

Marking Systems for Lightweight Residential Construction

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CERTIFICATION STATEMENT

I hereby certify that 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.

Signed: _____

Abstract

The problem was that the Lenexa Fire Department did not have a system in place to alert firefighters of residential structures containing lightweight construction. The purpose of this project was to identify systems that can be utilized by the Lenexa Fire Department to alert firefighters of residential structures containing lightweight construction. This study used a descriptive research methodology to answer three research questions, (a) What strategic adjustments should LFD employ for fires in residential structures containing lightweight construction? (b) What identification process can LFD utilize to determine which structures contain lightweight construction? (c) What system can LFD utilize to alert first responders of residential structures that contain lightweight construction? This project used comprehensive literature review to determine current fire service practices related to structures containing lightweight construction and methods to identify these structures. Interviews and a questionnaire were utilized for literature review comparison and determination of practical application for the LFD. The results indicate while the fire service recognizes the dangers of lightweight construction in general, it has not caused wide spread operational changes. Pre-fire survey, fire inspections and construction sight inspection are methods to identify constructions features. Building marking systems and standard operating guidelines are systems used to improve safety at these structures. The recommendations for the LFD include determining a method to identify these structures, utilization of the mobile data terminals to disseminate the information, development of a standard practice guideline specific to structures containing lightweight construction, and utilization of social media to educate the public regarding the catastrophic impact of fire on the structural stability of structures containing lightweight construction.

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The United States Fire Administration (USFA) is an organization developed to assist the fire service in improving effectiveness and safety. To this end, the USFA established five goals. The five goals focus on prevention / mitigation, planning / preparedness, improving emergency service response capability, and improving the professional status of fire service personnel (USFA, 2010).

Strategic initiatives that are directly tied to the goals were also developed. The strategic initiative that focuses on line of duty death and injuries has been widely embraced and become an emphasis nationally (USFA, 2010).

In 1992, the National Fallen Firefighters Foundation (NFFF) was developed. The motivation was to honor firefighters who die in the line of duty and prevent line of duty death and injuries. The NFFF, through the Everyone Goes Home Program, developed 16 firefighter life safety initiatives. The initiatives include areas such as risk management, national training /certification standards, medical policies, psychological support, equipment safety, response policy standards, firefighter fitness, safety and accountability (NFFA, 1992)

Many of these initiatives can be at least partially accomplished through local fire department efforts. Policy changes, incident management practices, firefighter fitness and physicals, and increased training on fireground strategies are examples of areas that can be the focal point of improvement. When the changes are in areas where local departments may lack the financial resources to complete, the federal government can often provide assistance through the Firefighters Grant Program (Federal Emergency Management Agency, 2010).

But not all of these initiatives are easily accomplished at the local or even federal level. Initiative 15 states “Advocacy must be strengthened for the enforcement of codes and the installation of home fire sprinklers” (NFFA, p.1, 1992). This can be challenging as fire service and the construction industry are often at odds related to fire safety measures and the economic impact of those measures in the construction process.

Organizations such as the Wood Truss Council of America (WTCA) and the Structural Building Components Association (SBCA) have been involved in successful lobbying in contrast to recommendations from the fire service related to fire protection systems in lightweight wood and truss construction. This includes the State of Kansas as the following legislation demonstrates:

The State of Kansas legislation “(KS SB 573 and HB 2515 does the following 1) prohibits state and local jurisdictions from requiring fire sprinklers in new or existing 1- or 2- family dwellings or buildings with up to 4 units; 2) prohibits local governments from adopting residential fire sprinkler mandates without first holding public hearings; or 3) creates an interim study to examine the fire sprinkler mandate in the 2009 building codes” (Structural Building Components Association, 2012, para. 8).

Kansas is now one of twelve states with similar legislation in place. The WTCA reports that it is not against sprinkler systems and “supports making a positive effort to promote universal building sprinklers for all types of construction and structural elements, provided they are cost effective and do not create a competitive advantage for one structural element over another” (Wood Truss Council of America, 2003, para. 2) .

The challenge for the fire service then becomes how the safety of fire service personnel can be increased in lightweight construction with the understanding that sprinkler systems may not be an achievable solution. The ability to at least identify these structures may be the first step.

The problem is that the Lenexa Fire Department does not have a system in place to alert firefighters of residential structures containing lightweight construction. The purpose of this project is to identify systems that can be utilized by the Lenexa Fire Department to alert firefighters of residential structures containing lightweight construction.

This study uses a descriptive research methodology to answer three research questions, (a) What strategic adjustments should LFD employ for fires in residential structures containing lightweight construction? (b) What identification process can LFD utilize to determine which structures contain lightweight construction? (c) What system can LFD utilize to alert first responders of residential structures that contain lightweight construction?

Background

The LFD is a career department with 75 personnel who are directly involved in emergency operations and an additional 10 personnel who serve in an administrative capacity. The Lenexa Fire Department operates out of five strategically located stations.

The LFD is the first responder to fire, emergency medical, hazardous materials, and specialty rescue incidents. Additional functions and services provided include emergency management, building inspections, code enforcement, public education, and arson investigation.

The City of Lenexa was established in 1907 and was initially a farming community. Residential buildings, traditionally built with dimensional lumber, were the primary structures. This construction style continued for many years as the City continued to develop. This area today is known as “old town”.

The City of Lenexa has grown to an approximate population of 50,000 with an additional 100,000 transient population during business hours. From 1907 until today, there have been varying construction characteristics utilized in buildings and residential structures. These characteristics have mirrored the construction practices of the time. This includes lightweight steel trusses for many office / industrial buildings and wood truss / lightweight construction for floor and roof assemblies in residential structures. What this has created in Lenexa is a community with buildings and structures whose construction characteristics are not easily identifiable for fire department personnel.

This poses a significant challenge for the LFD. Building construction characteristics are a consideration in the development of fireground strategies and tactics; ultimately impacting the ability to effectively mitigate building fires.

This research is related to the National Fire Academy Executive Leadership course and corresponds to Unit 4 “Recognize how an understanding of political relationships can contribute to designing effective strategies for leading adaptive change” (National Fire Academy, 2012, SM 4-2). Additionally, this applied research project correlates to the United States Fire Administration’s first operational objective “Reduce risk at the local level through prevention and mitigation” (National Fire Academy, 2009, II-2).

Literature Review

The lightweight construction concept became a feature in residential construction in the late 1970’s. Wood truss design began to replace traditional construction methods as support for the roofing structures. Wood truss design is primarily constructed with 2 x 4’s which are connected with a finger joint or a metal gusset plate. The weakness of this style of construction is at the

connection. The main characteristic of truss construction system is that each 2 x 4 is dependent on the rest to retain its strength.

Wood truss construction was followed by the introduction of composite I-beam. I-beam construction uses laminated wood particles and dimension lumber less than 2 x 4 inches to form an I-beam shape. These are used to replace 2 x 10 pieces of lumber for floor supports (Underwriters Laboratories, 2008).

Lightweight construction, whether its light a weight steel truss, wood truss or, wooden I-beams, are a very common construction feature. This has become a practice due to the advantages they provide the construction industry. Lightweight construction is less expensive to build which can equate to a lower consumer cost. As suggested by the name, they are lightweight but still can support heavy loads. It provides for long spans which creates flexibility in design. They can also be prefabricated and delivered to the construction site which saves time and money during the construction process (Brannigan & Corbitt, 2008).

The fire service has been seeking to identify the impact of fire on lightweight construction. Underwriters Laboratories completed a study that focused on the performance of lightweight construction during fire through fire test data. The study utilized nine specific test samples to achieve the final results. "Seven of the samples represented floor-ceiling construction and two samples represented roof-ceiling construction" (Underwriters Laboratories, 2008, para 4).

There are two significant findings in this study that pertain to lightweight construction. The fire service has asserted that lightweight floors and roofs collapse without surface heat indicators. During the nine studies the temperatures on the subfloor or roof decking, 30 seconds before collapse, reached anywhere from 1089 degrees to 1330 degrees. However, the temperatures on

the unexposed floor and roof shingles, 30 seconds before collapse never reached higher than 204 degrees and the lowest reading was 86 degrees. This information supports the belief that lightweight construction provides little, if any, indication that catastrophic collapse is imminent.

The second fire service assertion is that the lightweight construction floor and roofs fail much more rapidly than joist construction. These test utilized typical residential construction on floors and ceiling assembly made out of 2 x 10 or 2 x 6 support members. These support members were unprotected by drywall during the benchmark test. These assemblies failed at 18 minutes in the temperature time curve. The unprotected lightweight floor and ceiling assemblies failed at the four minute mark. An interesting observation was identified, by simply adding ½” thick gypsum board between the heat and the lightweight construction, allowed the assemblies to remain stable seven minutes longer, increasing the time to failure to 11 minutes. This information supports the belief that unprotected lightweight construction has the potential to fail in fire conditions more quickly than traditional construction methods. (Underwriters Laboratories, 2008)

In the article “They Don’t Build ‘Em Like They Used To” (Nisja, 2010) offers an even stronger opinion. He indicates that this construction style will fail in less than 10 minutes under fire conditions. The failure will not be limited to the area directly involved in fire but will be catastrophic. Additionally, he suggests that there will be little to no warning prior to the collapse (Nisja, 2010).

An additional impact of truss construction on the fire industry is the increase in void spaces. Truss ceilings and roofs create a large number of void spaces which are not large enough to be an attic but allow fire spread. These voids also make fire extinguishment activities difficult due to

the size of the spaces. These void spaces are not limited to attic areas and are also present when truss construction is used for floors instead of joist construction. The void spaces interconnect to allow for utility passage ways (Brannigan & Corbitt, 2008).

The fire service had understood the challenges and dangers associated with lightweight construction for years. There have been numerous near-miss incidents and several line of duty deaths that can be directly attributed to the impact of fire on lightweight construction. Based upon the performance of lightweight construction features in fire conditions along with the increased floor space and large attic void spaces associated with today's houses; the fire service needs to modify its approach to these structures (Backstrom, Dorpe, Kerber & Van Dorpe, 2010).

Specific tactical considerations should be developed for lightweight construction. One of the ways to accomplish this is through the development standard operation guidelines (SOG). Some of the things to consider in the SOG are as follows:

- Size up is critical for effective fire ground operations on any building fire, but the importance is amplified in buildings with lightweight construction. The size up should attempt to determine the type of building construction. If the construction type cannot be identified, utilization of strategies and tactics with the assumption that lightweight construction is present will provide for increased safety. Size up should also attempt to determine the location of the fire. It is critical to eliminate fire personnel working on floors above the fire.
- A risk / benefit analysis should not be limited to fires in lightweight construction. It should, however, be understood that risk is increased in these structures because the time before collapse is potentially reduced. This makes determining the victims' survival potential a crucial element. Once established, fire ground operations should

be based upon the ability to conduct safe operations and the survivability of the occupants.

- Consideration should be given to a transitional fire attack where water is quickly applied from the exterior to control or slow fire spread. This provides increased time to search for occupants. It also allows interior crews the time necessary to begin interior fire attack operations.
- Continuous monitoring of conditions will allow for operational flexibility. If the current strategies are failing to provide intended results, new strategies should be utilized that focus on placing personnel in safer positions while the fire is controlled (Backstrom, Dorpe, Kerber & Van Dorpe, 2010).

Establishing a rapid intervention team is a practice that should be employed on all fire grounds. Increasing the size of the team is a consideration for lightweight construction fires as the likelihood of their deployment is increased (Backstrom, Dorpe, Kerber & Van Dorpe, 2010).

Based upon the fact that catastrophic collapse should be a consideration on all fires involving lightweight construction, the importance of establishing collapse zones is amplified. This means that occupants of the building not only need to leave the structure but they need to be directed to an area that will be safe from collapse. This is also true for firefighters. An offensive fire attack where personnel are inside the structure can still be a viable strategy early in these fires. But once a defensive strategy has been established, firefighters should operate in an area that is outside the collapse zone (Hovelmann, 2012).

Thermal imaging can also be utilized in the development of strategies for fires in lightweight construction structures. The 360-degree walk around is the first opportunity to gain information with a thermal imaging camera. Heat signatures on exterior walls can provide information

regarding location of fire. It can also provide information on the amount of heat the trusses supporting the roof are experiencing. Thermal imaging can also be utilized inside the structure to determine floor heat prior to personnel entering the room or structure. It does not provide clear indication that the floor is stable; it simply indicates heat the structural members are under (Bailey, 2008).

In summary, the utilization of lightweight construction is becoming a common practice due to the benefits it provides the construction industry. There is a corresponding negative impact for the fire service. Practices to address this type of construction must be a focus of fire service organizations to effectively and safely mitigate fires. This includes aggressive and ongoing size ups, solid risk/benefit analysis, transitional fire strategies, operations flexibility, effective collapse zones, utilization of thermal imaging, and establishment of RIT teams with a sufficient number of personnel.

“Fire Departments must be aware of the location of lightweight construction in their response areas” (Klaene & Sanders, 2009, p. 32). One of the ways this is accomplished is identifying construction characteristics during the construction phase. Construction site visits can provide valuable information that is not limited to construction type. This information is a valuable educational tool for the fire personnel that are present. Another way this is accomplished is through a pre-fire survey. Pre-fire survey consists of fire department personnel visiting structures in their response area to gain an understanding of the unique characteristics of each building. It can include a review of on-site hazardous material, roof access, hydrant location, sprinkler systems, and any other information specific to the occupancy. This is also the best time to develop strategic and tactical considerations for fire response. With both, construction site

visits and pre-fire surveys, the information obtained needs to be documented in a fashion that allows for retrieval during incident response (Klaene & Sanders, 2009).

Jackson Michigan Fire Department's pre-fire survey program is designed to provide personnel with a better understanding of things they might encounter during an emergency at high hazard buildings. The program includes the creation of a detailed diagram of the structure and the surrounding areas as well as description of the nature of business conducted in the occupancy. It also includes the completion of an inventory hazardous material inventory sheet. Completion of the pre-fire survey program is the responsibility of captains. The pre-fire survey information and diagrams are stored in files in the captain's office. The ability to gain access to this information during emergency response is not achievable at this time. They are in the process of determining a data storage system that can provide this information to responding resources (Jackson Michigan Fire Department, 2013).

The Columbia, South Carolina Fire Department has many of the same components in their pre-fire survey program. In addition, they have established the goal of conducting a survey every six months on all structures that are considered high risk. High risk is defined as high rise structures and occupancies that present a potentially high dollar loss. Pre-fire surveys on occupancies that do not meet the definition of high risk are completed as time allows. The information is entered into a data storage system. High risk pre-fire surveys are printed daily and carried on the fire apparatus (Columbia, South Carolina Fire Department, 2010)

The Chicago Fire Department utilizes a different approach specific to pre-fire surveys at the University of Chicago. The main components are the same, ensuring fire personnel are familiar with the layout, construction characteristics, hazards, and suppression systems. But instead of storing this information at the fire department or on the fire apparatus, they are secured at the

specific buildings on the University campus. The pre-fire surveys are secured in a locked box at designated entrances that can only be accessed by Fire Department and University Environmental Health and Safety personnel (Chicago Fire Department, 2012) .

South Kitsap Fire provides a Home Safety Survey program that provides two benefits. It enhances the safety of the community by serving as a home safety inspection where personnel check extension cords, smoke detectors, flammable liquid storage as well as providing safety recommendation in other areas. This service also creates an opportunity to enter residential structures that would otherwise be inaccessible. It provides fire personnel the opportunity to learn construction characteristic of these homes (South Kitsap Fire and Rescue, 2013).

Another approach is to develop a home and business inspection program. The home inspection program is simply an opportunity to provide fire safety information and develop evacuation routes for residents. The business inspection program focuses on fire prevention through fire and building code enforcement. Both of these programs provide fire department personnel the opportunity to gain knowledge of the specific construction characteristics in each of these occupancies (Wheaton, Illinois, 2013).

In summary, there are several specific programs fire service agencies utilize to gain understanding of the construction characteristic in their districts or cities. This includes construction site visits, pre-fire surveys, home safety programs, home inspections, and business inspection programs. While the components of each of these programs vary, they all have the common feature of providing fire personnel access to structures to gain valuable insight. There were also varying approaches to how the information was stored and retrieved. Not all of the programs identified this feature, the ones that did focused on providing this information in a timely manner to emergency response resources.

In dealing with the dangers to fire personnel associated with lightweight construction the National Institute for Occupational Safety and Health (NIOSH) created an alert “Preventing Injuries and Deaths of Fire Fighters due to Truss System Failures”. In addition to many of the tactical considerations already mentioned, NIOSH recommended a building notification system for structures with lightweight construction. It does not give specific recommendation on the appearance or location of the notification system but suggested they include the presence and location of lightweight construction members, sprinkler systems, and chemicals on sight (NIOSH 2005).

In 1989 two orange county firefighters, Todd Aldridge and Mark Benge, died as a result of injuries sustained during a structural from fire. This incident highlighted to the elected officials the dangers associated with lightweight construction. In 2008, the Florida legislature passed the Aldridge/Benge Firefighter Safety Act. “The act requires that commercial, industrial or multi-unit residential structures, in which the main structural elements are constructed of lightweight materials, be affixed with a notification system” (Klipa, 2008, p. 2). It clearly identifies the type and size of notification symbol as well as the specific location on the structure. It also allows for multiple notification symbols for structures with several entrances (Klipa, 2008).

The State of New Jersey was one of the first states to mandate exterior building notification systems. This also came about as the result of firefighter fatalities. The notification system has been built into the State’s Uniform Fire Code and has been required since 1992. The code specifically requires a 12 x 6 inch reflective triangle emblem on the street side of the structure. This applies to all commercial structures and planned residential developments (Moran, 2011).

A similar program is being attempted in Greencastle Indiana with a different approach. A member of the city’s Board of Alderman is attempting to gain community support for the idea.

The community is being asked the question “would you pay five dollars if it meant potentially saving a volunteer firefighter’s life” (Driscoll, 2009, para 1). If support can be achieved, a five dollar fee would be imposed during the permit phase of construction projects and would apply to all new construction (Driscoll, 2009).

In summary, the literature indicates that a few states are adopting or mandating marking systems for structures containing lightweight construction. The marking system and location varied between jurisdictions as well as between the types of structures in which they were required. Only one jurisdiction, identified in the literature review, required a marking system for residential construction, the marking system in that case was specific to new residential construction.

Procedures

The procedures followed for this research project began by identifying a researchable problem within the LFD. Several options were identified but none that posed a greater risk to the health and safety of LFD members than identifying ways to alert responding personnel of lightweight construction in residential structures.

A questionnaire was developed for research purposes that were based upon findings in the literature review component. The questions focused on line or duty deaths or near miss incidents due to lightweight construction, ways to identify lightweight construction, standard operation guidelines for lightweight construction, how related information is disseminated, and the use of building marking systems for lightweight construction.

The structure of the questionnaire consisted of 6 questions and addressed the desired information in the following format:

Question 1 elicited information that related to line of duty deaths or near miss incidents and included raw data in addition to the provided responses.

Question 2 elicited information related to standard operating procedures specific to lightweight construction and included raw data in addition to provided responses.

Questions 3-4 elicited information regarding the identification process for structures containing lightweight construction and the communication process for information dissemination. The question included raw data in addition to provided responses

Questions 5-6 elicited information regarding the utilization of notification systems on structures containing lightweight construction.

Assistant Professor of Marketing at Mid-America Nazarene University, Mrs. Lisa Wallentine provided information to assist with questionnaire development. Recommendations provided by Professor Wallentine were as follows:

- 1) Scaled response answers provide for more magnitude, intensity, and mathematical analysis than Yes/No questions.
- 2) Add an “other” option on multiple-choice questions to provide a place to answer when the category doesn’t fit the respondent’s situation.

Once the changes to the questionnaire were completed, (Appendix C) the information was provided to Training Division staff for assistance in publication via an online electronic feedback instrument.

The Deputy Fire Chief possessed an electronic mail address list for fire service organizations throughout the country. This list was compiled through professional organization membership, conference attendance, and Executive Fire Officer Participants.

The author sent an electronic mail message to identify the purpose of the questionnaire and participation in Executive Officer Program. The electronic mail included contact information for the author and advised the findings of the research would be forwarded to any requesting parties once the results were tabulated. A copy of the letter is included in (Appendix A).

The questionnaire was distributed to 505 fire service organizations via electronic mail. The questionnaire was accessible from March 17, 2013 until March 31, 2013. Of the 505 targeted recipients, an error message was received from (122) fire service organizations, leaving a total of (383) distributed questionnaire. A total of (85) respondents completed the questionnaire.

Phone contact was made with personnel in the Community Develop Department for the City of Lenexa. Contact was initiated with personnel who deal with building codes enforcement. Once contacted, a phone interview was completed. The phone interview focused on the ability of Community Development personnel to provide information related to lightweight features on new residential construction project.

Phone contact was made with personnel from the Johnson County Emergency Communication Center (JCECC). The JCECC is the dispatch center for the Lenexa Fire Department as well as the one responsible for updating information in the mobile data terminals. Mobile data terminals provide responding units with address information, nature of call, and other information that has been predetermined as important. Once contacted, a phone interview was completed. The phone interview focused on the ability of JCECC to upload information on the Mobile data terminals relevant to lightweight construction if the LFD was able to provide the data.

Personal interviews were conducted by phone and followed the predetermined format but multiple choice options were not included. The answers provided were recorded by written transcript (Appendix B).

Limitations

While there was a significant amount of information related to lightweight construction in general, there was a limited amount that focused how information on location of these structures was obtained. Additionally, there was limited information on programs departments were utilizing to deal with the dangers of lightweight construction.

The accuracy of the questionnaire results is entirely dependent on the respondents understanding of the lightweight construction and building marking systems. It could not be verified that the information received from the questionnaire participants was entirely accurate and thorough.

The detailed information desired for this project required the use of questions with multiple answer formats. It is more challenging to analyze data and determine preference with these type questions.

The questionnaire focused specifically on residential structures and did not include commercial buildings. This factor could result in considerations that are not addressed in this research.

Results

This section of the project was designed to provide data from fire service organization as it relates to lightweight wood construction. The questions were designed based upon the information gained in the literature review section. This will allow for comparison of the literature and research during the discussion phase of the project.

Research Question 1 Results

What strategic adjustments should LFD employ for fires in residential structures containing lightweight construction? Pertinent data related to the research question was obtained in questions 1 and 2.

Question one asked “Has your department experienced a line of duty death or a near miss incident as a result of lightweight construction? The question was in a yes or no answer format and included a “please describe” option for respondents who answered yes. A total of 85 respondents answered the question. Results indicate that the majority of respondents, 78 (91.8%), had not experienced a line of duty death or near miss incident resulting from lightweight construction. Seven respondents (8.2%) indicated that their organization had experienced a near miss incident or line of duty death. The written descriptions provided by the respondents are included in Appendix C.

Question two asked “What standard operating guidelines (SOG’s) does your department have related to fires in buildings containing lightweight construction?” The question was presented in a multiple choice format and included an N/A as well as an “other” option with an available text box for a description. A total of 85 respondents answered the question. A little over half of the respondents 46 (54.1%) indicated that their department does not have standard operating guidelines specific to lightweight construction. The remaining results indicate that a variety of SOG’s are utilized as 13 (15.3%) selected transitional fire attack, 9 (10.6%) selected increase the number of personnel to the rapid intervention team, and 4 (4.7%) indicated external thermal imaging was utilized. An Additional 13 (15.3%) selected “other”, the written descriptions provided by the respondents are included in Appendix C. It should be noted that 1 respondent selected a multiple choice answer as well as provided a comment in the “other” section.

Research Question 2 Results

What identification process can LFD utilize to determine which structures contain lightweight construction? Pertinent data to the research question was obtained in questions 3 and 4.

Question three asked “What method does your department utilize to identify structures containing lightweight construction? The question was presented in a multiple choice format and included an N/A as well as an “other” option with an available text box for a description. A total of 84 respondents answered the question with 1 having skipped for an unknown reason. The research indicates that the ways departments identify lightweight construction was divided between review of building plan 17 (20.2%) and on sight construction review 14 (16.7%). One respondent (1.2%) utilize a residential inspection/safety program. However, 41 (48.8%) of the respondents selected the N/A option indicating their department does not have a process in place. An additional 11 (13.1%) selected “other”, the written descriptions provided by the respondents are included in Appendix C.

Question four asked “What method does your department utilize to make personnel aware of structures containing lightweight construction? The question was presented in a multiple choice format and included an N/A as well as an “other” option with an available text box for a description. A total of 85 respondents answered the question. Over half of the respondents 46 (54.1%) selected N/A indicating their departments does not have a process in place to alert personnel to the presence of lightweight construction in a structure. Of the remaining respondents 12 (14.1%) utilize a technology based system, 8 (9.4%) place the information on district apparatus, and 2 (2.4%) utilize a building notification system. An additional 17 (20.0%) selected “other”, the written descriptions provided by the respondents are included in Appendix C.

In a personal interview M. Souder (personal interview on March 6, 2013) indicated that the Community Development Department for the City of Lenexa receives the construction plans for all building projectes approved in the City. He further specified that the plans would indicate if

lightweight construction was to be utilized, as well as the location within the structure. He indicated Community Services personnel could provide this information to LFD through e-mail or that all construction projects could be required to furnish a copy of the building plan to LFD.

Question 3 Results

What system can LFD utilize to alert first responders of residential structures that contain lightweight construction? Pertinent data related to the research question was obtained in questions 5 and 6.

Question five asked “If your department utilizes a building notification system to alert the presence of lightweight construction, where is the notification placard located? The question was presented in a multiple choice format and included an N/A as well as an “other” option with an available text box for a description. A total of 84 respondents answered the question with 1 having skipped for an unknown reason. The majority of respondents 77 (91.7) selected N/A indicating a building notification system is not utilized by their department. Four (4.8%) of the respondents indicated that building notification systems were located at the front door. An additional 3 (3.6%) selected “other”, the written descriptions provided by the respondents are included in Appendix C.

Question six asked “If your department utilizes a building notification system to alert the presence of lightweight construction, when is the placard obtained by the resident? The question was presented in a multiple choice format and included an N/A as well as an “other” option with an available text box for a description. A total of 84 respondents answered the question with 1 having skipped for an unknown reason. The majority of respondents 80 (95.2) selected N/A indicating a building notification system is not utilized by their department. Two (2.4%) indicated that the placard is obtained during the building plan review and 1 (1.2%) during the

certification of occupancy inspection. An additional 1 (1.2%) selected “other”, the written descriptions provided by the respondents are included in Appendix C.

In a personal interview M. Whelan (personal interview on March 26, 2013) indicated that information related to lightweight construction could be advised through the Mobile Data Terminal on each apparatus. The information provided in the notes section of the main page or could be provided or included as a pre-plan index. He further advised that the information would need to be provided to the Johnson County Emergency Communications Center by the LFD for inclusion on the mobile data terminal.

Discussion

Based upon a United Laboratories report, the literature indicates that structures with lightweight construction are more likely to fail under fire conditions than traditional construction methods. Specifically the literature indicates that floor and roof collapse can occur in as little as four minutes for lightweight construction that is not protected by drywall. In addition, warning signs of collapse are less obvious than traditional construction. The research was consistent with these concerns as 8.7% of respondents reported a near miss incident resulting from lightweight construction. In all cases, the near miss was related to roof or floor collapse. It is noted that the research sample size of 85 is not substantial, but results that suggest a near 10% rate of near miss incidents is still significant.

The literature indicates that there are several tactical considerations that should be implemented when dealing with structure fires in lightweight construction. Included in these considerations were aggressive risk/benefit analysis, early establishment of a collapse zone, and maintaining operational flexibility. The research focused on some of the more specific recommendations of increasing the size of the rapid intervention team, completing a 360 degree

size up with the aid of a thermal imaging camera, and utilization of a transitional fire attack to slow the fire growth from the exterior before entering the structure. The research results were somewhat inconclusive. While all of these tactical considerations were utilized by the respondents, the numbers were lower than expected. Over 50% indicated that these tactics are not a consideration during structures fires in lightweight construction. This suggests that these type of structures are treated the same as traditional construction or that departments are still in the process of developing procedures for this construction feature. Another possibility is that the respondents' departments are utilizing tactical considerations that were not provided in this research project. It was expected that those occurrences would have been reflected in the "other" category, but only 13 (15.3%) selected this category and provides supporting text.

The literature suggested that fire departments can utilize several approaches to identify the presence of lightweight construction. On-sight inspection during the construction phase has the benefit of firsthand knowledge as well as the ability to identify other construction features that could be unique. Pre-fire surveys and building inspections provided the benefit of visiting the structure once occupied. This can provide the opportunity to gain information beyond simple building construction that might be beneficial during a fire event. The last approach to this identification process was through home safety checks. This provides the ability to gain access to residential construction characteristics. The research indicated that 41 (48.8%) do not have a process in place to identify structures containing lightweight construction. This is inconsistent with the literature that indicated an identification process as important. This suggests that departments are failing to employ strategies for this identification process and are leaving it to responding personnel to identify structures with lightweight construction, or organizations are still attempting to identify the best approach to utilize for the identification process. Of the

respondents who indicated that they do have a process in place, building plan review (20.2%) and on sight construction review (16.7%) were the two most common approaches.

The literature review section indicated that identifying structures with lightweight construction was only the first step. Once identified a system to communicate the information to department personnel was necessary. The literature was able to provide some examples of this process but often it appeared departments had a process in place that was minimally effective in disseminating this information or had yet to determine the best way to accomplish. The research was consistent with the literature findings. Only 14 (16.5%) of respondents have a formal process in place to communicate this type of information. The most common (14.1%) was the use of a technology based system. The 17 (20%) respondents who selected “other” described, in large part, relying on responding personnel to be knowledgeable regarding their districts and structures. Over half (54.1%) of the respondents indicated that a formal communication system was not in place for the dissemination of information related to building construction features.

The literature indicated that one of the trends in the fire service is to identify buildings containing lightweight construction with a placard on the exterior of the structure. This provides responding personnel with information rapidly upon arrival. The research indicates that the majority of respondents 77 (91.7) do not use a building marking system in their jurisdiction. Of the 4 (4.8%) respondents who utilize this system, the placard was located at the front door of the structure. The research suggests that the utilization of a building marking or placard system for structures that contain lightweight construction has not become an accepted practice in the fire service. However, it is noted as is somewhat indicated in the literature, that this may be a practice utilized in some regions of the country and may be slowly gaining acceptance. Of the

jurisdiction that are utilizing this system, the most common ways for the occupant to obtain the placard was during the building plan review process or the certificate of occupancy inspection.

Recommendations

The purpose of this applied research paper was to identify systems that can be utilized by the Lenexa Fire Department to alert firefighters of residential structures containing lightweight construction. The LFD has practices in place that can be enhanced to provide this ability for commercial structures. The Fire Inspection Program and the Pre-fire Survey Program can be augmented and provide for this identification process. However, the LFD does not have programs or practices in place to address residential occupancies. As a result of this project the LFD should consider several recommendations to obtain this ability.

It is recommended that the LFD research options to provide for the identification of structures containing lightweight construction. The evaluation process should include practices for both current residential and future residential occupancies. There are a couple of approaches that could be viable options and a determination of the most appropriate for LFD is required.

Considerations should be given to the development of an on sight construction review process for new residential construction projects. This could provide the ability for shift personnel to gain knowledge of specific construction characteristic in their response district. The use of on duty personnel will also reduce impact on the department's budget.

Evaluate the feasibility of obtaining a copy of building plans from the City of Lenexa Community Development Department for all approved residential construction projects. This would provide immediate notification of lightweight construction features on individual residences. It would also be less time demanding than the on sight construction review process

and have would little to no impact on the readiness of personnel to respond to emergencies. There would be limited if any budget impact from this option.

Research is required to identify options for determining the presence of lightweight construction in existing residential structures. The literature review section of this project provided the idea of home safety inspections. No other options were noted through the literature review or research portions. Additional research is required to identify programs that would allow LFD personnel access to residential structures while providing a benefit to the citizens,

It is recommended that the LFD utilize the mobile data terminal (MDT) to disseminate information related to residential structures with lightweight construction, once identified. This will not only allow LFD personnel to access the information but would also be a reference for all fire department personnel in the Johnson County area. This is a crucial element due to the frequency of automatic and mutual aid that occurs within the county. This will also prevent the need to affix a placard or marking system on the exterior of the structure, which could be met with resistance by the community. The LFD will need to define the process and frequency in which this information is provided to Johnson County Emergency Communication for uploading to the MDT as well as determine the location of the information in the call log data fields.

It is recommended that the LFD develop a Standard Practice Guideline (SPG) to be utilized on residential structures with known lightweight construction features. The literature review and research data suggests that there is a higher potential for collapse in these structures and, as such, an SPG with specific strategies and an aggressive risk/ reward analysis format should be created. Consideration should be given to tactics such as 360 degree size ups with thermal imaging camera utilization, expanded collapse zones, expanding the size of the rapid intervention team, and utilization of a transitional fire attack. Additional research should also be conducted to

identify additional considerations not address in this project. A focus on standard practice guideline from departments across the county is recommended.

One area that the literature review and research did not address is the idea of public education. The LFD uses social media to regularly communicate important information to citizens. The LFD should evaluate the benefits to educating City of Lenexa residents on the dangers of lightweight construction during fire events. Consideration should be given to the utilization pictorial depictions on how these construction features performed during fire events in which LFD has responded. Additionally, evaluation is required to determine if there would be benefit in describing the increased performance of lightweight construction, as indicated in the Underwriters Laboratories findings, when protected by drywall or gypsum board.

There are few, if any, areas more critical to the safety for firefighters than the development of solid fire ground strategies. In order for that to occur, an understanding of the construction characteristics of residential structures is required. Identification of these characteristic once the fire has occurred reduces the likely hood of good fire ground strategies. While the LFD has a history of solid fire ground strategies and has not sustained a line of duty death, improvements can be made to ensure the safety of personnel. The benefits of the recommendations will be apparent if implemented. The expected results would be improved information by which to make fire ground decision and ultimately result in an increase of safety for personnel.

Recommendation for future researchers includes researching the benefits of employing only defensive fire ground strategies when an active fire is found by the first arriving fire department resource.

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Appendix A

Dear Fire Service Professionals,

I am a fourth year student in the National Fire Academy's Executive Fire Officer Program and am requesting your assistance in completing a questionnaire. The information gained will be used as part of the applied research component of the program. I am conducting this research to identify policies and procedures related to buildings containing lightweight constructions.

The questionnaire has 6 questions and should take no longer than 10 minutes to complete. The responses to the questions are anonymous.

The questionnaire can be located by clicking on the link provided:

<http://www.surveymonkey.com/s/MyrtleEFOv03152013>

If you would like to have the results of this questionnaire please reply to this e-mail and I will forward the findings once tabulated.

Thank you for participating in this research project. If you would like to reach me I can be contacted by e-mail at smyrtle@lenexa.com or by phone at (913) 477-7908. Again, I appreciate your responses and look forward to reviewing the results.

Stan Myrtle

Battalion Chief

City of Lenexa | Fire Department

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Service ~ Protection ~ Compassion

Appendix B

Interview Form

Date: March 6, 2013

Name Matt Souder

Organization: City of Lenexa

Title: Building Services Specialist

1) Does the City of Lenexa receive a construction plan on all residential construction?

Yes, a construction plan is submitted for all residential construction for approval from a building code and fire code perspective.

2) Would the building plan include the utilization of lightweight construction and location in the structure?

Yes, it would show the type of lightweight construction (Truss, wood I-beams etc.) it would also show the location and if it would be covered with dry wall.

3) Does the City retain an electronic copy of residential construction plans?

We don't have any electronic copies of residential construction plans. We have just begun using digital plan review for commercial projects but not residential. Residential plans are submitted on paper and retained for 2 years.

4) Would there be a feasible way for the Fire Department to be provided information regarding lightweight construction in residential buildings?

Yes, it would be as simple as requiring builders to submit an additional plan that could be forwarded to the Fire Department.

Appendix B

Interview Form

Date: 03/26/2013

Name: Mark Whelan

Organization: Johnson County Emergency Communications Center

Title: GIS/Mapping Coordinator

1) Do the Mobile Data Terminal support the ability to provide information on buildings that contain lightweight construction?

The Mobile Data Terminal can include this information but it doesn't support the ability to highlight that information in the incident nature or address sections.

2) Where could that information be displayed?

The information could be included in the notes section on the first page. The information contained in the area is specific to each address. There is a need minimize the amount information contained in this area to allow for easy identification of important information. The other option is to include it in a pre-fire index. The index does require the viewer to open the file but the data or information can be displayed in a priority format with no limitation on the amount of data.

3) Does the Mobile Data Terminal support the ability to highlight an address by color that could be used to identify structures with lightweight construction?

Not at this time, but updated features may include that ability?

4) What is the best way for the Johnson County Emergency Communication Center to receive information on structures that contain lightweight construction?

Fire Departments will need to gather the information and provide to us. The same procedures used to provide any of the other updated information will be sufficient.

Appendix C

1. Has your department experienced a line of duty death or a near miss incident as a result of lightweight construction?

		answered question	85
		skipped question	0
		Response Percent	Response Count
Yes		8.2%	7
No		91.8%	78
If Yes please describe circumstances Hide replies			5
1.	Fully involved apartment, built with an automatic sprinkler system - the attic wasn't protected; when firefighters entered an apartment, the attic truss fell through. The building basically fell apart.	Sun, Mar 17, 2013 9:38 PM	Find...
2.	collapse in 2002	Sun, Mar 17, 2013 7:20 PM	Find...
3.	Near miss about 18 years ago when truss construction came down on two interior crews. Sent several to the hospital and could have easily been an LODD.	Sun, Mar 17, 2013 1:51 PM	Find...
4.	Floor and rafter failure. Near miss type stuff	Sun, Mar 17, 2013 1:27 PM	Find...
5.	Roof collapse of a lightweight construction house with tile roof, personnel had just been evacuated when the roof collapsed.	Sun, Mar 17, 2013 8:38 AM	Find

2. What standard operating guidelines (SOG's) does your department have related to fires in buildings containing lightweight construction?

		answered question	85
		skipped question	0
		Response Percent	Response Count
Exterior thermal imaging camera utilization		4.7%	4
Additional personnel committed to Rapid Intervention Team		10.6%	9
Transitional attack (Quick exterior attack to control fire)		15.3%	13
N/A		54.1%	46
Other (please specify) Hide replies		15.3%	13
		25 responses per page ▼	
1.	We have employed all of these measures	Sat, Mar 23, 2013 9:28 PM	Find...
2.	Mandatory application of situational awareness, reading smoke, and knowledge of building construction.	Tue, Mar 19, 2013 11:15 AM	Find...
3.	If it more than a contents fire and becomes a structure fire all units will be withdrawn and an exterior attack will occur.	Tue, Mar 19, 2013 11:12 AM	Find...

2. What standard operating guidelines (SOG's) does your department have related to fires in buildings containing lightweight construction?

4.	The first three	Tue, Mar 19, 2013 7:39 AM	Find...
5.	We have a Fire Ground Strategy and Safety Policy that covers the utilization of all these factors for the fire ground. We also send an extra engine company for RIT team assignment. It may only be a crew of three though.	Mon, Mar 18, 2013 9:39 AM	Find...
6.	careful assessment of go-no go	Sun, Mar 17, 2013 7:20 PM	Find...
7.	Incident timer	Sun, Mar 17, 2013 2:37 PM	Find...
8.	Both exterior TIC and RIT staffing	Sun, Mar 17, 2013 1:51 PM	Find...
9.	TIC use and attack mode are standard training topic zone wide. RIT and TinTout are state law	Sun, Mar 17, 2013 1:27 PM	Find...
10.	Almost all buildings in our area are lightweight construction	Sun, Mar 17, 2013 10:20 AM	Find...
11.	All apply. Your format does not permit all to be checked.	Sun, Mar 17, 2013 9:01 AM	Find...
12.	We use a fire attack method we call Coordinated Fire Attack, uses PPV to quickly vent heat and smoke so that personnel can access fires quickly for rapid extinguishment. Have been using this for 6 years with great success.	Sun, Mar 17, 2013 8:38 AM	Find...
13.	Small combination fire department we approach everything with a slower approach because of lack of staffing. A 360 with Tic is normal for us	Sun, Mar 17, 2013 8:28 AM	Find...

3. What method does your department utilize to identify residential structures containing lightweight construction?

		answered question	84
		skipped question	1
		Response Percent	Response Count
Review of building plans		20.2%	17
On sight construction review		16.7%	14
Residential inspection/safety program		1.2%	1
N/A		48.8%	41
Other (please specify) Hide replies		13.1%	11
		25 responses per page	
1.	Information is given to FDNY from Bldg Dept (DOB) and the company goes out and inspections the building and puts LW construction on a CIDS Card (Critical Information Dispatch System)	Tue, Mar 19, 2013 11:12 AM	Find...
2.	Building Construction training. This is a monthly Battalion Drill that is done every year on all three shifts.	Mon, Mar 18, 2013 9:39 AM	Find...
3.	Date of construction	Mon, Mar 18, 2013 8:22 AM	Find...
4.	Age of Construction is obvious because our original housing stock is very	Mon, Mar 18, 2013 7:22 AM	Find...

3. What method does your department utilize to identify residential structures containing lightweight construction?

		AM	
5.	Size-up during the incident	Mon, Mar 18, 2013 7:03 AM	Find...
6.	preplans	Sun, Mar 17, 2013 7:20 PM	Find...
7.	Crew walk throughs- new development means it's light weight	Sun, Mar 17, 2013 1:51 PM	Find...
8.	We do site plans on comm and MFres. Lt wt SFR is based on age	Sun, Mar 17, 2013 1:27 PM	Find...
9.	West Coast- all of our structures are light weight.	Sun, Mar 17, 2013 9:21 AM	Find...
10.	Treat all as if it is lightweight until proven otherwise	Sun, Mar 17, 2013 8:38 AM	Find...
11.	Training and familiarity, a community of 10,000 is small enough to plan.	Sun, Mar 17, 2013 8:28 AM	Find...

4. What method does our department utilize to make personnel aware of structures containing lightweight construction?

		answered question	85
		skipped question	0
		Response Percent	Response Count
Building Notification Systems		2.4%	2
Mobile Data Terminal (other technology based system)		14.1%	12
Binder or folder on district apparatus		9.4%	8
N/A		54.1%	46
Other (please specify) Hide replies		20.0%	17
		25 responses per page ▼	
1.	Pre-plans and knowledge of building construction.	Tue, Mar 19, 2013 11:15 AM	Find...
2.	For an address with CIDS (Critical Information Dispatch System) it is printed on our teleprinter in firehouse and also on our MDT	Tue, Mar 19, 2013 11:12 AM	Find...
3.	district familiarization	Mon, Mar 18, 2013 8:38 AM	Find...
4.	Date of construction	Mon, Mar 18, 2013 8:22 AM	Find...

4. What method does our department utilize to make personnel aware of structures containing lightweight construction?			
5.	all engine and ladder companies are required to do district survey	Mon, Mar 18, 2013 7:33 AM	Find...
6.	Treat all buildings as if the construction is present	Mon, Mar 18, 2013 7:03 AM	Find...
7.	Placards	Mon, Mar 18, 2013 5:47 AM	Find...
8.	Triangle sign with type of hazard posted	Sun, Mar 17, 2013 9:38 PM	Find...
9.	Passed along during training	Sun, Mar 17, 2013 9:04 PM	Find...
10.	fire prevention; plans review	Sun, Mar 17, 2013 7:20 PM	Find...
11.	Observations during the construction phase	Sun, Mar 17, 2013 2:37 PM	Find...
12.	Training	Sun, Mar 17, 2013 1:46 PM	Find...
13.	Construction info added to the dispatch cad system	Sun, Mar 17, 2013 12:49 PM	Find...
14.	All new homes are lightweight construction, so it is area specific knowledge.	Sun, Mar 17, 2013 10:27 AM	Find...
15.	Part of our initial FF1 training and on going training	Sun, Mar 17, 2013 10:20 AM	Find...
16.	West coast- all of our structures are light weight. We train everyone to fight fire in these structures.	Sun, Mar 17, 2013 9:21 AM	Find...
17.	Building Construction classes	Sun, Mar 17, 2013 8:38 AM	Find...

5. If your department utilizes a building notification system to alert the presence of lightweight construction, where is the notification placard located?

		answered question	84
		skipped question	1
		Response Percent	Response Count
Front Door		4.8%	4
Rear Door		0.0%	0
Gas Meter		0.0%	0
N/A		91.7%	77
Other (please specify) Hide replies		3.6%	3
1.	Information is placed on our CIDS Card (Critical Information Dispatch System)	Tue, Mar 19, 2013 11:12 AM	Find...
2.	placard out front	Mon, Mar 18, 2013 6:24 PM	Find...
3.	NJ mandates posting of truss sign on commercial buildings	Sun, Mar 17, 2013 12:49 PM	Find...

6. If your department utilized a building notification system to alert the presence of lightweight construction, when is the placard obtained by the resident.

	answered question	84
	skipped question	1
	Response Percent	Response Count
During Building Plan Review	2.4%	2
During Certificate of Occupancy inspection	1.2%	1
N/A	95.2%	80
Other (please specify) Hide replies	1.2%	1
1. DOB sends FDNY a notification of LW bldg products being used from the building permit application	Tue, Mar 19, 2013 11:12 AM	Find...