn, 2002).

Mr. Kirk Grundahl a nationally recognized leader in the wood truss construction industry. He states the issue is more with training than it is with the actual hazard of collapse. Pre-fire planning and actual fire ground training are very important in dealing with the destructive power of fire and protecting firefighter lives. Just as tactics have to change when fighting high-rise fires and again for light steel structure fires, new engineered wood products will require different fire ground tactics to meet this fire challenge (Grundahl, 2002).

Brannigan (2007) noted on the need to be educated on lightweight construction:

What is wrong? Over 30 years ago I wrote, you have been warned, "BEWARE THE TRUSS." I have received many honors for "saving fire fighters' lives", but there seems to be no end of truss deaths, and I'm fed up. It is time for straight talk. How many more firefighters must die to get all fire departments to adopt the following policy? As a crash program, survey your area day in and day out to determine every building that has wooden I-beams; unprotected steel; or wood truss floors, roofs, or both. Surveys take time. Train firefighters immediately on how to recognize the types of buildings in your area that are likely to have the hazards listed below:

Enter these *disposable* buildings using a system that will immediately notify responding units if the hazard.

- Required the use of thermal imaging cameras to determine the extent of the fire in roof and floor voids before entry.

- Issue the order that no firefighter are to be under or on burning trusses or wooden I-beams.
- Become aware of the truss floor/stairway hazard that may cause a huge loss of life in residential buildings.
- Don't ignore lightweight steel trusses in the attics of churches or other public buildings.

Not moved to action yet? Ask your local prosecutor about the possibility of a "reckless endangerment of human life" charge in an inexcusable fire fighter death, and pass this answer down to your subordinates. Every fire fighter should beware the truss!

Emery (2004) described a conversation with an engineer regarding trusses:

The engineer asked why the failure of a web member of a truss was a concern of the fire service. I explained that a truck company might want to operate on a roof supported by bar joist trusses to cut a hole to vent heat and smoke. He could not believe humans would operate above a fire, supported by trusses he designs and knows intimately.

McGee (1993) in his National Fire Academy applied research project discussed conversations with his son and another gentleman regarding their lack of any tutoring in their college structural engineering studies concerning the reactions of materials when impinged on by fire. McGee further stated that the conversations with the two architectural engineering students concluded that the fire service is not represented in the training of people that are designing the buildings of the future. So the fire service should not be surprised when architects are not fully aware and understand the concerns of collapse.

Lightweight building components are used extensively as structural members today, and the trend is for greater utilization in the future. Learning as much as possible about their structural and fire performance will only enhance firefighter safety (Grundahl, 1992).

Firefighting requires knowledge of fire behavior and building construction, as well as an understanding of how these two interact to pose a threat to firefighters. Additionally, experience has led to the development of successful tactical practices, procedures, and rule of thumb guidelines for safe working times during offensive interior operations. This experience was based primarily on fires in older buildings of ordinary conventional construction materials (i.e. full-dimension sawn lumber) and techniques. The traditional approach has been that barring total involvement on arrival, in older structures of that type there is generally time to ventilate the roof and windows, enter and search the building, and extinguish the fire prior to the imminent collapse of the structure (Clark, D., et al., 2007).

The 1988 collapse of a bowstring truss roof in Hackensack, New Jersey which killed five firefighters led that State to be the first to enact legislation mandating the marking of buildings to immediately alert firefighters to buildings which utilize truss construction. The idea behind the marking system is to alert firefighters and fire ground commanders of the presence of truss construction, thus enabling them to make strategic and tactical decisions based on protecting their firefighters should the building collapse (State of New Jersey).

Wheeling, Illinois is another municipality after a close call involving a collapse that has adopted an ordinance mandating that buildings utilizing lightweight trusses be marked by a visible, universally known signage. At 0938 hours, the Wheeling, Illinois Fire Department responded to a fire in a 13,000-square foot grocery store, the store was centrally located in an L-shaped strip shopping center in the heart of the community. The building was built in 1961 with

masonry walls and a wooden bowstring truss roof. The first arriving engine encountered a building filled with dense smoke, extensive heat conditions, and what was described as sounds like a train running overhead; the fire was apparently overhead in the structure (MacIssac, C. 1994).

Inconsistent re-evaluation of the fire ground by the Division Officer, Safety Officer, and Company Officers did not take into account the bowstring truss type of construction on the fire building, and the unfamiliarity of most suppression personnel with danger associated with heavy fire involvement in commercial/industrial structures with wooden truss roofs. While most personnel had heard about the dangers, most had not fought a fire of this size involving this type of construction. This caused the perception that the roof would last a long time and would show indications of weakness before failure. In fact, there were minimal indicators the roof would collapse (MacIssac, C. 1994).

The Wheeling Ordinance expressed the need for fire service commanders to recognize lightweight construction and its hazards during the early phases of a fire ground operation; and the need to mark such buildings.

While the Village of Wheeling Ordinance only mandates the marking of buildings whose roofs are constructed of lightweight materials, the State of New York has gone one step further. They have a law requiring the marking of buildings whose roofs and floors and constructed with lightweight materials (State of New York).

Mr. J.G Routley a former fire chief and now a nationally recognized fire service consultant commented on the following issues in an e-mail correspondence regarding marking buildings utilizing lightweight construction to alert firefighters:

"Marking buildings is a band-aid approach; the only buildings we should mark are the ones where there are lightweight trusses in situations where we would not otherwise expect to encounter them" (J. Gordon Routley, personal communication, October 11, 2006).

Routley also emphasized the need for firefighters to have an advanced knowledge of the building before a fire breaks out. They can accomplish this through inspections and occasionally visiting construction sites during the new construction or renovation of a building. Mr. Routely indicated, "I am an advocate of knowing as much as possible about every building where we (firefighters) might have to respond. I would like to have that information in a comprehensive automated pre-fire plan data system that immediately retrieves it and forces an incident commander to look at it as soon as an alarm is transmitted for that location" (J. Gordon Routley, personal communication, October 11, 2006).

Retired New York City Deputy Chief Vincent Dunn stated his thoughts on marking buildings utilizing lightweight trusses in their construction:

> No person would allow you to place a sign on their house. The NFPA 104 diamond placard for industry has an empty space that could be used. The NFPA should include construction hazard on the Diamond, the answer is we should inspect the buildings in our district know which ones are trusses and program them into our computers and the dispatcher should notify first responders. This is better than a placard (Vincent Dunn, personal communication, June 26, 2006).

After the City of Houston, Texas suffered a two firefighter fatality in a fire and subsequent collapse in a fast food restaurant, the department studied a building marking program to alert firefighters to the presence of truss construction. In describing the obstacles of instituting such a program Neal stated:

> Houston was going to implement a program, actually completed it, then decided against it. Too many people wanted to make change after change and wanted too many different types of stickers. Our powers that be decided to take the approach that our city is one that makes (builds) everything new and with trusses. So the assumption is that it has a truss until proven otherwise (Captain T. Neal, personal communication, July 22, 2006).

In May of 2007 the city of Acushnet, Massachusetts passed a by-law requiring the labeling of all commercial and industrial buildings with truss type construction. The Fire Chief, Mr. Kevin Gallagher (2007) stated that trusses are reliable, affordable, pre-engineered and a way to keep commercial construction costs in check.

The Fire Chief can be quoted as stating the following:

The fire service attempts to come up with different ways of driving the figure downward. A renewed focus on firefighter safety and health, improvements in equipment and ongoing training are some of the initiatives designed to save the lives of firefighters. But when two firefighters continue to die on average every week, it is clear that much more needs to be done (Gallagher, 2007).

When we make the choice to go in a fire for whatever reason, the fire will continue to grow according to the laws of combustion, and the building will become increasingly dangerous with each passing minute until we get control or get out (Coleman, 2005).

Summary Statement

The findings of noted fire service leaders and the unfortunate injuries and deaths of firefighters in collapses involving lightweight construction demonstrate that continued knowledge and education is needed on an ongoing basis for firefighters. In addition, the writings

and studies of others find that there must be an improvement in pre-fire planning of buildings which utilize lightweight construction as well as a better understanding of the building industry and their thoughts and feelings on the subject of firefighter fatalities.

The changing face of Elyria, from an old industrial city to a new commercial and residential housing gateway between Cleveland and Toledo is going to reason a modification on training and education in a department which prides itself in aggressive interior fire attack.

PROCEDURES

The desired outcome of this research project was to evaluate the need to better educate the City of Elyria Fire Department personnel on the subject of building construction and its behavior when exposed to fire. In addition to that information, why firefighters attack fires differently depending on the specific construction of a building. The research project gathered and analyzed information which relates to the problem of firefighting operations in lightweight construction, firefighter fatalities in such buildings and how fire departments attempt to safeguard their personnel from the dangers of collapse.

This study used historical, analytical and descriptive research methologies. Research concerning building construction and in particular, lightweight construction hazards under fire conditions, educating firefighters in recognizing these hazards, and publications written by building and architectural experts was accomplished through readings of professional publications and literature.

The research also concentrated on past building construction, firefighting tactics and strategies, firefighting fatality and injury statistics. Additionally, how architects and those responsible for building today's buildings consider the feelings of fire service leaders concerning lightweight construction.

Information was obtained from the Internet, fire service literature, The National Fire Academy's Learning Resource Library, videos, newspapers, Elyria Public Library, and Elyria Fire and Building Departments documents and reports. It is assumed that all books and literature were accurate in their findings because the authors were professionals in the areas of study and highly experienced in their respected fields.

An e-mail correspondence and interview was conducted with a leading fire service author, Mr. Vincent Dunn, retired Deputy Fire Chief for the City of New York Fire Department. Mr. Dunn was involved in a fire on October 17, 1966 in which a first floor collapse of a drug store claimed the lives of twelve firefighters. Upon his arrival at the fire, Mr. Dunn, a Lieutenant at the time, and another veteran fire officer, Lieutenant Joseph Priore reported simultaneously at the command post for assignment. The Chief in command randomly selected Lieutenant Priore's crew to enter the basement of the fire building and Dunn's crew to an adjacent building's basement to check for fire extension. Shortly thereafter, a collapse occurred in the building Priore was in. He was killed along with eleven others.

Dunn was profoundly affected by that evening. Golway (2005) acknowledges that in his book, *So Others Might Live.* Dunn committed himself to education and study in building construction so he could teach firefighters all he could about buildings and why they collapse. Vincent Dunn is the author of several books, articles and is a nationally distinguished lecturer. His comprehension on the subject of building construction and more specifically for this research lightweight construction was the number one reason he was contacted via e-mail for this paper.

Captain Neal, Public Information Officer for the City of Houston, Texas Fire Department was contacted when an Internet search found that Houston was one of the largest cities who have attempted to implement a building marking program labeling buildings which utilize lightweight construction. The impetus behind the marking program was a double firefighter fatality on February 14, 2000 when the lightweight roof of a McDonald's Restaurant collapsed during an after hours fire (Captain Neal, personal communication, July 22, 2006).

Also contacted via e-mail correspondence was Mr. Gordon Routley, a former fire chief and now a fire service consultant Routley completed several studies on firefighter fatalities for

the NFPA. He was directly involved in the establishment of the Fire Fighter Life Safety Initiatives Project for the National Fallen Firefighters Foundation. He is also a member of the Society of Fire Protection Engineers (SFPE), the Institution of Fire Engineers (IFE), the National Fire Protection Association (NFPA) and the Metropolitan Fire Chiefs Association (J. G. Routley, personal communication, October, 11 2006).

One member of the construction industry, Mr. Kirk Grundahl a Fire Protection Engineer who in 1992 authored a report titled, *National Engineered Lightweight Construction Research Project* was contacted to get the building industry's side to lightweight construction and their feelings toward educating firefighters.

The e-mail correspondence focused on their respected feelings on whether today's typical firefighter encompasses enough knowledge on the subject, their feelings towards preplanning systems and if, in their opinion, buildings utilizing lightweight construction should be marked to notify firefighters of their presence.

A survey form (Appendix 1) was disseminated via e-mail utilizing the website surveymonkey.com to 135 firefighters of all ranks from fire departments of all sizes in Ohio. Many of the firefighters were current or former students in the Ohio Fire Executive Program and instructors at the Cuyahoga County Community College Fire Training Academy, located in Parma, Ohio. Others were the Fire Chiefs of all Lorain County, Ohio Fire Departments. The survey also was sent to a few nationally recognized fire service experts and writers, including those corresponded by e-mail. Seventy-five participants responded for a return rate of over 55%.

Because buildings of lightweight construction and the hazards associated under fire conditions are found in virtually every city there was no discrimination as to size or population. The purpose of this survey was to ascertain what other chiefs, firefighters, and fire departments

in general felt about their knowledge of building construction. Particularly, lightweight construction and if the participants' departments have any established education or alerting system, such as building marking in place to warn their fire fighters of the presence of lightweight construction.

It is the nature of the fire service to always gauge the respective department's knowledge base and readiness against those departments similar in size and hazards. But because building construction is universal, department or community size comparables appears to be irrelevant.

Definitions of Terms

Gussets- "Plate that is used to connect the members of a wood or metal truss" (International Fire Service Training Institute [IFSTA], 1999).

Heavy timber- "Buildings constructed with non-combustible or limited combustible exterior walls and floors made of large dimensional lumber". Also known as Type IV construction (Brannigan & Corbett, 2007).

Lightweight wood truss- "A collection of lightweight structural components joined in a triangular configuration that can be used to support either floors or roofs, the components require a fire resistance rating of one hour or more in accordance with the American Society for Testing and Materials [ASTM], Standard E119". (Dennis M. Kovach, personal communication, July 31, 2007).

Open web bar joist- "Normally used as a horizontal supporting member between beams or other structural members, suitable for the support for some roof decks". Retrieved electronically, July 31, 2007 from http://www.dctaylorco.com/knowledge/RoofingDictionary.html#o

Pyrolysis- "The chemical change brought about by the action of heat". (Merriam-Webster, 2007).

Size up- "Evaluation of an incident from inside and from outside a burning building". (Dunn, V., 2007).

Strategy- "Planning and directing large numbers of firefighters, apparatus, and equipment during a fire, a plan of action". (Dunn, V., 2007).

Tactics- "Operations of fire companies at a fire or emergency. For example, hose stretching and ladder raising are firefighting tactics". (Dunn, V. 2007).

Placarding-The placing of a sign or decal on a building alerting firefighters to the presence of lightweight construction.

Ordinary construction- "Structural type in which all or part of the interior structural elements may be of combustible materials or any other material permitted by the particular building code being applied" (National Fire Protection Agency, 1991).

Masonry parapet- "A freestanding wall that continues beyond an exterior wall above the roof level. A parapet wall is waist high and encircles the roof". (Dunn, V., 2007).

Lightweight construction- "Construction using members which require a protective membrane to achieve a fire resistance rating of one hour" (Dennis M. Kovach, personal communication, July 31, 2007).

Limitations of the Study

A basic knowledge of building construction and characteristics of newer incorporated lightweight construction is essential in understanding the inherent risks with firefighting in both older, heavy timber type buildings, as well as today's modern buildings. To fully understand the recommendations of fire service professionals, architectural experts and apply them to situations encountered when confronted with a structure fire, the reader should have some background in how fire affects building construction.

RESULTS

Research question one asked, what has changed historically in building construction, from heavy timber type to modern lightweight construction?

The literature reviewed found that building construction techniques of the early 20th Century focused on mass and economics to craftsmanship. Additionally, fire stopping and fire prevention concentrated on avoiding a conflagration.

Smith (2007) describes modern wood buildings being constructed with nominal lumber whereas in years past, carpenters utilized large pieces of lumber which were cut to the actual size they were described. Example: today's wooden 2 x 4 may only actually be 1 5/8" x 3 ½ inches.

Angle, Gala, Harlow, Lombardo, & Maciuba (2001) in discussing reason for change in the fire service, state that while there have been many changes in building structural materials and the fire load contained within. For example, there are many variations and different types of engineering in building construction and flammable materials commonly found in homes and businesses.

The building industry years ago piled on dead loads without any regard to the consequences, or even in the mistaken belief that strength was being added to the structure by the added weight. Furthermore, modern builder more clearly understands that dead weight breeds more dead weight, and by removing a pound of dead weight at the top of the building enables the builder to reduce ounces at many points in the supporting structure (Brannigan & Corbett 2007).

Research question two asked, what are the hazards of lightweight construction in relation to firefighting?

The research showed that more than 60% of the roof systems in the United States are built using a truss system. By design, wooden truss systems contain a significant fuel load and

are often hidden from sight. Fires in truss systems can burn for long periods before detection and can spread quickly across or through the trusses. Steel trusses are also prone to failure under fire conditions and may fail in less time than a wooden truss under the same conditions.

The research also gathered that the number of firefighter fatalities related to structural collapse could be significantly reduced through proper education and information concerning truss construction.

Dunn (1992) states the following on fire firefighter fatalities: "fires are not predictable; conditions often deteriorate quickly, and fire-damaged building components, including trusses, can collapse with little warning. Engineering calculations provide data for an approximate time of failure under specified fire conditions; however, under uncontrolled fire conditions, the time to truss failure is unpredictable."

Dunn (1998) describes at least three scenarios can occur in which firefighters suffer fatalities and injuries while operating at fires involving truss roof and floor systems:

1. While fire fighters are operating above a burning roof or floor truss, they may fall into a fire as the sheathing or the truss system collapses below them.
2. While fire fighters are operating below the roof or floor inside a building with burning truss floor or roof structures, the trusses may collapse onto them.
3. While fire fighters are operating outside a building with burning trusses, the floor or roof trusses may collapse and cause a secondary wall collapse.

One of the most common structures today is the strip mall built with steel bar joists and metal deck roofs. A serious fire in one of these structures should be expected to produce roof collapse in as little as five to 10 minutes. As such, they too should be attacked from defensive positions. Steel does have one advantage over wood trusses, in that if the steel can be cooled

with hose streams, it will retain and even regain its strength. It is possible to fight a fire in a row of strip mall (Norman, 1998).

White (2002) states the following on wooden I beam construction's early collapse potential. The newer structural components present the potential for two serious types of collapse. The first would be collapse of the local fire area involving the floor, if the spread of the fire is limited. In many situations, the collapse area would be relatively small and localized, about one-half a room. However, collapse of the floor can pull joists out of the walls, precipitating a major collapse.

The literature reviewed showed that lightweight construction materials have made their mark on the building industry and firefighters and those making fire ground tactical decisions must factor the presence of lightweight materials into their size up.

The literature also concluded that a risk-benefit analysis should indicate that firefighters should not risk their lives for protecting property. Some building fires should perhaps be allowed to burn longer and be fought defensively from the exterior rather than risk personnel for offensive interior operations.

Research question three asked, what possible new programs, improvements in training, changes and/or adjustments in fire ground tactics are available to assist the Elyria Fire Department relative to operating in buildings of lightweight construction?

The literature reviewed found that changes in tactics when operating in buildings utilizing lightweight construction occur after two results, firefighter fatalities, or a progressive fire department trying to improve safety and avoid a possibly dangerous situation involving their firefighters against the possible effects of fire on lightweight materials.

One program found in the literature reviewed was building labeling. Building labeling or placarding as it is also referred to in this paper, is a program where a small label or placard is attached to the exterior of a building warning firefighters of the presence of lightweight construction.

In its educational CD for the fire service, the Carbeck Structural Components Institute (2005) states that the use of building labeling must be used to help, rather than mislead firefighters. The CD also states that the structural component industry advocates the aggressive use of pre-fire plans and if the use of placards are considered, they should reference all forms of construction equally (see Appendix 3) for the building components industry's suggested building labeling example .

In the information identified in the literature reviewed and the information from the e-mail correspondences, building labeling, or placarding, to be successful needs to be coupled with an aggressive training and information program.

The literature reviewed also found that while the building industry does not necessarily oppose the labeling of buildings it does advocate that all types of construction including trusses be labeled for firefighter's safety.

The literature and correspondences concluded that the labeling of buildings has come after a close call involving firefighters or the actual deaths of firefighters due to a structural collapse.

A survey (Appendix 1) sent out to 135 firefighters was used to gauge how firefighters around Northern Ohio felt in regards to lightweight construction. The results of this survey parallels what is happening in Elyria, Ohio. It was, indeed, concluded that close calls with

lightweight construction under fire attack have occurred, and departments have no procedures either in dealing with or alerting firefighters to the presence of lightweight construction.

A large percentage of firefighters in the survey felt they do understand lightweight building construction and its hazards, yet the fire service still loses firefighters to collapse of such structures.

The following are the results of the survey. Of the 135 surveys sent out electronically, 75 respondents returned their surveys. This was a return rate of 44%.

Survey Question 1: Has your department ever experienced a close call in regards to a lightweight truss collapse?

Figure 5 depicts the results of this question in charted format. The survey shows that out of the 75 returned surveys, 40 percent have experienced some type of close call involving the collapse of a lightweight constructed building.

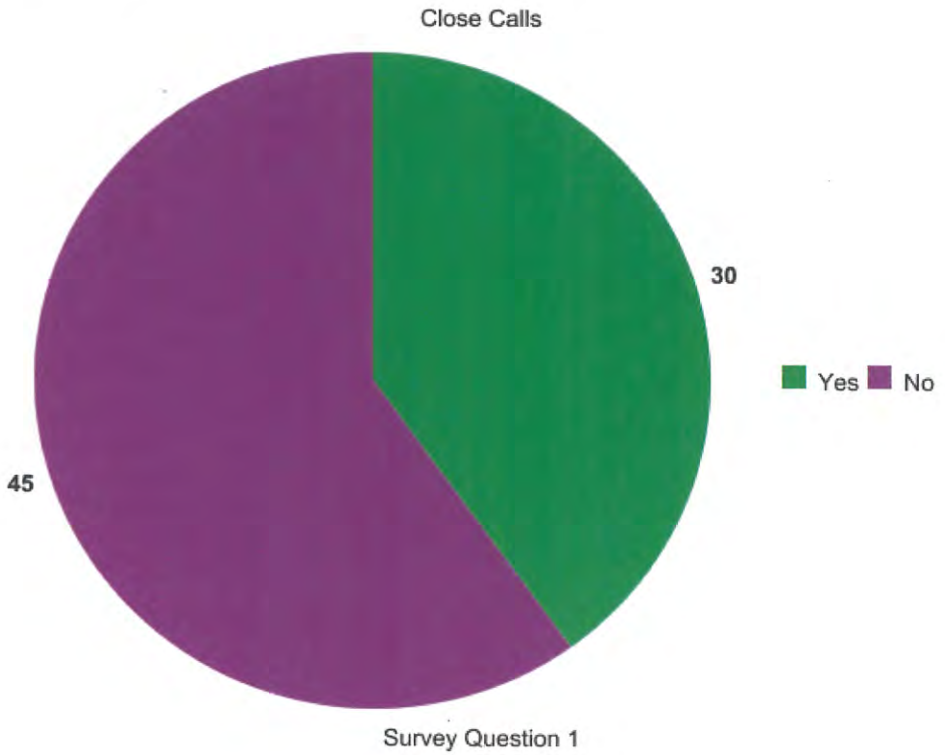

Figure 5. Results of Survey Question 1.

The survey did not separate what type of incident occurred or why it occurred. But the research conducted by the near miss reporting system sponsored by International Association of Fire Chiefs does indicate that a large percentage of injuries and fatalities occur because of human error.

An additional resource is indicated in the chart below. Figure 6 depicts a chart detailing the reasons for near misses at all emergency events reported by Tippett (2007) from the *Firefighter Near Miss Reporting System Group.* This group's prime focus is collecting information directly from firefighters involved in near fatal or serious injury causing incidents and using their experiences as a learning tool for the fire service community.

The graph clearly shows that in a study of 250 reports submitted by firefighters having a near miss at a structure fire, 202 reported that situational awareness was lax and perhaps was a contributing factor to the near miss. Additionally, 164 of the 250 also included fire ground decision making to be a factor.

More than 75% of all the near miss events listed on the near miss reporting website involving structural collapse, point to some type of personal error leading up to the event. That could be situational awareness, communication, or decision making failures.

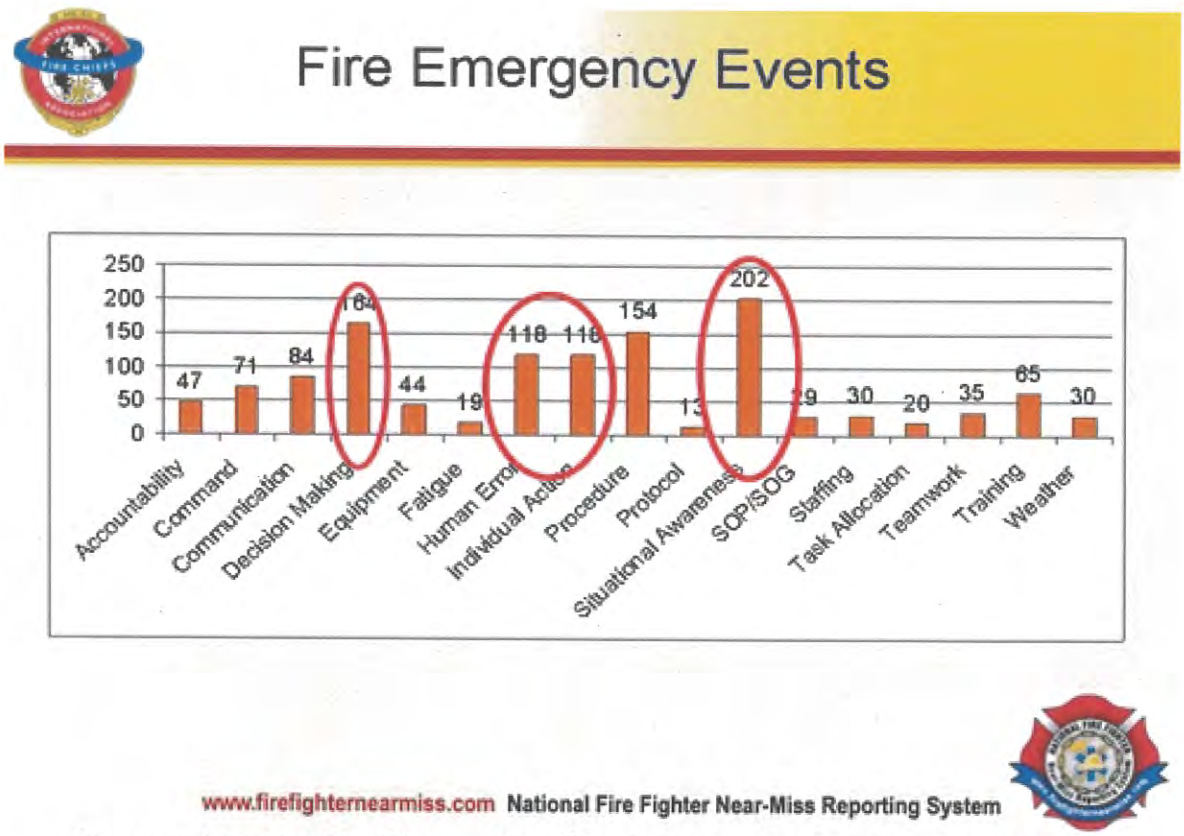

Figure 6. National Fire Fighter Near-Miss Reporting System. Tippet (2007).

Survey Question 2: Does your department have a standard procedure or guideline for fire attack in buildings constructed with lightweight trusses?

Figure 7 depicts a chart of the results. The survey showed that the Elyria Fire Department is not alone on failing to have a specific procedure dealing with lightweight construction. The majority of departments in Northern Ohio do not have a specific procedure or guideline for attack in buildings constructed with lightweight trusses.

However, a procedure from the Fire Department, of the City of New York (2001) shows the ability of a large department with a myriad of hazards to highlight the dangers of lightweight construction in many of its procedures for its 12,000 firefighters. The survey did not elaborate or ask specifics on why a department does not have a procedure in place dealing with the hazards of lightweight construction.

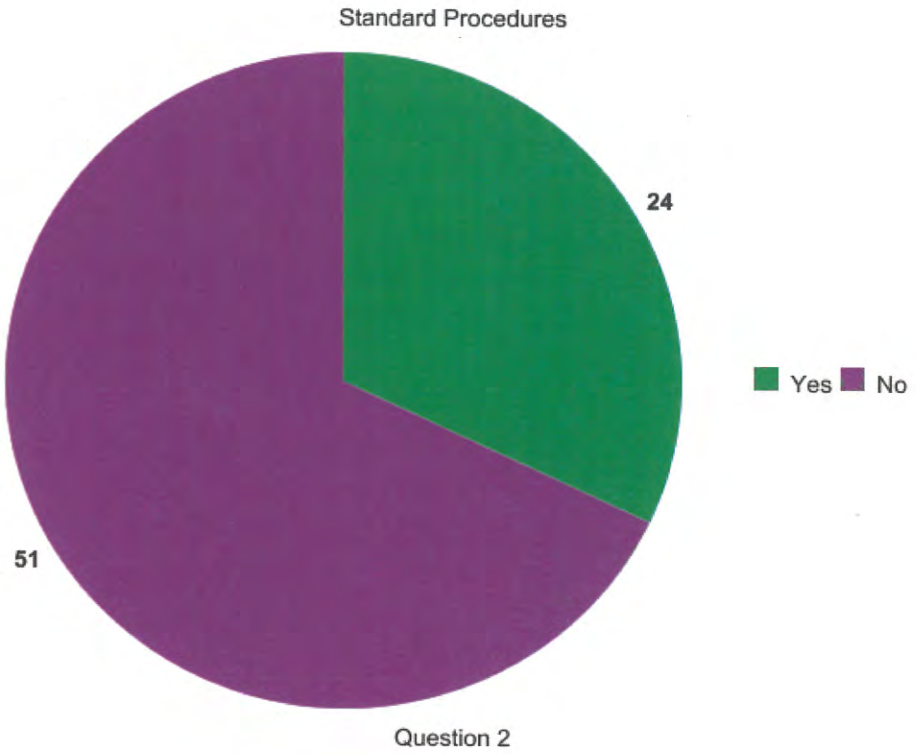

Figure 7. Results of Survey Question 2

Survey Question 3 asked, does your department conduct training on the topic of lightweight building construction at least one time per year?

Figure 8 depicts a chart of the results. The survey is not indicative of what type of training was received. As stated previously in this paper both the construction industry and fire service agree that training firefighters in lightweight construction is the key to increased safety and awareness.

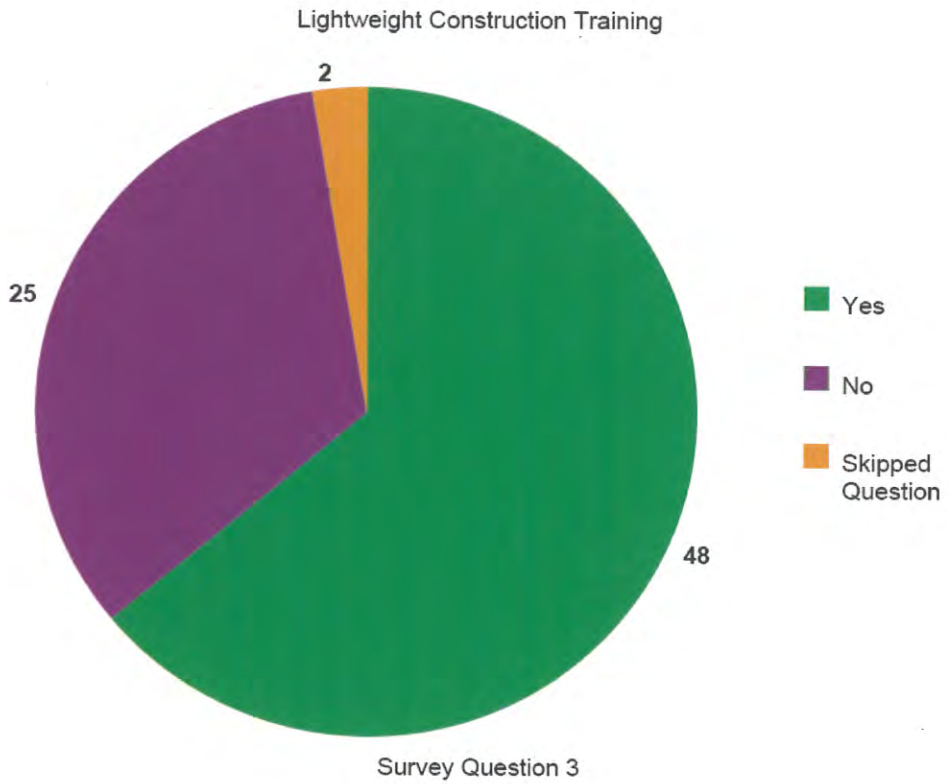

Figure 8. Results of Survey Question 3.

Elyria Fire Department members receive no formatted training on building construction. The last recorded formal class was 1991 when an instructor from the Cleveland, Ohio Fire Department, Mr. Jeff Shupe gave a three day lecture on building construction and fire spread.

NFPA (2002) report on structural fire fatalities from 1977-2000 clearly emphasizes the distress on the lack of proper training by stating the following:

There is a growing concern in the fire service related to whether firefighters and fire officers receive the degree of training and experience necessary to properly assess the risks on the fire ground. If the number of structure fires is decreasing, how in fact do firefighters and fire officers gain the experience to understand fire progression, fire behavior, and what happens to the structural integrity of a building under fire conditions?

Survey Question 4 asked, does your department have a system or program alerting fire personnel of buildings with lightweight construction?

Figure 9 depicts a chart of the results; the survey shows few departments having any type of alerting device (i.e. building labeling). The City of Elyria Fire Department Standard Operating Guideline 2.1.2 (2002), does state that the Incident Commander shall notify all personnel via radio if the building on fire is known to be constructed with lightweight materials.

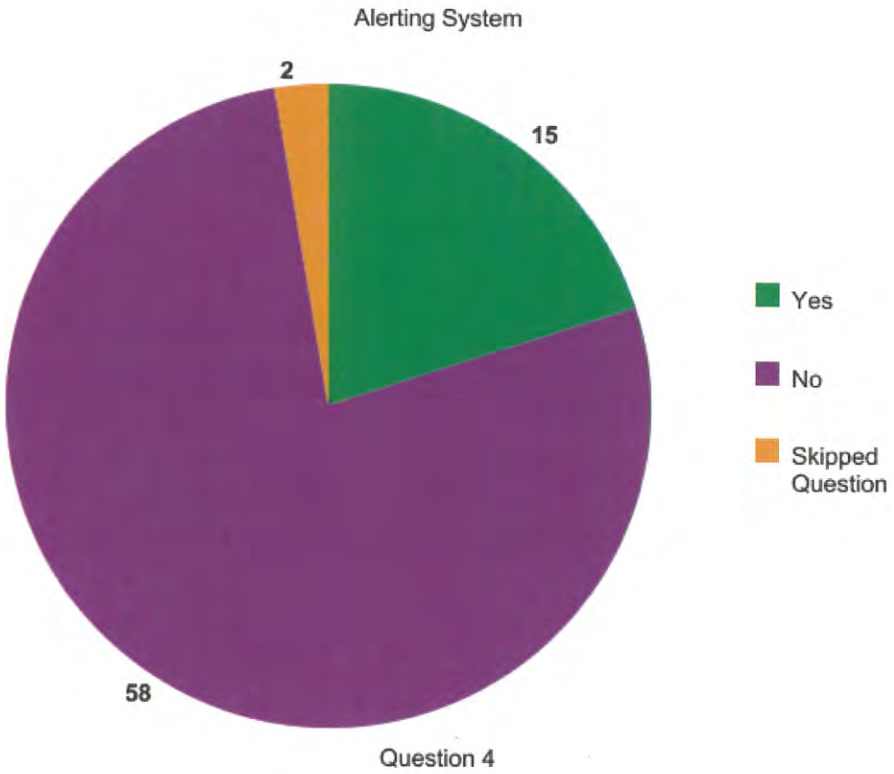

Figure 9. Results of Survey Question 4.

The current disadvantage of this procedure is relying on the Incident Commander being absolutely sure the building utilizes lightweight construction. In fact, the words absolutely sure are highlighted for emphasis in the Guideline. It also relies on the Incident Commander

communicating his knowledge. As shown in Figure 5, communication errors were noted in 84 of the 250 near misses reported to the Near Miss Reporting System's website.

Survey Question 5 asked, do you feel comfortable with your knowledge in recognizing light weight truss construction and its hazards under fire conditions?

Figure 10 depicts a chart of the results. This survey question may show that education and the multitude of learning opportunities available to firefighters today whether through tactical books written by fire service professionals or line of duty death reports is beginning to help alert firefighters to the hazards of lightweight construction and the hazards of fire upon it.

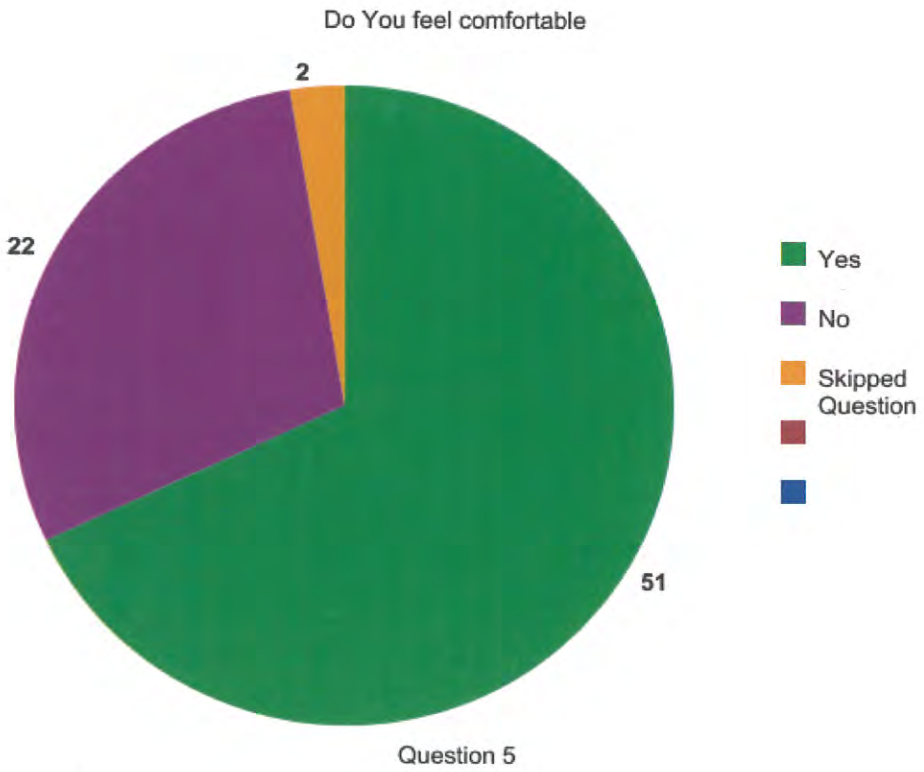

Figure 10. Results of Survey Question 5.

Emery (2004) feels that an uninformed, uneducated, overly aggressive fire ground officer is the most dangerous factor in a fireground operation.

Also the mass media availability to display video, newspapers articles, investigations, websites, etc. assist in the dissemination of fire department critiques involving any fire ground fatality. The heavily publicized prosecution of a fire ground commander in Canada involved in a lightweight construction collapse which killed two firefighters also assisted in increasing the knowledge base of firefighters in lightweight construction as multiple media outlets in the fire service commented and pushed for additional training based on this one event.

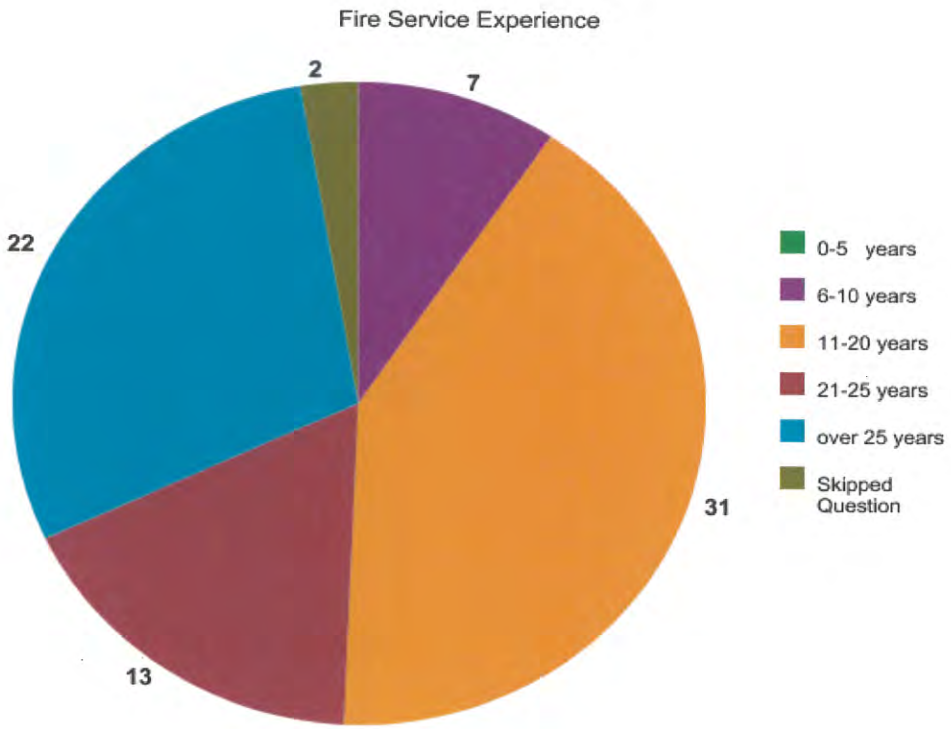

Figure 11. Results of Survey Question 6.

Survey Question 6 asked, how long have you been a member of the fire service? Figure 11 depicts a chart of the results. The National Institute of Standards and Technology Report (NISTR) *Trends in Firefighter Fatalities Due to Structural Collapse* 1979-2002 includes the following graph (Figure 11) on the experience level of firefighters who died in

collapsed structures from 1979-2002. The largest category among professional firefighter fatalities mirrored the largest experience age group of respondents in the survey.

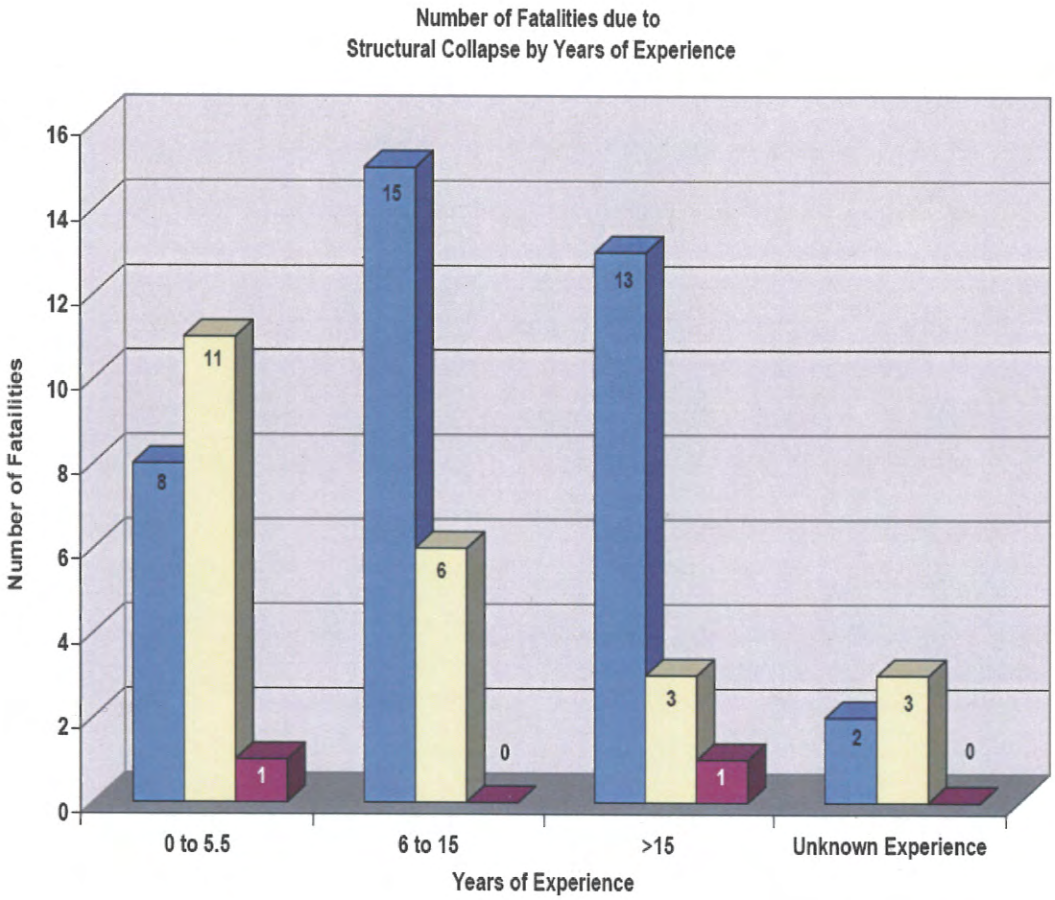

Figure 12. National Institute of Standards and Technology Report (NISTR) graph indicating the years of experience of firefighters killed in collapses (NISTR, 2002).

DISCUSSION

The methods of construction are a discipline that will be continuously defined and redefined at a rate that the fire service will find difficult to keep up with as far as new training methods and strategies to combat the effects fire on it.

Fire suppression considerations must reflect building information knowledge and if applicable, lightweight truss identification obtained from fire department conducted inspections and

Today's society places a huge emphasis on speed, whether it's getting on the internet or going through a fast food restaurant's drive through, people want their goods and services immediately. The construction industry is no different and has developed lightweight construction methods to satisfy those time requirements.

Time is money is a phrase heard many times in the building trades, and any effort to reduce the speed of which buildings are erected because of tougher enforcement or the altering of laws to mandate the use of densely made lumber products and steel will be a very difficult battle to wage against the building industry.

Brunacini (1985) stated in regards to aggressive interior attack, place the first stream between the fire and any persons endangered by it, protect the victims first then protect their means of escape. When no life is endangered, place the first line between the fire and the most severe exposure.

Since the majority of the commercial and housing stock in the city was built before the advent of lightweight construction (pre-1960), the attack mentioned in the previous paragraph is the standard operating procedure in the Elyria Fire Department. Construction methods utilized in the city in the earlier part of the twentieth century were heavy timber which, because of the

density of the wood, allowed for this type of attack, the wood took a longer period of time before collapse was a worry under fire conditions.

The survey sent out to the 135 firefighters and chiefs did indicate that even though the majority feels secure in their individual knowledge of lightweight construction, Elyria Fire Department as well as other departments must devise a better way to educate their members and notify them of the presence of lightweight construction during a fire event. The survey also indicated that procedures on fire attack in lightweight constructed buildings need to become a standard in fire departments; this is confirmed by many NIOSH reports detailing firefighter fatalities in collapses.

During a live web cast on Firehouse.com July 12, 2007 the lecturer, Captain Michael Dugan from the New York City Fire Department stated that in having a conversation with a manager of a large franchise fast food restaurant he was told that the building did not have any fire insurance. When questioned further the manager stated that the corporation takes into account that they will lose a percentage of buildings per year to fire and that the buildings, which are widely known by firefighters to be more constructed with lightweight materials are considered *disposable* by the corporation. If a large corporation considers its buildings to be disposable, the fire service must take a more defensive approach to attacking fires in these structures. If they do not care enough to place insurance on such buildings why are we risking our firefighters?

Murphy (2007) in a Fire Engineering article stated the following relative to new building materials:

> As the use of pre-engineered lightweight construction techniques increases, the fire service must reconsider its aggressive attack strategy. If there is no life safety threat, the

surround and drown defensive (SADD) mode is appropriate. The insurance industry also needs to better understand that the fire department SADD tactical approach to pre-engineered lightweight construction may become more common when it comes to what the fire service refers to as *throw-away* buildings which can be defined as quickly assembled buildings comprised of modular components, many of which are lightweight; the building will never qualify as a structure with landmark status.

On June 18, 2007 the City of Charleston, South Carolina suffered the loss of nine firefighters when the roof of a sofa warehouse collapsed, while an official investigation has not been completed and published, some fire service information web sites refer to the lightweight construction of the building as a contributing factor to the deaths.

Charleston is a city much like Elyria although on a larger scale, it too has a strong mix of old and new buildings. The Charleston Firefighters went in conducting an aggressive offensive attack and the roof collapsed in less than thirty minutes, Menchaca, R., Bartelme, T. (2007) stated the initial call came in at 1911 hours and by 1930 flames had engulfed most of the building and the roof had collapsed (appendix 2).

Menchaca, R., Bartelme, T. (2007), quoted Charleston Assistant Fire Chief Larry Garvin as saying that when he went into the burning store he observed smoke coming from the ceiling tiles. Menchaca, and Bartelme also stated that an April 2006 Charleston's Fire Department inspection report on the sofa warehouse did not affirm anything on the roof construction of the warehouse.

Chief Garvin also was quoted by Menchaca, R., Bartelme, T., (2007) as saying that he didn't know if his members knew the sofa warehouse's roof was supported by lightweight steel trusses regardless of the lack of such information being acknowledged on an inspection report.

On Sunday July 1, 2007 Menchaca, R. (2007), on the nine firefighter fatalities in Charleston, South Carolina June 19, 2007, stated, "Charleston firefighters were often told in training that they weren't doing their jobs if a newspaper photographer snapped their photo at a fire scene. That meant they were standing outside the burning building, rather than attacking the blaze head-on".

To control aggressive firefighting, fireground commanders must be disciplined to observe the building involved and have the training in building construction and fire spread to make the correct decisions involving their firefighters. There is no doubt that this tragedy will once again put a match to the fire service to evaluate how the fire service trains and attacks fires in buildings of lightweight construction.

One town who has already evaluated their lightweight construction procedures and knowledge prior to the Charleston tragedy is Acushnet, Massachusetts. This town should be a shining example to Elyria, Ohio and any community for that matter in working to get a labeling system passed and enacted upon. On May 21, 2007 at a town meeting, voters approved the by-law requiring the labeling (Figure 13) of commercial and industrial properties with truss type construction.

Figure 13
Acushnet, Massachusetts building label indicating the presence of truss construction. Photo: Provided by Chief Kevin Gallagher, Acushnet Fire Department.

It is the hope of this project to bring to light to the department administration and city officials that with all the new construction, development and revitalization, a new thought process on fire attack must be embedded into the minds of fireground commanders and firefighters. The future firefighter will need every advantage they can get when battling fires in the future. Labeling can help, but education is also the key.

All firefighters endanger themselves and others when they fail to study and understand building construction. It is worth reemphasizing that firefighter's can die when they fall short in understanding construction elements and the fire conditions under which they are likely to collapse.

If there is any crime of oversight that has been repeated through decades of modern firefighting, it is the fire commanders' and firefighters' lack of understanding on the effect of gravity on a building.

Chief officers, company officers, and all firefighters are responsible for a size-up en route and on arrival at a fire scene. One part of the size-up relates to the building's type of construction and the likelihood of fire spread.

In addition to the fire spread risks and collapse hazards associated with each type of construction, firefighters should also be aware of other potential hazards associated with the type of construction. A firefighter fails if he operates on a peaked roof unaware of its inherent risks. A firefighter can meet disaster in failing to understand the dangers of masonry parapets. The firefighter must also be familiar with the effect of wind and weather conditions on a structure.

Comstock & Maxwell, (2004) acknowledged that "Informative texts, publications, and seminars are available for all members of the fire service to learn the simple principles of

building construction that will keep them alive while operating on a fireground. But a firefighter who wants to die will never consult any of them"

RECOMMENDATIONS

The research and survey process indicates that much has been written on the subject of building construction related to the fire service and Elyria's firefighters' obligation to be well-informed if they are to be safe when conducting fire attack.

The recommendations to enlighten Elyria's Firefighters will be a two-pronged approach. One will involve the training of Elyria Firefighters, and the other will include multiple agencies and organizations to begin the process of labeling or placarding of buildings utilizing lightweight construction.

Training

The recommendation of training all Elyria Firefighters utilizing the curriculum based on the International Fire Service Training Association's *Building Construction Related to the Fire Service* 2nd Edition 1999. The Elyria Fire Department currently has seven State of Ohio certified fire service instructors. These members can assist the full time Training Officer in coordinating shift training involving classroom lessons as well as site visits of buildings utilizing lightweight construction.

The department should also evaluate the feasibility of utilizing the National Fire Academy Outreach Program on Building Construction utilizing an interactive study guide; this guide may be found at www.woodaware.info.

Other training methods should include the development of a procedure mandating the dissemination to all Elyria Fire personnel information on any buildings utilizing lightweight construction found during the building plan review conducted by the Elyria Fire Department's Fire Prevention Bureau. All buildings before an occupancy permit is issued must have a building plan review approved by the City of Elyria Fire Marshal.

In addition to the improvement of communications between the Elyria Building and Fire Departments, the establishment of Elyria Fire Department building inspection forms specific in identifying those structures utilizing lightweight construction methods.

An additional recommendation to improve the knowledge base includes the use of digital cameras already procured by the City of Elyria, to take pictures of buildings in the city under construction or renovation. A file can then be kept and reviewed as needed by the department members at any time.

The utilization of a building preplanning program should begin based on recommendations from the National Fire Protection Agency's Standard 1620: *Recommended Practice for Pre-Incident Planning 1993.*

All Elyria Fire Department members who may act in the role of Shift Commander shall participate in a Safety Officer course based on NFPA 1521 *Standard for Fire Department Safety Officer*. Part of the curriculum for that course includes a major emphasis on building construction.

The fire officer promotion process in the Elyria Fire Department is a two-part process in which the firefighters eligible to take the promotional exam take a two hundred question multiple choice written examination. If the examination is passed successfully the candidates are then interviewed by a promotional testing company. The Fire Chief in the City of Elyria is responsible for selecting the reference material for the examination. As of 2007, the promotional examination for Assistant Fire Chief did not include any type of reference material in which building construction is covered in depth (City of Elyria, Ohio 2006).

Future examinations should have reference materials in which building construction, especially light weight construction and its effects under fire are reviewed in detail. This is one step towards better educating Elyria Firefighters, especially future fire ground commanders.

The Elyria Fire Department as well as all other Lorain County Fire Departments receives a majority of its emergency calls through a central 9-1-1 dispatch center. This center utilizes the latest technology in dispatching, and the Elyria Fire Department should work with the dispatch center to utilize the center's ability to send building information to the department's computers.

Once the program is working, any address reporting a fire utilizing lightweight materials previously identified by the department can have that information sent immediately to the Elyria fire ground commander's vehicle computer.

Chief Timothy Sendelbach (2003) states in a Firehouse website article that fire service building construction veteran Francis Brannigan once said, "There is no substitute for the fire department developing a system of accumulating and organizing information for retrieval at the time of the fire. This situation is analogous to military intelligence. It is vital to know the disposition of the enemy." Knowing your enemy is a rule every firefighter and fireground commander should live by. No fireground can ever be made entirely safe, but it goes without saying, if we know the enemy up front the odds of winning the war are dramatically increased in our favor.

Labeling or placarding of buildings

The steps involved in creating a system where commercial buildings utilizing lightweight construction include the coordination of the City of Elyria's Building, Fire, and Law Departments. The first step is for the Fire Department to create a detailed procedure on how the

process will take place; discussions with the city's head building official and Elyria City managers such as the Director of Public Safety (Appendix 3).

It will be important to note to all those involved that the proposed ordinance will not impact residential properties. Many houses in the City of Elyria have lightweight materials in their construction, while a concern when exposed to fire, does not present the same extent of hazards found in commercial buildings.

That being said, part of this program should include the education of residents and the encouragement that they place the label on their homes. The City in the past has successfully initiated programs where homes are marked in a non-mandatory way indicating children and invalids living within. This program should follow the same context.

The next step in this recommendation will include the drafting of a sample ordinance (Appendix 3). This will need to be done with the assistance of the Law Department, and the education of City Council members who will have to vote on the proposed ordinance and refer it to the Elyria City Council Safety Committee who will review the ordinance. If it is approved, the proposal will be referred back to the Council for a final vote. The ordinance must go through three readings of council unless it is passed on the first reading as an emergency.

The financial implications of a marking system will also need to be investigated. Many non-profit and civic organizations should be utilized to assist financially with this project.

The final goal is to have a decal affixed to the building, inconspicuous to those who utilize on a regular basis, but at the same time immediately known to firefighters responding. This system coupled with the training curriculum will assist Elyria Firefighters in making the correct tactical decisions when confronted with lightweight construction.

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APPENDIX 1 – SURVEY RESULTS

Survey Results sent via email to 135 firefighters around Northern Ohio and also to several nationally renowned fire service authors, lecturers, and Fire Chiefs.

1. Has your department ever experienced a close call in regards to a lightweight truss collapse?

	Response Percent	Response Total
Yes	40%	30
No	**60%**	**45**
Total Respondents		**75**
(skipped this question)		**0**

2. Does your department have a standard procedure or guideline for fire attack in buildings constructed with lightweight trusses?

	Response Percent	Response Total
Yes	32%	24
No	**68%**	**51**
Total Respondents		**75**
(skipped this question)		**0**

3. Does your department conduct training on the topic of lightweight building construction at least one time per year?

	Response Percent	Response Total
Yes	**65.8%**	**48**
No	34.2%	25
Total Respondents		**73**
(skipped this question)		**2**

4. Does your department have a system or program alerting fire personnel of buildings with lightweight construction?

	Response Percent	Response Total
Yes	20.5%	15
No	**79.5%**	**58**
Total Respondents		**73**
(skipped this question)		**2**

5. Do you feel comfortable with your knowledge in recognizing lightweight truss construction and its hazards under fire conditions?

	Response Percent	Response Total
Yes	**69.9%**	**51**
No	30.1%	22
Total Respondents		**73**
(skipped this question)		**2**

6. How long have you been a member of the fire service?

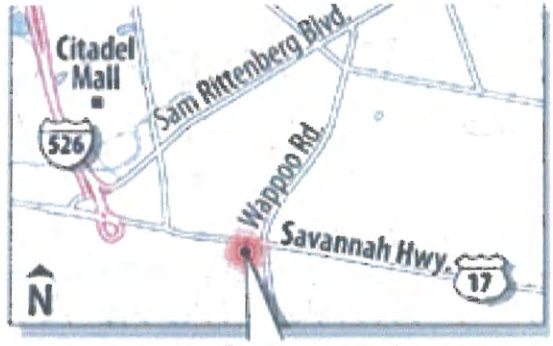
	Response Percent	Response Total
0-5 years	0%	0
6-10 years	9.6%	7
11-20 years	**42.5%**	**31**
21-25 years	17.8%	13
over 25 years	30.1%	22
Total Respondents		**73**
(skipped this question)		**2**

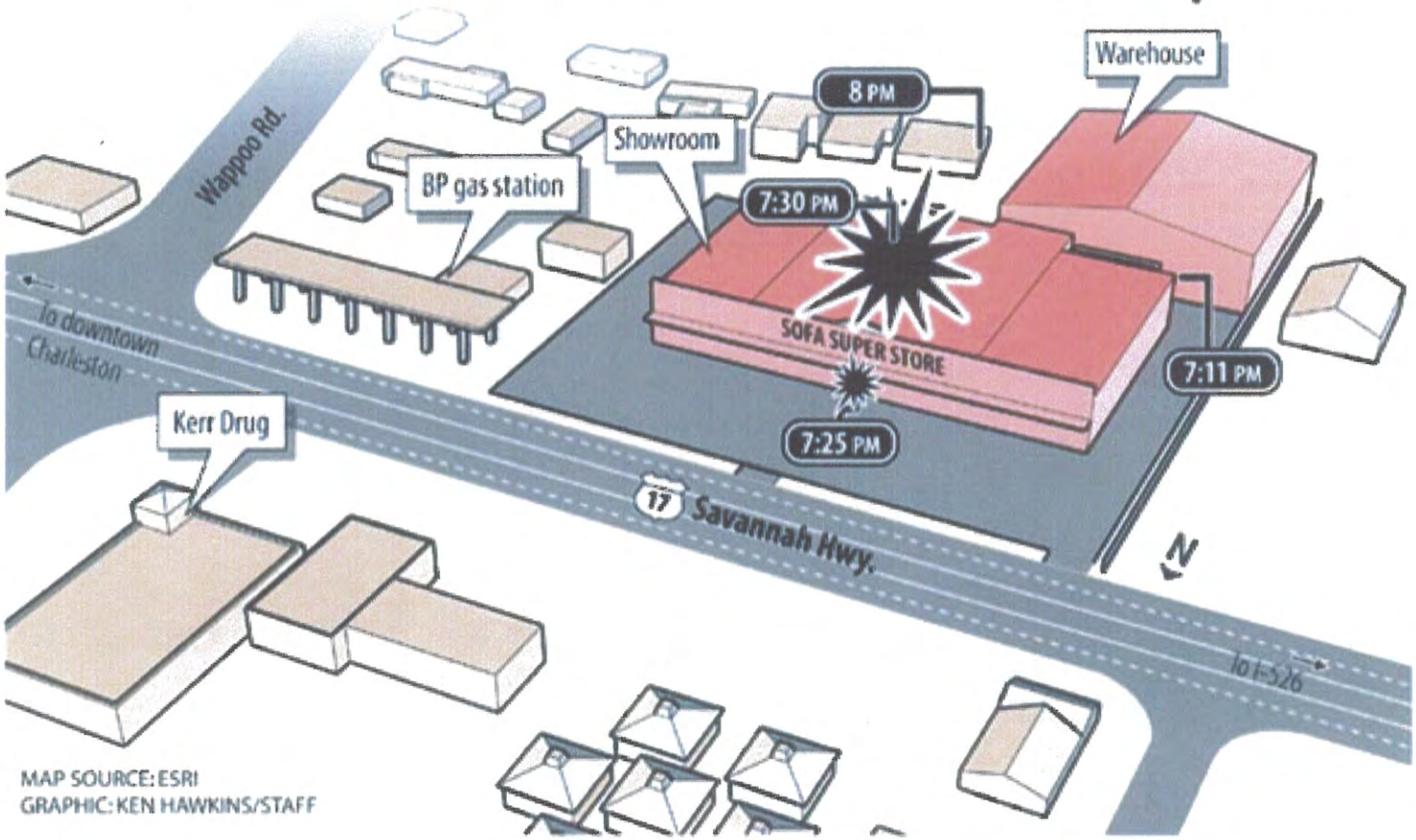
APPENDIX 2 – CHARLESTON GRAPHIC

Collapse Graphic compiled by (Menchaca, R., 2007) displaying the time line involved from the time of alarm to actual collapse at a Charleston, South Carolina furniture store which killed nine firefighters.

Collapse in 30 minutes

Firefighters arrived at the scene at 7:11 Monday evening and noted no fire inside the building, but by 7:30 the showroom was engulfed and the building's ceiling had collapsed. Here's a rundown of what happened (note that most times are approximate):





MAP SOURCE: ESRI
GRAPHIC: KEN HAWKINS/STAFF

7:00 p.m. Monday
Charleston firefighters are called to Sofa Super Store at 1807 Savannah Highway.

7:11 p.m.
Firefighters arrive and begin fighting a fire in a trash bin outside the store, between the showroom and the warehouse behind the showroom. They find no fire inside either building.

7:15 p.m.
The fire spreads to the showroom porch and blows in through a back door. Fire shoots up the sides of both buildings and reaches inside, igniting furniture. Sofa Super Store employee Jonathan Tyrrell III is trapped in a workshop in the warehouse and calls 911 for help.

7:20 p.m.
As firefighters ax through the wall of the warehouse to rescue Tyrrell, firefighters begin attacking the fire inside the showroom.

7:25 p.m.
A rolling ball of gas and fire sweeps through the building, overcoming firefighters. At least two of them leap through the front windows of the store to safety. Firefighters call for help, and a "mayday" call is issued. One firefighter can be heard praying. Another says, "Tell my wife I love her."

7:30 p.m.
The front of the massive showroom building collapses and sends a burning ball of smoke and debris shooting across the street over the top of fleeing firefighters. Hundreds of onlookers are showered with hot ash. Fire shoots more than 30 feet into the air and portions of the roof begin to collapse.

8 p.m.
As flames build, residents start to worry about the neighborhood. Firefighters spray water on three adjacent houses. The heat melts the vinyl siding on one.

8:30 p.m.
Hundreds of firefighters from around the region are on the scene to help.

10 p.m.
The Sofa Super Store buildings lay in a smoldering heap of rubble. The remains of two firefighters are found near the center of the building.

10:45 p.m.
It begins to rain as Charleston Mayor Joe Riley announces in a news conference that several firefighters are missing.

11 p.m.
Two more firefighters are found about 30 feet away from the first group.

11:15 p.m.
Three firefighters are found at the south end of the building.

4 a.m. Tuesday
Rescue workers find the last two firefighters at the northeast corner.

TIMES PROVIDED BY CHARLESTON FIRE DEPARTMENT

APPENDIX 3 – RECOMMENDED POLICIES

1) Recommended Language provided by the National Institute of Occupational Safety and Health for the labeling of building utilizing lightweight construction.

2) Currently Enforced Elyria Fire Department Standard Operating Guideline 2.1.2. *Fireground Safety/Risk management.*

3) Proposed Elyria Fire Department Standard Guideline detailing a building labeling program.

4) City of Elyria Fire Proposed Truss Signage.

5) City of Elyria, Ohio proposed truss signage ordinance.

EXAMPLE LANGUAGE FOR A LAW REQUIRING LABELING OF BUILDINGS FOR THE FIRE SERVICE

This sample language is based on recommendations in the National Institute for Occupational Safety and Health (NIOSH) report entitled "NIOSH Alert: Preventing Injuries and Deaths of Firefighters due to Truss System Failures." The report states:

> "Consider placing building construction information outside the building. Include information about roof and floor type…[1]

The NIOSH report also recommends as part of pre-fire planning to:

> Record data regarding roof and floor construction (e.g., wooden joist, wood truss, steel joist, steel truss, beam and girder, etc.) [NFPA 2003].[2]

The sample language below provides building labeling that identifies the building's construction type, is simple yet logical, and should allow firefighters to quickly know the building's floor and roof construction materials, promoting better and more complete information on the fireground and increased firefighter safety.

xxx Identification of structural construction. Structural construction types shall be identified by a sign or signs, such as that shown in Figure 1, in accordance with the provisions of this section.

Figure 1

xxx.1 Signs. Signs shall be affixed where a building or a portion thereof is classified as Group A, B, E, F, H, I, M, R-1, R-2, R-4 or S occupancy. The owner of the building shall be responsible for the installation of the sign.

xxx.2 New buildings and buildings being added to. Signs shall be provided in newly constructed buildings and in existing buildings where an addition that extends or increases the floor area of the building. Signs shall be affixed prior to the issuance of a certificate of occupancy or a certificate of compliance.

xxx.3 Existing buildings. Signs shall be provided in existing buildings. Signs shall be affixed within ninety days of being notified in writing by the Code Enforcement Official.

xxx.4 Contents of signs. Signs shall consist of a diagram (see Figure 1) 6 inches (152.4 mm) in height and width, with a stroke width of ¼ inch (6.4 mm). The sign background shall be reflective white in color. The diagram and contents shall be reflective red in color, conforming to Pantone matching system (PMS) #187. Where a sign is directly applied to a door or sidelight, it may be a permanent non-fading sticker or decal. Signs not directly applied to doors or sidelights shall be of sturdy, non-fading, weather resistant material.

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[1] National Institute for Occupational Safety and Health, "NIOSH Alert: Preventing Injuries and Deaths of Fire Fighters due to Truss System Failures," p. 10.

[2] Ibid., p. 8.

xxx.5 Identification of construction classification. Signs shall contain the roman alphanumeric designation of the construction classification of the building, in accordance with the provisions for the classification of types of construction (types I through V) of the building code. The roman numeral designating construction classification shall be 1 inch (25.4 mm) minimum in height and have a stroke width of ¼ inch (6.4 mm) minimum, and it shall be reflective white in color on a background of reflective red.

xxx.6 Identification of year of construction. Signs shall indicate the building's year of construction or major reconstruction. The arabic numeral indicating year of construction shall be 1 inch (25.4 mm) minimum in height and have a stroke width of ¼ inch (6.4 mm) minimum, and it shall be reflective white in color on a background of reflective red.

xxx.7 Identification of structural construction types. Signs shall contain the alphabetic designations identifying the structural construction types used in the building, as follows:

"W" shall mean sawn joist/rafter construction, wood members

"I" shall mean engineered I-joist construction, wood members

"S" shall mean steel construction

"T" shall mean truss type construction[3]

"C" shall mean concrete construction

Figure 2

The construction type of the building's floors shall be indicated by placing the appropriate designating letter or letters in the lower portion of the diagram, and the construction type of the building's roof shall be indicated by placing the appropriate designating letter in the upper portion of the diagram, as shown in Figure 2. The designating letters shall be 2 inches (50.8 mm) minimum in height and have a stroke width of ½ inch (12.7 mm) minimum.

xxx.8 Location. Signs shall be placed at each entry of the structure used by the general public for entrance. The sticker/decal shall be placed on the glazing on the leaf of the entrance door, or on its sidelights, where applicable. Where no such glazings exist at the entrance, an aluminum plaque backer shall be installed in the same region as that where a sidelight would be permitted. The sign shall be at least 42 inches above grade but less than 60 inches. When installed on other than the door leaf, the sign shall be applied to the glazing/plaque within 8 inches of the door leaf.

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[3] Truss type construction is defined as a fabricated structure of wood or steel, made up of a series of members connected at their ends to form a series of triangles to span a distance greater than would be possible with any of the individual members on their own. Truss type construction shall not include individual wind or seismic bracing components which form triangles when diagonally connected to the main structural system.

SUBJECT:FIREGROUND SAFETY/RISK MANAGEMENT
SOG: 2.1.2

PURPOSE. The Elyria Fire Department often responds to incidents that present an unusually high risk to fire fighter safety. The purpose of this procedure is to increase the level of safety for fire department personnel operating at emergency situations.

SCOPE: This SOG affects all Elyria Fire Department personnel.

RESPONSIBILITY: All officers are responsible to comply with and ensure that personnel under their command are adequately trained, fully understand, and comply with this guideline. All Elyria Fire Department members have the responsibility to learn and follow this guideline.

GUIDELINE: The company officer or acting officer shall be held accountable for the actions he/she takes or fails to take. If a firefighter enters a IDLH atmosphere without wearing appropriate protection and the officer fails to take corrective action, the officer is not fulfilling his/her responsibilities.

An effective company officer must know his/her assignment. He/she must set an appropriate example with the proper behavior and attitude, motivating firefighters into thinking safety at all times.

THERE IS NO ROOM ON THE FIREGROUND FOR FREELANCING BY FIREFIGHTERS OR COMPANIES,OVER-AGGRESSIVENESS MUST BE CONTROLLED.

RISK MANAGEMENT:

Command shall integrate risk management into the regular functions of incident command. (see Incident Command S.O.G.)

The concept of risk management shall be utilized on the basis of the following, activities that present a significant risk to safety of personnel shall be evaluated and limited to situations where there is potential to save endangered human lives. In other words, FIREFIGHTERS MAY RISK THEIR LIVES IN A CALCULATED MANNER TO SAVE A LIFE THAT IS SAVABLE.

Activities that are routinely employed to protect property shall be recognized as inherent risks to the safety of personnel, and actions shall be taken to reduce or minimize these risks. FIREFIGHTERS MAY PLACE THEMSELVES IN A SITUATION WITH MODERATE RISK TO SAVE PROPERTY THAT IS SAVABLE. When there is no possibility to save lives or property.....

FIREFIGHTERS WILL RISK NOTHING TO SAVE LIVES WHICH HAVE ALREADY BEEN LOST OR PROPERTY WHICH ALREADY HAS BEEN DESTROYED.

Command shall constantly evaluate the risk to fire department personnel with respect to the purpose and potential results of their actions in each situation encountered.

Command shall provide an adequate number of personnel to safely conduct emergency scene operations, whether this is by using on duty, off duty recalled personnel or mutual aid. Operations by command shall be limited to those that can be safely performed by personnel on scene.

TACTICAL POSITIONING

Positioning of operating companies can severely affect the safety/survival of such companies. Personnel must use caution when placed in the following positions:

1. Above the fire (floors/roof)
2. Where fire can move in behind them
3. Where sector officers cannot control position/retreat
4. When involved with opposing fire streams
5. Combining interior/exterior attack
6. Limited access-one way out
7. Operating under involved roof structures
8. In areas containing hazardous materials
9. Below grade fires (basements, cellars, etc.)
10. In areas where a back draft or flashover potential exists
11. Above/below ground rescue

The safety of all firefighting personnel represents the major reason for an effective and well-timed offensive/defensive decision. When the rescue of savable victims has been completed, Command must ask:

"IS THE RISK TO MY PERSONNEL WORTH THE PROPERTY I CAN SAVE?"

OFFENSIVE OPERATIONS

When operating in an offensive strategy, be aggressively offensive. An effective cooridinated interior attack operation directed toward knocking down fire eliminates most eventual safety problems.

In situations where crews must operate from opposing or conflicting positions, such as, front vs. rear attack streams, roof crews vs. interior, etc. utilize radio or face to face communications to coordinate your actions with those of the opposing crew in an effort to prevent needless injuries. COMMAND SHALL NOTIFY COMPANY OFFICERS OF OPPOSING/CONFLICTING OPERATIONS.

When it is necessary to engage personnel in exceptionally hazardous circumstances (i.e. to perform a rescue), Command will limit the number of exposed personnel to an absolute minimum. And assure all feasible safety measures are being taken.

In extremely hazardous situations (flammable liquids, LP gas special operations, etc.) Command will engage only an absolute minimum of personnel within the hazard zone. Unmanned master streams will be utilized whenever possible.

When operating either above or below ground level, establish two separate escape routes/means where possible, (such as stairways, ladders, exits, etc.) preferably at opposite ends or diagonal corners of the building or separated by considerable distance.

When operating on a roof, the ladder selected shall be one which will extend 2'-3' above the roof line.

DURING ANY INTERIOR ATTACK COMMAND SHALL HAVE AT LEAST A TWO PERSON R.I.T. AVAILABLE FOR IMMEDIATE DEPLOYMENT IF NEEDED. (see R.I.T. S.O.G.)

Interior operations should be abandoned when the extent of the fire prohibits control or the structure becomes unsafe to operate within. When such conditions make a building untenable, evacuate building using E.F.D. evacuation procedure. (see evacuation S.O.G.)

DEFENSIVE OPERATIONS

Defensive operation positions should be AS FAR FROM THE INVOLVED AREA AS POSSIBLE WHILE STILL REMAINING EFFECTIVE. POSITIONS AND OPERATE BEHIND BARRIERS IF AVAILABLE (FENCES, WALLS, ETC.) Utilize a flanking position on the building if possible.

The intent is for personnel to utilize safe positioning where possible/available In an effort to safeguard against sudden hazardous developments such as backdraft explosion, structural collapse, etc.

STRUCTURAL COLLAPSE

In recent times, structural collapse has been the leading cause of serious Injuries and death to firefighters. For this reason the possibility of structural collapse should be a major consideration in the development of any tactical plan.

IF IT IS KNOWN WHEN ARRIVING AT A WORKING FIRE IN A BUILDING OF LIGHTWEIGHT CONSTRUCTION, (wood truss, lightweight metal truss, Plywood I beam, etc.) COMMAND SHALL NOTIFY ALL COMPANIES OF THIS FACT. Example: "Command to all companies be advised this building's roof is supported by a wood truss."

Structural collapse is always a possibility when a building is subject to intense fire. In fact, if fire is allowed to affect a structure long enough,failure is inevitable.

In a typical fire involved building, the roof is the most likely candidate for failure, however failure of the roof may very likely trigger a collapse of one or more wall sections. This is especially true if the roof is peaked or of bow string truss construction. Company officers should keep this in mind when spotting apparatus.

SIGNS OF COLLAPSE:
-Cracks in exterior walls
- Bulges in exterior walls
- Sounds of structural movement-creaking, groaning,snapping
- Smoke, water leaking through walls
- Flexible movement of any floor or roof where firefighters walk
- Interior or exterior bearing walls or columns—leaning, twisting,or flexing
-sagging or otherwise distorted rooflines
-Time of fire involvement

The following construction features have been known to fail prematurely or to contribute to early failure.

-Parapet walls
-Large open (unsupported areas—supermarkets, warehouses,etc.)
-Large signs or marquees—which may pull away and collapse
- Cantilevered canopies—which depend on the roof for support and may collapse if roof fails
-Ornamental or secondary front or sidewalls – which may pull away and collapse
-Buildings w/ lightweight truss, bar joist, bow string, plywood I beam roofs
-Buildings supported by unprotected metal—beams, columns, etc.

Buildings containing one or more of these features must be constantly evaluated for collapse potential.

Most structures are not designed to withstand the effects of fire, and can be expected to fail if exposed to fire involvement. If after 10-15 minutes of interior operations heavy fire conditions still exists, Command should initiate a careful evaluation of structural conditions, and should be prepared to evacuate interior crews and go defensive.

Command may also ask dispatch to give 10 or 15 minute "time checks", this may be especially useful during a marginal interior fire attack.

Example, "Dispatch to Command, this is a 10 minute time check", Dispatch would continue to do this every 10 minutes until told otherwise by Command, again this is initiated at Command's discretion.

SUBJECT: Building Labeling
SOG: PROPOSED

PURPOSE:

The use of trusses in building construction presents a great danger to firefighting personnel when those structures are involved with fire. By design, the truss members in floor and roof assemblies will collapse, without warning, after being exposed to heat or flame contact for a very short period of time.

Because of the inherent danger firefighters must face while operating within these buildings, a Truss Identification Program (TIP) has been initiated to alert personnel of the danger prior to beginning fire suppression operations.

The Truss Identification Program is intended to alert the members of the Elyria Fire Department with pertinent pre-plan information before fire fighting forces are committed to an interior attack.

The following guidelines shall be followed whenever a truss assembly is discovered in any commercial building in the City of Elyria.

SCOPE:

This SOG affects all Elyria Fire Department personnel.

RESPONSIBILITY:

All officers are responsible to comply with and ensure that personnel under their command are adequately trained, fully understand, and comply with this guideline. All Elyria Fire Department members have the responsibility to learn and follow this guideline.

Policy

The TIP shall be an ongoing program applied to all commercial buildings inspected by the Elyria Fire Department. Overall responsibility for implementation and control of the program will be at the Fire Marshall and/or Fire Chief.

The Station Commanders will ensure that all commercial buildings within their district are inspected in accordance with provisions of the City of Elyria, Standard Operating Guidelines.

Company Officers will ensure that personnel under their command are trained and understand the different types of building construction and truss assemblies.

Procedure

A. Notification

1. Upon discovering truss assembly in building construction, a Truss Identification Program Reporting Form will be completed and forwarded to the F.P.B Office.

2. When the Truss Identification Program Form has been received by FPB, it will be entered on the Lorain County 9-1-1 C.A.D. system premise file.

B. Pre-Fire Plan Truss Labels:

1. One florescent orange pre-fire plan truss warning label shall be applied to the top center portion of the pre-fire plan when truss assemblies are identified as part of the construction members of that particular building. While in route to the scene, pre-fire plans should be placed on the accountability clipboard for easier access and review by the arriving Incident Commander.

C. Applying Truss Identification Stickers (T Stickers)

1. Explain to the business owner/occupant that "T" stickers do not mean that their building is hazardous. It does not effect their insurance rates nor the basis for any other concern of the business owner. "T" stickers are applied to alert firefighters of a potential danger of collapse of the building when the building is involved with fire. In all cases, Fire Department personnel should be polite, courteous, and professional in their interaction with the public. A fact sheet should be left with the owner or representative of each building upon which a "T" sticker is applied.

2. If the business owner remains objectionable to application of the "T" sticker, comply with their wishes and refer the matter to the Fire Marshal's Office. Enforcement will be in accordance with City of Elyria Ordinance XXX

3. Upon obtaining the business owner's permission to apply the "T" sticker, the following procedure should be implemented:
   a. Thoroughly clean an area on the top right-hand corner of the main entry door.
   b. Apply the pressure sensitive "T" sticker to the cleaned area.
   c. In multiple occupancy structures (shopping centers, strip malls, etc.) it will be necessary to place a "T" sticker at each occupancy address.
   d. In cases where the Fire Department may make initial entry through the rear door of an occupancy, a "T" sticker should also be applied to that door.
   e. In cases where one business occupies several addresses, good judgment should be used to decide the number of "T" stickers that should be applied.
   f. In cases of multiple adjacent doors, only the door closest to center

should be marked. It is not necessary to mark every door when several doors are located at a common entrance point to the structure.

g. Good judgment should be exercised so that existing lettering or advertisement is not concealed or disturbed.

Accepted By:

Chief John Zielinski: _____ Date_____

Assistant Chief Glenn Saddler _____ Date_____

Assistant Chief Ron Brlas _____ Date_____

Assistant Chief Tim Mitchell _____ Date_____

Assistant Chief Bob Dempsey _____ Date_____

ELYRIA FIRE DEPARTMENT
Building Construction
Tactical Fire Evaluation and Assessment Form

Address:	
Occupancy Type:	**Residential:** ☐ **Single Family** ☐ **Multi Family # of Stories:** _____ ☐ **Commercial Occupancy:** _____ **#of Stories:** _____
Roof Framing:	☐ **Wood Trusses** ☐ **Steel Bar Joists** ☐ **Conventional Wood Frame** ☐ **Steel Trusses** ☐ **Wood I-Joists:** ☐ **Other (Describe):**
Floor Framing:	☐ **Wood Trusses** ☐ **Steel Bar Joists** ☐ **Conventional Wood Frame** ☐ **Steel Trusses** ☐ **Wood I-Joists:** ☐ **Other (Describe):**
Span of Framing Members:	**feet**
On Center Spacing of Framing Members:	**inches on center**
Depth of Framing Members:	**inches**
Special Framing:	☐ **Girder Trusses** ☐ **Interior Bearing Walls** ☐ **Centerline Headers and Beams** ☐ ☐ ☐ **Other (Describe):**
Floor Construction:	☐ **Plywood** ☐ **OSB** ☐ **Gypcrete/Light Weight Concrete** ☐ **Other:** _____
Ceiling (Describe):	☐ **Suspended** ☐ **1 or 2 Layers GWB** ☐ **Unprotected**
Special Loads:	☐ **Air Handlers/Conditioners:** _____**lbs.** ☐ **Special Storage:** _____**lbs.** ☐ ☐ ☐ ☐ **Other (Describe:**
Fire Sprinklers:	☐ **Yes** ☐ **No**

Elyria Fire Department
Building Construction
Fire Incident Reporting Form

Address: **Incident #**
:_____

☐ **Residential:**

☐ **Commercial**

Name of Business_____ **#of Stories:** ____

Times
Received:_____
Dispatched:_____
Arrived:_____
Tap Out:_____

Did structure collapse: yes no

Time of Structural Collapse: _____

Roof Framing:
☐ Wood Trusses ☐ Steel Bar Joists
☐ Conventional Wood Frame ☐ Steel Trusses
☐ Wood I-Joists: ☐ Other (Describe:

Floor Framing:
☐ Wood Trusses ☐ Steel Bar Joists
☐ Conventional Wood Frame ☐ Steel Trusses
☐ Wood I-Joists: ☐ Other (Describe:

On Center Spacing of Framing Members: _____ **inches on center**

Depth of Framing Members: _____ **inches**

Floor Construction:
☐ Plywood ☐ OSB
☐ Gypcrete/Light Weight Concrete
☐ Other: _____

Ceiling (Describe): ☐ Suspended ☐ 1 or 2 Layers GWB ☐ Unprotected

Room of Fire Origin:

Probable Cause of Fire:

Describe Any Problems Encountered with this fire as it relates to the Building Construction (e.g. penetrated fire stops, poor maintenance, roof mounted loads, etc.):

Fire Sprinklers present: ☐ Yes ☐ No **Fire Sprinklers operational:** ☐ Yes ☐ No
# of sprinklers flowing: _____
Minutes Flowed by sprinklers_____
Estimated Gallons flowed by sprinklers:_____

Number of Injuries: _____ **Civilians** _____**Firefighters**

Number of Deaths: _____ Civilians _____Firefighters
Report by:_____ Rank:_____ Station/Shift:_____

R

Call 440-323-3307
for Information

Do Not Remove

R/F

Call 440-323-3307
for Information

Do Not Remove

F

Call 440-323-3307
for Information

Do Not Remove

Proposed Elyria Ordinance XXXXXX 20_ _

XXXXX Definitions.

For the purposes of this Chapter, the following terms, phrases, words and their deviations shall have the meanings given herein:
(a) "Sign" means a nine inches (minimum) by three inches (minimum) piece of aluminum or stainless steel stock plate, one-eighth inch thick (minimum), covered with red 3M diamond grade reflective film or equivalent.
Located at the center of the sign is a white 3M diamond grade or equivalent reflective letter "R, "F", or "R/F" which is three inches (minimum) in height.
(b) "Property owner" means any person, firm or corporation having a legal ownership interest in the property.
(c) "Wooden truss roof or floor" means a wooden roof/floor structure consisting of a group of triangles arranged in a single plane in such a manner that loads applied at the points of the intersections of the structural members will cause only direct stresses, tension or compression, within the structural members. Wooden truss roofs may include, but are not limited to the following general types of construction: bowstring, warren, sawtooth, k truss, scissors, cambered fink, hammerbeam, pratt, fink and inverted queen post.
(d) "Open web bar joist" means a steel roof/floor structure consisting of a group of triangles arranged in a single plane in such a manner that loads applied at the points of the intersections of the structural members will cause only direct stresses, tension or compression, within the structural members.

XXXXX Required signage.

The owner of any commercial or industrial structure which has a wooden truss roof assembly shall be required to mount warning signs meeting the following minimum requirements:
(a) Size and Construction. Each sign required to be installed in accordance with this Chapter shall be of the size and construction defined within Section 14.08.010(a).
(b) Mounting Locations and Height from Finished Grade. A sign shall be mounted directly to the right of each series of entrance doors (front, rear and sides of the building or structure) at a height of five feet up from finished grade. Additional signs may be required by the fire chief, when the distance between entrance doors or the length of a series of entrance doors would require additional warning signs for visibility by fire department personnel.

XXXXX Property owner responsibility.

It shall be the responsibility of each property owner to mount, maintain and prevent obstruction of any warning signs required to be mounted on the building or structure.

XXXXX Penalty for violation.

Any person, firm or corporation violating the provisions of this Chapter shall be subject to a fine of not less than fifty dollars or no more than five hundred dollars. Each day that said violation is permitted to exist shall constitute a separate offense.