The Development of Criteria to Determine Aerial Apparatus Specifications for the City of Thornton Fire Department.

Leading Community Risk Reduction

By: Leonard Giuliano
Thornton Fire Department
Thornton, Colorado

An applied research project submitted to the National Fire Academy as part of the Executive Fire Officer Program

January 2004

Abstract

The Thornton Fire Department has not purchased an aerial apparatus in 25 years. Thus, the city of Thornton has to establish criteria identifying the features of aerial apparatus that will best serve the citizens of Thornton and community response needs. The purpose of this research project is to use action research methodology to accomplish the following: (a) to identify positive and negative features of aerial apparatus in the current literature; (b) identify professional, national, state, or local standards for aerial operation; (c) assess the local needs for aerial apparatus; and (d) identify any political and social factors that should be considered in an aerial apparatus purchase.

The crucial features of appropriate aerial apparatus included determination of local need, length of the aerial device, and the need for a platform or aerial ladder. Using historic references specific to the City of Thornton, multi-family structures without detection or suppression systems were identified as the highest risk structures in the city. All structures meeting these criteria were assessed for the ability to affect a rescue, perform firefighting tasks, and overall cost. The assessment demonstrated a very low probability of safely affecting a rescue or performing firefighting tasks from the aerial device itself. It was also discovered a shorter 75 foot aerial ladder could perform the probable functions of roof access and elevated water streams as well as the larger 100 foot platform. Therefore, the recommendations resulting from this research include an initial purchase of a 75 foot ladder, quint type of apparatus to meet current needs and improve the Insurance Service Office rating of the city. Furthermore, it was recommended that the city work diligently through code adoption and prevention programs, to minimize the need for additional apparatus purchases in the future.

Table of Contents

Introduction

The Thornton Fire Department needs to establish criteria that identify community requirements for aerial apparatus that will best serve the citizens of Thornton. The purpose of this research project is to develop these criteria, based on industry standards, national experience, and specific local needs: the Thornton Fire Department can use when purchasing aerial apparatus. The approach will be to identify major aerial apparatus features and evaluate them against actual experiences and existing needs within the City, and to formulate the criteria for future purchases. Action research methodology was employed to answer the following questions:

1. What does the current literature identify as positive or negative features in aerial apparatus?
2. What are, if any, the professional standards, national, state, or local, for the operation of aerial apparatus?
3. What are the specific local needs for aerial apparatus?
4. What are the local political and social factors that should be considered in an aerial apparatus purchase?
5. Which aerial apparatus specifications will improve the Insurance Service Office rating of the city of Thornton?

Background and Significance

During the 1970's, the Thornton Fire Department purchased a one hundred foot ladder apparatus that was never staffed and rarely used. When the ladder was used, it was brought into the latter stages of an incident and used only as an elevated water stream.

Due to its lack of use and maintenance costs, the large ladder apparatus was sold in the early 1980’s. As replacements, two of the staffed engine companies were modified with 50 foot Tele-Squirts. At that time, staffing the two 50 foot Tele-Squirts earned Insurance Services Office (ISO) credits that were equivalent to those of the 100 ft ladder apparatus. This allowed the Thornton Fire Department to maintain its ISO rating of 4 throughout the 1980’s and into the 1990’s. The ISO rating affects a majority of the residential and commercial buildings insurance premiums in the city. In 1994, the Thornton Fire Department and a neighboring department consolidated to form a single fire authority. The neighboring department provided an additional 50 foot aerial apparatus, which was over 20 years old at the time, and the two 50 foot Tele-Squirts were taken out of service and sold. Nevertheless, the ISO rating of the consolidated fire authority remained the same through 1999. However, the consolidated fire authority was dissolved at the end of 1999 and the Thornton Fire Department was reestablished. Since then, the Thornton Fire Department has maintained engine companies with ground ladders, the tallest being 35 feet. In 2001, the Thornton Fire Department earned an ISO rating of 5. The higher ISO rating caused the average homeowner to experience an increase of approximately 50 dollars a year in insurance premiums and commercial properties paid approximately $12 more per $100,000 in valuation. The ISO rating of the Department in 2001 was consistent with fire departments having the capability to fight fires in buildings with a maximal size of two stories. In the same year, public concern over a perceived lack of fire-fighting capability prompted the Thornton City Council to commission a study on the level of services provided by the Thornton Fire Department. Berkshire Advisors (2002) were charged with completing the study and published their findings in early 2002. The report concluded that the fire department should replace two engine companies with aerial apparatus. However, the report did not specify what type of a replacement apparatus would be appropriate.

In this research report, methods are applied to extend the Berkshire Advisors' study to provide a recommendation for the purchase of specific aerial apparatus. It is envisioned that implementing the results of this research report will not only improve the ISO rating of the Thornton Fire Department, but, more importantly, lower the risk of death for the citizens exposed directly to fire, an important hazard identified in the Leading Community Risk Reduction course at the National Fire Academy (2003).

Literature Review

In formulating a recommendation for the purchase of an aerial apparatus, a large body of knowledge on the subject was first examined. The ISO cites a specific criterion that requires response areas to have a ladder company with some regulations on height, but does not differentiate between a ladder and platform (ISO, 1998):

> Response areas with 5 buildings that are 3 stories or 35 feet or more in height, or with 5 buildings that have a Needed Fire Flow greater than 3,500 gpm, or any combination of these criteria, should have a ladder company. The height of all buildings in the city, including those protected by automatic sprinklers, is considered when determining the number of needed ladder companies (p.23).

Moreover, the NFPA (2001) Standard 1710 does not require fire departments to operate aerial apparatus, yet it references how they are to be staffed if they are used.

Thus, the ISO and NFPA guidelines provide technical requirements for the purchase of an aerial apparatus.

Once the need for aerial apparatus has been established, Cavette (2001) provides guidelines for the purchasing department, highlighting possible restrictions. For example, if the unit will be primarily used for rescue and firefighting, a platform-based apparatus may be preferable. The platforms usually cost and weigh more than ladders but have a broader spectrum of functions including being more useful in incidents with a large number of people needing evacuation, and incidents where rescue and firefighting duties, such as applying multiple master streams, are both required.

Additionally, consideration of typical roof heights and building setbacks within the department’s response area are important parameters. Peters (2000) approaches purchasing decisions in this area as a series of “trade-offs.” What is the most important need of the department amongst the following: reach, rescue capabilities, working position, or safety? He details the advantages of platforms as allowing for easier rescue of incapacitated victims and having the ability to move from point to point. However, the most significant disadvantages of platforms relates to their overall size, weight, and cost. The larger these vehicles grow, the more restrictive they become. Examples of these limitations include operating and maneuvering on roads or bridges that are narrow or have weight restrictions, providing the capacity to fit them into existing fire stations, and providing for the additional maintenance costs. Morris (2001) relates virtually the same trade-offs listed above, citing superior capabilities of the platforms during rescues and firefighting. He also notes the cost and maneuverability disadvantages over ladders. Dunn (1989) discusses the extreme danger in attempting rescues from aerial ladders and suggests that rescues should be initially attempted through safe interior stairwells or fire escapes, if available. He further suggests removal of victims from a burning building in an escape-route priority: smoke-proof tower, safe interior enclosed stairway, fire escape, aerial platform, and aerial ladder. Additionally, he discusses the possibility of safely securing the victims in place until the fire is out. Wieder (2001) relates the importance of positioning and the safe operation of aerial apparatus. He suggests avoiding use of any aerial apparatus with long extensions and low angles. He also discusses the stresses put on apparatus under certain conditions like nonparallel positioning. He also discusses the possibility of ventilation from aerial apparatus and how with proper positioning this may be possible. Vaccaro (2001) discusses the ability to complete multiple firefighting activities from an aerial platform with an articulating boom. Overall he relates that this additional feature adds an important asset to the aerial platform. Jakubowski (1997) relates similar findings for the articulating boom, and suggests that it is a safe working platform over large roof areas. He also states straight ladders have some advantages like operating more easily in narrow spaces. Cook (2002) doesn’t advocate purchasing an aerial with the longest reach or most features, but advises that each community decide what is reasonable. He continues to relate how actual reach distance is a significant factor in evaluating aerial apparatus and demonstrates the use of the Pythagorean Theorem to calculate the actual reach. Hill (1995) found aerial ladders typically were actually used on an average of 1.8 incidents a year and that shorter aerial ladders would have accomplished the same result.

Procedures

The initial approach taken was to search the fire service literature on aerial apparatus, through the Learning Resource Center at the National Emergency Training Center in Emmitsburg, Maryland. The focus of the search was on comparisons of ladders and platforms. There was a significant amount of literature on the subject, the majority of which was anecdotal but proved to very valuable. The literature gathered typically recommended a starting point of self assessment to determine needs. The city of Thornton is less than 50 years old with no structures over three stories that do not have suppression or detection systems installed and separate fire escape stairwells. This led the author to survey the highest risk group in the city, unprotected multi-family dwellings. All multi-family buildings in the city without suppression systems were assessed for occupant egress points and roof profile for access and ventilation. Those results are detailed in Appendix.

A search for national standards started with the National Fire Protection Association, Standards Handbook. The National Fire Protection Association (2001) only referenced how to staff and operate aerial apparatus. The Insurance Services Office (1998), Fire Suppression Rating Schedule was obtained and evaluated as a professional standard.

There are many aspects to aerial apparatus that may have been evaluated that were not part of this project. This project was limited to determining which major type of apparatus, overall length and type between ladder and platform, best meets the needs of the city. The needs of the city were identified from the survey completed, historical experience, and current risk. The Fifth Edition of the Publication Manual of the American

Psychological Association and the Executive Fire Officer Program, Operational Policies and Procedures, Applied Research Guidelines, Revised June 1, 2002 were used as formatting guidelines for this project.

Definition of Terms:

Aerial Ladder: A self supporting, turntable-mounted, power operated ladder of two or more sections permanently attached to a self-propelled automotive fire apparatus and designed to provide a continuous egress route from an elevated position to the ground (Peters, 2003).

Elevating Platform: A self supporting, turntable-mounted device consisting of a personnel-carrying platform attached to the uppermost boom of a series of power operated booms that articulate, telescope, or both, and that are sometimes arranged to provide the continuous egress capabilities of an aerial ladder (Peters, 2003).

Egress Side: A side of a structure that the occupants may use as a point of egress or may be used as a point of access for firefighter to complete a rescue.

Results

Building profiles found in Appendix detail specific findings for the city of Thornton.

Answers to questions:

Research Question #1: What does the current literature identify as positive or negative features in aerial apparatus?

Overwhelmingly the literature directs readers to determine local needs and projected uses for aerial apparatus as a first step in evaluating features. Apparatus with platforms are considered to provide safer operations in rescue, ventilation, and attended master stream application. The ability to stow numerous tools and apply multiple master streams are also considered positives. The negatives with platforms start with their overall size and weight. They are typically much heavier and less maneuverable which causes them to be slower on responses and sometimes incapable of being positioned properly. The cost and maintenance of platforms are considerably more than aerial ladders. Aerial Ladders are usually smaller and easier to put into use. Aerial ladders provide a safe means of applying an elevated master stream which can be directed from the inside of a structure, through an opening. The platforms have a slight advantage for ventilation roof access and a larger one for ventilation of vertical opening. The concept of ventilating a roof from the platform itself would be considered a huge advantage but the chance of being able to properly position the unit makes this a remote possibility.

Research Question #2: What are, if any, the professional standards, national, state, or local, for the operation of aerial apparatus?

The only national standard found that related to the operation of aerial apparatus was the Fire Suppression Rating Schedule, Insurance Service Office (1998). This schedule gives the same rating for aerial ladders or platforms. The ratings for the height of the apparatus would only vary for three buildings in the City of Thornton. The standard requires the apparatus to reach the roof line of all buildings. The three buildings have a roof line assessable by a 100 foot aerial and not by a 75 foot aerial. The credits are prorated if existing equipment has insufficient reach. There is no state or local standards relating to the operation of aerial apparatus.

Research Question #3: What are the specific local needs for aerial apparatus?

The city of Thornton has had very few, if any, fires in a commercial building more than one story in height. All of the multi-story commercial buildings in the city of Thornton have suppression systems and escape stairwells. The majority of fires have occurred in single family dwellings or multi-family residential structures less than three stories in height. Building profiles detailed in Appendix reveal further needs for these high risk occupancies. In the event of a fire in these occupancies, more than 53% of the egress sides are not accessible by any aerial apparatus. There are no egress points which exceed the capabilities of a 35 foot ground ladder. Over 75% of these building have pitched roofs which would increase the need for vertical ventilation. The most significant finding is the ability of a 75 foot aerial to reach the roof of each building profiled except one. The Brookside Condos, on Fox Street, may appear to be accessible by a 100 foot aerial but that would have to be an articulating unit as they are obstructed by covered parking structures.

Research Question #4

What are the local political and social factors that should be considered in an aerial apparatus purchase?

The political factors are mostly based on budgetary issues. The city of Thornton is a growing community which just expanded its fire department by one fourth. This expansion did not include the purchase or staffing any aerial apparatus. In the history of city of Thornton, there has not been a fire related death attributed to absence of aerial apparatus. There has been additional fire loss due to the limited capabilities, but this type of issue tends to be overlooked by the public. The social factors are usually related to demographics. The southern portion of the city is the oldest and has a lower per capita income than the northern portion which leads to an increased fire probability. The factors affecting the purchase of an aerial apparatus should be based on where the city stands to have its most significant possibility of losses, the southern portion. The majority of the buildings profiled in Appendix are located in the southern portion of the city.

Discussion

In assessing all the buildings in the city of Thornton, the Insurance Service Office (1998) criterion for aerial apparatus appeared to match the need displayed. Their criterion identified the value of accessing the roofs of all structures with in the city. The height requirements were very attainable for structures through four stories. As the structures grow taller the requirements also increase but they are prorated so a few tall buildings do not skew the actual need of the city. Assessing the city’s needs first, as Cavette (2001) stated, the study found a very low need for aerial apparatus that could reach higher than four stories or fifty feet. Vaccaro (2001) discusses important safety issues on operating from a platform like rescue and ventilation. Morris (2001) related similar advantages but the increased costs were also noted. The “trade-offs” identified by Peters (2000) and the findings of Hill (1995) directed the study to assess the probability of performing a rescue from an aerial apparatus. The study found even if there was a significant fire in a high risk building, the majority of the rescues would come from an egress point aerial apparatus cannot reach, thus rendering them useless for rescues. The concept of aerial apparatus rescues is further dampened by Dunn (1989) who places this idea at the bottom of a list of safer rescue options. "A longer reach is not necessarily better," writes Cook (2002) and the study confirmed his opinion. A 75 foot aerial would reach the roofs of all the building in the city except for three commercial buildings that have complete suppression and exiting systems. Weider (2001) identifies the hazard of continuous use of aerial apparatus with long extensions at low angles which would be the most frequent use of a 100 foot aerial in the city of Thornton.

The author has come to understand the distinct difference in the capabilities of aerial platforms and aerial ladders. The ability to operate safely from an aerial platform is a powerful concept, but the reality is in the city of Thornton performing these tasks on an actual fire scene might never happen. The author has also learned the significant differences between a 75 foot aerial and a 100 foot aerial. The differences include the overall cost to purchase and maintenance, the ability to house the unit, and the ability to be used as an engine company.

The smaller 75 foot aerial ladder would best fit the needs of the city of Thornton because it will provide roof access and elevated master stream capabilities to virtually every building as would a 100 foot aerial ladder or platform. The city of Thornton cannot afford to staff an aerial apparatus only as a truck company. All aerial apparatus will be staffed as primary engine companies, therefore the smaller unit will be more cost effective.

Recommendations

In order to purchase the most cost effective and usable apparatus, the city of Thornton should purchase a 75 foot aerial ladder. This apparatus will be equally functional as an engine company on a medical incident and as a truck company on a structure fire. Purchase of this apparatus will help to increase the ISO credits and the firefighting capabilities of the department without a loss of service in another area. This apparatus should replace an existing engine and be used as a quint apparatus.

The rationale for identifying risk was based on the presence of suppression systems and other fire safety features. It is also recommended the city of Thornton continue adopting current building and fire codes which will limit risk in future buildings. The city of Thornton should also consider adopting retroactive codes which will decrease risk in older buildings thereby decreasing the need for additional aerial apparatus.

When evaluating what type of aerial apparatus a city or District may need, the organization should assess if their needs are growing or diminishing. Has the organization proactively developed a philosophy of prevention which can reduce the demand for bigger apparatus and more personnel? Future readers should consider the idea of removing needs instead of trying to always meet higher demands.

References

Berkshire and Advisors (2002). *Report of a management review of the Thornton Fire Department.* Austin, TX: Author.

Cavette, C. (2001). Up in the air about aerials? *Fire Chief In Service, 3,*49-55.

Cook, S. (2002). Ladder success: a short course in aerial ladder strength. *Fire-Rescue Magazine, 20(8),* 79-82.

Dunn, V. (1989). The dangers of climbing an aerial ladder. *Fire Engineering, 142(6),* 40-43.

Hill, D (1995). *The use of aerial ladders in Sioux Falls.* Executive Fire Officer Research Paper, Emmitsburg: National Fire Academy.

Insurance Service Office. (1998) *Fire suppression rating schedule*. Jersey City, NJ: Author

Jakubowski, G. (1997). Will it reach? Aerial ladder positioning on the fireground. *Fire-Rescue Magazine, 15(4),* 39-42.

Morris, G. (2001) Roundtable-opinions from around the country. *Fire Engineering, 154(4),* 30-44.

National Fire Academy (2003), *Leading community risk reduction, student manual* (NFA-LCRR-SM). Emmitsburg: Author.

National Fire Protection Association (2001). *Standard for the organization and development of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments.* (NFPA 1710). Quincy, MA: Author.

Peters, W. (2000). Aerial, platform, or quint? that is the question! *Fire Engineering, 156(6),* 57-60.

Peters, W. (2003). Specifying aerial apparatus. *Fire Engineering* , *156(6)*, 57-60.

Vaccaro, B. (2001). Little boom with a big bang. *Fire-Rescue Magazine*, *19(10)*, 27-29.

Wieder, M. (2001). Positioning aerial apparatus. *Firehouse*, *26(1)*, 50-52.

Appendix A
Building Profiles

Complex	Total Number of Buildings	Number of egress sides	Egress Sides not accessible by an Aerial apparatus	Height of Roof:	Setback Distance	Other Issues	Maximum height of reach by 100 foot Aerial, with maximum setback	Difference between maximum height and actual height	Maximum height of reach by 75 foot Aerial, with maximum setback	Difference between maximum height and actual height
Pine View Village (300 Russell)	9	18	9	22	35		85.1	63.1	66.3	44.3
Brookside Condos(Fox)	3	6	6	40	>70	No access to living area as parking structure obstructs access point.	59.7	19.7	26.9	-13.1
Town Center (W. 91st)	9	24	18	32	<20	One unit totally inaccessible	89.8	57.8	72.3	40.3
Viewpoint (Ura)	10	40	23	20	70	Balconies only 18 feet above grade	59.7	39.7	26.9	6.9
Village 88 (88th Av.)	6	12	8	25	50		77.2	52.2	55.9	30.9
Star Point (Huron)	10	40	27	Vary	36	Balconies only 18 feet above grade	84.7	59.7	65.8	40.8
Carriage Hills (Huron)	6	12	6	20	40	Balconies only 12 feet above grade	82.8	62.8	63.4	43.4
Fox Creek (89th and Huron)	3	6	3	<20	<20	Balconies only 12 feet above grade	89.8	64.8	72.3	47.3
Snowcap Ridge(88th and Pecos)	1	2	1	30	65	Trees obstruct access to building	65.1	35.1	37.4	7.4
Parkside (102nd and Quivas)	98	196	98	18	12	Limited access into driveway areas,	91.2	73.2	74.0	56.0
Aztec Villa(86th and Mariposa)	18	36	18	18	37		84.2	66.2	65.2	47.2
Parkview Terrace(87th and Osage)	23	46	20	18	37		84.2	66.2	65.2	47.2
Hallcraft Parknorth (88th and Lipan)	37	74	59	24	40	Overhead electrical limits access.	82.8	58.8	63.4	39.4
Autumn Creek(Tpky and Gale)	37	74	21	24	<50		77.2	53.2	55.9	31.9
Creekside (Gale and Lipan)	24	96	61	36	<50		77.2	41.2	55.9	19.9
Prarie Green (96th and Huron)	4	8	5	30	<50		77.2	47.2	55.9	25.9

Appendix A
Building Profiles

Complex	Total Number of Buildings	Number of egress sides	Egress Sides not accessible by an Aerial apparatus	Height of Roof:	Setback Distance	Other Issues	Maximum height of reach by 100 foot Aerial, with maximum setback	Difference between maximum height and actual height	Maximum height of reach by 75 foot Aerial, with maximum setback	Difference between maximum height and actual height
Hilcrest Townhomes(Lane and 96th)	72	144	72	20	20	No access to rear units, with drives	89.8	69.8	72.3	52.3
Brookshire (88th and Corona)	4	8	4	45	40	Wires obstruct access on West side	82.8	37.8	63.4	18.4
Hillcrest at Remmington	16	32	16	10	30		87.0	77.0	68.7	58.7
Catalina (88th and Colorado)	9	36	17	28	30		87.0	59.0	68.7	40.7
Newport Village	25	100	60	Vary	50		77.2	52.2	55.9	30.9
Brittany Downs (88th and Pearl)	22	88	40	20	35	Access stairwells similar to balconies	85.1	65.1	66.3	46.3
Sunset Peak (Russel and Pearl)	15	30	19	18	70		59.7	41.7	26.9	8.9
Summit at Thornton	14	56	27	30	35		85.1	55.1	66.3	36.3
Peppercorn (89th and Grant)	19	38	13	27	30		87.0	60.0	68.7	41.7
Elmwood Manor (94th and Hoffman)	5	17	13	24	25		88.5	64.5	70.7	46.7
Brookshire (103rd and York)	18	9	5-Jan	30	20		89.8	59.8	72.3	42.3
Village of Yorkshire	8	16	8	30	50		77.2	47.2	55.9	25.9
Prospectors at Settlers	34	68	34	12	20		89.8	77.8	72.3	60.3
Hertigage Condo (103rd and Steele)	18	72	18	20	20		89.8	69.8	72.3	52.3
Lamplighter (100th and Washington)	3	26	16	24	20		89.8	65.8	72.3	48.3
Sassafrass (103rd and Riverdale)	7	14	14	20	50	Parking structures obstruct access	77.2	57.2	55.9	35.9
Quail Ridge(102nd and Grant)	9	18	10	20	20	Parking structure obstruct access.	89.8	69.8	72.3	52.3

Appendix A
Building Profiles

Complex	Total Number of Buildings	Number of egress sides	Egress Sides not accessible by an Aerial apparatus	Height of Roof:	Setback Distance	Other Issues	Maximum height of reach by 100 foot Aerial, with maximum setback	Difference between maximum height and actual height	Maximum height of reach by 75 foot Aerial, with maximum setback	Difference between maximum height and actual height
Peach Tree (129 & York)	7	14	8	22	15		90.8	68.8	73.5	51.5
Legends at Hunters Glenn	20	80	70	Vary	70		59.7	34.7	26.9	1.9
Wildflower at Hunters Glen	9	18	9	18	15		90.8	72.8	73.5	55.5
Hunters Glen	34	68	34	18	15		90.8	72.8	73.5	55.5
Pinnacle at Hunters Glen	12	48	28	30	40	Obstruction: Parking Structures	82.8	52.8	63.4	33.4
Courtyard at Northlake(2200 E.128)	7	14	9	20	15		90.8	70.8	73.5	53.5
Harvard Commons (130 and Harris)	12	24	2	12	12		91.2	79.2	74.0	62.0
Hawthorne Hills (120th and York)	7	14	12	18	40		82.8	64.8	63.4	45.4
Thornton Ridge (3900 E. 121st)	17	34	11	18	40		82.8	64.8	63.4	45.4
Fow Creek (121st and Colorado)	12	24	11	22	38		83.8	61.8	64.7	42.7
Steeplechase (122nd and Colorado)	10	20	12	18	15		90.8	72.8	73.5	55.5
Oakshire Townhomes (119th)	15	60	12	18	40		82.8	64.8	63.4	45.4
Holly Ridge (112th and Holly)	15	30	30	18	12	No access due to trees	91.2	73.2	74.0	56.0
Totals	773	1910	1017	45' Highest						

Appendix A
Building Profiles

Notes:

Egress Sides:

Of the buildings studied, there are 1,910 sides to those building where occupants may try to exit or become trapped. Of those sides, 1,017 are inaccessible to an aerial apparatus of any type. In the event of a fire, there is a 53% chance an aerial apparatus will be of no use to affect a rescue.

Roof Access:

The tallest roof line of all the structures profiled was 45 feet above grade. Therefore, every balcony and window would be accessible by ground ladders.

The maximum height of reach by a 100 foot or 75 foot aerial was calculated by subtracting the 8 foot pedestal height of the apparatus from the overall length which gives the hypotenuse of a right triangle. Then using the Pythagorean Theorem, the maximum height is the square root of the adjusted reach squared less the maximum distance squared.

Of all the buildings studied, only one could not be reached by a 75 foot aerial. This building exhibits a negative number in the difference between maximum height and actual height column. This building would actually be inaccessible by larger aerial apparatus due to the obstruction created by the covered parking structures.