Out of Reach?

Evaluating the risk for ground ladder rescues at multi-family dwelling fires

Brian Brush

West Metro Fire Rescue, Lakewood, Colorado

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

A working fire in one high density residential structure can present with an equivalent life hazard to an entire neighborhood of single family dwellings. As an organization West Metro Fire Rescue has identified the increased risk for and severity of fires in multi-family dwellings and attempted to address them. The problem is that West Metro Fire Rescue has not evaluated the risk for ground ladder rescues at multi-family dwellings.

The purpose of this research was to use the community risk reduction model to analyze the community of West Metro Fire Rescue, identify hazards, casual factors and assess vulnerability of residents and responders regarding ladder rescues at multi-family dwellings. Using the descriptive research methods of literature review and interviews the following research questions were answered. a) What is the ground ladder rescue risk for West Metro Fire Rescue at multi- family dwellings? b) What are the hazards and casual factors associated with ground ladder rescues at multi-family dwellings? c) Does the current training, staffing and equipment response of West Metro Fire Rescue to multi-family dwelling fires match the potential ground ladder rescue risk? d) What are the opportunities to reduce risk associated with ground ladder rescues at multi-family dwellings using the “5 Es” of prevention?

The results of this research paper identify associated risks of ground ladder rescues, opportunities for intervention methods and metrics for evaluation from a district wide to individual building level. Recommendations for rapid and low cost application of the research and findings contained in this project are presented and possible areas of continued work discussed.

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Introduction

Twenty six percent of West Metro Fire Rescue's (WMFR) population resides in multi-family dwellings (Saito, 2012). Multi-family dwellings in Lakewood, Colorado house an average of 3.5 persons per unit. Some apartment complexes have as many as 36 units per building, for up to 126 occupants per structure (Beavers, 2014). Compare this to a standard single family dwelling with an average of 2.23 occupants per structure for the district (Saito, 2012). With up to 126 residents in each building this would place the equivalent of an entire single family residential neighborhood at risk in one building fire.

Multi-family dwellings account for 30% of the district's working structure fires (Pfannenstiel, 2014). In the calendar year of 2012, WMFR reported 53 working structure fires at multi-family dwellings. Seventy-five percent of those fires had a point of origin above the first floor (Pfannenstiel, 2014). On average West Metro Firefighters are responding to a working structure fire in a multi-family dwelling once a week. The fact that the floor of origin is also most commonly above the first floor presents a greater risk of entrapment to citizens in our district who live in these occupancies.

In 2010 WMFR increased the operational response to confirmed fires in multi-family dwellings with an additional tower company in an attempt to address the increased life hazard and fire problem associated with these occupancies. A complete review of WMFR greater alarm fires over the past five years reveals that 80% of all working fires which exceeded the initial alarm dispatch assignment involved multi-family dwellings (Brush, 2014). This internal data shows that the demands of these incidents continue to outpace initial responding resources and do so statistically more than any other occupancy type.

WMFR has identified multi-family dwellings as a significant life hazard and fire risk both. Operationally the district has increased resource responses and in prevention developed educational programs. Unfortunately these interventions are not effectively addressing present or potential challenges such as an “all hands” rescue situation.

The problem is that West Metro Fire Rescue has not evaluated the risk for ground ladder rescues at multi-family dwellings. One of the core organizational values of WMFR is “prevention of emergencies and awareness of the dangers to our citizens to reduce the risk of their lives” (West Metro Fire Rescue [WMFR], 2012, P.5). Too often identifying a problem and attempting to find solutions through programs or additional resources will fall short due to lack of clarity on the casual factors, hazards or appropriate intervention methods.

The purpose of this research is to use the community risk reduction model to analyze the community of WMFR, identify hazards, casual factors and assess vulnerability of residents and responders regarding ladder rescues at multi-family dwellings.

Using the descriptive research method this project answers the following research questions. a) What is the ground ladder rescue risk for West Metro Fire Rescue at multi-family dwellings? b) What are the hazards and casual factors associated with ground ladder rescues at multi-family dwellings? c) Does the current training, staffing and equipment response of West Metro Fire Rescue to multi-family dwelling fires match the potential ground ladder risk? d) What are the opportunities to reduce risk associated with ground ladder rescues at multi-family dwellings using the “5 Es” of prevention?

Data gathered for this applied research project will enhance the awareness of WMFR to the risk of ground ladder rescues at multi-family dwellings and provide recommendations for specific intervention methods to reduce those risks

Background and Significance

West Metro Fire Rescue (WMFR) is a fire protection district governed by seven publicly elected officials. WMFR serves a population of approximately 265,000 residents across a 110 square mile jurisdiction with a full strength uniform staff of 340 firefighters. Operating out of 15 stations with an annual budget of 49 million dollars, WMFR serves a combination of towns and cities across two counties on the western side of the Denver Metropolitan area. The department is an all risk organization, providing fire protection and prevention services, advanced life support, technical rescue, hazardous material response and mitigation both locally and regionally.

In August of 2012 WMFR became an internationally accredited agency. A pillar of the accreditation process is the development and commitment to a five year strategic plan. The district outlined and described organizational values as a foundation for the strategic plan and the direction of the district. One of the core values of WMFR is “prevention of emergencies and awareness of the dangers to our citizens to reduce the risk of their lives” (West Metro Fire Rescue [WMFR], 2012, p. 5).

The second year curriculum for the Executive Fire Officer Program at the National Fire Academy is Executive Analysis of Community Risk Reduction (EACRR). The primary goal of EACRR is the empowerment of the Executive Fire Officer (EFO) to lead community risk reduction in a strategic manner (*EACRR Student Manual*, 2013).

In support of the organizational values outlined in the WMFR Strategic Plan in conjunction with the vision of community risk reduction set forth by the United States Fire Administration (USFA) in the EACRR curriculum, WMFR has established several strategic goals and objectives for the organization.

Strategic Goal #2: Reduce the number and severity of emergency incidents (Page 11)

- Objective 2A Evaluate and enhance a public education and information program targeted at reducing the risk to our citizens (page 11)
- Objective 2G Provide apparatus and equipment evaluation to enhance operational effectiveness (page 15)
- Objective 2H Increase preparation for catastrophic/unforeseen events. (Page 16)

Strategic Goal #5: Promote a Strategic Management Culture through Craftsmanship, Innovation and Excellence (Page 22)

- Objective 5B Develop a risk assessment process to evaluate the exposures within our community (page 23)

(WMFR, 2012)

WMFR has clearly illustrated that community risk reduction is an organizational priority and the USFA has made material and methods readily available for implementation of programs and evaluation of local risks. At WMFR these programs and initiatives remain largely in the Fire Prevention or Community Outreach divisions of the organization. By limiting the analysis of community risk to these divisions the scope of risk analysis is limited and potentially risks and trends in operational divisions may be missed.

Between 01/01/2012 and 12/31/2012 West Metro Fire Rescue responded to 24,060 emergency incidents. Over 32% of these responses were to Multi-family dwellings, hotels or assisted living facilities where residents, temporary or permanent, exceed a single family classification (Long, 2013). During this same time frame WMFR responded to 186 incidents classified as structure fires involving enclosed buildings (Long, 2013). This incident classification is not only determined by the officer in command and responsible for the incident

but also reviewed by Fire Prevention Division Lieutenant Bill Maron to ensure criteria are accurately met and fire activity is reported appropriately. Of these 186 structure fires, 53 occurred in a multi-family dwelling accounting for 30% of the districts structure fires. This is consistent with overall district response to these occupancies; however, only 26% of the district's population resides in multi-family dwellings (Saito, 2012, p. 3).

The scope of the afore presented information does not reveal an outstanding risk; however a follow up review of this information begins to display a more focused issue and the direct relationship to the Operations Division and citizens. Within this data set of 53 structure fires at multi-family dwellings, forty of the fires (75%) had a point of origin above the first floor (Pfannenstiel, 2014). In a poll of West Metro Firefighters regarding response to multi-family dwellings, 65% reported the most common multi-family dwelling they were responding to was the three story occupancy (Brush, 2014). On average West Metro Firefighters are responding to a working structure fire in a multi-family dwelling once a week. The fact that the floor of origin is also most commonly above the first floor presents a greater risk of entrapment to the citizens in the district who live in these occupancies.

In 2010 WMFR increased the initial alarm assignment to confirmed fires at multi-family and commercial structures with the dispatch of a second tower (ladder company with 4 members) in an effort to improve our response to these incidents (West Metro Fire Rescue [WMFR], 2014). A complete review of WMFR second alarm or greater fires over the past five years revealed that 80% of fires that exceeded the initial alarm dispatch assignment involved multi-family dwellings (Brush, 2014). This shows that the demands of these incidents continue to outpace initial responding resources and do so statistically more than any other occupancy type. The tactical

demands of incidents at these occupancies are one piece of a hazard assessment, the true life hazard present at these occupancies should also be evaluated by WMFR.

Multi-family dwellings are defined by housing more occupants than a typical residence. According to the property manager at Americana Lakewood Apartments in Lakewood, Colorado, the 16 building complex was 100% occupied. The apartment buildings in the complex contain either 24 or 36 units and average 3.5 occupants per unit (T. Beavers, personal communication, Feburary 21, 2014). All of these buildings are 4 story wood framed buildings with the ground level as covered parking. All residents are living above grade in this complex due to this construction feature. Anywhere from 84 to 126 residents on average reside in each building. The additional tower company on a fire dispatch does not match the exponential increase in life hazard and access challenge present at these occupancies. When compared to a standard single family dwelling which has an average of 2.23 occupants per dwelling for the district, the risk is immense (Saito, 2012).

This is only one complex covering several acres within a fire district of over 110 square miles and a resident population of 265,000 however, the low vacancy rate and high occupant load is common for our area. The Denver Metro Area served by West Metro Fire Rescue had a multi-family vacancy rate of 3.6% one of the lowest in the metro area (Throupe & Von Stroh, 2013). City of Lakewood had an overall multi-family dwelling vacancy rate of 3.2% which is the lowest for suburban communities surrounding the City and County of Denver (Throupe & Von Stroh, 2013).

Low vacancy rates translate to a low supply of housing and in the multi-family category this is a low supply of affordable housing for low income families which can result in

overcrowding of the available units. The incidence of fire is two to three times higher in housing tract areas ranked high on crowding (United States Fire Administration, 1997).

Beyond the statistical data for our organization and district there is a great deal of research into the topic of fires at multi-family dwellings. In a 1997 report from the Federal Emergency Management Agency titled the Socioeconomic Factors and the Incidence of Fire, several points are addressed which clearly demonstrate why multi-family dwellings are a higher risk occupancy for fire than other dwellings. The report begins by presenting the fact that nationally, over 66% of all residential fire causes are human related and that evaluation of the socioeconomic factors are the best known predictors of fire rates at the neighborhood level (Federal Emergency Management Agency [FEMA], 1997).

In addition to socioeconomic factors, ownership of property plays a significant role in the increased risk of fire at multi-family dwellings. These units are primarily rented and not privately owned occupancies. Fire rates in areas with low individual home or property ownership have been determined to be more than two times that of areas with high home ownership (United States Fire Administration, 1997, p. 5)

The 110 square mile area which is the West Metro Fire Protection District is divided into 3 operational districts numbered 1 through 3 from North to South. Each district is managed by a district chief who oversees 5 fire stations (www.westmetrofire.org). The Northern most portion of the fire district is District 1. District 1 almost exclusively covers the incorporated city of Lakewood. The population of Lakewood served by WMFR is 147,850 with median household income reported as $52,512 and 11.9% of the population in this area living below the poverty level (Saito, 2012, p. 2).

District 2 is mainly the geographic center of the fire protection district which spans the South and Western parts of the City of Lakewood as well as the Northern end of unincorporated Littleton in Jefferson County. The population of unincorporated Jefferson County served by WMFR is 102,388 with a median household income of $76,877 and 6.5% of the population living below the poverty level (Saito, 2012, p. 2).

District 3 is the Southern end of the fire district serving mostly unincorporated Jefferson County and parts of Northern Douglas County in the community of Roxborough. The population of unincorporated Douglas County served by WMFR is 9,482 with a median household income of $99,409 and 3.2% of the population living below the poverty level. (Saito, 2012, p. 3)

As is indicated by the demographics cited from a department analysis of community risk by the WMFR Community Education Specialist there is a significant difference in the income level of the populations in each district. The median income in Douglas County is nearly double that of residents in District 1 and the percentage of the population living below the poverty level is nearly four times that found in Douglas County. “Virtually every study of socioeconomic characteristics has shown that lower levels of income are either directly or indirectly tied to and increased risk of fire.”(United States Fire Administration, 1997, p. 2)

According to the Denver Metro Area Apartment Vacancy and Rent Survey which reviews multi-family dwelling occupancy rates, rent averages and forecasted units being developed for the five county metro area apartment rents in Lakewood is $841.84 a month (Throupe & Von Stroh, 2013). This is the second lowest of all reported neighborhoods and over $150.00 a month lower than the Denver Metro Average of $992.89 (Throupe & Von Stroh, 2013).

Housing quality and housing affordability are directly related. The cost of a housing unit for sale or for rent is priced according to the quality of its given location and amenities (United States Fire Administration, 1997, p. 13). Poor housing quality refers to age and quality of construction, up keep of the property and maintenance of systems, as well as crime rate in the area. This correlation between low rent and housing quality would indicate that the most densely populated, lowest income areas of the West Metro Fire Protection District are also some of the most socioeconomically challenged areas of the Denver Metro area.

> "In most urban areas the lowest income units are in the oldest most run-down portion of the city's housing stock. Living in an older poorly maintained housing unit raises a households risk for fire for several reasons."
>
> - Poor maintenance of systems, heating and such which increases mechanical malfunction and the risk of fire.
> - Dated electrical wiring systems are typically overloaded by modern technology and alternative strategies increase electrical fire risk.
> - Households may be forced to compensate for poor systems of construction with stop gap measures such as space heaters.
> - Construction in these areas is typically before modern building codes and enforcement with very little retrofitting.
>
> (United States Fire Administration, 1997, p. 12)

Housing quality and age of dwellings is expanded on as a significant factor in the risk of and severity of fires. The USFA estimates that 92% of dwellings built since 1981 have working smoke detectors. The estimate for dwellings constructed prior to 1980 is only 74% (United States Fire Administration, 1997). For the City of Lakewood there is a marked difference in the

vacancy rates in housing built prior to 1980 versus that which was built after 1981. Within Lakewood multi-family dwellings built before 1980 have the lowest vacancy rate at 2.7% compared to 1981 to present with a 4.4% vacancy rate (Throupe & Von Stroh, 2013). As data collection and initial investigation begins to demonstrate the fire risk in multi-family and contributing factors begin to compound in areas with increased density and socioeconomic challenges.

While the information presented to this point would direct attention towards a specific area of the district and a focused fire risk, line members of WMFR believe that there are operational challenges associated with all multi-family dwellings not just those in high density low income areas. Through an online poll regarding responses to multi-family dwellings, 65% of the members who responded reported they are “often” responding to multi-family dwellings with 17% reporting “sometimes,” 13% “rarely” and 5% as “almost always”(Brush, 2104). As indicated by department statistics theses occupancies account for just over 32% of all district responses (Long, 2013). With nearly one third of emergency responses to these occupancies, district firefighters are very familiar with the operational challenges they present.

Members reported the two most common accesses to residences in multi-family dwellings as a common open stairwell (60% of responses) or closed common stairwell (30% of responses)). In regards to the interior of the multi-family units 90% of the members questioned, reported that from the front door of the unit the kitchen area was open to, or between the front door and the sleeping areas (Brush, 2014). These two findings are significant factors in occupant egress during fire events.

Cooking fires are the leading cause of multi-family dwelling fires at 69% and cooking areas and kitchens are the primary areas of origin for non-confined multifamily dwelling fires at

33% (United States Fire Administration [USFA], 2012). With multi-family units being smaller occupancies they almost exclusively have a single means of egress with the front door, as opposed to a single family dwelling which may also have a back and or side door to the exterior. As indicated in the poll of members as well as an internet search of multi-family unit floor plans the kitchen is usually in close proximity to the front door and sleeping areas remote to the front door. The high likelihood of fire starts in the kitchen area between sleeping areas and egress places occupants of the fire unit in multi-family dwellings at a higher risk of entrapment by fire.

Thirty-one percent of multi-family dwelling fires extend beyond the unit of origin (USFA, 2012). Common stairwells to multiple units in multi-story occupancies are vulnerable to exposure especially when the fire apartment door is left open and products of combustion rise through these channels.

Sixty five percent of members who responded to the multi-family dwelling poll described apparatus access to these occupancies as "poor," 30% as "good" and only 5% as "great." When asked "If a significant fire occurred in a multi-family dwelling in your district what would be the best means for evacuating residents?" 60% responded standard egress and 30% responded ground ladders (Brush, 2014). While aerial ladder was an option it was not selected by any of the members questioned.

On January 16th 2007, at 0047 hours Colorado Springs Fire Department (CSFD) was dispatched to a reported fire in an apartment building. Three minutes later, the first district chief arrived and immediately requested a second and third alarm when he arrived to find a working fire with dozens of occupants at windows and balconies (Royal, 2009). "We addressed the obvious challenge and priority of the life safety need by calling for an 'all hands' rescue" (Royal, 2009, p. 56). The first three companies to arrive on scene made 40 ladder rescues. Nine apparatus

from the first three alarms were dedicated to ladder rescues and responsible for removing a total of 85 occupants via ground ladders (Royal, 2009). The 85 occupants rescued from upper floors represent 25% of the buildings total residents (Royal, 2009). The City of Colorado Springs is very similar both geographically and demographically to West Metro Fire Rescue's district and apartment complexes of like design and era of construction can be found in our response districts.

The Castle West Apartment fire is described by Battalion Chief Randy Royal as one of the most dangerous and devastating fires in the City's history (Royal, 2009). Chief Royal and the Colorado Springs Fire Department went to great lengths to share the lessons learned from this very challenging fire through publication of articles, procedure changes and even no cost regional presentations. It is possible that the presentations were viewed more as a historic outlier than a sign of what potential may exist for WMFR. Unfortunately WMFR staff did not attend any of these presentations.

In July 2013, a website was created to establish a location for reporting rescues made by firefighters. The website is dependent on voluntary submissions of rescues made by fire departments which have been confirmed by the department or a media source. As a voluntary reporting system it will only capture a certain percentage of the true data as is the same for the National Fire Incident Reporting System (NFIRS); however, the data provided is still valuable. While the incredible challenge of rescuing 85 occupants from a building by ground ladders at a single incident is unique, the act of rescuing occupants by ground ladders at multi-family dwellings is much more common. In the first four months of 2014, 117 rescues by ground ladders from multi-family dwellings were reported to www.firefighter rescues.com (http://www.firefighterrecues.com). Nine fire incidents at multi-family dwelling fires resulted in

more than 5 rescues on each scene, and 65% of fires at multi-family dwelling fire where ground ladder rescues were reported had multiple rescues (http://www.firefighterrecues.com). To see 117 documented ladder rescues from multi-family dwelling fires in the first 121 days of the year through a voluntary reporting system would present the case that on average a civilian is rescued everyday by firefighters with ladders in the United States. A review of West Metro Fire Rescue's recent history found no documented ladder rescues. Some members have reported fires in recent years where occupants were removed from balconies or windows of multi-family dwellings, however, I was unable to official confirm these stories through department reporting systems. The lack of occurrence at WMFR should increase our degree of concern not be viewed as a success or lack of needed preparation. The frequency of our response to these occupancies combined with the occurrence and location of fires in these structures statistically places civilians at great risk on a weekly basis.

To summarize the background on the potential for civilian rescues by ground ladders at multi-family dwelling fires in the West Metro Fire Rescue District, a significant risk potential exists for several reasons. The life hazard density of these occupancies puts the equivalent of an entire neighborhood of single family dwellings into a single structure. The demographics of West Metro Fire Protection District and the reported effects those demographics have on the risk of fire in relation to the socioeconomic factors presents an elevated risk in all multi-family dwellings and has revealed areas of WMFR where a high degree of risk is present. Building construction and unit design not only contribute to the spread of fire and products of combustion but also have increased potential to expose or cut off paths of egress for residents. Building construction and design have also been clearly identified as challenges by WMFR members responding to and operating in these structures.

West Metro Fire Rescue has not been challenged with an “all hands rescue” (Royal, 2009, p. 56) operation, however the Castle West Apartment Fire incident presents both a regional peer experience and an example of extreme test of readiness and resources. The improved reporting to www.firefighterrescues.com demonstrates that high risk low frequency situation locally is presenting itself on a regular basis on a national level.

West Metro Fire Rescue (2012) has identified prevention as an organizational core value and therefore a more thorough evaluation of the risk potential for ground ladder rescues at multi-family dwellings is necessary. To wait until a significant event occurred would be reactionary and counter to the department’s mission.

The work of this project supports the United States Fire Administration’s goal number one, to reduce risk at the local level and goal number two to improve local planning and preparedness (*EACRR Student Manual*, 2013). The applied research connects to the second year executive fire officer program, executive analysis of community risk reduction curriculum by utilizing the community risk reduction model and assessing community risk as outlined in unit two (*EACRR Student Manual*, 2013). Application of this research internally at WMFR will support all objectives of strategic goal two; reduce the number and severity of emergency incidents and objective B of strategic goal five; to develop a risk assessment process to evaluate the exposures within our community (WMFR, 2012).

Literature Review

Using the descriptive research method, literature review began with a review of information regarding multi-family dwelling fires to determine the level of value in further investigating the topic. Once it was determined that a body of work in the area was sufficient and the problem was significant enough to support further research, the literature review process followed the first three steps outlined in step two of the community risk reduction model; analyze community, identify hazards and causal factors and assess vulnerability (*EACRR Student Manual*, 2013).

In 2012 the United States Fire Administration (USFA) published a report on four years of data collected on multi-family residential building fires from 2008 to 2010. In the United States annually there was 102,300 multi-family building fires causing an estimated 400 deaths, 4,175 injuries and 1.2 billion dollars in property loss (USFA, 2012). The report notes that nationally multi-family dwellings account for 28% of all residential building fires (USFA, 2012).

The frequency of multi-family dwelling fires does not present a significant problem, it is where these fires are occurring which highlights the risk especially in the design and density of these occupancies. Cooking fires account for 69% of multi-family residential building fires. This is more than twice that of other residential building fires (USFA, 2012). Cooking areas in multi-family dwellings are in close proximity or directly open to the single means of egress for the unit and the common means of egress for other units. This point justified an in depth evaluation of the potential effects this has on rescue operations at these occupancies.

The response data of West Metro Fire Rescue (WMFR) is consistent with the findings in the report from the USFA. West Metro Fire Rescue responded to 186 structure fires between January 1st 2012, and December 31st 2012. Fifty three of these fires occurred in Multi-family

dwellings accounting for 30% of district's structure fires (Long, 2013). When the fire cause is reviewed in this data set provided by Marion Long of the National Fire Incident Reporting System (NFIRS) it is discovered that of the 186 structure fires classified by NFIRS the district responded to 29 fires in the category "cooking fires confined to a container." Nineteen of the 29 fires in this category or 65% of these fires occurred in multi-family dwellings (Long, 2013). District data is very close to the national averages reported by the USFA.

The benefit of the use of modern electronic reporting systems is that queries of information can be conducted quickly and in great detail. In a review of this same data set of structure fires through WMFR High Plains reporting system it was discovered that 40 of the fires or 75%, had a point of origin above the first floor (Pfannenstiel, 2014). This finding further confirmed the potential for above grade entrapment of occupants at working fires in multi-family dwelling fires which are statistically occurring on a weekly basis in district.

The aforementioned findings set the foundation for the project and continued literature review, by helping to develop my personal vision and outline a plan of approach for the project as found in step one of the community risk-reduction model "getting ready" (*EACRR Student Manual*, 2013)

Step two in the community risk-reduction model is assessing community risk and begins with analyzing the community (*EACRR Student Manual*, 2013). Literature review shifted to evaluate both the civilian community living in multi-family dwellings and the internal community of the operations division firefighters responding to and operating in these occupancies.

The latest community analysis of the WMFR was conducted in 2012 by Community Education Specialist Susan Saito. According to the document WMFR serves a population of

247,648 citizens and averages about a 1% growth rate from year to year (Saito, 2012). For the district the average single family household is 2.23 persons per occupancy (Saito, 2012).

The report also states that 26% of the district's residential occupancies are multifamily dwellings (Saito, 2012). Multi-family dwellings are defined by housing more occupants than a typical residence. The Americana Lakewood Apartments in Lakewood, Colorado represent a mid-range multi-family dwelling complex for the West Metro Fire Rescue District in terms of size, era of construction and socioeconomic make up. In an interview with the property manager she advised that the 16 building complex currently had no vacancies. The apartment buildings in the complex contain either 24 or 36 units and average 3.5 occupants per unit (T. Beavers, personal communication, February 21, 2014). Mrs. Beavers also advised that in her work with other complexes in Lakewood and across the Denver Metro she believed this average of occupants per unit is consistent. Overcrowding increases fire risk which is defined by the USFA as more than 1 person per room in a dwelling (United States Fire Administration, 1997).

Multi-family dwellings are not just a present risk, they are a growing future risk. Denver Metro multi-family dwelling vacancy rate is currently 4.6% trending down consistently from 6% 10 years earlier and a high of 9% in 1st quarter of 2009 (Throupe & Von Stroh, 2013). According to an article in the Denver Business Journal from September 2012, the Denver Metro area is seeing approximately 3,000 new multi-family units become available every year; however the market can support up to 4,500 leaving a supply shortage and therefore high rents and low vacancy rates (Huspeni, 2012). The high demand and rapid growth of multi-family dwellings was reported on specifically regarding Lakewood Colorado and the development along the Regional Transportation District Light Rail West Line in a recent article from the Denver Post. "In 2013 the city of Lakewood had 11 multi-family or mixed occupancy developments along the

W-Line in the preplanning stage and 10 more further along in the site development phase" (Briggs, 2014, p. 6A).

The high demand and low supply for multi-family units in WMFR has led to low some of the lowest vacancy rates in the Denver Metro area. The Denver Metro Area served by West Metro Fire Rescue had a multi-family vacancy rate of 3.6% one of the lowest in the metro area (Throupe & Von Stroh, 2013). City of Lakewood had an overall multi-family dwelling vacancy rate of 3.2% which is the lowest for suburban communities surrounding the City and County of Denver (Throupe & Von Stroh, 2013). There are areas of WMFR where high demand and low supply are leading to developers competing for market share and bringing in higher quality and more desirable housing units; however this is not the case in most of the City of Lakewood.

Average rent for a unit in a multi-family dwelling in Lakewood is $841.84 which is the second lowest for suburban communities surrounding the City and County of Denver behind "Aurora – Central" at $826.78 (Throupe & Von Stroh, 2013). When low cost housing and low vacancy rates (over-crowding) are paired together the risk for fire increases significantly. "Virtually every study of socioeconomic characteristics has shown that lower levels of income are either directly or indirectly tied to and increased risk of fire."(United States Fire Administration, 1997, p. 2) In the lowest rent areas of the district the available housing is also the oldest. Without the drive of competition by building owners and managers the housing quality suffers.

Within Lakewood multi-family dwellings built before 1980 have the lowest vacancy rate at 2.7% as compared to those constructed from 1981 to present with a 4.4% vacancy rate (Throupe & Von Stroh, 2013). Poor housing quality refers to age and quality of construction, up keep of the property and maintenance of systems.This correlation between low rent and housing

quality indicates that the most densely populated, lowest income areas of the West Metro Fire Protection District are also some of the most socioeconomically challenged areas of the Denver Metro area.

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Housing quality and age of dwellings is expanded on as a significant factor in the risk of and severity of fires. The USFA estimates that 92% of dwellings built since 1981 have working smoke detectors. The estimate for dwellings constructed prior to 1980 is only 74% (United States Fire Administration, 1997). The USFA (1997) also states that housing that does not have working smoke detectors are two and a half times more likely to have a reported fire.

Analyzing the community of citizens living in multi-family dwellings through related literature, displays an elevated fire risk. The age and condition of dwellings themselves, over-crowding due to low vacancy rates and socio-economic factors further increase risks on a

neighborhood by neighborhood basis. In order to determine if there is an increased potential for ladder rescues at these occupancies a review of material related to the types of structures, the design of them in the district, and operational community analysis of West Metro Firefighters needs to be completed.

Americana Lakewood Apartments, West Dakota Avenue Lakewood, Colorado

Multi-family dwellings are defined by housing more occupants than a typical residence. The Americana Lakewood Apartments in Lakewood, Colorado pictured above are a relatively common style of multi-family dwelling at WMFR. In an interview with the property manager she advised that the 16 building complex currently had no vacancies. The apartment buildings in the complex contain either 24 or 36 units and average 3.5 occupants per unit (T. Beavers, personal communication, Feburary 21, 2014). All of these buildings are 4 story wood framed buildings with the ground level as covered parking. All residents in these units are living above grade due to this construction feature placing anywhere from 84 to 126 residence on average in each building.

Seventy-five percent of the working structure fires at multi-family dwellings that occurred in West Metro Fire Protection District in the calendar year of 2012 had a point of origin above the first floor (Pfannenstiel, 2014). In a poll of West Metro Firefighters regarding responses to multi-family dwellings, 65% reported the most common multi-family dwelling they

were responding to was the three story occupancy (Brush, 2014). On average West Metro Firefighters are responding to a working structure fire in a multi-family dwelling once a week. The fact that the floor of origin is also most commonly above the first floor presents a greater risk of entrapment to the citizens in the district who live in these occupancies.

In 2010 WMFR increased the initial alarm assignment to confirmed fires at multi-family and commercial structures with the dispatch of a second a tower (ladder company with 4 members) in an effort to improve our response to these incidents (West Metro Fire Rescue [WMFR], 2014). In a complete review of WMFR second alarm or greater fires over the past five years also revealed that 80% of all working fires that exceeded the initial alarm dispatch assignment involved multi-family dwellings (Brush, 2014). The additional tower company on a fire dispatch does not match the exponential increase in life hazard at these occupancies up to 3.5 per unit (Beavers, 2014) versus a standard single family dwelling which has an average of 2.23 occupants per dwelling for the district (Saito, 2012). This data also shows that the demands of these incidents continue to outpace initial responding resources even with the additional unit on the first dispatch and they do so statistically more than any other occupancy type.

The response of an additional tower company on dispatch may or may not be of much added benefit to the initial operations according to a poll of West Metro Firefighters. Sixty-five percent of members who responded to the multi-family dwelling poll described apparatus access to these occupancies as “poor,” 30% as “good” and only 5% as “great” (Brush, 2014). When asked “If a significant fire occurred in a multi-family dwelling in your district what would be the best means for evacuating residents.” Sixty percent of the firefighters who responded reported standard egress and 30% responded ground ladders (Brush, 2014). While aerial ladder was an option it was not selected by any of the members questioned.

In reviewing the article of lessons learned from the Castle West Apartment Fire in Colorado Springs, 85 occupants were rescued by ground ladders and none were removed by aerial ladders. On January 16th 2007, at 0047 hours Colorado Springs Fire Department (CSFD) was dispatched to a reported fire in an apartment building. Three minutes later, the first district chief arrived and immediately requested a second and third alarm when dozens of occupants were observed at windows and balconies (Royal, 2009). "We addressed the obvious challenge and priority of the life safety need by calling for an 'all hands' rescue" (Royal, 2009, p. 56).

Laddering is traditionally considered a truck company function, the opinion of West Metro Firefighters and the experience of the Colorado Springs Fire Department (CSFD) at the Castle West Fire shows that most if not all ladder rescue work will be performed with standard ground ladders and the immediacy of an "all hands rescue" situation will be placing all companies arriving with ladders to work. The first three companies to arrive on scene at the Castle West Fire made 40 ladder rescues. Nine apparatus from the first three alarms were dedicated to ladder rescues and responsible for removing a total of 85 occupants via ground ladders (Royal, 2009). The 85 occupants rescued from upper floors represent 25% of the buildings total residents (Royal, 2009). The City of Colorado Springs is very similar both geographically and demographically to West Metro Fire Rescue's district and apartment complexes of like design and era of construction can be found.

Through personal communication with Chief Royal (2014) he reported a significant take away from the Castle West Fire and in the years since the incident is CSFD truck companies routinely drill with neighboring engine companies to maintain proficiency in ground ladder work. WMFR has done a good job of training all members in the use of ground ladders. In a review of WMFR "quick drills" and training events from the last two years, ground ladder skills

work is either an area of focus or related component of official district training on nearly a bi-monthly basis. Unfortunately in reviewing the same training documents and department standard operating procedures there is no “all hands rescue” training, scenario or operational procedure developed.

A review of West Metro Fire Rescue’s recent history found no documented ladder rescues. Some members have reported fires in years past where occupants were removed from balconies or windows of multi-family dwellings, however, I was unable to official confirm these stories through department reporting systems. The lack of occurrence at WMFR should increase our degree of concern not be viewed as a success or lack of needed preparation. The frequency of our response to these occupancies combined with the occurrence and location of fires in these structures statistically places civilians at great risk on a weekly basis.

In July of 2013, a website was created to establish a location for reporting rescues made by firefighters. The website is dependent on voluntary submissions of rescues made by fire departments which have been confirmed by the department or a media source. As a voluntary reporting system it will only capture a certain percentage of the true data as is the same for the National Fire Incident Reporting System (NFIRS). The data provided is valuable. While the incredible challenge of rescuing 85 occupants from a building by ground ladders at a single incident is unique, the act of rescuing occupants by ground ladders at multi-family dwellings is much more common.

In the first four months of 2014, 117 rescues by ground ladders from multi-family dwellings were reported to www.firefighter rescues.com (http://www.firefighterrecues.com). Nine fire incidents at multi-family dwelling fires resulted in more than 5 rescues on each scene, and 65% of fires at multi-family dwelling fire where ground ladder rescues were reported had

multiple rescues (http://www.firefighterrecues.com). There were several multi-family dwelling fires which would meet the “all hands rescue” situation described by Royal(2009) where as many as 10 civilians were removed via ground ladders. To see 117 documented ladder rescues from multi-family dwelling fires in the first 121 days of the year through a voluntary reporting system would present the case that on average a civilian is rescued everyday by firefighters with ladders in the United States.

To analyze the operational community the question then becomes how many WMFR companies are available to execute ground ladder rescues upon arrival at a working fire in these occupancies. The current first alarm assignment to a confirmed fire at a multi-family dwelling is; three engine companies, two medic units, two tower companies, one heavy rescue, two district chiefs, one safety officer and one bureau officer. This totals between 29 and 32 personnel (WMFR, 2014). Current fire ground operations and responsibilities at WMFR are mixed between past practices and an “on deck” system (“Blue Card,” 2014).

Past practices at WMFR have implied roles for apparatus based on arrival order; first arriving engine is attack, second engine supply and third engine is the rapid intervention team. Medic units (ambulances with two firefighter paramedics) also have implied roles with the first arriving medic unit to support fire attack and the second to provide medical for the scene. Within this frame work of operation the heavy rescue and two tower companies (12 members) are available for any fire ground support function (WMFR, 2014). This preplanned assignment system assists with anticipation of duty and has historically worked well on routine incidents where variables are limited.

The “on deck” system outlined in the Blue Card Command training program WMFR is currently using is a more explicit and real time assignment model where units are directly

assigned tasks by the command officer (“Blue Card,” 2014). In theory this allows for more flexibility in assignments to match incident specific needs and without predetermined assignments would make any company available for ladder rescues. This system has not been fully implemented either in policy or practice at WMFR. The most common concern about the “on deck” system among members questioned is that personnel and apparatus which have not traditionally performed different tasks or worked with apparatus specific equipment would not be as efficient as those who had. Examples would be using a first arriving tower company personnel as fire attack and a later arriving medic unit from a different station to access the ladders and equipment from that apparatus to perform vertical ventilation. It is still to be determined which operational framework WMFR will operate in coming years.

If the transition is made to a system where not just tower and rescue, but all companies are prepared and equipped to handle an “all hands” rescue situation, are there ways to improve capabilities beyond regular drilling with ladders? I contacted Lieutenant Oren Bersagel-Briese assigned to Quint 155 in Castle Rock, Colorado, a suburban community of about 55,000 residents in the Southern Metro Denver area to answer this question. His company recently took delivery of a new quint and three of the department’s engines were also replaced. The Castle Rock Fire Department is an all risk agency that also provides fire based EMS and has a career staff of 76 members, daily operational staffing of 19 for 1 battalion chief, 3 engines 3 medic units and 1 quint (“Town of Castle Rock,” 2014). According to NFPA standard 1901 a “quint” is a fire apparatus with a permanently mounted fire pump, a water tank, a hose storage area, an aerial ladder or an elevating platform with a permanently mounted waterway, and a complement of at least 85 feet of ground ladders as compared to a required 48 feet on an engine company (Peters, 2001). In the operational model of a quint the apparatus is used as the initial response

unit for all calls in their immediate response district and also provide aerial apparatus response for the entire town.

Lieutenant Bersagel-Briese was asked if they had considered the need to improve the laddering capabilities of all companies in the event the quint was on another call at the time of a working fire and if he believed the reduced quint ladder complement provided adequate ground ladders for the potential risk in the town. Lieutenant Bersagel-Briese was on the committee that purchased the new apparatus and he advised that ground ladders were an area of focus in the purchasing and outfitting of the apparatus. There was additional planning and design work involved to get the quint equipped with a total of 184 feet of ground ladders, exceeding the NFPA minimum standard by nearly 100 feet (O. Bersagel-Briese, personal communication, May 16, 2014). The 184 feet of ground ladders also exceeds the NFPA ground ladder compliment for truck companies, which are 115 feet (McCormack, 2011). In reviewing the Tower companies at WMFR, ground ladder compliments are between 140 and 150 feet, essentially one ladder less than what is carried on the Castle Rock Quint.

Castle Rock Fire Department (CRFD) also adjusted the ladder compliments of the engine companies. The industry standard ground ladder compliment for engine companies is a 14 foot roof ladder, 24 foot extension and 10 foot folding ladder (Shand & Wilbur, 2013). The apparatus committee for the new purchases elected to outfit all engine companies as well as the quint with 28 foot extension ladders and 16 foot roof ladders. The change to 28 and 16 foot ladders not only increases the reach of the ladders in these categories but also in width, making them a better tool for effecting rescues (O. Bersagel-Briese, personal communication, May 16, 2014). The CRFD was specific about the manufacturer of their selected ladders. As displayed in the chart below the

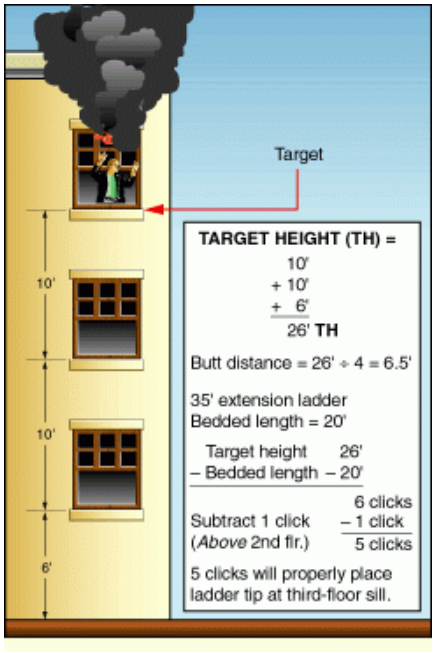
service test rating is set by NFPA and is the same for all ladders yet there is a marked difference in weight and a slight difference in the width.

	Duo Safety Weight	Duo Safety Width	Alco-Lite Weight	Alco-Lite Width
14 foot roof ladder	28 lbs	21″	42 lbs	21″
16 foot roof ladder	39 lbs	22″	48 lbs	21″
24 foot extension ladder	72 lbs	22″	75 lbs	21″
28 foot extension ladder	87 lbs	24″	114 lbs	22″
35 foot extension ladder 2 section	122 lbs	24″	139 lbs	22″
35 foot extension ladder 3 section	129 lbs	24″	170 lbs	22″

(Alco Lite Ladders, 2014) (Duo Safety Ladders, 2014)

Denver Fire Department is the largest fire department in the state of Colorado and operates within an implied role system similar to how WMFR has operated in the past. One of the key differences in operations is the resources available. WMFR has three tower companies and one heavy rescue with 15 engine companies. Denver Fire Department (DFD) has 29 engine companies and 15 truck companies, 1 heavy rescue and 1 haz-mat unit (“City of Denver,” 2014). The engine/truck ratio, as this metric is commonly referred to, for WMFR is 5 to 1 and for Denver fire it is roughly 2 to 1. This not only makes more truck companies available for ladder rescues but it also places them in a closer proximity to incidents due to the higher ratio which places them on scene quicker. Even with this favorable engine/truck ratio, DFD truck companies are still looking for opportunities to improve their rescue capabilities. Captain Vern Scott of DFD truck company 15 explained in a phone interview that due to the high density three and

four story multi-family dwellings in his response district, he worked through the equipment request process to change out the two 24 foot ladders that are standard for DFD truck companies for a 28 foot extension ladders (V. Scott, personal communication, January 6, 2014). Through his experience he found that while four feet is perceived to be a small difference it is consistently the difference in making the tip to a balcony railing or to a fourth floor window sill in the presence of a garden or walk out level (V. Scott, personal communication, January 6, 2014).



(Avillo, 1999)

Due to the climbing angle of ladders a rule of thumb for the working length for ground ladders less than 35 feet is 1 foot less than the total length and two feet less for ground ladders over 35 feet (Avillo, 1999). The graphic above uses common residential floor and window sill heights found in multi-family dwellings to demonstrate the target height of a third floor window at 26 feet. This would be out of the working length reach of a 24 foot ladder which is 23 feet but within normal operation of a 28 foot extension ladder with a working length of 27 feet. As indicated by the poll completed by WMFR firefighters the 3 story multi-family dwelling is our most common and therefore should be our main area of focus (Brush, 2014).

Through analyzing both the citizen and operational communities in the literature review numerous casual factors were identified from socioeconomic factors to building construction, unit design all the way to engine company ground ladder selection. Nearing the completion of the literature review there was a portion of the rescue situation which had not yet been evaluated within this paper, the stress of a situation where lives were at risk. Rescue situations for firefighters are survival situations for civilians. There can be severe mental and physical impairments from the stress of those situations which maybe the difference between success and fatality.

> "Only 10 to 20% of the general population can stay calm and think in the midst of a survival situation. They are the ones who can perceive their situation clearly; they plan and take correct action, all of which are key elements of survival. Confronted with a changing environment they readily adapt." (Gonzales, 2003, p. 24)

The physiological effects of stress on a person during a survival situation will quickly overwhelm their ability to think logically or even perform simple physical tasks (Brush, 2013). Extensive research on this topic can be found across several fields and professions which were used as the foundation for my first year Executive Fire Officer Applied Research Project *The Missing Pieces of Firefighter Survival: Investigating the Psychology and Physiology of Surviving on the Fire Ground.* One of the key findings in the research was that awareness, training and conditioning for life threatening situations and their effects prior to the events is the greatest factor in improving the odds of survival and ability to act appropriately (Brush, 2013). As firefighters we are very familiar with this approach, a great deal of our professional careers is centered on preparation and planning for emergencies however this is not the case for the

majority of society. We can find some examples where regular preparation of emergencies of the general population is accepted and routine practice.

One of the greatest challenges to fire safety education and risk reduction programs is community access. Fire departments struggle with ways to work with or create events where a captive audience is available. This is largely why most fire service efforts are focused on children in schools. Public school systems are not only charged with educating children, they are also trusted with keeping them safe during the school day. Most fire service programs including the National Fire Protection Association Fire Prevention Week are specifically targeted at school aged children. One of the other pieces of keeping children safe at schools is regular fire drills. In most school systems, fire drills are conducted twice in the first month of school to re-engage the student's minds in the potential for a fire and repeated once a month for the rest of the school year to ensure the children are practiced in the procedure (Jefferson County Public Schools, 2013).

Multi-family dwellings present a captive audience and a unique community in that the vast majority of these occupancies are rented as a contractual agreement between the renter and the leasing company. In addition to this agreement, the leasing company and the building owner are operating as a business within a municipality or fire district which is also conducted through codes, rules and regulations. These avenues provide opportunities for awareness, training and conditioning for potential fire emergencies that most single family dwellings with private ownership would not.

> "Apartment buildings, with or without onsite management, must provide an emergency guide to tenants. The guide must describe the location, function and use of all fire protection equipment and appliances accessible to tenants, including fire alarm

> systems, single-station smoke detectors and portable fire extinguishers. The guide shall also include an evacuation plan for each dwelling unit." ("San Diego Fire Rescue," 2014)

San Diego Fire Rescue is using regulation through operation of the business of an apartment building in the jurisdiction to push building owners to improve awareness of the occupants. This policy could be supported through the fire department by supplying these building owners with educational materials such as documents on the importance of closing the door to prevent fire extension. In New York City, fire codes require actual fire evacuation or protect in place drills for high rise residential occupancies. After 9/11 it was expanded to include high rise commercial office buildings. With the implementation of the 2008 New York City Fire Code, high rise office buildings are required to have Emergency Action Plans (EAP) and conduct drills twice a year under the supervision of fire department (Greenberg, 2008). Requiring occupancies to conduct actual drills and a physical exercise moves the education to the training and conditioning level and significantly increases the likelihood of occupants responding appropriately in the event of an actual emergency. WMFR has no requirements of multi-family dwellings regarding either occupant education or fire drills.

In the past WMFR has identified this as an avenue for targeted community education and risk reduction. Prior to district budget cuts WMFR had a Community Outreach Division which worked within the Life Safety Division to educate on hazards and enforce fire code related to the use of barbecue grills on balconies of multi-family dwellings. In the contacts I made regarding the program it was confirmed that this was a department supported program however due to layoffs and retirements I was unable to access any truly accurate information on how the program was developed and supported or what the associated methodology and curriculum was.

Currently WMFR offers a multi-family dwelling safety workshop through the training division, however there have been no requests for the program in recent years (www.westmetrofire.org)

In summary, the literature review spanned several texts, journals and reports including multiple queries of WMFR response and reporting data. Interviews and personal communication were necessary to find real experience with both the operations and life in the management of multi-family dwellings as well as the actual firefighting and even the performance of ground ladder rescues at these occupancies.

The literature review demonstrates that the topic of ground ladder rescues at multi-family dwellings is an extremely narrow focus. Using a tool such as the Community Risk Reduction Model to evaluate the topic will pushed the research to explore the extensiveness of associated factors, stakeholders, vulnerabilities and solutions. Research compiled in this literature review adequately demonstrates the risk for ground ladder rescues at multi-family dwellings and exposes the scope of West Metro Fire Rescue's current and potential multi-family dwelling fire problem.

Procedures

The purpose of this research is to use the community risk reduction model to analyze the community of West Metro Fire Rescue, identify hazards, causal factors and assess vulnerability of residents and responders regarding ladder rescues at multi-family dwellings. Research for this paper was conducted using the descriptive research method to collect data, identify hazards and associated factors which place citizens of the district at risk or responders in situations where ladder rescues are necessary at multi-family dwelling fires.

The primary method of research for this project was literature review and personal communication. Research material was collected from area real estate experts and study groups,

fire service prevention and risk reduction communities and operational firefighters to answer the following questions: a) What is the ground ladder rescue risk for West Metro Fire Rescue at multi-family dwellings? b) What are the hazards and causal factors associated with ground ladder rescues at multi-family dwellings? c) Does the current training, staffing and equipment response of West Metro Fire Rescue to multi-family dwelling fires match the potential ground ladder rescue risk? d) What are the opportunities to reduce risk associated with ground ladder rescues at multi-family dwellings using the "5 E's" of prevention?

Research began while on campus at the National Fire Academy for Executive Analysis of Community Risk Reduction. The research process was initiated with the National Fire Incident Reporting System (NFIRS) data for WMFR that was compiled by Marion Long, Fire Program Specialist with the National Fire Data Center for the United States Fire Administration. Within this data set I found that fires in multi-family dwellings accounted for 30% of the districts structural fires. As I continued to evaluate the WMFR statistical data I used the Learning Resource Center (LRC) to search for material related to multi-family dwelling fires and ladder rescues. The LRC served as a resource for compiling literature on multi-family dwelling fires and casual factors on a national level, but was lacking information specific to WMFR. In reviewing past Executive Fire Officer Papers there was no previous research into ground ladder rescues.

Upon returning to Colorado I began to conduct localized research and data review. This work included reviewing internal documentation at WMFR such as previous community risk assessments, training documents, department policies and procedures and queries of internal reporting systems. Online searches through the University of Denver School of Business also provided detailed information as to the multi-family dwelling market and demographics for the

area. I visited several apartment complexes to interview property managers to compare information discovered in literature with the experience of the people who are managing these communities and their trends on a daily basis.

To get an improved comparison between data collected for WMFR and day to day operations an online poll was created through Survey Monkey. The poll included 10 multiple choice questions regarding response to, construction features and challenges of fires in multi-family dwellings. 65 members completed the poll representing 21% of the department's current uniform membership, although participation was low quality data was collected.

The literature review prepared a solid foundation to evaluate the community, identify casual factors and vulnerabilities of those living in multi-family dwellings. The response and preparation of the operational community of the district was also well documented, however, direct connection to ground ladder rescues was lacking. This led me to start with the source that sparked my interest in the risk of ground ladder rescues at multi-family dwelling fires. The 2007 Castle West Apartments Fire in Colorado Springs, Colorado, where 85 occupants were rescued by ground ladders was reviewed.

Notes from the 2010 Castle West Fire lessons learned presentation were reviewed The 2009 article in Fire Engineering about the incident reread and a meeting with Colorado Springs Fire Department Battalion Chief and incident commander at the Castle West Apartment Fire Randy Royal was planned. The information in these reviews and collected in the personal communication with Chief Royal assisted me in making connections from the information I had collected already to the use of ground ladders at these occupancies in rescue scenarios.

Attending the Fire Department Instructors Conference in Indianapolis, Indiana in April of 2014 also provided ideas to expand research through two key points. In a class presented by

Battalion Chief Curt Isakson he mentioned the website www.firefighterrescues.com. The website was created in July of 2013 as a voluntary reporting system to start tracking civilian rescues made by American fire departments. This website provided a location to evaluate the reported rescues on the page for the type of dwelling and method used. I confirmed each report to the site with local media sources to ensure accuracy.

In another presentation by Lieutenant Rob Fisher of Snohomish County Fire District the specification of 28 foot ground ladders for aerial apparatus was discussed. The discussion included the differences in working length in regards to real world application. Upon returning from the conference I researched and contacted members of area departments who used 28 foot extension ladders to discuss the thought processes behind this equipment selection over the more common 24 foot extension ladders.

The literature review proved comprehensive enough to answer all research questions thoroughly and from a broad range of sources. The key limitation to this research process was the lack of direct sources on the topic. Civilian rescues and methods are not a required component of the National Fire Incident Reporting System unless they are listed as causalities. The scope of information regarding ground ladder operations on the fire ground is also relatively limited in comparison to that which can be found on hose, nozzles or the current coverage on the topic of fire ground ventilation.

Results

The descriptive research method and a literature review process were used to produce results from the evaluation of material across a broad scope of sources and persons. The work conducted for this paper presented not only provided answers and insight for the research questions, it also has provided this author with a sound foundation for organizational decision

making, training programs and operational procedures going forward. The following research questions were answered: a) What is the ground ladder rescue risk for West Metro Fire Rescue at multi-family dwellings? b) What are the hazards and causal factors associated with ground ladder rescues at multi-family dwellings? c) Does the current training, staffing and equipment response of West Metro Fire Rescue to multi-family dwelling fires match the potential ground ladder rescue risk? d) What are the opportunities to reduce risk associated with ground ladder rescues at multi-family dwellings using the "5 E's" of prevention?

a) What is the ground ladder rescue risk for West Metro Fire Rescue at multi-family dwellings?

Multi-family dwellings are defined as housing more occupants than a typical residence. The Americana Lakewood Apartments in the Green Mountain area of Lakewood is a typical multi-family dwelling for WMFR. In an interview with the property manager she advised that the 16 building complex currently had no vacancies and each building contained either 24 or 36 units with an average 3.5 occupants per unit (T. Beavers, personal communication, February 21, 2014). This represents an exponential increase in life hazard as compared to a standard single family residence which has an average of 2.23 occupants per dwelling for the district (Saito, 2012). With an average of 84 to 126 residents in each building this would place the equivalent of an entire single family residential neighborhood at risk in one building fire.

Twenty six percent of the district's population resides in multi-family dwellings (Saito, 2012) and multi-family dwellings account for 30% of the districts working structure fires (Pfannenstiel, 2014). This data shows that nearly 1/3 of the district's population and fire activity centers around multi-family dwellings. In evaluating emergency responses for the district across all risks, between January 1st 2012 and December 31st 2012, West Metro Fire Rescue responded

to 24,060 emergency incidents. 32.23% of these responses were to Multi-family dwellings, hotels or assisted living facilities where residents, temporary or permanent, exceed a single family classification (Long, 2013).

The 53 incidents of structure fires in an enclosed building, classified as a multi-family dwellings, represents 30% of the district's working structure fires in 2012. Within this data set of 53 fires, 40 of the fires (75%) had a point of origin above the first floor (Pfannenstiel, 2014). On average West Metro Firefighters are responding to working fires in multi-family dwellings once a week, the fact that the floor of origin is most commonly above the first floor presents a greater risk of entrapment to the citizens of our district who live in these occupancies.

Members reported the two most common accesses to residences in multi-family dwellings as a common open stairwell (60% of responses) or closed common stairwell (30% of responses)). In regards to the interior of the multi-family units 90% of the members questioned, reported that from the front door of the unit the kitchen area was open to the front door or between the front door and the sleeping areas (Brush, 2014). These two findings are significant factors in occupant egress during fire events.

Cooking fires are the leading cause of multi-family dwelling fires at 69% and cooking areas and kitchens are the primary areas of origin for non-confined multifamily dwelling fires at 33% (United States Fire Administration [USFA], 2012). With multi-family units being smaller occupancies they almost exclusively have a single means traditional egress with the front door, as opposed to a single family dwelling which may also have a back and or side door to the exterior. Additionally as indicated in the poll of members as well as an internet search of multi-family unit floor plans the kitchen is usually in close proximity to the front door and sleeping areas remote to the front door. The high likelihood of fire starts in the kitchen area between

sleeping areas and egress places occupants of the fire unit in multi-family dwellings at a higher risk of entrapment by fire.

Thirty-one percent of multi-family dwelling fires extend beyond the unit of origin (USFA, 2012). Common stairwells to multiple units in multi-story occupancies are vulnerable to exposure especially when the fire apartment door is left open and products of combustion rise through these channels.

With nearly 1/3rd of our emergency responses to these occupancies, district firefighters are very familiar with the operational challenges they present. In a poll of West Metro Firefighters regarding response to multi-family dwellings, 65% reported the most common multi-family dwelling they were responding to was the three story occupancy (Brush, 2014). Sixty-five percent of members who responded to the multi-family dwelling poll also described apparatus access to these occupancies as "poor," 30% as "good" and only 5% as "great". When asked 'If a significant fire occurred in a multi-family dwelling in your district what would be the best means for evacuating residents?" Sixty percent responded standard egress and 30% responded ground ladders (Brush, 2014). While aerial ladder was an option it was not selected by any of the members questioned.

Multi-family dwellings are not just a present risk; they are a growing future risk through both new development and aging current housing stock. Denver Metro multi-family dwelling vacancy rate is currently 4.6% trending down consistently from 6% 10 years earlier and a high of 9% in 1st quarter of 2009 (Throupe & Von Stroh, 2013). According to an article in the Denver Business Journal from September 2012, the Denver Metro area is seeing approximately 3,000 new multi-family units become available every year; however, the market can support up to 4,500 leaving a supply shortage and therefore high rents and low vacancy rates (Huspeni, 2012).

The high demand and rapid growth of multi-family dwellings was reported on specifically regarding Lakewood and the development along the Regional Transportation District Light Rail West Line in a recent article from the Denver Post. “In 2013 the city of Lakewood had 11 multi-family or mixed occupancy developments along the W-Line in the preplanning stage and 10 more further along in the site development phase” (Briggs, 2014, p. 6A).

The high demand and low supply for multi-family units in the West Metro Fire Protection District has led to low some of the lowest vacancy rates in the Denver Metro area. The Denver Metro Area served by WMFR had a multi-family vacancy rate of 3.6% one of the lowest in the metro area (Throupe & Von Stroh, 2013). City of Lakewood had an overall multi-family dwelling vacancy rate of 3.2% which is the lowest for suburban communities surrounding the City and County of Denver (Throupe & Von Stroh, 2013). There are areas of the West Metro Fire Protection District where high demand and low supply are leading to developers competing for market share and bringing in higher quality and more desirable housing units; however this is not the case in most of the City of Lakewood.

Average rent for a unit in a multi-family dwelling in Lakewood is $841.84 which is the second lowest for suburban communities surrounding the City and County of Denver behind “Aurora – Central” at $826.78 (Throupe & Von Stroh, 2013). When low cost housing and low vacancy rates (over-crowding) are paired together the risk for fire increases significantly. In the lowest rent areas of the district the available housing is also the oldest and without the drive of competition by building owners and managers the housing quality suffers putting residents once again at an increased risk.

Within Lakewood multi-family dwellings built before 1980 have the lowest vacancy rate at 2.7% as compared to those constructed from 1981 to present with a 4.4% vacancy rate

(Throupe & Von Stroh, 2013). Poor housing quality refers to age and quality of construction, up keep of the property and maintenance of systems, as well as crime rate in the area. This correlation between low rent and housing quality would indicate that the most densely populated, lowest income areas of the West Metro Fire Protection District are also some of the most socioeconomically challenged areas of the Denver Metro area.

Research collected as a result of this project shows that the risk for ground ladder rescues for West Metro Fire Rescue is greater at all multi-family dwellings. The research also displays significant portions of the district present a high risk for ground ladder rescues when socioeconomic factors, occupant load, building construction and access are combined in an assessment.

b) What are the hazards and causal factors associated with ground ladder rescues at multi-family dwellings?

"Virtually every study of socioeconomic characteristics has shown that lower levels of income are either directly or indirectly tied to and increased risk of fire."(United States Fire Administration, 1997, p. 2) This quote is an excerpt from the report Socioeconomic Factors and the Incidence of Fire by the United States Fire Administration (USFA). The quote is powerful in that they are the foremost evaluators of national fire risk data and trends. In compiling research for this project I found that most of the socioeconomic factors the USFA cites as contributors to increased risk of fire were found to be more common if not compounded in the resident population of multi-family dwellings.

The 110 square mile area which is the West Metro Fire Protection District is divided into 3 operational districts numbered 1 through 3 from North to South. Each district is managed by a district chief who oversees 5 fire stations (www.westmetrofire.org). The Northern most portion

of the fire district is District 1. District 1 almost exclusively covers the incorporated city of Lakewood. The population of Lakewood served by WMFR is 147,850 with median household income reported as $52,512 and 11.9% of the population in this area living below the poverty level (Saito, 2012, p. 2).

District 2 is mainly the geographic center of the fire protection district which spans the South and Western parts of the City of Lakewood as well as the Northern end of unincorporated Littleton in Jefferson County. The population of unincorporated Jefferson County served by WMFR is 102,388 with a median household income of $76,877 and 6.5% of the population living below the poverty level (Saito, 2012, p. 2).

District 3 is the Southern end of the fire district serving mostly unincorporated Jefferson County and parts of Northern Douglas County in the community of Roxborough. The population of unincorporated Douglas County served by WMFR is 9,482 with a median household income of $99,409 and 3.2% of the population living below the poverty level. (Saito, 2012, p. 3)

As is indicated by the demographics cited from a department analysis of community risk by the WMFR Community Education Specialist there is a significant difference in the income level of the populations in each district. The median income in Douglas County is nearly double that of residents in District 1 and the percentage of the population living below the poverty level is nearly four times that found in Douglas County. This economic status variation can be used as one of many socioeconomic factors in identifying levels of risk in the district.

The Denver Metro Area served by West Metro Fire Rescue had a multi-family vacancy rate of 3.6% one of the lowest in the metro area (Throupe & Von Stroh, 2013). City of Lakewood had an overall multi-family dwelling vacancy rate of 3.2% which is the lowest for suburban communities surrounding the City and County of Denver (Throupe & Von Stroh,

2013). Low vacancy rates translate to a low supply of housing and in the multi-family category this is a low supply of affordable housing for low income families. This pressure can result in overcrowding of the available units as is demonstrated above in an average of more than one occupant per multi-family unit than found in a single family dwelling. The incidence of fire is two to three times higher in housing tract areas ranked high on crowding (United States Fire Administration, 1997).

Ownership of property is also a casual factor in the increased risk of fire at multi-family dwellings which are primarily rented and not privately owned occupancies. Fire rates in areas with lower individual home or property ownership have been determined to be more than two times that of areas with high home ownership (United States Fire Administration, 1997, p. 5). Rented units in multi-family dwellings are not owned by occupants therefore the fire risk would be associated with that of areas of low individual property ownership.

This elevated risk can be further examined by evaluating the price of rents. According to the Denver Metro Area Apartment Vacancy and Rent Survey which reviews multi-family dwelling occupancy rates, rent averages and forecasted units being developed for the five county metro area apartment rents in Lakewood is $841.84 a month (Throupe & Von Stroh, 2013). This is the second lowest of all reported neighborhoods and over $150.00 a month lower than the Denver Metro Average of $992.89 (Throupe & Von Stroh, 2013).

Housing quality and housing affordability are directy related, the cost of a housing unit for sale or for rent is priced according to the quality of its given location and amenities (United States Fire Administration, 1997, p. 13). Poor housing quality refers to age and quality of construction, up keep of the property and maintenance of systems. This correlation between low rent and housing quality would indicate that the most densely populated, lowest income areas of

the West Metro Fire Protection District are also some of the most socioeconomically challenged areas of the Denver Metro area.

> "In most urban areas the lowest income units are in the oldest most run-down portion of the city's housing stock. Living in an older poorly maintained housing unit raises a households risk for fire for several reasons."
>
> - Poor maintenance of systems, heating and such which increases mechanical malfunction and the risk of fire.
> - Dated electrical wiring systems are typically overloaded by modern technology and alternative strategies increase electrical fire risk.
> - Households may be forced to compensate for poor systems of construction with stop gap measures such as space heaters.
> - Construction in these areas is typically before modern building codes and enforcement with very little retrofitting.
>
> (United States Fire Administration, 1997, p. 12)

Housing quality and age of dwellings is expanded on as a significant factor in the risk of and severity of fires. The USFA estimates that 92% of dwellings built since 1981 have working smoke detectors. The estimate for dwellings constructed prior to 1980 is only 74% (United States Fire Administration, 1997). For the City of Lakewood there is a marked difference in the vacancy rates in housing built prior to 1980 versus that which was built after 1981. Within Lakewood multi-family dwellings built before 1980 have the lowest vacancy rate at 2.7% compared to 1981 to present with a 4.4% vacancy rate (Throupe & Von Stroh, 2013). As data collection and initial investigation begins to demonstrate the fire risk in multi-family and

contributing factors begin to compound in areas with increased density and socioeconomic challenges.

In regards to the interior of the multi-family units 90% of WMFR firefighters who questioned in an online poll, reported that from the front door of the unit the kitchen area was open to, or between the front door and the sleeping areas (Brush, 2014). These two findings are significant factors in occupant egress during fire events.

Cooking fires are the leading cause of multi-family dwelling fires at 69%. Cooking areas and kitchens are the primary areas of origin for non-confined multifamily dwelling fires at 33% (United States Fire Administration [USFA], 2012). With multi-family units being smaller occupancies they almost exclusively have a single means traditional egress with the front door, as opposed to a single family dwelling which may also have a back and or side door to the exterior. As indicated in the poll of members as well as an internet search of multi-family unit floor plans the kitchen is usually in close proximity to the front door and sleeping areas remote to the front door. The high likelihood of fire starts in the kitchen area between sleeping areas and egress places occupants of the fire unit in multi-family dwellings at a higher risk of entrapment by fire.

Thirty-one percent of non-confined multi-family dwelling fires extend beyond the unit of origin (USFA, 2012). Common stairwells to multiple units in multi-story occupancies are vulnerable to exposure especially when the fire apartment door is left open and products of combustion rise through these channels.

According to the report from the USFA building age and quality are significant factors in the incidence and severity of fires. Building design and unit floor plans are also significant factors in the severity of fire and in the multi-family dwelling also play a role in access and

egress. The Americana Lakewood Apartments on the western side of Lakewood in District 2 demonstrates such a design factor. All 16 buildings in the Americana complex are 4 story wood framed buildings with the ground level as covered parking. The three stories above the parking is where all residents are living. Due to this construction feature anywhere from 84 to 126 residents in each building are living above grade with a single open stairwell. Each stairwell serving a set of 12 apartments, approximately 40 potential residents (T. Beavers, personal communication, Feburary 21, 2014).

At the Lamar Kendall Apartments in the eastern part of District 1, another construction feature common to the area and age of construction contributes to fire severity and potential for trapped occupants. Center hall construction in these apartments is accessed by open stairwells on opposite sides of the building and a common center hallway for access to each unit. This construction feature presents great risk to all occupants of the building in the event that the door to a fire unit is left open the products of combustion will quickly fill the common hallways and stairwells. Without balconies, these occupants have no other means to escape other than a ladder to a window in the event hallways and stairwells are blocked by fire or smoke.

Lamar Kendall Apartments, 14th Avenue and Lamar Street, Lakewood, Colorado

Center Hall Design

Center hall apartment design is another example of a casual factor which would increase the risk for ground ladder rescues during a working fire. Center hall construction was reported as a key contributing factor to the severity of the Castle West Apartment Fire in Colorado Springs in 2007, where 85 occupants were rescued by ground ladders (Royal, 2009). The open stairwells to the common hallways allowed for free and possibly accelerated fire spread which almost immediately trapped nearly all the residents (R. Royal, personal communication, March 8, 2014). This construction feature continues to be a rescue problem for Colorado Springs Fire Department. In the first quarter of 2014 they have rescued 17 civilians by ground ladders from center hall design apartment fires (R. Royal, personal communication, March 8, 2014).

Age, condition and design of the structure have been shown to be casual factors in the incidence and risk of fires and potential rescues. Another factor which can have a profound effect on the risk to occupants and the potential for WMFR to utilize ground ladders regardless of the age of the building is access. About 20% of WMFR firefighters responded to an online poll regarding multi-family dwelling. The respondents were fairly balanced in assignment across all three districts. When asked to describe apparatus access to multi family dwelling in their district,

65% reported access was “poor”, 30% “good” and only 5 % as “great” (Brush, 2014). Through the same online poll firefighters were asked “if a significant fire occurred in a multi-family dwelling in your district, what would be the best means for evacuating residents?” 60% reported standard access and 30% reported ground ladders (Brush, 2014). While aerial ladders were an option, none of the respondents selected it. Apartments with poor access for responders will inherently mean that there is poor egress for occupants and this presents a significant factor in evaluation of risk at a multi-family dwelling.

Having covered some of the of the factors which can be used in combination to objectively evaluate risk from a district level all the way down to individual structures it would be remiss to not discuss some of the human factors associated with rescue situations. In his book *Deep Survival*, Laurence Gonzales explains that the comforts of the modern world have eroded our survival skills and that as little as 10 to 20% of the general population can remain calm and think clearly in a life threatening situation (Gonzales, 2003). Without educating and training the population of residents in multi-family dwellings through programs and fire drills, responders must anticipate panicking occupants. The lack of rational thought can have a profound effect on operations. Occupants of the fire units may leave their apartment door open in their escape contributing to fire spread or less threatened occupants may present at windows demanding rescue, in the process of jumping or even throwing children.

Life safety is the first organizational priority of WMFR. From pressures of panicked occupants to the shift in focus from fire suppression to occupant rescue as described by Chief Royal these can be extreme tests of first arriving companies. This is shown by Chief Royal when explains how seven of the nine first alarm apparatus were committed to ladder rescues at the Castle West incident. “Upon arrival Chief Brown noticed dozens of occupants were already

hanging off balconies, leaning out of windows and preparing to jump. We addressed the obvious challenge and priority of the life safety need by calling for an ‘all hands’ rescue” (Royal, 2009, p. 56). In the early stages of a resource limited response choosing to make rescues over fire attack may be very appropriate but it has the potential to contribute to the fire severity through the delay of suppression.

The scope of hazards and casual factors associated with ground ladder rescues is far broader than I ever anticipated. This short list of socioeconomic, building condition and design, human and operational factors is not all inclusive and research should continue. With that said this list does present a substantial foundation across multiple dimensions for a sound evaluation of risk for the community of WMFR from a district overview down to an occupancy by occupancy target hazard identification.

c) Does the current training, staffing and equipment response of West Metro Fire Rescue to multi-family dwelling fires match the potential ground ladder rescue risk?

In 2010 WMFR increased the initial alarm assignment to confirmed fires at multi-family and commercial structures with the dispatch of a second a tower (ladder company with 4 members) in an effort to improve our response to these incidents (West Metro Fire Rescue [WMFR], 2014). In a complete review of WMFR second alarm or greater fires over the past five years also revealed that 80% of all working fires exceeded the initial alarm dispatch assignment involved multi-family dwellings (Brush, 2014).

The additional tower company on a fire dispatch does not match the exponential increase in life hazard at these occupancies. Multi-family dwellings in the Lakewood area house an average of 3.5 persons per unit, with as many as 36 units per structure, for up to of 126 occupants per structure (Beavers, 2014). This compared to a standard single family dwelling which has an

average of 2.23 occupants per structure for the district (Saito, 2012). This internal data also shows that the demands of these incidents continue to outpace initial responding resources even with the additional unit on the first dispatch and they do so statistically more than any other occupancy type.

The response of an additional tower company on dispatch may or may not be of much added benefit to the initial operations according to a poll of West Metro Firefighters. Sixty-five percent of members who responded to the multi-family dwelling poll described apparatus access to these occupancies as "poor," 30% as "good" and only 5% as "great" (Brush, 2014). When asked "If a significant fire occurred in a multi-family dwelling in your district what would be the best means for evacuating residents?" 60% responded standard egress and 30% responded ground ladders (Brush, 2014). While aerial ladder was an option it was not selected by any of the members questioned.

In reviewing the article of lessons learned from the Castle West Apartment Fire in Colorado Springs, 85 occupants were rescued by ground ladders and none were removed by aerial ladders. On January 16th 2007 at 0047 hours Colorado Springs Fire Department (CSFD) was dispatched to a reported fire in an apartment building. Three minutes later, the first district chief arrived and immediately requested a second and third alarm when he arrived to find a working fire with dozens of occupants at windows and balconies (Royal, 2009). "We addressed the obvious challenge and priority of the life safety need by calling for an 'all hands' rescue" (Royal, 2009, p. 56).

While laddering is traditionally considered a truck company function, the opinion of West Metro Firefighters and the experience of the Colorado Springs Fire Department (CSFD) at the Castle West Fire shows that most if not all ladder rescue work will be performed with

standard ground ladders and the immediacy of an “all hands rescue” situation will be placing all companies arriving with ladders to work. The first three companies to arrive on scene at the Castle West Fire made 40 ladder rescues. Nine apparatus from the first three alarms were dedicated to ladder rescues and responsible for removing a total of 85 occupants via ground ladders (Royal, 2009). The 85 occupants rescued from upper floors represent 25% of the buildings total residents (Royal, 2009).

The City of Colorado Springs is very similar both geographically and demographically to West Metro Fire Rescue’s district and apartment complexes of like design and era of construction can be found in our response districts. Through personal communication with Chief Royal (2014) he reported that this point was a significant take away from the Castle West Fire and in the years since the incident CSFD truck companies routinely drill with neighboring engine companies to maintain proficiency in ground ladder work. WMFR has done a good job of training all members in the use of ground ladders. In a review of WMFR “quick drills” and training events from the last two years, ground ladder skills work is either an area of focus or related component of official district training on nearly a bi-monthly basis. Unfortunately in reviewing the same training documents and department standard operating procedures there is no “all hands rescue” training, scenario or operational procedure developed.

To analyze the operational community the question then becomes how many WMFR companies are available to execute ground ladder rescues upon arrival at a working fire in these occupancies. The Current first alarm assignment to a confirmed fire at a multi-family dwelling is; three engine companies, two medic units, two tower companies, one heavy rescue, two district chiefs, one safety officer and one bureau officer to total between 29 and 32 personnel (WMFR,

2014). Current fire ground operations and responsibilities at WMFR are mixed between past practices and an "on deck" system ("Blue Card," 2014).

Past practices at WMFR has implied roles for apparatus based on arrival order; first arriving engine is attack, second engine supply and third engine is the rapid intervention team. Medic units (ambulances with two firefighter paramedics) also have implied roles with the first arriving medic unit to support fire attack and the second to provide medical for the scene. Within this frame work of operation the heavy rescue and two tower companies (12 members) are available for any fire ground support function (WMFR, 2014). This preplanned assignment system assists with anticipation of duty and has historically worked well on routine incidents where variables are limited.

The "on deck" system outlined in the Blue Card Command training program WMFR is currently using is a more explicit and in real time assignment model where units are directly assigned tasks by the command officer ("Blue Card," 2014). In theory this allows for more flexibility in assignments to match incident specific needs and without predetermined assignments would make any company available for ladder rescues. This system has not been fully implemented either in policy or practice at WMFR so an evaluation of it would be unfair. The most common concern among members questioned is that personnel and apparatus which have not traditionally performed different tasks or worked with apparatus specific equipment would not be as efficient as those who had. Examples would be using a first arriving tower company personnel as fire attack and a later arriving medic unit from a different station to access the ladders and equipment from that apparatus to perform vertical ventilation. It is still to be determined which operational framework WMFR will operate in coming years.

If the transition is made to a system where not just tower and rescue, but all companies are trained, prepared and equipped to handle an “all hands” rescue situation are there ways to improve capabilities beyond regular drilling with ladders? In the quint concept operational model utilized by Castle Rock Fire Department (CRFD) a quint the apparatus is used as the initial response unit for all calls in their immediate response district and also provide aerial apparatus response for the entire town.

Lieutenant Bersagel-Briese was on the committee that purchased new apparatus for the Town of Castle Rock. He advised that ground ladders were an area of focus in the purchasing and outfitting of the apparatus. There was additional planning and design work involved to get the quint equipped with a total of 184 feet of ground ladders, exceeding the NFPA minimum standard by nearly 100 feet (O. Bersagel-Briese, personal communication, May 16, 2014). The 184 feet of ground ladders also exceeds the NFPA ground ladder compliment for truck companies, which are 115 feet (McCormack, 2011). In reviewing the tower companies at WMFR, ground ladder compliments are between 140 and 150 feet, essentially one ladder less than what is carried on the Castle Rock Quint.

CRFD also adjusted the ladder compliments of the engine companies. The standard ground ladder compliment for WMFR engine companies is a 14 foot roof ladder, 24 foot extension and 10 foot folding ladder. The apparatus committee at CRFD for the new purchases elected to outfit all engine companies as well as the quint with 28 foot extension ladders and 16 foot roof ladders. The change to 28 and 16 foot ladders not only increases the reach of the ladders in these categories but also in width, making them a better tool for effecting rescues (O. Bersagel-Briese, personal communication, May 16, 2014).

The CRFD also was specific about the manufacturer of their selected ladders. As displayed below, while the service test rating is set by NFPA and the same for all ladders, there is a marked difference in weight and a slight difference in the width. WMFR has traditionally purchased Duo Safety brand ladders and should continue to in the future as the chart below displays they are lighter weight with the same or wider base section.

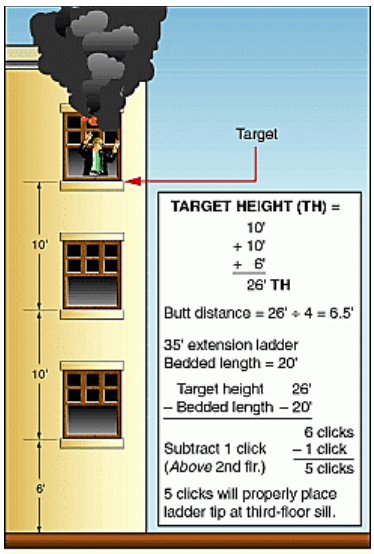
	Duo Safety Weight	Duo Safety Width	Alco-Lite Weight	Alco-Lite Width
14 foot roof ladder	28 lbs	21”	42 lbs	21”
16 foot roof ladder	39 lbs	22”	48 lbs	21”
24 foot extension ladder	72 lbs	22”	75 lbs	21”
28 foot extension ladder	87 lbs	24”	114 lbs	22”
35 foot extension ladder 2 section	122 lbs	24”	139 lbs	22”
35 foot extension ladder 3 section	129 lbs	24”	170 lbs	22”

(Alco Lite Ladders, 2014) (Duo Safety Ladders, 2014)

Denver Fire Department (DFD) is the largest fire department in the state of Colorado and operates within an implied role system similar to how WMFR has operated in the past. One of the key differences in operations is the resources available. WMFR has three tower companies and one heavy rescue with 15 engine companies. Denver Fire Department has 29 engine companies and 15 truck companies 1 heavy rescue and 1 haz-mat unit (“City of Denver,” 2014). The engine/truck ratio as this metric is commonly referred to for WMFR is 5 to 1 and for DFD it is roughly 2 to 1. This not only makes more truck companies available for ladder rescues but it also places them in a closer proximity to incidents due to the higher ratio which places them on

scene quicker. Even with this favorable engine/truck ratio, DFD truck companies are still looking for opportunities to improve their rescue capabilities.

Captain Vern Scott of DFD truck company 15 explained in a phone interview that due to the high density three and four story multi-family dwellings in his response district that he worked through the equipment request process to change out the two 24 foot ladders that are standard for DFD truck companies in favor of 28 foot extension ladders (V. Scott, personal communication, January 6, 2014). He stated that in his experience that while four feet is perceived to be a small difference it is consistently the difference in making the tip to a balcony railing or to a fourth floor window sill in the presence of a garden or walk out level (V. Scott, personal communication, January 6, 2014).



(Avillo, 1999)

Due to the climbing angle of ladders a rule of thumb for the working length for ground ladders less than 35 feet is 1 foot less than the total length and two feet less for ground ladders over 35 feet (Avillo, 1999). The graphic above uses common residential floor and window sill heights found in multi-family dwellings to demonstrate the target height of a third floor window at 26 feet. This would be out of the working length reach of a 24 foot ladder which is 23 feet but

within normal operation of a 28 foot extension ladder with a working length of 27 feet. As indicated by the poll completed by WMFR firefighters the 3 story multi-family dwelling is our most common and therefore should be our main area of focus (Brush, 2014).

The research question was not if West Metro Fire Rescue was a well-trained, staffed and equipped department. The question was if the training, staffing and equipment matched the risk for ground ladder rescues at multi-family dwellings? The answer is no. This was determined in the problem statement that WMFR has not evaluated the risk for ground ladder rescues at multi-family dwellings. Operationally WMFR will respond to these incidents and function as we have for years; most often successfully, but without a thorough evaluation as was conducted for this project, properly matching training, staffing and equipment to a risk is more by chance then by design.

d) What are the opportunities to reduce risk associated with ground ladder rescues at multi-family dwellings using the "Five Es" of prevention?

The mnemonic "Five Es" is a prompt to consider education, enforcement, engineering, economic incentives and emergency response when developing programs and solutions for community risk reduction (*EACRR Student Manual*, 2013). For the target risk of ground ladder rescues at multi-family dwellings there are two communities present; the civilian community residing in and managing these occupancies and the uniform community responding and enforcing code for theses occupancies. For this each of the Es will be examined for application opportunities in both communities.

Education

One of the greatest challenges to fire safety education and risk reduction programs is community access. Fire departments struggle with ways to work with or create events where a

captive audience is available. This is largely why most fire service efforts are focused on children in schools. Public school systems are not only charged with educating our children they are also trusted with keeping them safe for the full days they have them in the school. Most fire service programs including the National Fire Protection Association Fire Prevention Week are specifically targeted at school aged children.

Multi-family dwellings present a captive audience and a unique community in that the vast majority of these occupancies are rented as a contractual agreement between the renter and the leasing company. In addition to this agreement the leasing company and the building owner are operating as a business within a municipality or fire district which is also conducted through codes, rules and regulations. These avenues provide opportunities for awareness, training and conditioning for potential fire emergencies that most single family dwellings with private ownership would not and some fire agencies are taking advantage of them.

> "Apartment buildings, with or without onsite management, must provide an emergency guide to tenants. The guide must describe the location, function and use of all fire protection equipment and appliances accessible to tenants, including fire alarm systems, single-station smoke detectors and portable fire extinguishers. The guide shall also include an evacuation plan for each dwelling unit." ("San Diego Fire Rescue," 2014)

This serves as an excellent example of how San Diego Fire Rescue is using regulation through operation of the business of an apartment building in the jurisdiction to push building owners to improve awareness and education of the occupants. This policy could be supported through the fire department by supplying these building owners with educational materials such as documents on the importance of closing the door to prevent fire extension.

WMFR has in the past identified this as an avenue for targeted community education and risk reduction. Prior to district budget cuts, WMFR had a Community Outreach Division which worked closely the Life Safety Division to educate on the hazards and enforce fire code related to the use of barbecue grills on balconies of multi-family dwellings. Currently WMFR offers a voluntary one-day workshop on Pre-Planning & Safety for managers and property owners of Multi-Family Housing properties which can be scheduled through the district's training center (www.westmetrofire.org).

With the completion of this project WMFR will have detailed documentation of the risk for ground ladder rescues in the district. This project can support the education of members internally for both immediate and future operations or training and longer term organizational strategic decisions from apparatus placement to equipment selection. The foundation for this work was the problem statement that until now WMFR has not evaluated the risk for ground ladder rescues at multi-family dwellings. With the completion of this project a formal evaluation has been completed and within it an education on the scope of the risk. By definition the purpose of an applied research project is to apply the research to the organization, the first step in the application will be education.

Enforcement

One of the other pieces of keeping children safe at schools is regular fire drills. In most school systems fire drills are conducted twice in the first month of school to re-engage the student's minds in the potential for a fire and repeated once a month for the rest of the school year to ensure the children are practiced in the procedure (Jefferson County Public Schools, 2013).

In New York City, fire codes have required actual fire evacuation or protect in place drills for high rise residential occupancies for years. In the wake of 9/11 it was expanded to high rise commercial office buildings. With the implementation of the 2008 New York City Fire Code, high rise office buildings are required to have Emergency Action Plans (EAP) and conduct drills twice a year under the supervision of fire department (Greenberg, 2008). Requiring occupancies to conduct actual drills and a physical exercise moves the education to the training and conditioning level and significantly increases the likelihood of occupants responding appropriately in the event of an actual emergency.

WMFR currently has no requirements for conducting fire drills at multi-family dwellings. As a district which provides fire protection across two counties, a larger city and many towns it is unknown to this author what the opportunities for development, implementation and enforcement of this type of code would be across the district or at the local level. If the establishment of enforceable fire drills at multi-family dwellings through code is an opportunity even in the smallest communities in the district, it is an effort worth undertaking to create the framework.

West Metro Fire Rescue currently conducts annual company level fire inspections of fire protection systems, alarms and common areas of district multi-family dwellings. WMFR utilizes the 2012 International Fire Code as the grounds for code enforcement within the district. In the past training for company level officers and crews conducting these inspections has been generalized in an attempt to make the inspection process simple as many stations are tasked with hundreds of occupancies to inspect. A more specific and detailed training from the life safety division on the inspection of multi-family dwellings may improve the extent and consistency in which codes are enforced in these occupancies.

As explained in the above narrative enforcement as an intervention method for reducing the risk of ground ladder rescues presents many opportunities and when available is a powerful tool when it can be supported legally. The power in this intervention method is also the limiting factor in the development of new enforcement methods would have to have full legal review prior to implementation.

Engineering

Multi-family dwellings in the West Metro Fire Protection District span a broad range of age, type and construction that a solution as technical as engineering could not provide a global reduction in risk for ground ladder rescues. Improved building codes requiring standpipe and sprinkler systems, modern detection and alarm systems have the potential to reduce the severity of fires in newer construction. The toxicity of smoke due to the increased use of synthetic materials in home furnishings and lightweight building materials make even smaller fires just as hazardous. Any influence the fire service would have over changes in engineering these occupancies would be through the development and implementation of codes which returns to enforcement.

For WMFR there are opportunities through engineering with equipment selection and apparatus design to improve our abilities as responders to these incidents. With the identification of the 3 story multi-family dwelling with limited apparatus access as the key hazard occupancy through the online poll of WMFR firefighters, ground ladder selection should focus on this target.

Denver Fire Department (DFD) Captain Vern Scott of Truck 15 explained in an interview that he exchanged the standard issue two 24’ extension ladders which arrived with his aerial for 28’ extension ladders due to the concentration of 3 story multi-family dwellings in his response

district (V. Scott, personal communication, January 6, 2014). This exchange increased working reach by four feet and width of two inches making for a more versatile rescue tool (Duo Safety Ladders, 2014). The interior storage of the DFD truck did not have to be adjusted to allow for the increased bedded width and length of these ladders.

Castle Rock Fire Department was proactive in improving the ground ladder rescue capabilities of their firefighter by communicating their needs to the vendor in the specification phases for new apparatus (O. Bersagel-Briese, personal communication, May 16, 2014). The result was a quint aerial outfitted with 184 feet of ground ladders in comparison to an average of 140 feet on WMFR aerials a realized gain of two additional ladders. The new engine companies were also configured to support the combination of a 28 foot extension and 16 foot roof ladder as compared to the standard compliment of the 24 foot extension and 14 foot roof ladder on WMFR engine companies.

With the completion of this research project the risk for ground ladder rescues at multi-family dwellings has been determined to be significant and the most common type of dwelling, the 3 story occupancy has been identified. WMFR has the opportunity to utilize this information and engineering as an intervention tool to improve capabilities of companies to affect rescues through apparatus set up and equipment selection.

Economic Incentives

A fire protection district cannot provide residents or property managers of multi-family dwellings with economic incentives for improved fire safety or risk reduction. Through education it can be demonstrated that fire safe measures have the potential to reduce the risk and severity of fires, therefore lessening the economic impact of incidents. The district does not have the means to provide a direct monetary benefit.

Insurance companies are for profit businesses and it is in their interest for their customers to reduce their risk as it will in turn reduce the potential for the business to file a claim. The multi-family dwelling safety workshop provided by WMFR for property managers and owners is considered as continuing education for some property management certification agencies and has the potential to reduce the rates of some insurance premiums with proof of attendance and implementation of programs (www.westmetrofire.org). The potential for rate reduction and amount is determined by each insurance provider. The workshop is an opportunity for reducing risk in the community and also potentially reducing insurance rates demonstrates how economic incentives are an intervention opportunity.

For WMFR I could not identify a realized economic incentive for reducing the risk for ground ladder rescues at multi-family dwellings. Various points could be made of how measures could reduce the economic impact of a potential event. It is difficult to identify any tangible economic incentives for the district in risk reduction. Unfortunately there may be expenses associated with new program development, implementation and equipment purchase.

Emergency Response

For the residents and property managers of multi-family dwellings the best opportunity for reducing risk in their emergency response is the creation, communication and practice of an emergency plan. As explained above, these measures are primarily voluntary actions by individual occupants or manager and owners. WMFR inspections enforce code related to the presence and maintenance of emergency systems and equipment but not plans or drills. The available multi-family safety workshop provided by the department includes tools for emergency planning and implementation but it is not a required program (www.westmetrofire.org). WMFR fire companies conducting annual inspections could stress the importance of having plans in

place that are well communicated to residents or even rehearsed and make all managers aware of the workshop offered by the district.

Improving emergency response as an intervention method presents the greatest number of opportunities for WMFR to reduce the potential risk of ground ladder rescues at multi-family dwellings. Most of these opportunities are centered on improved emergency response planning to these events. Two of those opportunities were discovered in reading and interviewing Chief Royal from Colorado Springs Fire Department (CSFD) regarding the Castle West Apartment Fire.

The CSFD uses a target hazard system to identify occupancies, areas or incidents which present with unique or high risk factors that can be predicted to potentially affect operations. In the identification of a target hazard, the threat is indicated and specific resource needs are adjusted from a standard incident response based off of that threat (R. Royal, personal communication, March 8, 2014). The Castle West Apartments and most center hall design apartment buildings in Colorado Springs are classified as target hazard-high life threat occupancies (R. Royal, personal communication, March 8, 2014).

CSFD also has “all hands” rescue as a part of their organizational language, procedure and practice (R. Royal, personal communication, March 8, 2014). In the middle of the night with temperatures near zero and the presentation of a well advanced fire with occupants in need of immediate rescue the friction of trying to develop and communicate a plan on the spot could have a profound effect on the potential outcome. The existence of a plan and practice within CSFD prior to this event without a doubt contributed to a positive outcome for the 85 residents who were rescued by ground ladders. WMFR routinely practices the triage and transport or EMS

components of mass causality incidents but has not practiced or developed a plan or procedure for a mass evacuation or rescue.

As indicated by department history, 80% of greater alarm incidents over the past 5 years are fires in multi-family dwellings. The demands for these incidents quickly out pace resources available. With specific regards to ground ladder rescues, nine companies from the first three alarms at the Castle West Apartment Fire made a total of 85 ladder rescues, most of those companies were engines (Royal, 2009).

WMFR has the opportunity to improve emergency response and reduce the risk associated with ground ladder rescues at multi-family dwellings. With an improved understanding of the scope of the risk, tools to specifically rate the level of risk at the occupancy level through target hazard identification and lessons learned through the experience of our peers WMFR can attempt to accurately match emergency response to the risk that is present.

Discussion

The purpose of this research is to use the community risk reduction model to analyze the community of West Metro Fire Rescue (WMFR), identify hazards, causal factors and assess vulnerability of residents and responders regarding ladder rescues at multi-family dwellings. The literature review proved comprehensive enough to thoroughly answer research questions and evaluate the risk of ground ladder rescues at multi-family dwellings for the civilian and sworn communities of WMFR. It was determined by this author that there is a significant risk of ground ladder rescues at multi-family dwellings. It is also clear that there are simple metrics and factors that are easily recognized that can further grade the level of that risk.

The current climate at WMFR is one of change as the district faces the toughest financial times in recent history. From top to bottom and across all division the organization is being

forced to reevaluate and restructure to maximize efficiency while maintaining our mission. This state of affairs presents both great opportunity and great challenge. By definition the purpose of an applied research paper is to apply the research to the organization and operations. Research contained within this paper has the potential to assist these processes through an improved vision of the risks associated with 28% of the districts population, 30% of the districts fire activity and 80% of the districts major fire events.

The title of this paper uses the term evaluating for a specific reason. The research and results presented in this document can do little more than provide an initial evaluation of the risk of ground ladder rescues at multi-family dwellings. In working through this material many additional topics of research and investigation have presented themselves. I foresee this paper serving as a catalyst for several smaller and more focused projects to assist with the institution of the recommendations. In order to further this work in many areas more work will be required. Greater efforts through neighborhood and building evaluations, program development and hands on training with ladders are the means by which problems will be addressed. In many ways where this paper leaves off is where the work will begin.

The foundation of research for this project is the civilian community living in multi-family dwellings and the operational community of WMFR, both of which are dynamic. Changes in real estate markets, the economy and neighborhood make up can have a profound effect on residents of multi-family dwellings in short time periods due to the fact that the population is more transient with residences rented and not mortgaged. As mentioned before budget pressures are reshaping the deployment, staffing and equipping of WMFR resources. The base for the operational community used in this project may see significant changes as early as

July 1, 2014. For these reasons there are areas of this document that will require revisiting to maintain an accurate picture of risk and abilities.

Recommendations

One of the core values of West Metro Fire Rescue (WMFR) is the prevention of emergencies and awareness of the dangers to our citizens to reduce the risk of their lives (West Metro Fire Rescue [WMFR], 2012, p.5). In today's environment there is great pressure for budgets to direct services however as a public safety organization our first consideration must be our mission. With risk reduction as a core organizational value and the purpose of applied research to apply information to organizational decision making and operations the following recommendations are opportunities for intervention in the risk potential for ground ladder rescues at WMFR.

1.) Develop a target hazard identification system for multi-family dwellings. High density residential occupancies present with a greater life hazard. This lead WMFR to universally increase the resources responding to fires in these occupancies in 2010. Unfortunately the addition of a tower company to the first alarm assignment has done little to meet the demands of these working incidents as 80% of the district's greater alarm fires over the past 5 years are multi-family dwellings. The research shows that there are numerous factors associated with the incidence and severity of fire which can be identified through pre-incident evaluation from socioeconomic status to building access. Annual inspections are already being conducted at the company level in these occupancies. By providing companies with additional education on casual factors and hazards associated with these occupancies and an evaluative tool, WMFR can continue to improve the detail of the awareness of danger to our citizens. These

evaluations can be reviewed by command staff to match response to risk on a case by case basis.

2.) Enhance and expand the current Safety for Multi-Family Housing workshop offered by the WMFR training division. WMFR has identified the fire problems associated with multi-family dwellings and the opportunities they present for direct prevention measures through past programs and the current offering of the Multi-Family Housing Workshop. In speaking with the WMFR Community Education Specialist Susan Saito the Multi-Family Housing Workshop has not been utilized in recent years and the curriculum has not been updated or localized to WMFR specific data. She advised that the greatest challenge with the program and any community education programs is available resources. This applied research project can be utilized internally to update and localize the curriculum and be used externally to present the risk in a formal manner for grant applications to find outside support for needed resources. These resources may also be used to start new programs such as a "close the door" or "wait for us" campaign.

3.) Develop "all hands" rescue procedure and training. Colorado Springs Fire Department (CSFD) had "all hands" rescue as a part of their organizational language, procedure and practice prior to the Castle West Fire (R. Royal, personal communication, March 8, 2014). In the middle of the night with temperatures near zero and the presentation of a well advanced fire with occupants in need of immediate rescue the friction of trying to develop and communicate a plan on the spot could have a profound effect on the potential outcome. The existence of a plan and practice within CSFD prior to this event without a doubt contributed to a positive outcome for

the 85 residents who were rescued by ground ladders. This plan and practice continues to save citizens lives as CSFD has rescued 17 people in the first quarter of 2014 from working fires at multi-family dwellings via ground ladders. WMFR routinely practices the triage and transport or EMS components of mass causality incidents but has not practiced or developed a plan or procedure confining fire with a few units to support a mass evacuation or rescue of occupants. Many departments locally and nationally have “all hands” rescue procedures and training materials that can be used as a base for a WMFR specific program.

4.) Apparatus and equipment strategic planning team evaluation of 28 foot extension ladders. WMFR regularly evaluates equipment with changes in technology, trends, and material, to see if those changes can improve operations but the district has not yet evaluated the 28 foot extension ladder as a potential tool. The research contained in this document identifies the three story multi-family dwelling as the occupancy with the greatest risk of ground ladder rescues. Interviews with peers in the operational area of the fire service have presented various benefits of the 28 foot ladder as a rescue ladder specifically for the three story multi-family dwelling. WMFR should explore these benefits and the potential for 28 foot ladders to improve our operations, capabilities and reduce the potential for trapped occupants at these dwellings to be out of reach of WMFR’s current most common fire ground ladder, the 24 foot extension.

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