FINAL REPORT

RISK ASSESSMENT STUDY
DRACUT FIRE DEPARTMENT
DRACUT, MA

AUGUST 2016

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Municipal Resources

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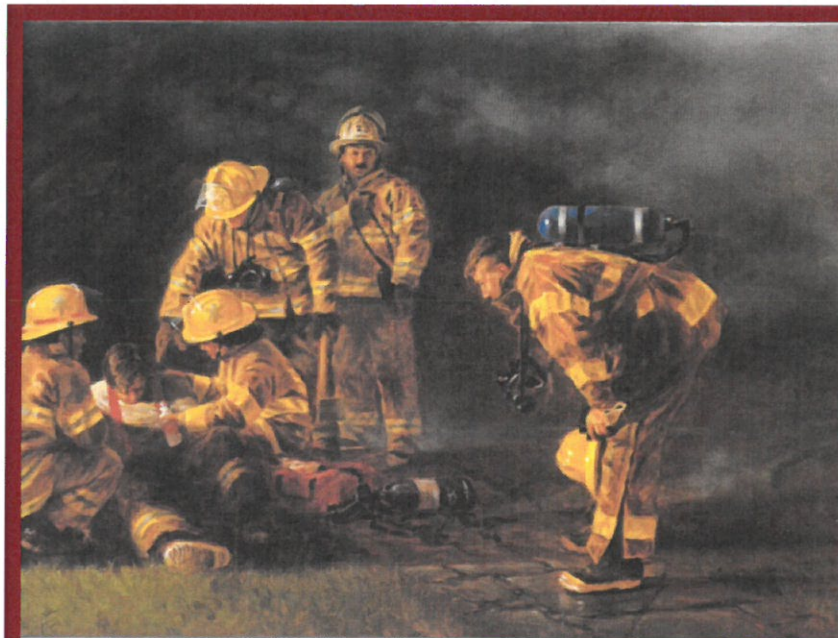
Services for Effective Government

Dracut, Massachusetts



Fire Services Risk Analysis

July 2016

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CHAPTER 1

INTRODUCTION AND SCOPE OF WORK

Municipal Resources, Inc. (MRI) was engaged by the Town of Dracut, MA, to complete an organizational risk assessment of the Dracut Fire Department. The scope of this project was to review the manner in which fire services are provided within the town from a risk management, as well as operational, perspective. Using this review as a basis, MRI was to make recommendations for improvements that would take into consideration the current and future financial ability of the town, appropriate modifications to the delivery systems to provide optimum response time and service to the entire town, location or expansion of physical facilities and equipment, and whether the current organization is appropriate or should be modified.

Over a period of several months, a team of MRI fire service consultants spent considerable time analyzing data, meeting with staff, reviewing documents, and inspecting on-site operations. In addition, MRI provided all employees with an opportunity to provide input through the distribution of an internal survey instrument and one-on-one interviews. The following report is the product of this assessment.

SCOPE OF SERVICES

This study will review the manner in which fire services are provided within the Town from a risk management as well as operational perspective. Using this review as a basis, MRI will make recommendations for improvements that are to take into consideration the current and future financial ability of the Town, appropriate modifications to the delivery systems to provide optimum response time and service to the entire Town, location or expansion of physical facilities and equipment, and whether the current organization is appropriate or should be modified.

In undertaking this review and analysis, and in its report, MRI will distinguish between and separately review, analyze, and report on the functions of the Department so as to facilitate meaningful comparisons with other municipalities which may not have comparable fire services and infrastructure, and to present a clear depiction of the financial, facility, personnel, and equipment resources devoted to fire service activities.

Using the Town's most recent data, MRI will focus upon the following key elements:

- Organization, Staffing and Manpower;
- Adequacy of Financial Controls;
- Facilities and Equipment;
- Goal setting, long and short range;
- Procurement practices;
- Overtime policies;
- Comparative analysis with other municipalities and other comparable private enterprise activities

Our approach to this project will include the following:

1. Document and evaluate current fire performance and workload levels for:

    A. Operations
    B. Command Staff
    C. Fire Prevention
    D. Support Personnel

2. Identify opportunities to improve performance with existing resources and identify alternative funding sources.

3. Evaluate overtime costs and the purposes for which overtime was paid.

4. Estimate the staffing requirements, equipment needs, and associated costs that would be needed to achieve Town and Fire management performance objectives.

5. Evaluate fire service activities to determine effectiveness of this strategy and/or weaknesses of current practices, and recommend strategy improvements as needed.

6. Evaluate the current detail system and method of scheduling and recommend improvements as needed.

7. Evaluate the current command structure to determine efficiency of existing structure or recommend alternative approaches.

8. Identify risk as it relates to the operation of the department as determined by the assessment.

CHAPTER 2

ADMINISTRATION

2.1 ORGANIZATION

Overview

The mission performed by the fire department is one of the fundamental functions of government: to ensure the safety and protection of its residents and visitors. The expectations for the quality and quantity of fire and emergency services must come from its residents and other taxpayers and stakeholders. There is no "right" amount of fire protection and EMS delivery services. It is a constantly changing level based upon the expressed needs of the community. It is the responsibility of elected officials) to translate community needs into reality through direction, oversight, and the budgetary process. It is their unenviable task to determine the appropriate level of risk they are willing to assume for those they represent, and maximize the delivery fire, EMS, and other services (both emergency and non-emergency) within the reality of the community's ability and willingness to pay. This is particularly true in today's new economic realities and environment.

The organizational structure of any organization or entity, whether public or private, establishes and illustrates the important heirarcial relationships between various personnel, supervisors/ subordinates, levels, divisions, and bureaus within the organization that allow it to function properly, operate effectively and efficiently in its daily operations, or the pursuit of its mission. It also helps to clearly define the organizational chain of command from top to bottom, an especially important consideration in a quasi-military public safety organization such as the fire department where everyone from the highest rank to the lowest is subject to receiving orders, and, with the exception of the lowest rank also issues them. Effective communications in any organization, but especially public safety agencies, are essential and a cohesive chain of command allows everyone to know excactly who they report to, and/or who reports to them.

Observations

Like many fire departments in Massachusetts, the Dracut Fire Department is a fully career department which provides guaranteed protection to the town 24 hours per day, seven days per week. The department staffs three stations which are situated at various locations throughout the town.

At the time of this study, the Dracut Fire Department had a total staffing compliment of forty full-time, career personnel, plus one civilian administrative assistant. These personnel include:

- 1 - Fire Chief
- 1 – Administrative Assistant (civilian)
- 2 - Deputy Fire Chiefs
- 4 - Captains
- 8 - Lieutenants
- 25 - Firefighters

David Brouillette, the current fire chief, is the department's highest ranking officer and serves as the adminsitrative and operational head of the department. The fire chief's position is a "strong" chief under Massachusetts law, and, is also covered under the provisions of the Massachusetts civil service system. He works a straight day work schedule, Monday through Friday. The chief is assisted by a civilian administrative assistant who provides a wide range of administrative and support functions. The fire chief is appointed by the town manager and confirmed by the Board of Selectmen. As outlined by the Charter of the Town of Dracut the chief reports directly to the town manager.

The two deputy fire chiefs also work straight daywork but they each work a rotating schedule of four days on, followed by four days off including weekends. In addition to their operational responsibilities serving as command level chief officers, one of the deputy chiefs is responsible for overseeing the department's training functions while the other primarily handles fire prevention activities.

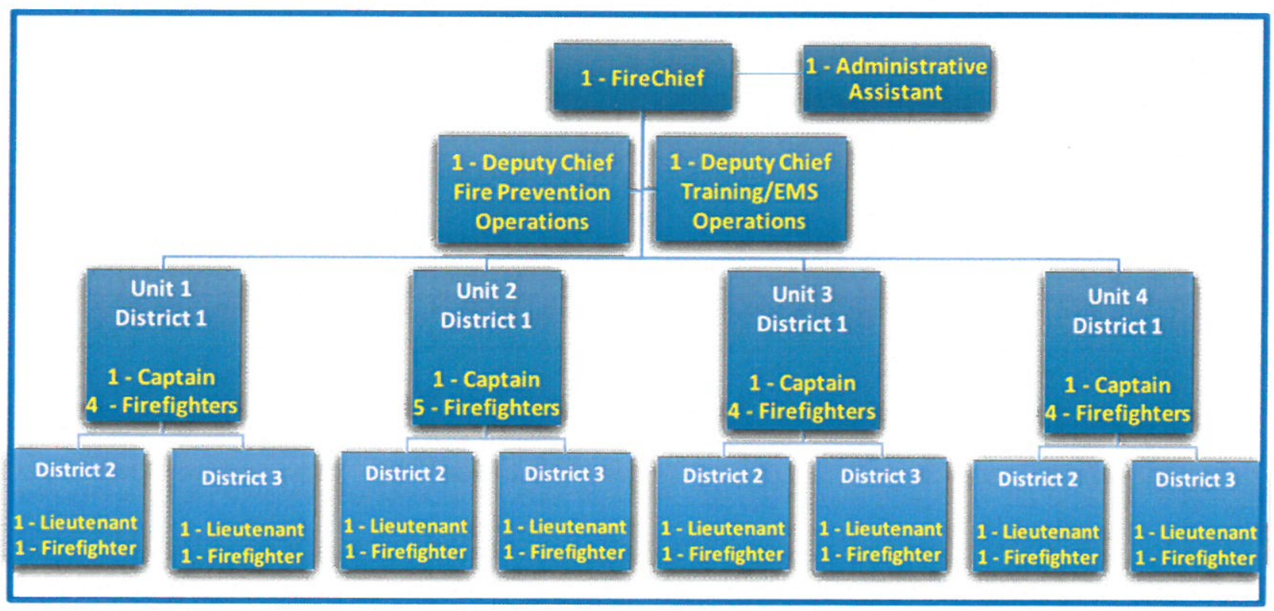
The department is currently authorized a total of four (4) captains and eight (8) lieutenants who are assigned as supervisors on each of the four (4) platoons/units. The captains are assigned as the company commander of Engine 1 at Fire Headquarters/Station (District) 1. In addition to the firefighters assigned to Engine 1 they are also responsible for supervising the firefighters assigned to the department's dispatch center. Engine 2 at Station (District) 2 and Engine 3 at Station (District) 3 are each commanded by a lieutenant. The captain and lieutenants serve as the department's first line supervisors, providing critical direction and direct oversight to the firefighters assigned to that platoon in each station. If the captain is off duty on any type of leave the senior lieutenant is detailed to Station 1 to serve as an acting captain. When this situation occurs, or when the lieutenant(s) are off for any reason, those positions are then filled by a firefighter serving as an acting lieutenant. There must be one sworn officer (lieutenant or higher) on duty at all times. A number of the officers have ancillary duties they have been assigned that assist with coordinating or managing various aspects of the department's operations.

Each platoon also has six firefighters (one has seven) deployed between the three stations. These personnel perform a range of fire, rescue, and EMS duties and responsibilities. A few participate in specialized regional teams and operations and perform various additional duties for the department.

All uniformed personnel, other than the fire chief, are represented in collective bargaining by Dracut Fire Fighters Local 2586 of the International Association of Fire Firefighters (IAFF). The current representation arrangement where rank and file firefighters, supervisors (lieutenants and captains) and mid-level management (deputy fire chiefs) are all in the same union creates problems and conflicts of interest within the department, particularly when it comes to the administration of discipline. All uniformed positions are classified in the Massachusetts civil service system. Under the civil service system, the town must adhere to specific requirements for recruiting, hiring, promoting, disciplining, and terminating fire department employees. Dracut has only been in the civil service system for about 10 years so many senior members of the department although now covered by civil service were actually originally hired under a different system.

The Massachusetts civil service system is struggling to obtain the necessary resources to meet the needs of the communities it serves. Several Massachusetts communities have or are actively considering withdrawing from this system. Based on the confines of the civil service system, we believe that the position of fire chief should be removed from this system. Removing the position of fire chief from the civil service system would not impact the current chief as he will be grandfathered until he retires. Removing the position from the confines of civil service would allow the Town to set educational and experience standards that best meet the needs of the community. This would provide the Town with the flexibility necessary to attract the best possible internal and external candidates.

FIGURE 2-1
DRACUT FIRE DEPARTMENT ORGANIZATIONAL CHART



The management structure of the Dracut Fire Department is somewhat limited. Although with just 40 total personnel the department is not large, the fire chief is the only non-union, executive management position. Although he does have two deputy fire chiefs who by all accounts do an excellent job and work well with the chief, they are both still members of the union rather than true exempt management which has the potential to create conflict. As a result, the chief does not have a real management and support assistant that can share responsibilities for confidential personnel matters, supervision, handling grievances or potential grievances, administering the collective bargaining agreement, overseeing budgetary expenditures, assisting with the development of policies and procedures, and the myriad of administrative and management tasks that are associated with running a modern, full service emergency services provider. In the absence of the fire chief, the town is without a true member of the executive management team to oversee a critical public safety agency.

Recommendations

2.1-1 The Town of Dracut should consider negotiating with the local bargaining unit for the purpose of establishing a non-union position of assistant fire chief delineating a clear number two position in the fire department and to provide the chief with another confidential management position to assist him with leading the department. This position should be an executive management position that is also exempt from the firefighters' collective bargaining unit.

2.1-2 The Town of Dracut should remove the position of fire chief from the confines of the Massachusetts civil service system. This will maximize the ability for the Town to recruit the most qualified internal and external candidates to be the next fire chief when the current chief retires.

2.1-3 All officers in the Dracut Fire Department should be assigned additional ancillary duties in addition to their company supervisor responsibilities in order to the assist the chief(s) with the myriad of duties necessary to manage a modern fire department.

2.1-4 The Town of Dracut should make every attempt to separate the department's firefighters and the supervisors/management (lieutenants, captains, and deputy chiefs) into two separate bargaining units. This separation of workers from supervisors and management is very important to maintaining appropriate management, supervision, accountability and discipline within the department.

2.2 STAFFING AND SCHEDULING

Overview

The issue of fire department staffing has, over the past three decades, become one of the most widely and frequently debated topics in fire service history. This debate has intensified over the past several years as tax collection revenues have declined precipitously in many communities and governmental entities seek to reduce expenses. Although Dracut is a financially stable community compared to many in the commonwealth, the town is still sensitive to identifying cost savings where possible. Personnel costs account for the largest percentage of the operating budgets of career fire departments. In many cases this one-line item is 90% or more of the total budget. The debate becomes intense when the discussion turns to how many firefighters are necessary to provide adequate levels of service, fulfill the department's core mission(s), and how those firefighters are deployed. This is a basic risk assessment and management decision. Ultimately, determining the acceptable level of risk they are willing to assume for the citizens they represent is a key decision that is made by the board of selectmen and town manager.

The fire service has experienced tremendous technological advances in equipment, procedures, and training, over the past fifty years. Improved personal protective equipment (PPE), the mandatory use of self-contained breathing apparatus (SCBA), large diameter hose, better and lighter hose lines and nozzles, and thermal imaging cameras are just a few of the numerous advances in equipment that have enabled firefighters to perform their duties more effectively, efficiently, safely, and with fewer personnel. However, the fact still remains that emergency scenes present a dynamic, dangerous, frequently unpredictable, and rapidly changing environment where conditions can deteriorate very quickly and place firefighters in extreme personal danger.

The operations necessary to efficiently and safely extinguish a structure fire require a carefully coordinated and controlled plan of action. Simultaneous operations that must be carried out with a high degree of precision and timing include forcible entry, initial fire attack, search and rescue, ventilation, and the establishment of incident command. If there are not enough personnel on the incident initially to perform all of the critical tasks, some of these tasks will be delayed. This can result in an increased risk of serious injury, or death, to building occupants and firefighters, as well as increased property damage.

Staffing needs from an operational, emergency incident perspective, and more specifically, structural fires, are discussed in greater detail in Chapter 3, Fire/Rescue Operations. In this chapter staffing from the perspective of personnel deployment will be evaluated and discussed.

Observations

Captains, lieutenants, and firefighters in the Dracut Fire Department work a four (4) platoon, 24 hour shift schedule for an average work week of 42 hours per week. Their schedule consists of 24 hours on duty followed by 48 hours off duty then another 24 hour tour on duty and finally 96 hours off duty. This type of schedule is highly typical for fire departments in the northeastern United States.

Each deputy chief's work an alternating, straight daywork schedule of four ten hour days on, followed by four days off. Their normal work hours are 7:30 AM to 6:00 PM including weekends. Provided one of the deputies is not off on some type of leave there is a deputy chief on duty seven days per week. However, when a deputy is off on leave their position is not filled or replaced. In addition, there is no chief level officer on duty at night. This situation leaves the on duty captain (who may be a newly promoted lieutenant serving in an acting capacity) to run the shift, and, at least initially, all emergency scene operations which under current deployment models are going to be under staffed.

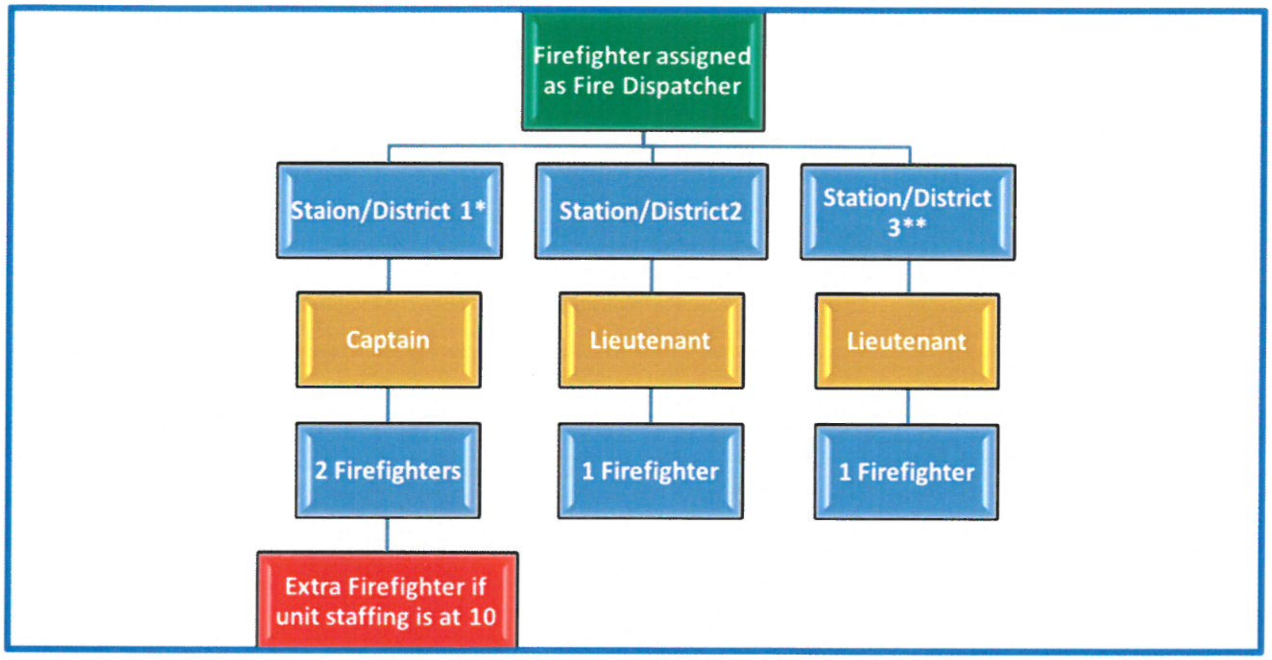
The one significant downside to the 24-hour schedule is that there can be a tendency for continuity and/or progress on projects to be slowed by the fact that the personnel assigned to, or working on them, are only available every third or fifth day. When the fact that personnel work weekends and holidays when the fire chief is not normally working is factored in communications can be problematic as the fire chief may go a week, or longer, without seeing certain personnel who he may need to get updates from, provide direction/instruction to, etc. While there is a wide array of alternative communications mediums available today that can minimize these issues, there is still no form of communication that is as effective as face-to-face communications.

As previously mentioned, on-duty personnel in the Dracut Fire Department are divided into four units (platoons) and work 24-hour shifts with an average workweek of 42 hours. Each unit is currently comprised of nine (9) personnel if all members are available to work. This includes one (1) captain, two (2) lieutenants, and six (6) firefighters (Unit 2 has seven (7) firefighters). Minimum daily shift strength is set at eight (8) which includes one (1) captain, two (2) lieutenants and five (5) firefighters. The captain's slot can be filled by a lieutenant working as an acting captain, and the two (2) lieutenant's positions can be filled by firefighters who are also acting. At least one (1) sworn officer must be on duty at all times. One of the firefighters is assigned as the dispatcher at fire headquarters and thus is not available for response to emergency incidents. One option to increase staffing would be to negotiate the transition to three platoons and then use the increased staffing created by consolidating a platoon to bolster on duty resources. This strategy could be utilized to enhance the minimum staffing on the outlying pieces of apparatus which is addressed later in this report.

Eight (8) personnel is generally the standard level of staffing. When staffing falls below eight personnel, off duty personnel are utilized on overtime to bring the number of personnel to eight.

The following chart depicts the current staffing levels of the Dracut Fire Department:

FIGURE 2-2
CURRENT STAFFING ARRANGEMENT FOR EACH GROUP



Total unit (platoon) staffing: 9 which includes 1 captain, 2 lieutenants and 6 firefighters.
Minimum unit (platoon) staffing: 8 which includes 1 captain, 2 lieutenants and 5 firefighters.
*** Station/District 1 personnel cross staff Engine 1 and Ladder 1 depending upon the location and nature of the incident.**
**** The chief informed the study team that when staffing permits he has ben trying to ensure that Station/District 3 is staffed with 3 personnel rather than 2 since it is the busiest district for responses.**

As illustrated in Figure 2-2 above, each sub-station or district (Stations 2 and 3) is currently staffed with two (2) personnel, which is inadequate and can be downright dangerous for the personnel assigned. Although even the OSHA two in – two out rule permits an exception for life hazard or rescue situations; the reality is that in one of the most serious life hazard fire situations that can be encountered, trapped civilians, a firefighter may need to place themselves in extreme danger by entering the structure alone. The final National Institute for Occupational Safety and Health (NIOSH) report on the death of a Kansas firefighter more than 20 years ago cited a number of "preventable events" that contributed to the firefighter's death not the least of which was an inadequate number of personnel on the initial response and the lack of additional adequate safety procedures. Among other issues the report stated, *"A two firefighter engine is, at minimum, 50% under-staffed and increases the work effort of the two* *firefighters by a factor of 3".* Almost every NIOSH line-of-duty death report recommends that fire departments "provide adequate firefighter staffing to ensure safe operating conditions".

Research on the effects of various staffing levels consistently confirms that company efficiency and effectiveness decrease substantially and injuries increase when company staffing falls below four personnel. The *Multi-Phase Study on Firefighter Safety and the Deployment of Resources*, (Appendix B) completed by the National Institute of Standards and Technology (NIST) and Worcester Polytechnic Institute (WPI), evaluated the performance of fire department crews at residential fires, which is where the majority of fire injuries and fatalities occur. The study concluded that the size of firefighter crews has a substantial effect on a fire department's ability to protect lives and property in residential fires and occupancies. Several key findings of the study include:

- Four-person firefighting crews were able to complete twenty-two essential firefighting and rescue tasks in a typical residential structure thirty percent (30%) faster than two-person crews and twenty-five percent (25%) faster than three-person crews.

- The four-person crews were able to deliver water to a similar sized fire fifteen percent (15%) faster than the two-person crews and six percent (6%) faster than three-person crews, steps that help to reduce property damage and reduce danger/risks to firefighters.

- Four-person crews were able to complete critical search and rescue operations thirty percent (30%) faster than two-person crews and five percent (5%) faster than three-person crews.

All of these factors must be taken into consideration as Dracut reaches consensus on the acceptable community fire safety risk level, affordable levels of expenditure for fire protection, and appropriate levels of staffing.

When compared to other communities surveyed by MRI the Dracut Fire Department is staffed with fewer firefighters than all but the Milford Fire Department (figure 2-3). Both Dracut and Milford have a total of 40 sworn personnel. Based on population served Dracut has the least per capita firefighters with 1.9 firefighters per 1,000 residents (figure 2-4). The Tewksbury Fire Department had the largest number of sworn personnel with 55 and 2.62 per capita. It should, however, be noted that Tewksbury provides transport EMS services.

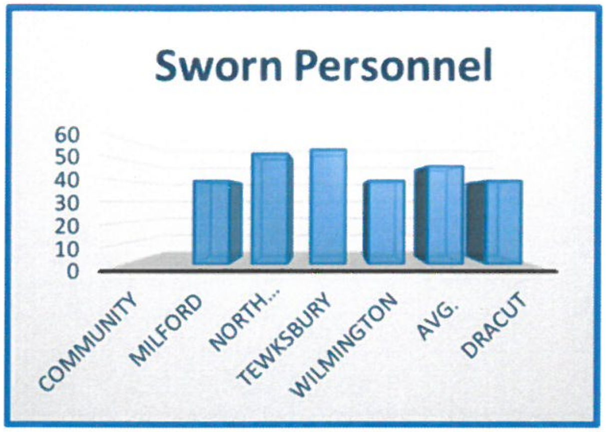


FIGURE 2.3 COMPARATIVE STAFFING

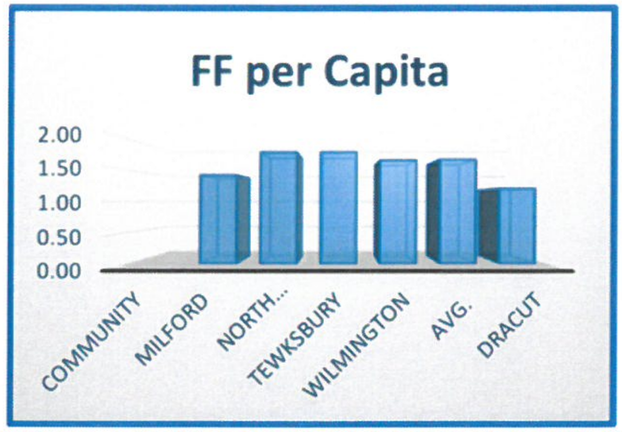


FIGURE 2.4 COMPARATIVE STAFFING PER CAPITA

The MRI study team has identified several serious concerns related to the current method of deploying personnel in the Dracut Fire Department.

First, and foremost, is the lack of adequate staffing at both Stations 2 and 3. Not only is the practice of staffing a station with just two personnel dangerous, it will significantly increase the amount of time it takes for personnel to perform even basic tasks like stretching a hose line. Even once a hose line has been stretched the crew will have very limited options on the tactics they can utilize, or the actions they can take until additional personnel arrive on the incident scene. Finally, the officer in these areas will be unable to perform some critical aspects of their job such as completing a full incident size-up since they must be the primary person to gert lines in position or begin to deploy other equipment.

The MRI study team believes that the performance…and safety…levels in both districts 2 and 3 (Station/Engine 2 and Station/Engine 3) could be dramatically improved if their staffing is increased to three (3) personnel.

Second, one firefighter on duty each day is unable to respond to emergency incidents by virtue of the fact that they are assigned as the department's dispatcher responsible for receiving emergency calls, dispatching units and personnel, and handling all of the department's communications needs. In a department where inadequate staffing of two stations is a major concern it does not make any sense to continue to utilize in house dispatching at the expense of the availability of a trained firefighter/EMT for emergency response activities. There are other dispatching options available that the town should explore that would free up this firefighter for emergency response at minimal, if any, additional cost to Dracut.

When the fire chief and/or a deputy chief are on duty, one or both of them will respond immediately with their respective command vehicles, if necessary, depending upon the nature of the incident. When they are on duty the chief officer serves as the incident commander and is responsible for the command, coordination and direction of all emergency scene operations including supervision of the captain and lieutenants. He/she is the one who looks at the entire incident "big picture" and insures that, for instance, ventilation operations are being coordinated with fire attack operations, and that accountability for all personnel is being tracked and maintained. Once the chief officer assumes command of the incident the captains and lieutenants are then able to focus on the completion of specific tasks that have been assigned to their respective companies, such as interior fire attack, rescue, ventilation and/or water supply.

When there is no chief officer on duty at night, the captain is the ranking officer on duty for initial response to all incidents. However, he does not move into the command vehicle, he remains the company officer on Engine 1, which is staffed with just 3 personnel. The captain then becomes responsible for overall incident command until the arrival of the fire chief or one of the deputy chiefs at a significant incident, which may or may not happen in a timely manner during their off-duty hours. This situation can also limit the tactical options available to the first arriving units.

The Dracut Fire Department continues to evaluate overall, as well as, daily on duty staffing within the context of the department's needs, and the established fiscal parameters. The fire department has recently applied for a *Staffing for Adequate Fire & Emergency Response (SAFER)* grant which provides funding to a community in order to assist in the costs associated with hiring and paying for personnel including training, equipment and a portion of their salary to maintain safe staffing levels in a fire department.

When considering ways to provide better staffing and personnel coverage, we would be remiss if we did not mention an alternative shift schedule that involves fire department personnel operating in a three (3) platoon system where the work week averages 56 hours per week. While there are numerous work schedule variations to this system, the most common shift, and simplest schedule, involves personnel working 24 hours, followed by 48 hours off duty. While not totally extinct, this work schedule has become very rare in the northeast and specifically in Massachusetts where virtually all fire departments operate with a four platoon, 24-hour work schedule. Outside of the northeast, however, the three (3) platoon system is widely used including in Los Angeles, Phoenix, San Antonio (three of our nation's 10 largest cities) and many of the large county fire departments in the northern Virginia suburbs of Washington, DC. Recently Baltimore, Maryland, a large urban fire department, and, more locally, Gloucester, Massachusetts, switched to three (3) platoon work schedules from their traditional four (4) platoon rotations. Both Baltimore and Gloucester made the switch for the purposes of maintaining (Baltimore) or increasing (Gloucester) on duty shift strength without the need for hiring additional personnel.

Recommendations

2.2-1 The Town of Dracut and Dracut Fire Department should proactively and aggressively explore other options for providing dispatch services to the department with the goal

of transitioning away from self dispatch at the earliest possible date. Eliminating in house dispatching will provide the town and fire department with an additional trained firefighter/EMT on each unit that will be available for emergency response at little, if any, additional cost to the town. More importantly it will assist with allieviating the unsafe practice of staffing fire apparatus with just two personnel caused by chronic staffing shortages.

2.2-2 The Dracut Fire Department, in consultation with the town administration should analyze the short and long term benefits, commitment, and, any potential liabilities for the town of applying for a Staffing for Adequate Fire and Emergency Response (SAFER) Grant. Being awarded a SAFER grant could have a significant positive impact on the fire department's chronic staffing shortage which will result in improved public safety. The key decision the town would need to make is if they could continue to afford the additional personnel after the grant funding ends in several years.

2.2-3 Contingent upon the town's conclusions regarding recommendation #2.2-2, above, the Town of Dracut should apply for a Staffing for Adequate Fire and Emergency Response (SAFER) grant for four to eight additional personnel. These personnel should be deployed to the District 2 and District 3 stations, permitting those engines to be staffed with three (3) personnel each and get the department closer to being able to achieve compliance with NFPA 1710.

2.2-4 Regardless of the method utilized to fund the necessary positions, the Town of Dracut should take steps to ensure that all three district stations and their engines are staffed with a mimimum of three (3) personnel 24/7. This is not only an important operational consideration, it is also a major safety concern that could impact both firefighters and citizens. Minimum on duty staffing should be nine (9) personnel, three (3) at each station.

2.2-5 In order to assure that the important position of overall incident commander is filled, and that there is mission critical command continuity and consistency on the emergency scene, at least one of the Dracut's chief officers should respond automatically…and immediately… to any reported structure fire or other incident that could become significant during nights, and, at any other time there is no chief officer working.

2.2-6 All Chief officers should be issued staff vehicles and participate in an on-call rotation to ensure that a Chief officer is available to respond to any significant incident during off duty hours.

2.3 POLICIES AND PROCEDURES

Overview

The use of rules and regulations, operational procedures, and various other forms of written communications are vital parts of a fire department's overall operations. Rules and regulations establish expected levels of conduct and general obligations of department members, identify prohibited activities, and provide for the good order and discipline necessary for the credible operation of a quasi-military emergency services organization. Operational procedures ensure the consistent, effective, efficient, and safe operation of various aspects of the department's operations, both emergency and routine. One of many common denominators among the best fire departments across the United States is that they have a comprehensive and up-to-date operational procedural manual and their personnel are well versed and well trained in those procedures. The inclusion of written documents such as training and safety bulletins serves to make the system more effective.

Fire department rules, regulations, and policies should work in tandem with and be consistent with the overarching ordinances, rules, regulations, and policies that have been adopted by the Town of Dracut. For example, policies concerning such topics as non-discrimination, sexual harassment, purchasing, freedom of information, Internet and computer usage (including social media), and smoking (on town premises or in municipal vehicles) are typically applied across-the-board to all departments and employees. While the town should provide training and familiarization concerning these policies on a regular basis (an annual review is usually adequate, with appropriate documentation), employees are obligated to be familiar with and comply with each policy.

The MRI study team evaluated the Dracut Fire Department's current written policy and procedures system and found it limited in scope, content, and timeliness. There are significant inconsistencies in the current system, and, an absence of important procedures.

Observations

The Dracut Fire Department does have a stand-alone Rules and Regulations document that is fairly comprehensive in scope. However, this document was first developed in April 1970 (46 years ago) and last revised in June 1999, nearly 17 years ago. Reading through it, it is obvious that at least portions of the document have not remained current as the department's operations have evolved over the intervening years. In addition, many of the sections and provisions found in the document would be better suited to be included in Standard Operating Procedures/Guidelines (SOPs/SOGs).

The chief did inform the MRI study team that he had recently put together a committee to update the rules and regulations. The committee is comprised of a deputy chief, two lieutenants, and two or three firefighters. He stated that among other things that he was looking for a good social media policy, along with a good policy on the use of electronic devices while working. This committee should be encouraged to continue their work on the development of an updated rules and regulations document with a target of having it completed by the end of 2016.

Effective communications systems are key to successful operation of any emergency services organization. SOPs/SOGs and other orders are mission critical to consistent, effective, and safe operations. Without them there is a tendency to "freelance" and personnel may not all be on the "same page" regarding a wide range of emergency and administrative operations.

The department has very few standard operating procedures/guidelines (SOPs/SOGs) and in fact refers to them as policies which is a term often reserved for formal documents that have been adopted at the town rather than the department level. Using the terms policy and procedure interchangeably in various documents can ultimately cause confusion regarding the relative importance of the various types of documents. The study team was provided with, and reviewed, a limited number of operational/administrative "policies" that the chief acknowledged are the extent of the current system. Some of the documents had hand written notes on them.

Working on the assumption that these documents comprise the extent of the department's current written communications system, the system as it exists is seriously deficient for providing the wide ranging guidance and direction necessary for operations involving a 21st century fire and EMS provider. The lack of an effective system of standard operating procedures/guidelines (SOPs/SOGs) will have an adverse impact on many different facets of the day-to-day operations of the department that can result in a lack of consistency during operations, freelancing, unsafe actions, loss of accountability and discipline, poor performance of individuals and operational crews, and increased risk to firefighters and citizens.

There are no operational procedures/guidelines in place to deal with mission critical operations such as *Structure Fires*, *Basic Engine Company and/or Truck Company Operations*, *Vehicle Extrication Operations*, or, *Thermal Imaging Camera* and *Automatic External Defibrillator Use* to name just a few. These are the types of operational procedures/guidelines that are most important and provide standardization and consistency of operations. On the administrative side, MRI was provided with few policies, or procedures that might cover topics such as personal grooming, meal and rest periods, unit coverage procedures when vacancies occur, incident reports, etc.

The MRI study team believes that the Dracut Fire Department should continue to utilize a separate rules and regulations document that identifies and establishes expected levels of conducted and prohibited actions for all members of the department. In addition, it must be ensured that the town's personnel and other policies that are applicable to members of the fire department, such as non-discrimination, sexual harassment, purchasing, freedom of information, Internet and computer usage (including social media), and smoking (on town premises or in municipal vehicles), are fully integrated into the fire department's written communications system and are available to all members of the department since they are unequivocally applicable to them. The relative importance and relationship to each of the various types of documents should be clearly delineated in the rules and regulations.

Department level communications should be referred to as standard operating procedures (SOPs) or standard operating guidelines (SOGs). General Orders should be used for the issuance of immediate and/or specific directives.

Fire department personnel can provide a valuable technical resource in the development of SOPs and SOGs. For the most part, the development and drafting of these documents should not be a top-down management driven process. The personnel who are going to be required to adhere to and follow the procedures should have input into their development. Input from personnel at all levels will strengthen the quality and effectiveness of SOPs and SOGs. In addition, the department training officer should play a critical role in the development and implementation of any SOPs and SOGs. We encourage fire departments to draw upon the policies, practices, and procedures of other organizations, both local and distant. The experiences and lessons learned from other fire departments can be extremely helpful in the development of SOPs and SOGs. No fire department should be expected to write a policy document from scratch or without a template.

The study team was informed that the department does have working group that is tasked with updating and developing new SOPs/SOGs, however, they do not necessarily meet regularly. The chief informed the team that SOGs are reviewed at each officer's meeting. The SOGs are color coded with white being administrative, yellow operations and red safety. <u>This is a commendable effort which MRI considers a ***best practice***.</u>

Some personnel informed the MRI personnel that this "group" was only put together after the study RFP was issued. Regardless of when this group was established, or how frequently they have met in the past, the development of a comprehensive SOP/SOG manual should be a top priority of the Dracut Fire Department.

Discipline is another important area that lacks a formal policy/procedure/process in the Dracut Fire Department. Discipline is most effective when the least amount of corrective force is applied in a timely and consistent manner. Interviews conducted during this study revealed that discipline is not consistently applied, and, the lack of a formal policy or process perpetuates this issue. The purpose of discipline is bringing about positive change with the least impact on the employee. It should not be punitive but rather constructively address performance, conduct, or attendance problems. A good discipline policy offers supervisors a guide to be fair and consistent.

During our field visits, our review of pertinent documentation provided by the department, and, in interviews with the department's internal stakeholders, we learned that the Dracut Fire Department does not have either a formal respiratory protection plan or a blood borne pathogens/exposure control plan. Both of these plans are critical to the safety of employees, to the department's overall risk management program, and, are required by OSHA regulations.

Recommendations

2.3-1 The Dracut Fire Department should give priority support to the committee that is developing an updated comprehensive rules and regulations document that identifies anticipated, acceptable/permitted, and prohibited behaviors. This document should be approved by the Board of Selectmen and then distributed to and signed for by each member of the department. It will also provide important guidance to new employees.

Some suggested sections for the rules and regulations could include, but are by no means limited to:

- **A preamble**
- **Department vision statement and mission statement**
- **Purpose of the rules and regulations**
- **Organization**
- **Membership requirements**
- **General rules of conduct and prohibited behaviors**
- **Officer qualifications and selection (may just reference current department procedure, CBA language and/or civil service language)**
- **Officer duties and responsibilities**
- **Chain of command**
- **Uniforms and grooming**
- **Discipline**
- **Other areas that may be agreed upon for inclusion**

2.3-2 The Dracut Fire Department should make the activities of the SOP/SOG working group a high priority. Utilizing a cross section of department members, they should be tasked with the development of a comprehensive department standard operations procedures or guidelines (SOP/SOG) manual starting with mission critical procedures such as, but not limited to, *basic engine company and truck company operations, dwelling fires, commercial structures, industrial incidents, rapid intervention team operations, personnel accountability, gas leaks, hazardous materials incidents, ice rescue, vehicle extrication operations, thermal imaging camera and automatic external defibrillator use, and mass-casualty incidents.* The addition of numerous

other procedures covering additional operational, routine administrative and training procedures should then follow.

The committee should be comprised of members of each rank and include specific representation by a senior officer of the union. Due to the urgency of this task, and its significant importance to the department's future success, the committee should be given whatever support is necessary to complete this task within one year. If necessary, outside professional assistance is available to assist with facilitating this endeavor.

The general set up and organization of the manual is a very important consideration and the department must insure that the manual/system is easy to utilize and cross reference the necessary procedure. If personnel are going to be required to learn and adhere to the department's procedures, then the format, organization, and filing of them must be user friendly, otherwise they will sit on a shelf unused.

The first operational procedure should identify and explain the components of the Written Communications System, including the use and organization of the SOP manual and other components of the system such as standardized forms. This procedure should also contain a provision that the entire SOP Manual will be reviewed on at least an annual basis and that updates and revisions can/will be made at any time, as necessary. All procedures/revisions should be approved and issued after being signed by the fire chief.

2.3-3 The Dracut Fire Department should adopt a standardized SOP/SOG form that includes the following information:

- **Title of the SOP/SOG**
- **Number of the SOP/SOG**
- **Category of the SOP/SOG (EMS Operations, Training, Administration, etc.)**
- **Page number and total number of pages**
- **Effective date**
- **Revision date (if applicable)**
- **Approval/signature of the fire chief**

If a procedure is re-issued with only minor to moderate revisions it can carry the original issue date with the revision date also noted. Revisions from the previous version should be identified by some means within the revised document. Full-scale revisions to a procedure should result in it being reissued with a new issue date.

Each SOP/SOG should, at a minimum, contain the following sections:

- **Purpose**
- **Scope (If necessary and/or appropriate)**
- **Definitions of terms (If necessary and/or appropriate)**
- **Procedure(s)/Main body**
- **References (If necessary and/or appropriate)**

2.3-4 Working in close consultation with the town's legal and personnel departments the Dracut Fire Department should ensure that all of their operational procedures meet, and are consistent with, applicable federal and state laws and regulations, and town ordinances and policy. This would include such topics as handling Freedom of Information requests, and human resources related issues such as Family Medical Leave Act, Pregnancy, Sexual Harassment, Equal Employment Opportunity (EEO), Diversity, Privacy, and Health Insurance Portability and Accountability Act (HIPAA).

2.3-5 The Dracut Fire Department should institute a process for issuing general orders, which are directives and/or special instructions that cover various facets of department operations, but can be quickly issued as needed. They may cover a particular period of time regarding a special situation or may provide a temporary procedure pending development and issue of a full operational procedure.

Also included in the system should be training bulletins that would be issued to serve as reference with regard to tested and approved methods of performing tasks; safety bulletins, that are issued to serve as references with regard to general and specific safety and health issues; and informational bulletins or memorandums that are published for the general knowledge of recipients such as temporary street closures, hydrants out of service, community events, etc. A numbering system should be implemented to keep track of these documents for indexing and future reference purposes.

2.3-6 The Dracut Fire Department should develop an effective system for ensuring that any new standard operating procedures, general orders, training bulletins, safety bulletins, and informational bulletins are distributed to all personnel and stations. Electronic communications are highly recommended as the method of choice for distributing departmental communications and documents. All town policies and department procedures should be posted on the department intranet and employees should be required to review this information. All revisions should be e-mailed to each member and then posted on the intranet.

2.3-7 Since town policies and personnel regulations apply to all town employees, this material should be made available in each station (or on line), and policy training should be conducted on a regular basis as a component of each training session (review 1-2 policies or SOPs) for all personnel.

2.3-8 The Dracut Fire Department should develop and implement a procedure that provides for the documented review of policies, procedures, general orders, training and/or safety bulletins, etc. that includes a provision requiring each member of the department to sign that they received the document, have read it, and understand it.

2.3-9 At least one policy or SOP/SOG should be reviewed by the company officer with each crew during every shift. The shift commander should select the material to be reviewed and provide that material to his/her first line supervisors so that all crews review a consistent set of documents.

2.3-10 The Town of Dracut should form a committee that includes representatives of town and fire department management, the bargaining agent, and town human resources develop an internal disciplinary policy that is consistent with the town's preexisting progressive disciplinary process. Appropriate training, and more importantly a strong level of support, should be provided to all supervisory and management personnel with regards to the new disciplinary policy and its processes.

2.3-11 The Dracut Fire Department should immediately develop a comprehensive respiratory protection plan in accordance with 29 CFR 1910.134, and a blood borne pathogens/exposure control plan in accordance with 29 CFR 1910.1030. Appropriate SOPs that implement various components of these plans should also be developed as part of the ongoing process to update that manual. Annual training as required should be provided to all personnel.

2.4 TRAINING

Overview

The primary function of a fire department is to respond to emergency incidents, save lives and to protect property and the environment. A department that is not well trained, prepared, and operationally ready is unable to effectively, efficiently, correctly, and safely fulfill its emergency response obligations and mission. A comprehensive, diverse, and on-going training program is absolutely critical to the fire department's level of success.

An effective fire department training program must include all of the essential elements of a fire department's specific core missions and responsibilities. The program must include an appropriate combination of technical classroom training and manipulative or hands-on/practical evolutions. Most of the training, but in particular, the hands-on training evolutions, should be developed based upon accepted best practices and up to date standard operating guidelines (SOGs), standard operating procedures (SOPs), and adapted to the operational environment. They should also be consistent with nationally recognized standards that could be used as a benchmark to evaluate the department's operations.

The U.S. Occupational Safety and Health Administration (OSHA) has established requirements for minimum training that must be completed on an annual basis, covering various topics including:

- A review of the respiratory protection standard, self-contained breathing apparatus (SCBA) refresher and user competency training, SCBA fit testing (29 CFR 1910.134)
- Blood borne Pathogens Training (29 CFR 1910.1030)
- Hazardous Materials Training (29 CFR 1910.120)
- Confined Space Training (29 CFR 1910.146)
- Structural Firefighting Training (29 CFR 1910.156)

Although local government employees in Massachusetts are exempt from compliance with US OSHA regulations, it is the policy of the Massachusetts Division of Occupational Safety that public-sector employees follow the OSHA standards as a minimum in the absence of specific standards.

National Fire Protection Association (NFPA) standards contain recommendations for training on various topics such as a requirement for a minimum of 24 hours of structural firefighting training annually for each fire department member.

Firefighters have a thirst for knowledge, will be more confident and will perform in a safer manner if they are well trained. When training is increased, injuries decrease. As with all other fire department operations, there must be consistency in how the training is being conducted.

Observations

The MRI study team evaluated the Dracut Fire Department's training and professional development programs. Through staff interviews, observation, and an evaluation of the current training program, the team reached the conclusion that department's training program is a priority for the organization's leadership and appears to be fairly comprehensive and realistic, at least at the basic level. Overall, we found that it was more organized, developed, consistent, effective, and, given a higher level of importance than in many other departments that we have evaluated.

One of the department's two deputy fire chiefs serves as the department's training officer, in addition to his operational command duties. Although perhaps not the optimal arrangement since the chief needs to split his time between training and other responsibilities the system does seem to be working well in Dracut and significant time is devoted to managing the training program.

Each unit (platoon) in the department is supposed to train for two to three hours each duty day that falls on Monday through Friday. Weekends and holidays are exempt from training. The deputy chief prepares a monthly training schedule with assigned training topics, officer(s) responsible for delivering it, and the location. He then distributes a calendar with the training for the month listed (figure 2-5). Some of the monthly training is completed by the captains and lieutenants for their respective units while the deputy chief will deliver other topics personally to assure continuity of delivery. The current training focus is on basic firefighter skills and rapid intervention team (RIT) training.

FIGURE 2-5
SAMPLE MONTHLY TRAINING SCHEDULE

February 2016
Training Schedule

Sun	Mon	Tue	Wed	Thu	Fri	Sat
	1 U3 **RIT Powerpoint** Station 1 Classroom Deputy Mackey	2 U1 **RIT Powerpoint** Station 1 Classroom Deputy Mackey **SCBA In-Service** Station 1 Classroom FTS	3 U4 **RIT Powerpoint** Station 1 Classroom Deputy Mackey **SCBA In-Service** Station 1 Classroom FTS	4 U3 **SCBA Harness Conversion** Stations 1, 2, 3 Cpt, Lt2, Lt3	5 U2 **SCBA In-Service** Station 1 Classroom FTS	6 U4
7 U1	8 U2 **EMS** Station 1 Classroom Carolyn Parmenter	9 U3 **EMS** Station 1 Classroom Carolyn Parmenter	10 U1 **EMS** Station 1 Classroom Carolyn Parmenter	11 U4 **EMS** Station 1 Classroom Carolyn Parmenter	12 U3 **SCBA In-Service** Station 1 Classroom FTS	13 U2
14 U4	15 U1	16 U2 **SCBA Don/Doff** Station 1 Truck Bay Captain	17 U3 **SCBA Don/Doff** Station 1 Truck Bay Captain	18 U1 **Air Management** Station 1 Classroom MFA **SCBA Don/Doff** Station 1 Truck Bay Captain	19 U4 **SCBA Don/Doff** Station 1 Truck Bay Captain	20 U3
21 U2	22 U4 **EMD Protocol Review** Station 1 Classroom Stephen L'Hereaux **Mask Confidence Crse** Station 1 Truck Bay Captain	23 U1 **Mask Confidence Crse** Station 1 Truck Bay Captain	24 U2 **Mask Confidence Crse** Station 1 Truck Bay Captain	25 U3 **Mask Confidence Crse** Station 1 Truck Bay Captain	26 U1 **Ropes & Knots** Stations 1, 2, 3 Capt, Lt2, Lt3	27 U4
28 U3	29 U2 **Ropes & Knots** Stations 1, 2, 3 Capt, Lt2, Lt3	**Notes:**				

While on site for one of our field visits in late February 2016, the MRI study team had the opportunity to observe one of the department's training sessions (figures 2-6 thru 2-8). This training was the "mask confidence course" that was being utilized as part of the training and familiarization program for the new MSA self-contained breathing apparatus (SCBA) the department had recently obtained. The training appeared to be well thought out and was definitely challenging for the personnel who were participating. This type of training would also satisfy the annual OSHA training requirements under the respiratory protection standard.

Figure 2-6: (left) SCBA mask confidence course set up on the apparatus floor at Fire Station 1.

Figure 2-7: (right) A Dracut Fire Department Lieutenant simulates giving air to a trapped firefighter while traversing the mask confidence course while wearing an obscured vision face mask.

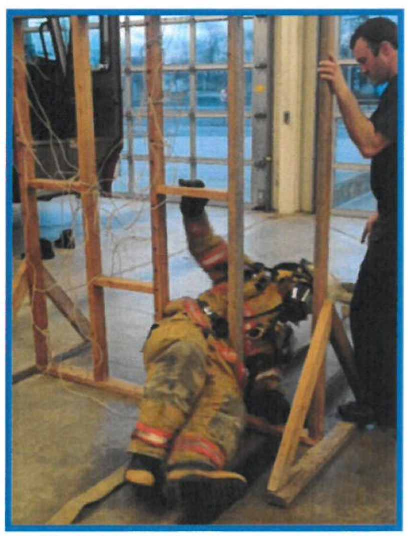


Figure 2-8: The lieutenant negotiates a diminished clearance obstacle that includes an entanglement hazard.

The department currently has a training manual that contains more than 100 lesson plans that have been developed for various topics and evolutions. They also utilize hands on training evolutions developed by the Fire Department Training Network (FDTN). All training is supposed to be conducted utilizing a lesson plan. The chief reported that compliance with this procedure is generally very good.

All personnel in the department are certified to the Firefighter I and II levels while they complete their basic fire academy training. All personnel are also certified to the hazardous materials awareness level and some are certified to the operations level. Some personnel have also received training and certification in various technical rescue disciplines.

Certification as an emergency medical technician (EMT) is not required. However, personnel who are certified receive a stipend so about 98% of the department maintain their certifications. All personnel receive CPR training. Patriot ambulance provides monthly EMS continuing education training to the department on various topics that complies with national standards. The records that were reviewed confirmed that EMS continuing education and refresher training is performed in accordance with state regulations.

Since the fire department receives emergency calls and does its own in-house dispatching, all personnel (including the administrative assistant) are trained as emergency medical dispatchers (EMD). The initial training was provided by the EMD vendor and was funded by the state. Continuing education training totaling 16 hours is required annually of each person. These training requirements are broken into four, 4 hour blocks which can be taken either in a traditional classroom, or online.

There is no periodic off duty training where an entire unit would go to a fire academy and do high intensity and/or live fire training. Money seems to be the limiting factor. The department has been utilizing the old town hall annex for practical training evolutions. This sometimes includes full scenario drills where personnel must utilize a variety of skills and evolutions like they would on an emergency incident. The problem with this situation is that the training can be interrupted at any time for an emergency response.

All training is documented in the Fire Programs database. Information that is supposed to be included is the topic(s) covered, number and names of attendees, and the amount of time that was spent on the training. The completion of this report also prepares a list that can be sorted by date, topic, or attendee. The MRI team was provided with a report that showed a total of 216 different training session conducted in 2015. Overall the training program is far above average and is an example that could be implemented in other communities.

Some of the personnel that the MRI study team interviewed complained that there was too much training. They informed the team that they have to train every day they work, sometimes twice in the same day with an EMS session in the morning and regular fire training in the afternoon and that it “can be too much”. The MRI team noticed only an occasional day when there was more than one training session scheduled and when this occurred at least one of the drills was usually more of a classroom session, certainly not something high impact that would physically tire personnel. We believe that within reason there is no such thing as “too much training” and that complaints of this nature are usually unfounded.

Professional development for fire department personnel, especially officers, is also an important part of overall training. The MRI Team determined there was no formal professional development program. Of the department's officers only the training deputy chief is known to possess Fire Instructor I, and Fire Officer I certifications. Supervisors are not required to hold fire officer certifications, and there is no system for professional development in anticipation of, or after, promotion. The team was informed that several of the department's younger officers are taking the fire instructor class on their own as a prelude to seeking fire officer certification.

The department has traditionally not encouraged or supported outside training endeavors by its personnel. There are numerous excellent opportunities for firefighters and officers to attend training and educational programs on a wide range of topics outside of Dracut, including the National Fire Academy in Emmitsburg, Maryland, the Massachusetts Firefighting Academy, Fire Department Instructors Conference (FDIC) in Indianapolis, Firehouse Expo in Baltimore, and local community colleges. For the most part these opportunities seem to have been ignored. Despite the fact that several of the officers possess the requisite bachelor's degree, none of the officers are enrolled in the Executive Fire Officer Program at the National Fire Academy.

Numerous, free on-line courses and training programs are also available. Beyond the practical benefits to be gained from personnel participating in outside training, encouraging, or if possible, requiring, personnel to earn and/or maintain specialized certifications such as fire instructor, or fire officer, increases the positive professional perception of the organization and can help to demonstrate a commitment to continued excellence. However, the study team was informed that personnel are not sent to the National Fire Academy or other training opportunities (even though some would like to attend) primarily due to limited funding.

The department's training resources for use by members appears to be very limited and most of them appear to be older material that may contain outdated or obsolete information. The department only subscribes to the FDTN videos and training materials and Fire Engineering.

There are a number of ways to evaluate the effectiveness of the fire department's training program. One increasingly common way is through the use of annual skills proficiency evaluations where all members of the department are required to successfully perform certain skills and/or complete standardized evolutions, either individually, or as part of a team. Post course evaluations, post incident critiques, and evaluation of incident operations and statistics can also provide important feedback regarding the training program. It is important that all training, no matter how minor or inconsequential, continue to be documented. Failure to do so may expose the department and town to significant risk and can jeopardize the town's ISO rating.

Recommendations

2.4-1 Although it already has a good training program, the Dracut Fire Department should conduct a comprehensive and formal training needs assessment for the purpose of determining training program priorities. Part of this needs assessment should be a formal, initial evaluation of the current basic skills proficiency of all department personnel.

2.4-2 In order to provide ongoing evaluation of the effectiveness of the training program, all Dracut Fire Department personnel should also be required to successfully complete an annual basic skills proficiency evaluation.

2.4-3 Additional, mandatory, high intensity training on various subjects, including periodic live fire training, should be conducted on a quarterly (preferred), or semi-annual (minimum) basis for all personnel, off-duty, at a formal fire academy where appropriate training facilities, structures, and props are available.

2.4-4 All officers should be formally certified at Fire Instructor Level I, and all captains and chief officers should be certified as Fire Instructor Level II. These certifications should be made a job requirement. Fire Instructor I is a 36-hour course and Fire Instructor II is a 35-hour course. Both courses are offered at the Massachusetts Firefighting Academy in Stow. The National Fire Academy also offers an in-residence course entitled "Training Program Management". This 10-day course is designed to provide training officers with the essential tools and skills to lead and manage a training function in a local fire/EMS organization.

2.4-5 The department should require its officers to complete rank appropriate fire officer training programs at the Massachusetts State Fire Academy and obtain a certain level of fire officer certification as a job requirement. Recommendations would be: Fire Officer I for lieutenant; Fire Officer II for captain; Fire Officer III for deputy fire chief; and Fire Officer IV for fire chief.

2.4-6 The Dracut Fire Department should implement a formal officer training and development program. There are several excellent programs available, including those from the International Association of Fire Chiefs and the Phoenix, Arizona, Fire Department. This program can also include bringing well-known fire service experts and instructors to Dracut to provide training for the officers and firefighters who may aspire to be officers.

2.4-7 The fire chief and future chief officers should be required to complete additional chief officer training program and obtain appropriate additional certifications such as Fire Officer III and Fire Officer IV, Massachusetts Fire Chief Management Training Program, and the Massachusetts Fire Chief Credentialing Program and/or the Chief Fire Officer designation.

2.4-8 The Dracut Fire Department should make a concerted effort to send as many officers as possible to the National Fire Academy. Any officers who meet the admissions criteria should be encouraged to enroll in the Academy's Executive Fire Officer Program. Training reports should be completed for any NFA training and copies of certificates placed in the personnel and training files.

2.4-9 The Dracut Fire Department should encourage personnel to seek additional training on their own, and to the financial and practical extent possible, send personnel to outside training opportunities such as the Firehouse Expo in Baltimore and the FDIC in Indianapolis. Information gained at this training can then be brought back and delivered to other members of the department. Training reports should be completed for all of this training, and copies of any certificates earned should be placed in the member's personnel and training files.

2.4-10 A training bulletin board should be placed in each station where upcoming training opportunities can be posted for all personnel to review. Training notices can also be sent electronically to all personnel and be posted in a member's only area of the department's web site.

2.4-11 The Dracut Fire Department should include in their training budget upgrades to their training resources such as manuals, DVDs, and subscriptions to other available training resources, including Internet/web based programs.

2.4-12 The Town of Dracut should provide the fire department with a reasonable annual training budget including training and travel expenses for department personnel, the utilization of outside training sources, the purchase and maintenance of training resources and props.

2.4-13 The Dracut Fire Department should fully utilize the internet and all of the various training resources available on line.

2.4-14 In addition to the training already being conducted, additional daily opportunities for training can be found during related activities such as daily/weekly apparatus and equipment inspections, building pre-planning activities, and short duration (10-15 minute) shift change and/or coffee break drills.

2.4-15 Since operational level personnel can take defensive actions at hazardous materials incidents (such as diking spilled materials, spreading absorbent, or vapor control), all Dracut Fire Department personnel should be trained to the hazardous materials operational level (24-hour program).

2.5 FIRE PREVENTION

Overview

The core service that a fire department provides to the public it serves begins with fire prevention. Fire prevention activities are one of the most important missions of a modern-day fire department. A comprehensive municipal fire protection system should include, at a minimum, the key functions of fire prevention, code enforcement, inspections, and public education. Preventing fires before they occur, and limiting the impact of those that do, should be priority objectives of every fire department. Educating the public about fire safety and teaching them appropriate behaviors on how to react should they be confronted with a fire is also an important life safety responsibility of the fire department.

Fire prevention activities in a municipal fire department typically include fire safety inspections; fire code enforcement; issuance and oversight of permits; review of construction plans for new buildings and the renovation of existing buildings; and public fire safety education programs. Since fire prevention should be approached in a systematic manner, and because the city has other departments that have a vested interest and/or responsibility in these efforts, various activities such as plan reviews, permits, and inspections should be coordinated with similar activities in the municipal building inspection department and the planning department.

Inspection and code enforcement procedures and policies must conform to Commonwealth of Massachusetts statutory requirements and the regulations and the policies of the Massachusetts Department of Fire Services, Office of the State Fire Marshal. The local fire chief or designee is authorized to enforce 527 CMR, Board of Fire Prevention Regulations, also known as the Massachusetts Comprehensive Fire Safety Code.

This division within a fire department must be led by a person who is not only knowledgeable in fire codes and standards; they must also have the ability to work with the public, contractors, and other government officials. The fire prevention officer must work closely with field suppression forces to ensure a smooth flow of information between the fire companies and the fire prevention division.

Fire prevention is a key responsibility of, and efforts should involve all members of, the department. For example, on duty personnel can be assigned with the responsibility for "in-service" inspections to identify and mitigate fire hazards in buildings and to familiarize firefighters with the layout of buildings, identify risks that may be encountered during firefighting operations, and to develop pre-fire plans. In many departments, these personnel are also assigned responsibility for permit inspections and public fire safety education activities. Fire companies are often in a position to recognize hazards or violations, whereas inspectors are often in a position to identify features of a specific property that could prove important during an emergency. Effective information sharing enhances the ability of the fire department to protect the community.

The fire prevention program must be organized in a manner that most effectively supports the goals of the community and department. Establishing the goals and objectives to be accomplished should be the first priority of a fire prevention program. It is imperative that the organization establish clear, specific goals and objectives they wish to achieve. The overarching goals should be included in the core values and vision statements of the organization and must be understood by all fire department personnel.

Observations

Fire prevention activities in the Dracut Fire Department are primarily coordinated through deputy chief Patterson who performs these duties in addition to his operational responsibilities. Although the deputy says fire prevention is basically a one-person operation, he does get assistance from the chief, the other deputy chief, the captains, and even the line personnel.

Dracut is primarily a residential community so it does not have a large number of commercial or industrial properties. It has no high life hazard occupancies such as nursing homes and the town's first assisted living facility is currently under construction. There are about 14-day care centers and more than 30 liquor license establishments that must be inspected on an annual basis. The latter inspections are performed in conjunction with the town building inspector. Massachusetts recently issued new fire safety regulations with regard to the hood systems over cooking operations in commercial and other occupancies. The town has 18 restaurants that must now be inspected annually that were previously inspected only by the health department. These inspections will also be jointly inspected for cross code compliance by both the fire and building departments.

The two deputy chiefs handle the majority of 26F smoke and carbon monoxide detector inspections for resale of one and two family dwellings. They also collaborate on required inspections of oil burners, oil storage tanks, and propane storage tanks.

Fire Prevention conducts plans reviews and inspections in concurrence with the building department for new constructions and renovations. The deputy chief normally performs plans review for commercial occupancies while the deputy and the chief split responsibility for residential projects. Inspections of these projects are usually handled by one of the chiefs but the captains will assist at times with residential occupancies. All violations are issued by the deputy chief. However, he reported that he usually is able to gain compliance through a warning letter and rarely needs to resort to fines or penalties.

The department does witness the initial tests required for new fire alarm and fire suppression systems. They also will witness reacceptance test after major repairs or other issues. They do not witness annual testing of systems. System test records are submitted electronically to the department for filing.

There are only about 30 large industrial or heavy commercial occupancies in town. The in service companies assist with the performance of these inspections and have developed very basic pre-fire/incident plans for them including floor plans and compiling a list of hazards. The purpose of a fire pre-planning program is to develop a fire response plan for buildings in the town. A pre-fire plan includes data such as the occupancy type, floor plans, construction type, hazards to firefighting, special conditions in the building, apparatus placement plan, water supply plan, and forcible entry and ventilation plan. Pre-fire plans should be reviewed regularly and tested by tabletop exercises and on-site drills. The department does not have mobile data terminals or tablets on their apparatus so these limited pre-plans are kept in three ring binders.

FIGURE 2-9
DRACUT FIRE DEPARTMENT INSPECTIONS 2012 – 2015

	2012	2013	2014	2015
Inspections Conducted	975	1,042	1,015	1,018
Certificate of Compliance	306	323	223	283
Permits Issued	229	198	150	150

Permits can include such things as smoke detectors and oil burners.

The deputy chief possesses a Fire Inspector Level II certification from the National Board on Fire Services Professional Qualifications (NBFSPQ/Pro Board). The chief, both deputy chiefs, and all of the captains possess Massachusetts certification at the Fire Inspector I level.

In January of 2015 the commonwealth switched many of its fire code regulations from the previously used Code of Massachusetts Regulations (CMR) to National Fire Protection Association (NFPA) 1: *Fire Code* which was adopted with amendments. It is now known as CMR 1. One of the provisions of this code is that is has eliminated some of the split responsibilities that previously existed between the building and fire departments that sometimes allowed issues to split through the cracks. The new code, while still delineating various responsibilities, dictates that all plans review and permitting is submitted to, and starts with, the building department.

Deputy Chief Patterson reported that he has a very good working relationship with both the town building department and the town health department. There are still a lot of code provisions that involve overlapping responsibilities and inspections and the three entities do well coordinating them with each other.

While the program does seem to be working fairly well as currently configured, there are some areas where there could be improvement. First, although the deputy chief was able to provide the study team with information on the number of inspections that are performed annually he could not provide a definitive answer on the number of business/commercial occupancies that are located within the town. He also could not provide the number of plans reviews that the department conducts annually. These are important statistics (and in the latter case "tasks") that could be utilized to show the productivity of the fire prevention function as well as justify necessary improvements to system in the future.

The town of Dracut as a whole is behind on utilizing the town's website for the submissions of permit and inspection applications, payment of fees, etc. In early April the town went live with the capability for electronic submission of plans and related applications. Approvals of these can now also be completed electronically.

The department has a fee schedule for permits, licenses and inspections. The authority for the issuance of permits and licenses is pursuant to Massachusetts General Law Chapter 148, or, 527 CMR. The authority to charge fees is derived from MGL Chapter 148, section 10A. With the last amendment to the fee schedule in 2012, for the most part, the town charges the maximum amount permitted by statute. The fire department's website contains the schedule for the various types of inspections which range from $25.00 ($15.00 for some re-inspections) up to $500.00 for larger residential occupancies which require multiple units to be inspected for smoke and carbon monoxide detectors. There is also a check sheet that homeowners can utilize to prepare for the required inspections. Although we were informed that the required permit and inspection applications are on line and available for download they were not able to be located by the study team. The permits and applications cannot be submitted or processed electronically.

All of the department's fire prevention records are maintained manually at the present time. This includes all files (the department has a file for every address in town), permits, applications, inspection reports, and any other correspondence or information regarding the location.

The Dracut Fire Department places emphasis on conducting public fire education activities. This effort is very commendable and results in time and resources well spent. Nearly 75% of all fires, fire deaths and injuries occur in the home, an area where code enforcement and inspection programs have little to no jurisdiction. Public education is the area where the fire service will make the greatest impact on preventing fires and subsequently reducing the accompanying loss of life, injuries and property damage through adjusting people's attitudes and behaviors with regard to fires and fire safety.

Dracut does have an active public fire education program which is an important component of an overall fire prevention program, particularly in a community that is primarily residential in nature. The department is an active participant in the grant funded Student Awareness of Fire Education (SAFE) program sponsored by the Massachusetts State Fire Marshal's Office and has been since its inception. This program is presented by firefighters who have been trained by the state. There are currently about 10 department personnel (25%) who are trained. At the time of this evaluation Dracut's program was targeted to all students from pre-school through the sixth grade. Day care centers and pre-schools are targeted for programs in the fall while the elementary schools from first through sixth grade receive programs in the spring. The elementary school programs are conducted by personnel on overtime. The department also participates in the town's annual Old Home Day which is a large community event. Utilizing Massachusetts Fire District 6's fire safety trailer between 500 and 600 students are provided with fire safety training.

The department does some minimal fire safety training for the elderly which is normally done by the two deputy chiefs. The department received an Elderly SAFE grant which allowed for the purchase of smoke detectors and 100 bed shakers which physically shake the bed of the resident to wake them up is the fire alarm sounds. The department also works with the Council on Aging to do various programs for the town's senior citizens.

The fire department does have some fire safety information on its website. This includes candle safety, general, winter and dryer fire safety tips, home escape plans, and maintaining smoke and carbon monoxide detectors in proper working order. The department's website has been linked to the township's. The fire department also has both Facebook and Twitter accounts that they post fire safety messages on.

Routine cause and origin fire investigations in Dracut are primarily conducted by either the chief or the on duty deputy chief. There is one captain and one firefighter who have attended fire investigation classes conducted through the Massachusetts Fire Academy and the International Association of Fire Investigators (IAAI). Although they are working towards it, these personnel are not formally certified at the time of this assessment as they have not completed the requirement to have investigated 50 fires. The department would like to send them for additional training and certification. Fire District 6 also has a fire investigation team that can be utilized to assist. One of the Dracut investigators is also a member of this regional resource.

The Dracut Police Department participates in the investigation of fires of suspicious origin or possible incendiary cause. Investigators from the State Fire Marshal's Office are requested to assist with large or complex fire investigations or when specialized investigative resources are required (such as an accelerant detection dog), which is typical for communities the size of Dracut. The State Fire Marshal's Office is also called in for all fires that result in a fatality.

Recommendations

2.5-1 Fire prevention should continue to be promoted as a key component of the operations of the Dracut Fire Department and should remain a major aspect of its primary mission. Aggressive fire prevention programs are the most efficient and cost-effective way to reduce fire risks, fire loss, and fire deaths and injuries in the community. Every member of the department should be responsible for fire prevention and involvement by on duty personnel should be increased wherever possible.

2.5-2 All officers in the department should be required to complete the four module, on line fire prevention inspector program. Once implemented by the state all lieutenants should be required to obtain certification as a Fire Inspector I and all Captains, and above, should be required to be certified as Fire Inspector II. This training and certification should also be made available to any and all department personnel who wish to receive them.

2.5-3 The Dracut Fire Department should continue to support training and professional development activities for the deputy fire chief, and, other officers. Personnel should be encouraged, if not required, to attend fire prevention, fire investigations, and management courses at the National Fire Academy.

2.5-4 The department should develop a library of fire prevention reference materials, such as the *NFPA Fire Protection Handbook*, NFPA *National Fire Alarm Code Handbook, NFPA Automatic Fire Sprinkler Systems Handbook, NFPA Flammable and Combustible Liquids Handbook, Brannigan's Building Construction for the Fire Service,* and various fire prevention and inspection training manuals of the International Fire Service Training Association (IFSTA).

2.5-5 The department should significantly expand the in-service fire safety inspection program to include all business occupancies in the town. On-duty companies should conduct regular fire safety of inspections of buildings/occupancies within their respective response districts. The purpose of these inspections is to a) identify and mitigate fire hazards and fire code violations; b) enable firefighters to become thoroughly familiar with buildings, including the building design, layout, structural conditions, building systems, and hazards and challenges to firefighting operations; c) to educate property owners and occupants on good fire safety practices; d) to establish a positive relationship with property owners and occupants. In order to enhance the in-service inspection program, it will be necessary to:

- **Provide additional training to personnel on proper inspection procedures**
- **Develop standard operating guidelines for in-service inspections**
- **Establish inspection schedules**
- **Enhance the system for documenting inspections and notifying property owners of fire hazards**
- **Ensure that an effective follow-up inspection system is in place to ensure that hazards have been mitigated**
- **Continue the practice of on-duty personnel conducting regular in-service inspections of all building construction sites in the city**

2.5-6 The Dracut Fire Department should continue to update its website and social media accounts on a regular basis to provide its customers, and other interested parties, as much information as possible on fire safety, fire prevention, and the department as a whole. The department should also make it a priority, and work actively, to make on-line permitting, inspection scheduling, etc. a reality.

2.5-7 The department should enhance and expand its fire pre-planning program to include all commercial occupancies, business and large residential complexes in town. The purpose of a fire pre-planning program is to develop a fire response plan for buildings in the town. A pre-fire plan includes data such as the occupancy type, floor plans, construction type, hazards to firefighting, special conditions in the building, apparatus placement plan, water supply plan, and forcible entry and ventilation plan. Pre-fire plans should be reviewed regularly and tested by table-top exercises and on-site drills. In addition, the department should develop a plan to make pre-fire plans accessible on mobile data terminals (notebook/laptop computers) on fire apparatus for use enroute to an incident and while on-scene.

2.5-8 The Dracut Fire Department should make it a priority to switch to an electronic fire inspection and records management program in order to more effectively and efficiently facilitate the department's fire prevention functions. The department should also acquire some type of mobile computers (lap tops, tablets, etc.) along with printers, for use by personnel conducting field inspections. In this way once the inspection is completed the inspection report can be completed on the computer, an inspection report and/or other appropriate documentation, certificates, etc. can be printed out and given to the facility/building representative. Once personnel return to the station the inspection reports can be uploaded into the main database. The inspection system and associated data base(s) should be cloud based systems that integrate with the rest of the department's records management system.

2.6 GOAL SETTING AND STRATEGIC PLANNING

Overview

The concepts of goal setting and long range/strategic planning are often ones that are neglected in the public sector. More immediate needs, the need to cut or at least stabilize taxes, reduced revenues, increased competition for scarce resources, major unanticipated expenses, skyrocketing health care costs, underfunded liabilities and political considerations all factor into this reality. In addition, in some communities that have done things a certain way for many years, the concept may be too abstract to grasp, or not be considered something that is important. Many communities do not even have an accurate or up to date capital budget plan as these needs are deferred by scarcity of available budget funds.

Long range planning can be a valuable tool for any organization particularly emergency service organizations and the communities they serve. The idea is to work through a process to develop a strategic roadmap for the organization that provides broad direction for the future. Once established, the strategic plan provides a compass on where the organization is headed. A key tool of the strategic planning process is what is known as a **SWOT** analysis. This analysis provides an opportunity to think about and write down **S**trengths, **W**eaknesses, **O**pportunities, and **T**hreats. It also provides an opportunity to begin discussions about the issues that are most critical to the department.

Out of the SWOT analysis, the department begins the development of goals, objectives, strategies, and tactics. Goals should be broad, general and possibly even abstract while objectives should be narrow, specific and concrete. Objectives should fit the **"SMART"** criteria. That is **S**pecific, **M**easurable, **A**ttainable, **R**elevant, and **T**imely.

Fire department operations and service delivery can be dramatically improved in those departments that commit resources to goal-setting, master planning, risk assessment, and performance measurement. A number of tools and resources are available to guide management in these efforts from organizations such as the US Fire Administration (USFA), National Fire Protection Association (NFPA), International Association of Fire Chiefs (IAFC), International Association of Fire Fighters (IAFF), and the Massachusetts Firefighting Academy, U.S. Department of Transportation (USDOT), and the Massachusetts Office of Emergency Medical Services (OEMS).

Performance improvement for fire suppression will become even more important in the coming years as the fire department command structure evolves from being a group with significant firefighting experience to a group with stronger EMS experience. Major fire incidents continue to decline because of better fire prevention and building code compliance, the advent of advance fire detection and suppression systems, and fire retardant building components and contents. As a result, the fire service will be challenged in the future to maintain the necessary skill sets to properly command and control major fire incidents. Training and performance improvement strategies must be aggressively improved in anticipation of this paradigm shift in fire department capabilities and experience.

Observations

A good mission statement states simply why the department exists, and, provides direction and boundaries to guide its future development. It should be an accurate statement of what the department actually does and should answer the following questions:

1. What we do?
2. How do we do it?
3. Why do we do it?

The home page of the Dracut Fire Department on the Town of Dracut web site offers the following mission statement:

MISSION STATEMENT

To effectively and efficiently protect the lives and property of the Town of Dracut against all emergencies, natural and man-made. Through our diligence in training we will excel in Fire Suppression, Fire Prevention, Public Education, and be second to none in our Emergency Medical Services.

This statement, if truly accurate, should provide the very foundation for the Dracut Fire Department and why it exists. While simple, direct and to the point, this mission statement should be providing the broad direction that everything else the fire department does is going to be built upon. Assuring that the department's mission statement is accurate and up to date is the first step in the long range or strategic planning process. The study team believes that overall, the Dracut Fire Department is fulfilling its mission, and does so in a more than adequate manner.

While a mission statement identifies the purpose of the department, the vision statement will describe what one aspires to be or seeks to achieve. The home page of the Dracut Fire Department on the Town of Dracut web site offers the following vision statement:

VISION STATEMENT

The Dracut Fire Department is to be a key team player with citizens of Dracut, local businesses and other government agencies working to maintain a community we can all be proud of with a strong sense of safety and security.

Provide responsive services to the citizens by investing in training, education, staffing, and equipment. Through these continued efforts we will strive to achieve a level of service that is viewed as a benchmark within the Fire Service and shall be second to none.

We are a team of dedicated and compassionate professionals, who are leaders in our profession and community role models.

The MRI team noted that the department's mission and vision statements are prominently displayed in each of the fire stations and in the administrative offices directly across from the dispatch center. This fact tends to show that the department truly believes in them and wants its personnel to be regularly reminded of why they are there and what they are trying achieve. The department's leadership should be commended for this initiative, something seen in fire stations on only an infrequent basis.

Thinking strategically, involves considering all assets and resources, deciding where the department wants to go and formulating ideas on how to get there. Once developed, the strategic plan needs to be a living documented that is reviewed and evaluated on an annual basis and updated in a continual manner so that the plan continues to match the reality.

The Town of Dracut has a long range capital planning document for Fiscal Years 2012 through 2016 that was developed by the capital planning committee. It is unclear as to how up to date this plan is at the time of this assessment. However, the plan did note that a funding was recommended in the final year of the plan, so FY 2016, for the replacement of Fire Station 3 which has long since outlived its serviceability as a fire station. Funding has not been allocated for this project, nor has any real planning taken place regarding it.

The MRI study team was informed by the chief that he has been working on the development of a five-year strategic plan for the fire department from 2016 through 2020. This document which is draft form was provided to the study team for review. It appears to be thorough and appropriate, and would provide a good roadmap for the department moving forward. The chief informed the team that he was making revisions to the draft and hoped to have it complete and ready for issue by late May 2016.

While the MRI study team does not want to take anything away from the chief regarding his efforts to develop this strategic plan, or the final product that he is working on; we do have a couple of concerns and suggestions that we believe would ultimately result in a more successful end product for the department and town as a whole. First, and foremost, it appears that the plan was primarily, if not solely, developed by the chief. While it is certainly one of the chief's most important duties to provide vision and direction for the department, in the 21st century that generally cannot be done in a vacuum or unilaterally. The chances of successful implementation, buy in, and achieving the ultimate goals of the plan will be significantly higher if the membership has input into its development and is a stakeholder in both it, and the process. This is particularly important because the team noted that the department's mission and vision statements have both been revised within this plan. In addition, a set of organizational values has been added. A reasonable question then becomes, whose vision and values are these, the chief's, or the organization as a whole?

Our interviews did not provide any indication that the fire department membership was involved in the process of developing this plan, nor did most of the members of the department even seem aware of it. Most strategic plans that are developed today are done so by committees that include a wide range of stakeholders, often both internal and external. While the chief should provide direction and vision to the committee that should be only part of the process. While we believe that the draft document that the chief has developed could serve as an excellent starting point, we believe that ultimately the Town of Dracut, the Dracut Fire Department and the citizens of the community would be better served if a committee was established to develop this plan. Although it is not uncommon for the development of an initial strategic plan to take between eighteen and twenty-four months, with the foundation already provided by the chief's efforts, Dracut should be able to complete theirs in a much shorter time frame.

The fire department's annual reports to the Town of Dracut include the following operation objectives:

OPERATIONAL OBJECTIVES

- **Emergency Medical Services: Initiating Basic Life Support to patients within six (6) minutes of receiving 911 calls into our Emergency Medical Dispatch Center.**
- **To access, extricate, treat, and prepare for transport to a trauma facility, all trauma patients, within the Golden Hour.**
- **To interrupt the progress of structure fires within 6 minutes of receiving a report of fire.**
- **Teach Student Awareness of Fire Education (SAFE) in grades K through 8. Continue to provide Fire Safety Education to the day care and nursery schools within the town.**
- **To optimize the performance and safety of department members through educational opportunities, capturing, developing and maintaining best practice.**
- **Ensure customer fire safety through timely and consistent code compliance.**
- **To provide all our services in a manner that meets the needs of our customers.**

While these are certainly reasonable operational objectives which are based upon national standards and best or recommended standards, the department does not report how well they actually meet or comply with their objectives. This is information that should be evaluated on a regular basis as it goes to the heart of how well the department is fulfilling its mission and achieving its own established benchmarks of service.

It does not appear that the Dracut Fire Department establishes ant formal goals or objectives on an annual basis. The Town of Dracut also does not provide any annual direction on goals for the upcoming year(s) or seek an assessment of to what extent previous goals were accomplished. Without these processes in place there is no way to evaluate whether the department is operating as effectively and efficiently as possible, or, if it is providing the level of protection that has been decided upon by the municipal governing body.

Recommendations

2.6-1 Working in conjunction with the town administration, and utilizing the already developed draft master plan as a foundation, the Dracut Fire Department should establish a committee to conduct a long-range/strategic planning process and develop a plan (roadmap) to guide the department's future over the next one to five years. If necessary, the department's mission and vision statements should be revised to properly and accurately reflect the department's overall mission within the community and vision for the future. In addition, the core or organizational values, should be developed by utilizing the input of all four work units. Although this can be a time consuming process, it serves as a foundation and sets a common direction for the organization.

The makeup of the committee should include internal stakeholders; labor, management, and town representatives. External stakeholders can provide considerable insight as well; business and other community leaders should be invited to be members of the committee. The committee should be provided with the support and resources they need to complete their task within a timely manner. Once developed, the plan should be formally approved/adopted by the board of selectmen. As a "living" document, the plan needs to be reviewed, and updated, on an annual (or other reasonable periodic) basis.

2.6-2 The Center for Public Safety Excellence (CPSE) offers fire department accreditation through the Commission on Fire Accreditation International (CFAI). It is described as "A self-assessment and evaluation model that enables organizations to examine past, current, and future service levels and internal performance and compare them to industry best practices. This process leads to improved service delivery." This process

provides the necessary tools to support what is currently in place, as well as, identify and attempt to mitigate any gaps in service delivery.

2.6-3 The town manager should take an active role in setting appropriate goals and a vision for the fire department. Town officials should include residents and the department in an open and honest discussion within the goal setting process.

2.6-4 The town manager should establish an annual goal-setting workshop with the fire chief to develop the sense of common vision necessary to improve the department and the quality of fire and EMS services the town receives.

2.6-5 The Town of Dracut and the Dracut Fire Department should publicly recognize the achievements of the department in reaching the various established goals as they are accomplished.

2.7 RECORDS MANAGEMENT

Overview

Records management, today often referred to as information management is the practice of managing the records of an organization throughout their life cycle, from the time they are created to their eventual disposal. This includes identifying, classifying, storing, securing, retrieving, tracking and destroying or permanently preserving records. The purpose of records management is part of an organization's broader function of administration, management, and compliance and is primarily concerned with the managing the proceedings and reports of an organization's activities. This can include the reduction or mitigation of risk associated with Its operations through the retention of such records as those related to training of personnel, and, in the case of the emergency services, inspections both internal and external. An entity's records preserve its organizational memory. In determining how long to retain records, their capacity for re-use is important, as well as any statutorily or regulatory retention requirements. Many are simply kept as evidence of an incident or occurrence.

A record is either created or received by an organization in pursuance of, or in compliance with, legal obligations, or in the transaction of its business. A thorough system of record keeping is particularly important for the emergency services due to the nature of their business. Not all documents are records. A record is a document consciously retained as evidence of an action.

Records must be stored in such a way that they are accessible and safeguarded against damage of any type. Certain records should be safeguarded against unauthorized access. In addition to being able to store records, organizations must also establish the proper capabilities for retrieval of records, and be able to do so in an effective, efficient and timely manner.

Today, records are generally divided into two broad categories. Physical records are those records, such as paper that can be touched and take up physical space. Electronic records, also often referred to as digital records, are those records that are generated with and used by computers, data bases, etc.

Observations

The MRI study team examined the Dracut Fire Department's records management system and found that although it appeared to be thorough and well maintained, it was still weighted heavily towards paper documents and manual record keeping practices. The team noted that most personnel records are still maintained through the use of paper documents and traditional files. Although employee timekeeping records are tracked by use of an Excel spreadsheet (as are other records), the department's administrative assistant must still manually enter the data for payroll each week.

All fire prevention records are completed and maintained manually at this time. Inspection reports are handwritten. Fire prevention maintains a hard copy file for every address in the town. While well maintained and easily accessible not maintaining these records electronically is not the common practice today. There is currently no capability for citizens to apply for permits or inspections on line nor pay the required fees. However, getting on line permitting and applications is a priority that is in development at the current time. The department's limited number of pre-fire plans are maintained in hard copy form stored in three ring binders rather than being electronic.

Vehicle inspection, maintenance and repair records are maintained in hard copy form at both the fire departments and by the Department of Public Works. The records are thorough and include work order requests and hand written narratives regarding and maintenance or repairs that were completed.

Incident reports are completed electronically in the Fire Programs data base and maintained in that environment. This allows incident records to be easily researched and statistical data to be retrieved and analyzed.

Training appears to be a department area where the majority of the records are maintained electronically. The training deputy prepares the training schedule and maintains training records and reports in the Fire Programs data base. Hard copies of training certificates are maintained in the member's personnel file.

The chief informed the MRI team that the department has utilized the Fire Programs data base since the 1990s. He informed the team that there are a number of additional management modules to this system that the department does not utilize such as for staffing and scheduling which would eliminate the need for manual entry of things like attendance and payroll records.

He also informed the team that the department does not utilize the program to its full capabilities.

The team was informed that the department is incrementally working on upgrading its data program. The chief recently sent two members to a multi-day class in Hollis, NH on using Fire Programs. He would like to send them to additional training to maximize their use of the program. As part of the upgrade he is trying to go to a cloud based system which he feels will be most versatile and beneficial. He would like to over time, scan many of the departments older, but still pertinent, records into the data base and reduce the number of paper, hard copy files.

The department has recently gained GIS capabilities with the town.

Recommendations

2.7-1 The Dracut Fire Department should purchase the fire inspection software module, for the current Fire Programs fire department records management system, then take immediate steps to insure that the database is utilized for all aspects of the fire prevention program including, inspections, permitting, and pre-fire/incident planning. To the extent practical, fire prevention permit, fee, and inspection records should be retroactively entered in the management program, including any information that is stored in any other databases.

2.7-2 The Dracut Fire Department should acquire mobile computers (lap tops, tablets, etc.) along with printers for use by all personnel conducting field inspections. Once the inspection is completed, the inspection report can be completed on the computer, and an inspection report and/or other appropriate documentation, certificates, etc. can be printed out and given to the facility/building representative. Once personnel return to the station, the inspection reports can be uploaded into the main database.

2.7-3 The needs of the fire department are unique and not typically solved with generic, off the shelf products. The Dracut Fire Department should upgrade its current Fire Programs fire department records management system with all needed modules including ones such as staffing and scheduling, equipment, etc. then take immediate steps to insure that the database is utilized for all aspects of the department's management, operations, and recordkeeping. To the extent practical, and as proposed by the chief, as many records as possible should be retroactively entered into the management program modules, including any information that is stored in any other databases.

2.7-4 The Dracut Fire Department should develop a plan to install mobile data terminals (MDTs) in all fire apparatus and the command vehicles. In developing the MDT plan,

consideration should be given to evaluating the latest technologies and software, including the use of tablets rather than laptop computers. At a minimum, the incident commander at a scene should have access to fire pre-plan data, building permit data (building plans and current data about renovation and construction projects), real-time weather data, and hazardous materials data.

2.7-5 The Dracut Fire Department should evaluate the capability of it current records management system to meet the future needs of the department. Consideration should be given to transitioning to a cloud based system with a high level of high connectivity.

2.8 DATA ANALYSIS

Overview

The fire service exists today in an environment constantly inundated with data, but data is often of little use in the everyday, real world in which first responders live and work. Information, on the other hand, is very useful indeed. Fire departments collect an immense amount of data, but do very little with it. Basic information is usually available but often not much else. Most departments track the number of fires handled each year, the number of fire-related injuries, and the number of fire deaths. It is often a different story, however, if more detailed information is asked for such as:

- How many fires took place on Sundays, Mondays, etc.?
- How many fires took place each hour of the day or month of the year?
- What was the average response time to fires?
- How much did response times vary by fire station areas?
- What was the average time spent at the fire scene and how much did the average vary by type of fire?

Many fire department decisions do not require analysis, such as choices on personnel, grievance proceedings, promotions, and even decisions on how to handle a fire. However, there are three good reasons for looking more closely at statistical data:

(1) To gain insights into fire problems,

(2) To improve resource allocation for combatting fires,

(3) To identify training needs.

Probably the most compelling is that analysis gives insight into your fire problems which, in turn, can impact operations in your department. The fire service of today is changing. More and more, it is not fighting tires as much as it is doing EMS, hazmat, inspections, investigations, prevention, and other non-traditional but important tasks which are vital to the community. Balancing limited resources and justifying daily operations and finances in the face of tough economic times is a scenario that every department can relate to. How well a department can do this depends mainly on how well it uses the information it has at its disposal.

Observations

The Dracut Fire Department very basic routine data analysis but little else. The chief informed the MRI study team that the three Dracut fire stations are situated so that the first due unit can be on the scene of an emergency within four (4) minutes of responding (and within six (6) minutes of receipt of the 9-1-1 call). The department was able to produce data that illustrated that they achieve this operational objective with an average on scene time less than what they target for actual fires. They also provided information on their EMS response times that showed they also arrive on scene on average in less than six (6) minutes from receipt of the call. Information was provided on the number of times each month there are multiple (2, 3, 4) simultaneous EMS incidents, and the percentage of incidents that result in an advanced life support (ALS) work-up or treat. Mutual aid given and received was also provided.

It does not appear that the data and information are analyzed on a regular basis; rather evaluations are conducted sporadically. The chief also informed the study team that due to the shortfalls in the department's current management program that much of the data the MRI team requested had to be compiled manually by personnel going through records one at a time or by going through the department's log books. Obviously this can be a very time consuming process, one that is also subject to mistakes and oversights. It also leads to the belief that much of this information was produced in response to MRI's requests rather than being regularly tracked and monitored.

The team did note that while EMS incident average on scene response times had been gradually decreasing from 5.9 minutes in 2012 to 5.3 minutes in 2015; fire incidents had generally been showing an increased average response time from 5.1 minutes in 2011 to 5.9 minutes in 2015. No explanation was available for this. The chief also informed the study team that he does not analyze NFPA 1710 compliance because it would be impossible for the department to achieve it.

The department's training records are for the most part computerized and the training deputy chief was able to quickly produce reports from Fire Programs for information requested. The department does maintain electronic files in programs such as Excel for tracking various aspects of its operations including time, attendance and payroll. However, these records are not analyzed on a regular basis to identify trends, or potential issues.

As was previously noted in in the records management section, the departments fire prevention and maintenance records are almost totally manual and hard copy based. This makes data analysis and the production of usable information very difficult and time consuming.

Recommendations

2.8-1 If Fire Programs is determined to be the best records management option for the Dracut Fire Department, this system should be updated and expanded with all needed modules including ones such as staffing and scheduling, equipment, etc. The department should then take immediate steps to insure that the database is utilized for all aspects of the department's management, operations, and recordkeeping.

2.8-2 The Dracut Fire Department should work with the town manager to identify additional relevant statistical data to be extracted from the records management system for regular review, analysis, and reporting. This will provide the catalyst for more reliable and accurate data and information driven decisions and planning.

2.8-3 The Dracut Fire Department should continue to send personnel to advanced training on the use of the Fire Programs fire department records management program. They should also seek additional opportunities for officers or other personnel to attend classes on data and information management such as those offered at the National Fire Academy.

CHAPTER 3

FIRE AND RESCUE OPERATIONS

3.1 DEMAND FOR SERVICE

Overview

Firefighting, emergency medical services, and rescue operations that include an incident command system and safety procedures are critical components of a municipal fire department. Because the greatest number of calls for service are predominantly for emergency medical incidents, in reality, many fire departments have shifted from being fire service agencies that provide EMS to EMS agencies that provide fire protection services.

In addition to structural firefighting and emergency medical services, the fire department is tasked with responding to and managing a broad spectrum of other types of emergencies, including, but not limited to, vehicle crashes, building collapse, water and ice rescue, mass casualty incidents, weather related emergencies, and natural and technological disasters. These types of incidents require special operations with specialized equipment and specialized training.

In all types of emergency responses, an incident command system (ICS) should be utilized that conforms to the National Incident Management System (NIMS) guidelines that have been promulgated by the U.S. Department of Homeland Security. While safety is the primary focus throughout all operations, a formal component of the ICS program includes the consistent assignment of an on-scene safety officer, when appropriate.

A community's demand for fire and EMS services are based on that community's demographics, socio-economic factors, the percentage of commercial, industrial, and residential properties, as well as, the town's infrastructure. By reviewing the historical demand for fire and EMS services and the fire department's ability to respond to those needs within the expressed expectations of that community; a fire department can evaluate what types and levels of services that they will need to provide. Though fire and EMS standards are helpful for modeling those services, no two communities are exactly alike. Budgeting and resources often determine what level of service a community expects, and, can afford. Fire departments, in conjunction with the town's management and political leaders, should work to establish plans that can deliver fire protection and emergency medical services at a level that meets the level of expectation that the community has established.

Observations

The Town of Dracut is located in north-central Massachusetts on the border with New Hampshire. Covering over 21 square miles the town had an estimated 2014 population of 31,079 which represents a population density of 1,379 persons per square mile. Dracut is considered a bedroom community with the majority of its population commuting to the metro Boston area for employment. Its population has grown 33.2% since 1970, including by about 5.5% between 2010 and 2014. A significant portion of the population is senior citizens who reside in public housing units, more so than in many other suburban communities. These facilities require special attention regarding EMS services by the Dracut Fire Department as well as, mutual aid departments.

Dracut is bordered by Tyngsboro to the west, the City of Lowell to the south and west, Methuen to the east, and Pelham, New Hampshire to the north. Tewksbury and Andover also border the town to the south, over the Merrimack River. However, there are no crossings of the river within Dracut's town limits, and thus Tewksbury and Andover are inaccessible directly from Dracut. There are several Merrimack River crossings in Lowell, in addition to one on I-93 in Methuen.

The Dracut Fire Department is typical of those found in similar communities throughout New England, both in the normal types of incidents they experience, and their strategies for dealing with them. The department responds primarily to EMS incidents, yet it remains operationally prepared to fulfill its core firefighting mission as well.

One of the best ways to get a broad overview picture of an emergency services provider is to look at, and analyze, their emergency response/incident statistics. Looking at statistical data that is compiled from incident reports that are generated for each and every emergency response, and/or request for assistance, will assist with determining the adequacy of current operations, as well, identify trends in responses, i.e.: increasing vs. decreasing, changing types of incident requests, increasing response times, frequency of simultaneous incidents, etc. Utilizing current trends to help predict future ones, while not an exact science, can be helpful to communities and fire departments in predicting, and planning for future operational needs. However, as with any other type of statistical analysis, the information that is analyzed is only as good, and/or reliable, as the data that was originally entered, and has been provided for evaluation.

In 2015, Dracut responded to 3,543 emergency requests for service of which 2,306 (65%) were EMS related. This equates an average of 9.7 responses per day of which 6.3 are EMS related, 0.2 are actual fire incidents and 3.2 are other types of emergencies. Over the four-year period from 2012 through 2015 the department averaged 3,439 total incidents of which 2,204 were EMS, 82.5 were actual fire incidents, and 1,152 were other types of emergencies (Figure 3-1).

Although the data from these years did not show a definitive pattern, nationwide statistics suggest that incidents may continue to gradually increase from year to year.

For actual fire incidents, the statistical sample is quite small, however, that would not be unexpected in a smaller community such as Dracut. It is very important to note that per National Fire Incident Reporting System (NFIRS) protocols, the category for "Fire Incident" must be an actual fire situation that in many, but not all, situations caused some type of damage. Many of the incidents that are classified under other types of incidents were probably initially dispatched as some type of fire incident, but ultimately were classified otherwise, for reporting purposes, based upon the situation actually found at the scene. From 2012 through 2015, the department responded to a total of 330 actual fire incidents, an average of 82.5 per year, or a little over 1.5 week. Actual fires accounted for 2.4% of the department's total responses during these years.

FIGURE 3.1
DRACUT FIRE DEPARTMENT EMERGENCY RESPONSES 2012 - 2015

YEAR	TOTAL EMERGENCY INCIDENTS	AVERAGE PER DAY	FIRE INCIDENTS	AVERAGE PER DAY	EMS INCIDENTS	AVERAGE PER DAY	OTHER INCIDENTS	AVERAGE PER DAY
2012	3215	8.8	99.0	0.3	2007.0	5.5	1109	3.0
2013	3605	9.9	82.0	0.2	2324.0	6.4	1199	3.3
2014	3394	9.3	69.0	0.2	2182.0	6.0	1143	3.1
2015	3543	9.7	80.0	0.2	2306.0	6.3	1157	3.2
AVERAGE	3439	9.4	82.5	0.2	2204	6.0	1152	3.2

Fire departments also respond to many other types of incidents that may, or may not, be fire related. These types of incidents frequently constitute the largest number of fire department responses and each must be treated as an emergency. In the case of automatic fire alarm systems, the incident must be treated as a potential actual fire until such time as a trained and qualified emergency responder arrives on the scene and determines otherwise. Other incidents, such as fuel or chemical spills, create other dangers and hazards to people, property, and the environment, unless they are properly mitigated.

FIGURE 3.2

DRACUT FIRE DEPARTMENT EMERGENCY INCIDENTS BY TYPE 2012 - 2015

INCIDENT TYPE	Year	2012	2013	2014	2015
Fire	100 Series	99	82	69	80
Explosion	200 Series	4	2	1	1
Rescue & EMS	300 Series	2007	2324	2182	2306
Hazardous Condition (no Fire)	400 Series	157	139	152	142
Service Call	500 Series	387	383	373	370
Good Intent Call	600 Series	59	79	64	84
Alarm Activation	700 Series	489	591	546	556
Severe Weather & Natural Disaster	800 Series	7	0	2	0
Special Type	900 Series	6	5	5	4
TOTAL RESPONSES		3215	3605	3394	3543

The Town of Dracut contracts with Patriot Ambulance Service, at no direct financial cost to the town, to supply emergency medical transport services at the Basic Life Support (BLS) level. Patriot deploys at least one ambulance in town at all times unless they are transporting a patient. Their partnership with the town requires that the fire department respond with the closest engine with firefighters that are trained as Emergency Medical Technicians (EMT) to provide initial patient evaluation and care. If an emergency medical call requires an Advanced Life Support (ALS) response that is provided by Lowell General Hospital paramedics who respond in a non-transport vehicle ("fly car"). This model, which is known as a multi-tier system, has worked well for the community.

Year	2013	2014	2015
Total EMS Responses	2324	2182	2306
ALS Responses	1207	1183	1187
ALS dispatches	52%	52%	51%
ALS work up %	47%	48%	43%
Transports	568	544	518

Figure 3.3: Dracut EMS responses and transports

In addition to providing BLS transport services Patriot personnel assist the fire department with EMS training, as well as, providing some EMS equipment, including oxygen tanks and refills. Patriot also provides an annual stipend of approximately $18,000 to the town for EMS dispatch services.

During the course of our interviews, the Dracut fire chief informed the MRI study team that he has done some preliminary research on the possibility of the fire department taking on the EMS transport services in the future. The chief is aware that this potential change in service delivery model will require an increase in staffing, training, additional equipment, ambulances, and most importantly, the support of the employees, as well as, the community. It is his belief that in addition to providing a high quality service to the community, the fire department and the town would have the opportunity to collect ambulance transport revenues to help supplement the municipal budget, and, ultimately offset some of the annual costs of providing emergency services. Fire based EMS transport services have been successful in a number of communities throughout the country. We believe that it would be prudent for Dracut to continue to investigate this possible change in town's service delivery model. However, revenue projections versus costs that are incurred with the current model along with increased operating expenses associated with the implementation of fire department based transport services should be carefully scrutinized.

Currently Patriot Ambulance is the private provider utilized for patient transport within the Town of Dracut. Rather than charging the Town of Dracut to provide this service, Patriot pays the Town $14,000 per year. Given the payer mix and Demographics present within Dracut, ambulance billing must factor in both write offs and adjustments. As we are aware that the fire department would like to enhance its service in the community and possibly expand into transport EMS, any investigation should consider the fiscal equation noted above, produce no sustained fiscal impact that requires the Town of Dracut to subsidize operations on an ongoing basis. Any fire based EMS venture should be transparent to the public and developed through an enterprise account to ensure that any EMS endeavor would be sustainable without additional support from the community.

As with most communities in the United States, the primary focus of firefighting operations for Dracut is on fires in residential occupancies (one and two-family dwellings, multi-family complexes, etc.) due to the high potential for loss of life. Until residential fire sprinkler systems become commonplace as a critical lifesaving feature in homes, the fire department will continue to be the only "front-line" resource available for firefighting and rescue. Firefighting in commercial occupancies is important to the economic well-being of the community; however, large commercial occupancies are often equipped with automatic fire suppression (sprinkler) systems to reduce risk and damage from fire.

Although Dracut does have a municipal water supply system it does not extend throughout the entire town. In communities, or areas of them, without a municipal water system, if an adequate water supply cannot be established quickly, and maintained, effective firefighting operations will simply not be possible. Rural communities that do not have a municipal, pressurized water supply must obtain their water needed for firefighting operations from other sources. Sometimes static water sources (lakes, rivers, ponds, cisterns) can be drafted out of, either manually, or with dry hydrants, to obtain the needed water supply to fight a fire. In cases where static water sources are not readily available, fire departments must utilize water tankers/ tenders to carry or shuttle the needed water from the supply source to the incident scene. The Insurance Services Office (ISO) places a high priority on a municipality's water supply needs and capabilities as part of its periodic evaluations. A community's ISO rating can be the basis for the fire insurance rates that are paid by commercial and residential property owners.

The establishment of rural a water supply operation requires significant resources, both personnel and equipment, all part of a closely coordinated effort. These are frequently labor intensive operations. Portable ponds or tanks are set up near the fire scene to supply engines operating to attack the fire. Water tenders transport water from supply sources located throughout the town to the dump tanks near the incident. The size of the fire, and the distance from the fire to the closest source(s) of water, will both directly impact the size and complexity of this type of operation. At an absolute minimum, three (3) rated Class A pumpers are required to maintain a rural water supply operation, along with an adequate number tenders/tankers. If a water supply is being established through the use of large diameter hose, additional pumpers will be required at intervals of no greater than 1,000 feet.

This situation can complicate firefighting efforts in the areas of town that are outside of the municipal water supply area. One alternative, and the best one, is to work through the planning board to require residential fire suppression systems to be installed in new single and two-family homes that are built within those areas of the community without a municipal water supply system and fire hydrants. Many Massachusetts communities have successfully implemented the requirement for residential sprinkler systems these areas.

Even in the areas of the town where there are hydrants, the fire department should approach developers/builders/owners to discuss the pros and cons of residential sprinkler systems during the approval process for subdivisions and other single family residences and encourage them to consider the installation of these life safety systems. There are a number of publications that the fire department can use as resources to market the benefits of residential fire suppression systems including from the NFPA which has developed the standards for the design and installation.

As an alternative to fire sprinkler systems, several New England communities that are similar in nature to Dracut, that is they have developing areas that are outside of the municipal water supply system, have adopted bylaws applicable to any new subdivision being built with three or more houses that a water supply cistern to hold water necessary for fire suppression operations be installed in the development. In some cases, individual homes that exceed a certain size...perhaps 3,000 square feet ...would be required to comply with the bylaw requirements as well. The requirements for these systems are detailed in several NFPA standards. This is an important fire and life safety initiative for a rural community. There are currently no such requirements of either type for one and two family homes, or planned subdivisions, that are being built throughout the town.

The gradual continued growth in Dracut's population, and the impact that it will continue to have on the fire department, will require long range strategic planning in order for the department to continue to fulfill its mission in the future. The purpose of the strategic plan is to determine a road map for the department and provision of emergency services for a number of years into the future. As members of the community continue to expect and demand the highest levels of service regarding fire protection and safety, fire suppression, rescue and EMS response the Dracut Fire Department will need to be prepared to respond to those demands, while simultaneously understanding that there will always be limitations to funding.

Recommendations

3.1-1 The Dracut Fire Department should continue the development of a long range strategic plan that is consistent with the Town's. This process should include other town departments, a review of the Town's economic and community master plans, and, should include a broad cross section of internal stockholders and external stakeholders. It cannot be developed unilaterally, or, in a vacuum.

3.1-2 The Town of Dracut and Dracut Fire Department should continue to explore the feasibility of the fire department providing EMS transport instead of the current service provided by Patriot Ambulance. Revenue projections versus costs that are incurred with the current model along with increased operating expenses associated with the implementation of fire department based transport services should be carefully scrutinized. Currently Patriot Ambulance is the private provider utilized for patient transport within the Town of Dracut. Rather than charging the Town of Dracut to provide this service, Patriot pays the Town $14,000 per year. Given the payer mix and Demographics present within Dracut, ambulance billing must factor in both write offs and adjustments. As we are aware that the fire department would like to enhance its service in the community and possibly expand into transport EMS, any investigation should consider the fiscal equation noted above, produce no sustained fiscal impact that requires the Town of Dracut to subsidize operations on an ongoing basis. Any fire based EMS venture should be transparent to the public and developed through an enterprise account to ensure that any EMS endeavor would be sustainable without additional support from the community.

3.1-3 The Dracut Fire Department should work with the town to develop long range capital plans to continue to expand the municipal water supply system to areas of town where it currently is not. Consideration should also be given to making changes in local planning, zoning, and building codes to require expansion of the water system into new major subdivisions.

3.1-4 The Dracut Fire Department should develop a compelling public education program that includes discussing the benefits of installing residential fire sprinklers in all new one and two story homes, particularly those located outside of the hydrant district.

3.1-5 The Town of Dracut should strongly consider adopting a municipal by-law requiring the installation of a fire water supply cistern in any new development consisting of three of more homes or, for any individual home of larger than a designated square footage, that are outside of the municipal water supply system.

3.1-6 The Town of Dracut and Dracut Fire Department should consider partnering with private property owners to install cisterns on private properties in Dracut that are outside of the hydrant district. The Town might consider a property tax abatement for being allowed to install a cistern on a private property. The fire department could develop a public education program that includes discussing the benefits to residents and property owners of installing cisterns for the storage of fire suppression system water supplies on various properties throughout the town.

3.1.7 The Town of Dracut and Dracut Fire Department should make it a priority to identify additional suitable locations for dry hydrants or standpipes in the areas of town outside of the municipal water supply area, and, in conjunction with the public works department, or through the formation of public/private partnerships, install several of them each year based upon the highest risk areas and/or year round accessibility and usability.

3.1.8 The Dracut Fire Department should expand rural water supply operations and develop a response card that initiates the response of at least two tankers when a structure fire is reported in an area beyond the confines of the water district. The department should also increase the amount of rural water supply training and develop an SOP for rural water supply operations.

3.2 NFPA 1710

Overview

The operations necessary to efficiently and safely extinguish a structure fire require a carefully coordinated and controlled plan of action. Simultaneous operations that must be carried out with a high degree of precision and timing include forcible entry, initial fire attack, search and rescue, ventilation, and the establishment of incident command. If there are not enough personnel on the incident initially to perform all of the critical tasks, some of these tasks will be delayed. This can result in an increased risk of serious injury, or death, to building occupants and firefighters, as well as increased property damage.

The National Fire Protection Association (NFPA) Standard 1710 – *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* (2010 Edition, National Fire Protection

Association, Quincy, MA) addresses the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by career fire departments. This standard is the nationally recognized consensus standard on staffing and deployment for career fire departments. The recommendations and requirements of the standard were first released in 2001. Though the NFPA 1710 standard is a nationally recognized standard it has not been adopted as a mandatory regulation by the federal government, or, the Commonwealth of Massachusetts.

The standard contains general requirements for managing resources and systems, such as health and safety, incident management, training, communications, and pre-incident planning. The standard was developed based on the deployment of firefighting operations using a typical 2,000-square-foot, two-story, single-family, residential structure as their structural example. The standard addresses the strategic and system issues involving the organization, operation, and deployment of a fire department and does not address tactical operations at a specific emergency incident. It is a valuable resource for establishing and measuring performance objectives in the Dracut Fire Department, but should not be the only determining factor when making local decisions about the town's fire and EMS operations.

Some of the key provisions of NFPA 1710 are as follows:

- Paragraphs 5.2.3.1.1 and 5.2.3.2.1 state that engine companies and truck companies respectively shall be staffed with a minimum of four on duty personnel.

- Paragraph 4.1.2.1 states that the first arriving engine company shall arrive at the scene of a fire suppression incident within four minutes or less and/or the entire full first alarm response should arrive on scene within eight minutes. For EMS incidents a unit with first responder or higher level (EMT-Basic, Intermediate, or Paramedic) trained personnel should arrive within four minutes, and an Advanced Life Support (ALS) unit should arrive on scene within eight minutes. Paragraph 4.1.2.2 requires the establishment of a 90% performance objective for these response times.

- Paragraph 5.2.4.2.2 establishes the following **minimum** personnel requirements on the full first alarm assignment which should arrive on scene within eight (8) minutes of dispatch:

FIGURE 3.4
NFPA 1710 RECOMMENDED STRUCTURE FIRE FIRST ALARM STAFFING

TASK	# Personnel
Incident Commander	1
Attack engine driver/operator	1
Water supply engine driver/operator	1
Two hand lines with two personnel each	4
Support/back-up Firefighter for each hand line	2
Search & rescue team	2
Ventilation team	2
Ladder company driver/operator	1
Rapid intervention team (RIT)	2
TOTAL MINIMUM NUMBER OF PERSONNEL	16

These numbers reflect personnel needs for a fire involving several rooms, in a 2,000 square foot, one-family residential occupancy. These are the proverbial "bread and butter" structural fire incidents that fire departments respond to and, are by far, the most common type of structure fire, accounting for around 70% of those types of incidents. Personnel requirements for fires involving large, more complex structures, such as commercial or industrial facilities or multi-family residential occupancies, will require a significantly greater commitment of personnel.

In its respected text book *Managing Fire Services,* the International City/County Management Association (ICMA) states, "that at least four and often eight or more firefighters under the supervision of an officer should respond to fire suppression operations". They further state, "If about 16 firefighters are not operating at the scene of a working fire within the critical time period then dollar loss and injuries are significantly increased, as is fire spread". MRI is not suggesting that Dracut staff sixteen firefighting personnel on duty at all times or staff all apparatus with four personnel. NFPA 1710 does permit fire departments to use established automatic and mutual aid agreements to comply with the staffing and response requirements. These types of agreements are mission critical to the Dracut Fire Department being able to handle most structure fires they will encounter.

NOTE: *While the NFPA standards are nationally recognized consensus standards, it is still the responsibility of the local jurisdiction to determine the acceptable level of risk and corresponding fire protection/EMS services. When applying any standard, including the NFPA standards, it is important to apply the document in its entirety. One should not selectively extract requirements to the exclusion of others or take a requirement out of context.*

Observations

The Dracut Fire Department does not currently meet the standards that have been established by the NFPA 1710 standard. However, this situation is not unique to Dracut. In fact, with the exception of the largest fire departments it is actually quite typical of most fire departments in Massachusetts and the northeast. The primary reason for this situation is grounded in the inability of communities to be able to fund fire departments to adequate staffing levels at either the company level, or, the daily shift staffing requirements. Longer response times are often based on the number, location and infrastructure/travel distances in a community. This is often the result of communities that have extended out from their traditional cores without having expanded services to match.

Dracut's fire chief is aware of these standards and that the department does not currently meet them. He is working with the town to develop plans that will allow the department to increase station and total on duty shift staffing while simultaneously attempting to reduce response times. In order to attempt to meet these standards the Dracut Fire Department has established response plans for many types of incidents as well as larger, multiple alarm incidents. The use of automatic and mutual aid agreements and quickly recalling off duty personnel are helping the department in staffing of personnel at the scene.

The number of companies and staffing, the location of the fire stations, the lack of staffing an incident commander position 24 hours a day, as well as the possibility of simultaneous incidents occurring limits the ability of the department from meeting this standard on a consistent basis if at all.

Company officers (captains and lieutenants) are working supervisors. They form an integral part of their company and it is often necessary for them to assume hands-on involvement in operations, particularly with companies that are minimally staffed, while simultaneously providing oversight and direction to their personnel. During structure fires and other dangerous technical operations, it is imperative that these officers accompany, and operate with, their crews to monitor conditions, provide situation reports, and assess progress toward incident mitigation. During structure fires, they operate inside of the fire building.

When they are on duty, the deputy fire chief serves as the incident commander and is responsible for the command, coordination, and direction of all emergency scene operations including supervision of the captain and lieutenants. They are the one who looks at the entire incident "big picture" and insures that, for instance, ventilation operations are being coordinated with fire attack operations, and that accountability for all personnel is being tracked and maintained. Once the deputy chief assumes command of the incident, the captains and lieutenants are then able to focus on the completion of specific tasks that have been assigned to their respective companies, such as interior fire attack, rescue, ventilation, and/or water supply. In Dracut, after 6:00 PM, one of the deputy chiefs, or the fire chief, fill this role by responding from home. However, this can leave a gap in the in command and control functions at a fire incident, particularly in the critical first minutes. The situation is compounded by the fact that Dracut operates with minimal staffing on their fire units.

All of these factors must be taken into consideration as Dracut reaches consensus on the acceptable community fire safety risk level, affordable levels of expenditure for fire protection, and appropriate levels of staffing. While four-person firefighting crews have been shown to be highly effective, the MRI study team recognizes that fiscal constraints in most municipalities necessitate creative staffing patterns that include cross-manning of apparatus and effective use of automatic aid and mutual aid to reach the objectives established in NFPA 1710 and NFPA 1500.

The town the size of Dracut averages about 80 structure fire dispatches a year. This is about average for a community this size. Though the department provided information on types of calls they responded to, they were unable to provide data on how many times they complied with NFPA 1710 by having all units initially dispatched to a structure fire, and sixteen personnel, on the scene within eight minutes. NFPA requires a 90% compliance rate for this benchmark. The fire department staff was only able to supply information to the MRI study team regarding initial response times.

It appears from the statistics that the study team analyzed that annual emergency incidents, handled by the Dracut Fire Department will continue to remain relatively consistent. However, as the town continues to experience growth and development, a gradual but steady increase in workload should be anticipated. Recommendations found in this and other chapters in this report seek to provide a blue print for Dracut to be able to more effectively and efficiently meet these challenges.

Recommendations

3.2-1 The Town of Dracut and Dracut Fire Department should continue to work to improve the department's staffing levels in order to increase operational effectiveness, efficiency and safety. Regardless of the method utilized to fund the necessary positions, the Town of Dracut should take steps to ensure that all three district stations and their engines are staffed with a mimimum of three (3) personnel 24/7. This is not only an important operational consideration, it is also a major safety concern that could impact both firefighters and citizens. Minimum on duty staffing should be nine (9) personnel, three (3) at each station.

3.2-2 Through the utilization of automatic and mutual aid agreements with neighboring communities, the Dracut Fire Department should attempt to achieve a goal of having a minimum of 16 personnel on the scene of any reported structure fire within eight (8) minutes of dispatch.

3.2-3 The Dracut Fire Department, in consultation with the town administration, should analyze the short and long term benefits, commitment and any potential liabilities for the town of applying for a Staffing for Adequate Fire and Emergency Response (SAFER) Grant. Being awarded a SAFER grant could have a significant positive impact on the fire department's chronic staffing shortage which will result in improved public safety. The key decision the town would need to make is if they could continue to afford the additional personnel after the grant funding ends in several years.

3.2-4 Contingent upon the town's conclusions regarding recommendation #3.2-3, above, the Town of Dracut should apply for a Staffing for Adequate Fire and Emergency Response (SAFER) grant for four to eight additional personnel stating a desire to more fully comply with the requirements of NFPA 1710.

3.2-5 The Town of Dracut should give consideration to negotiating with the collective bargaining agent for the purpose of designating the current captains of the Dracut Fire Department as the platoon commanders who respond in the command SUV. The captain should then be relieved of responsibilities as a company officer so that he/she can focus his/her efforts on supervising the overall on duty group and serving as the incident commander. The captain on should be replaced by a lieutenant as the company commander at Station 1. The captain should be expected to perform all of the duties that are specified in the Massachusetts promotional examination criteria for fire captain. The deputy chiefs and chief should still continue to respond as per current protocol.

3.3 OSHA TWO IN/TWO OUT COMPLIANCE

Overview

Beyond the NFPA standard(s), which as standards do not normally carry the weight of regulation or law unless they have been formally adopted by statute, regulation, or reference, is the Occupational Safety and Health Administration (OSHA) Respiratory Protection Standard, CFR 1910.134 which does carry the weight and force of regulation, thus making compliance mandatory. One key provision of the Respiratory Protection Standard that is directly applicable to fire department staffing is known as the "Two-In/Two-Out" rule. The purpose of this requirement is that there are at least two firefighters outside the hazard area to initiate a rescue of the firefighters inside, should they become lost, trapped, or disoriented, during the initial stages of the incident where only one crew is operating in the hazard area.

In brief, this regulation specifies that anytime firefighters operate in an environment/ atmosphere that is "immediately dangerous to life and health" (IDLH), whenever two members enter the IDLH area together, as a team, they must maintain visual, or voice, communication with each other, and with two additional firefighters who must remain outside of the IDLH atmosphere, prepared to render immediate emergency assistance to those inside. This assists in assuring accountability within the team. They must operate together as a team the entire time they are in the hazard area. At no time, under any circumstances are they permitted to separate from one another. If one firefighter has to exit the hazard area, for any reason, such as their air supply getting low, they must both exit. Fire department operating guidelines should also mandate that once a second crew is assigned or operating in the hazard area, the incident is no longer considered in the initial stages and a dedicated firefighter assist and search team or rapid intervention crew is required.

To comply with the "Two-In/Two-Out" rule, a team of four firefighters must be assembled before an interior fire attack can be made when the fire has progressed beyond the incipient stage, except in an imminent life threatening situation when immediate action could prevent the loss of life, or serious injury, before the team of four firefighters is assembled. The rule does not apply in emergency rescue situations where a person is visible, and in need of immediate rescue, or there is credible and reasonable information that potentially viable victims are still in need of rescue.

OSHA also emphasizes that the two-in/two-out provision, like all OSHA standards, states a minimum requirement. OSHA requires that one of the two firefighters outside must be dedicated to accounting for the two firefighters inside, and, if necessary, initiate a fire fighter rescue. The other firefighter is permitted to take on other roles, such as incident commander in charge of the emergency incident, safety officer, or equipment/pump operator. However, the second firefighter outside cannot be assigned tasks that are critical to the safety and health of any other employee working at the incident. Regardless of the size of the team, the least desirable situation would be to have only a single outside crew member, particularly one whose attention is focused on performing support functions rather than on monitoring the firefighters inside.

NFPA 1500, Standard on Fire Department Occupational Safety and Health Program (2013 edition) also contains key provisions regarding the "Two-In/Two-Out" rule.

Observations

The MRI study team did not evaluate the performance of the Dracut Fire Department during actual firefighting operations. Although there was no SOG to that effect, the majority of department personnel interviewed stated that the department usually utilizes the incident management system for the command and control of emergency incidents. However, the MRI study team also heard anecdotal reports of fire ground operations that did not follow IMS protocol. A special effort should be made to educate all Dracut firefighters and command staff in the value of improved firefighter safety provided by a well-organized and managed event.

MRI does realize that it may not be possible to assign all of the necessary incident command system (ICS) functions at a major incident until the arrival of mutual aid units or off-duty personnel, which is not unusual for fire departments throughout Massachusetts. For example, the critical role of on-scene safety officer may not be filled until the arrival of an off-duty or mutual aid command officer. Critical safety decisions during the early stages of an incident must be made by the incident commander, or a junior officer, who would also be responsible for immediate tactical responsibilities such as scene size-up, rescue, fire attack, water supply, and ventilation. Standard operating procedures (SOPs), standard operating guidelines (SOGs), and automatic aid agreements with neighboring department should be in place to address ICS capabilities.

Dracut does not have a specific SOG stating that the "Two-In/Two-Out" rule was required as part of department operations. With the department routinely operating with two (2) person engine companies, and even under the best of circumstances, three (3) person companies the department will rarely ever be able to meet the provisions with only the initial unit on the scene. When these are normal operating conditions it is not uncommon for this important safety requirement to be ignored, or generally not enforced. We believe this is probably the reality in Dracut as it is with many other fire departments.

Recommendations

3.3-1 The Dracut Fire Department should establish a Two-In/Two-Out Standard Operating Guideline (SOG) that complies with nationally recognized standards and regulations.

3.3-2 The Dracut Fire Department should develop a training program that reinforces the Two-In/Two-Out SOG based on current staffing levels with both two (2) and three (3)-person response crews. This training should be a part of the basic ICS training as well as fire ground operation training that should occur annually. The command level officers (chief and deputy chiefs) should carefully monitor and strictly enforce the Two-In/Two-Out requirements.

3.3-3 If a unit arriving on the scene of a fire incident is going to employ the Two-In/Two-Out exception due to imminent rescues, or credible information that there are viable victims, they should be required to announce this on the radio stating their reasons for non-compliance. The company officer should also be required to complete a separate, detailed narrative report regarding the non compliance at the conclusion of the incident.

3.4 RESPONSE TIMES

Overview

The appropriate deployment of resources is critical to the ability of any fire department to effectively, efficiently, and safely fulfill its core public safety and fire protection mission. In determining an acceptable level of risk, elected officials in every community must ask questions about the fire and EMS resources, such as: 1) how much do we need; 2) how much can we afford; and 3) how should those resources be positioned and deployed to provide maximum benefit to the community? These are never easy decisions especially when one considers the fact that virtually any decision on emergency service deployment that involves moving and/or relocating a resource, even for the considerable benefit of the community as a whole, may have a negative effect on at least a small percentage of the population.

From the perspective of stations and apparatus, there are three main factors that are used to help determine the deployment of resources: response time, travel distance, and call volume. For most evaluations, response time is the most critical factor for both fires and emergency medical incidents. It is not just a cliché that during critical life threatening situations, minutes and even seconds truly do count.

Heart attack and stroke victims require rapid intervention and care, and transport to a medical facility. The longer the time duration without care, the less likely the patient is to fully recover. Numerous studies have shown that irreversible brain damage can occur if the brain is deprived of oxygen for more than four minutes. In addition, the potential for successful resuscitation during cardiac arrest decreases exponentially with each passing minute that cardio-pulmonary resuscitation (CPR) or cardiac defibrillation is delayed.

Structural firefighting has become far more challenging and dangerous in the last thirty years with the introduction of significant quantities of plastic and foam based products into homes and businesses (*e.g.*, furnishings, mattresses, bedding, plumbing and electrical components, home and business electronics, decorative materials, insulation, and structural components). These materials ignite and burn quickly and produce extreme heat and toxic smoke. If firefighters cannot arrive in a timely manner and attack the fire quickly, a strong possibility exists that a dangerous flashover (simultaneous ignition of the all combustible materials in a room) will occur. Flashover can occur within five to seven minutes of fire ignition, and is one of the most dangerous events that a firefighter can face. When a flashover occurs, initial firefighting forces are generally overwhelmed and will require significantly more resources to affect fire control and extinguishment.

One of the areas that fire departments are being held increasingly accountable for are their response times. The performance and effectiveness of fire department operations can be significantly impacted by the time it takes for them to arrive on the scene of an emergency incident. The United States Fire Administration's (USFA) report, *Structure Fire Response Times,* has a useful framework for total emergency incident response time including definitions and components. The same report notes that about half of structure fires confined to the room of origin (51%) and confined to the floor of origin (51%) had a response time of less than 5 minutes. More than half of fires confined to the building of origin (54%) and nearly half of fires beyond the building of origin (49%) had a response time of less than 6 minutes.

As previously noted, NFPA 1710 – *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* (2010 Edition), is the nationally recognized consensus standard on staffing and deployment by career fire departments.

- Paragraph 4.1.2.1 states that the first arriving engine company shall arrive at the scene of a fire suppression incident within four minutes or less and/or the entire full first alarm response should arrive on scene within eight minutes. For EMS incidents, a unit with first responder or higher-level trained personnel should arrive within four minutes, and an Advanced Life Support (ALS) unit should arrive on scene within eight minutes.

- Paragraph 4.1.2.2 requires the establishment of a 90% performance objective for these response times.

NOTE: *The four-minute response time is from when the units are physically moving to the incident. One minute can be added for call processing and dispatch, and one minute can be added for turnout time, that is from when firefighters in the station are notified, until they are actually responding, providing six total minutes from the time the 9-1-1 call is answered until the first unit arrives on location.*

Insurance Services Office (ISO) Response Criterion

Another method of determining the appropriate deployment of resources is the fire company travel distance model employed by the Insurance Services Office (ISO) to assist them with determining the Public Protection Classification (PPC) rating that is utilized for determining fire insurance rates by participating insurance companies. Under the ISO deployment and coverage model, in order to obtain maximum point value for this particular component of an evaluation, the first due engine company should be within 1.5 miles' travel distance of every location within their first due response area. The first due ladder company should have a travel distance of no more than 2.5 miles. Travel distance is one of several factors that can have an impact on response time and is usually the most significant.

In evaluating a community's public fire protection, ISO considers the distribution of fire companies. ISO data also shows that risks located more than five (5) but less than seven (7) road miles from a responding fire station with a creditable water source within 1,000 feet had better loss experience than those farther than five (5) road miles from a responding fire station and/or with no creditable water source.

The RAND Corporation conducted extensive studies of fire department response times. They concluded that the average speed for a fire apparatus responding with emergency lights and siren is 35 mph. That speed considers average terrain, average traffic, weather, and slowing down for intersections. Those benchmark criteria produce an expected response time of 3.2 minutes for an engine company and 4.9 minutes for a ladder/service company, based on a formula developed by RAND. ISO, working with several fire departments, recently conducted its own review of the formula and found the earlier RAND research still valid as an evaluative tool.

EMS Response Times

As a percentage of overall incidents responded to, it could be argued that EMS incidents constitute the greatest number of "true" emergencies, where intervention by trained personnel does truly make a difference, sometimes literally between life and death. Heart attack and stroke victims require rapid intervention, care, and transport to a medical facility. The longer the time duration without care, the less likely the patient is to fully recover. Numerous studies have shown that irreversible brain damage can occur if the brain is deprived of oxygen for more than four minutes. In addition, the potential for successful resuscitation during cardiac arrest decreases exponentially with each passing minute that cardio-pulmonary resuscitation (CPR), or cardiac defibrillation, is delayed.

The EMS component of the emergency services delivery system is more heavily regulated than the fire side. In addition to NFPA 1710, NFPA 450 *Guidelines for Emergency Medical Services (EMS) and Systems*, (2009 edition) provides a template for local stakeholders to evaluate an EMS system and to make improvements based on that evaluation. The Commission on Accreditation of Ambulance Services (CAAS)[1] also promulgates standards that are applicable to their accreditation process for ambulance services.

Since the 1970s, arriving within eight minutes of receipt of an emergency call, 90% of the time, has been the recognized benchmark for determining the quality of an EMS system. Today, the national standard of care benchmark based on stroke and cardiac arrest protocols has evolved to have an emergency response unit on scene at a medical emergency within six minutes of receipt of the call. Paragraph 4.1.2.1(4) of NFPA 1710 recommends that for EMS incidents a unit with first responder or higher level trained personnel, and equipped with an AED should arrive on scene within six (6) minutes of the receipt of the emergency call (at the dispatch center), and an advanced life support (ALS) unit should arrive on scene within ten (10) minutes (eight (8)

[1] The Commission on Accreditation of Ambulance Services (CAAS) is an independent commission that established a comprehensive series of standards for the ambulance service industry.

minutes of response). According the NFPA 1710, *"This requirement is based on experience, expert consensus, and science. Many studies note the role of time and the delivery of early defibrillation in patient survival due to heart attacks and cardiac arrest, which are the most time-critical, resource-intensive medical emergency events to which fire departments respond."* CAAS recommends that an ambulance arrives on scene within eight minutes, fifty-nine seconds (8:59) of dispatch.

Typically, less than ten percent (10%) of 9-1-1 patients have time sensitive ALS needs. But, for those patients, time can be a critical issue of morbidity and mortality. For the remainder of those calling 911 for a medical emergency, though they may not have a medical necessity, this ninety percent, still expect rapid customer service. Response times for patients and their families are often the most important issue regarding the use the fire department's services, and, are what most often refer to when they "rate" their local emergency responders. Regardless of the service delivery model, appropriate response times are more than a clinical issue; they are also a customer service issue.

Observations

One of the criterion for evaluating the Dracut Fire Department's effectiveness is to examine their response times. It was anecdotally reported to the study team that on average the Dracut Fire Department arrives on location in about three minutes (00:03:00) to three minutes, thirty seconds (00:03:30). However, the fire department was unable to provide the MRI study team with reliable data that would have allowed us to properly evaluate various aspects of the department's response times. Apparently the fire department's current incident reporting software/database is unable to develop these types of reports as it does not have the capability to extract this information through a query or search function. As a result, an effort to compile this data would have needed to be done manually, an unreasonably labor intensive and time consuming task, with uncertain reliability in the results. The fire chief did inform the MRI team that the department was evaluating new software and had begun training some personnel in its use.

For a typical response time evaluation, at a minimum, MRI would like to review the following information:

- Average response time of first firefighting unit to arrive on scene
- Average response time of first ambulance to arrive on scene
- Average ALS response time
- Average response time of first IC/chief officer to arrive on scene
- Average response time for full complement of Dracut firefighters to arrive on scene
- Average response time for full NFPA compliant response

- All of the above actions broken down by minutes to determine NFPA 1720 compliance and 90th percentile response time
- Call processing time (receipt to dispatch)
- Turnout time (dispatch to response)

The Dracut Fire Department's fire dispatch and fire incident software does not maintain this data. The MRI team was able to review limited response data that was provided to us from the department's National Fire Incident Reporting System (NFIRS) filings for the past three years. We were also provided with a report from the fire department that they produced by reviewing their internal records. A review of this information allowed the completion of a very basic response time analysis (Figure3-5).

FIGURE 3-5
DRACUT FIRE DEPARTMENT AVERAGE RESPONSE TIMES

YEAR	2011	2012	2013	2014	2015
#100 SERIES (ACTUAL FIRE INCIDENTS)	66	80	64	59	57
TOTAL MINUTES FOR RESPONSE	340	404	368	324	340
AVERAGE MINUTES - 1ST DUE ENGINE CO.	5.1	5.4	5.7	5.5	5.9
AVERAGE MINUTES - BLS AMBULANCE		5.9	5.6	5.2	5.3
AVERAGE MINUTES - ALS RESPONSE UNIT	DATA UNAVAILABLE				
DOES NOT INCLUDE MUTUAL AID RESPONSES BY THE DRACUT FIRE DEPARTMENT					

Patriot Ambulance's average on scene arrival time is reported to be between five minutes (00:05:00), and five minutes, twenty seconds (00:05:20). However, statistics that would have supported these times and could be fully analyzed were not available. In addition, the information regarding EMS responses for the Lowell based ALS Unit were also unavailable.

Response times can be impacted by the number of resources a community can support as well as the number of incidents that may occur in a community. Every emergency services organization periodically experiences simultaneous, or overlapping, incidents. Whether they are handled by that department themselves, or through automatic/mutual aid, provisions need to be made to insure that these incidents are handled effectively, efficiently, and in a timely manner. However, as the number of simultaneous, or overlapping, incidents increases, that community and/or department can no longer rely on their neighboring communities/ departments to handle an ever increasing percentage of their incidents. This a key benchmark in the need to consider increasing the number of available resources that are in service.

The Dracut Fire Department was unable to provide data that would allow analysis of the overall number of simultaneous fire or other emergency incidents. However, the department was able to produce a report that showed that nearly twenty percent (20%) of EMS incidents occur simultaneously another EMS incident. With an average of just over six (6) EMS incidents per day this number of simultaneous incidents seems to be higher than would be expected. The information supplied by the fire department also did not take into account any other fire related incident that the department may have been dispatched to during that time.

<u>Recommendations</u>

3.4-1 Working in conjunction with the Town of Dracut's IT provider, the Dracut Fire Department should continue to explore options for replacing the current dispatch and fire incident data bases/records management systems with a cloud based high connectivity platform that better serves the needs of the department. Should this occur all fire department operations should be transitioned to use one database system to capture, store, and analyze data currently stored in different systems. Working with the IT provider, they should explore a customizable, software solution that addresses all fire department needs.

3.4-2 The Dracut Fire Department should take steps to be able to fully analyze the following response time related data and information:

- **Average response time of first firefighting unit to arrive on scene**
- **Average response time of first ambulance to arrive on scene**
- **Average ALS response time**
- **Average response time of first IC/chief officer to arrive on scene**
- **Average response time for full complement of Dracut firefighters to arrive on scene**
- **Average response time for full NFPA compliant response**
- **<u>All of the above actions broken down by minutes to determine NFPA 1720 compliance and 90th percentile response time</u>**
- **Call processing time (receipt to dispatch)**
- **Turnout time (dispatch to response)**

3.4-3 The Dracut Fire Department should work with the provider selected to provide transport EMS within the community to analyze their response times to all incidents within the town to assist with determining compliance with established standards, benchmarks and contracts.

3.4-4 The Dracut Fire Department should work with the provider selected to provide transport EMS within the community and Lowell General Hospital to analyze their response times to reported incidents that meet ALS dispatch protocols within the

town to assist with determining compliance with established standards, benchmarks and contracts.

3.4-5 The Dracut Fire Department should track and analyze the number of simultaneous or overlapping incidents that occur each month in the town. Part of this analysis should include time of day to determine times when incident activity is at its highest or spikes.

3.4-6 The Dracut Fire Department should work to comply with the response time requirements for various types of incidents found in NFPA 1710 including first unit on scene, ALS unit on scene, and full first alarm assignment for reported structure fires.

3.4-7 The Dracut Fire Department should work with the Town GIS personnel to develop and post incident location and response time projection maps. This information should be posted in each station to provide personnel with a perspective relative to where incidents most frequently occur and expected response times based on travel distance.

3.5 MUTUAL AND AUTOMATIC AID

Overview

Mutual Aid is a widely used and accepted model for providing fire and EMS services within most communities in the case of multiple alarm fires, mass casualty incidents (MCIs) or large-scale hazardous material incidents. The municipality where the emergency is occurring may call in resources from surrounding towns to either respond directly to the scene or take up quarters in their fire and EMS stations and respond to other incidents in that city or town when local crews are handling a protracted incident. It is an essential component of every fire department's operation. No municipal fire department can, or should, be expected to have adequate resources to respond to every type and sizes of emergencies. Mutual aid is shared between communities when their day-to-day operational fire rescue and EMS capabilities have been exceeded, and ensures that the citizens of the community are protected even when local resources are overwhelmed. Fire department mutual aid is almost always provided without financial charge to the municipality that requires assistance.

In most towns, local emergency crews are capable of handling the majority of incidents themselves; however, in the case of larger or more serious incidents, surrounding municipalities will often respond along with the local resources. Mutual aid can either be automatic (sent at the time of initial dispatch) or requested as needed. With mutual aid, the incident commander (IC) of an incident will request either predetermined resources, or may indicate specialized resources required to successfully mitigate the incident he/she is commanding. Since they all rely on, and benefit from the system, mutual aid is usually always reciprocal between the participating communities.

Automatic aid operates under the same concept as mutual aid. The main difference is that with automatic aid the additional resources are dispatched automatically, and immediately, at the time the incident is initially dispatched. There is no delay in waiting for the additional resources to be requested. Automatic aid is assistance provided 24 hours a day, 365 days a year and is dispatched automatically by contractual or mutual agreement between two communities or fire districts to all first alarm structural fires, or, to specific area of a town. In order for automatic aid to be effective it must be prearranged and should be in a written agreement according to a definite plan. For effective fireground operations and communications, the communities should have common dispatch and tactical radio frequency capability, and, standard operating procedures/guidelines.

In order to get as many resources to the scene as quickly and safely as possible, and attempt to meet the staffing and response time benchmarks established in the NFPA 1710 standard, many fire departments today rely on automatic aid. The fire department and the towns will enter into formal agreements similar to the mutual aid agreements that most communities have. Massachusetts General Law Chapter 48, Section 59A allows communities to authorize their fire departments to go to the aid of others for extinguishing fires and rendering other emergency assistance

Observations

The Dracut Fire Department is fortunate to participate in an active and robust mutual aid response system for fire, hazardous materials, and EMS operations. The department is a member of Massachusetts Mutual Aid Fire District 6, as well as, Border Area Mutual Aid (BAMA), a group of over 30 Massachusetts and New Hampshire fire departments including Lowell, and Nashua and Manchester NH. Fire District 6 coordinates the mutual aid response of Massachusetts fire departments in the greater Lowell area. The BAMA has not been an active group over about the past five (5) years; however, the member departments continue to rely on the organization and its agreements that were initiated many years ago in order to provide mutual aid to communities in both states. Between Fire District 6 and Border Area Mutual Aid the following services and activities are available to member communities:

- Centralized communications control center for mutual aid activities
- Operation of a multi-channel radio system for dispatch and coordination of firefighting apparatus and emergency medical units
- Mobile command and communications vehicle for complex operations
- Ten alarm running card system for coordination and deployment of apparatus, personnel and other resources
- Regional hazardous materials response team (funded by the MA Department

of Fire Services)

- ➢ Mobile air supply unit for refilling self-contained breathing apparatus at incidents
- ➢ MBTA evacuation and rehabilitation buses
- ➢ Fire safety house trailer for fire prevention and training purposes
- ➢ Critical incident debriefing team

The Dracut Fire Department uses a standard ten (10) alarm dispatch and response system that is developed not only to respond additional resources to the incident scene but also provide necessary resources and staffing to cover the Town of Dracut should the incident continue to escalate and require additional resources at the scene, or, to handle others incidents that may occur simultaneously (See Appendix D). This is the foundation and basis of the regional mutual aid agreements. This regional response model has worked effectively for many years in Massachusetts.

The Dracut fire department relies heavily on mutual aid for any significant incident as does also every community in the region and in fact in the commonwealth. The Dracut Fire Department does not participate with any of the surrounding fire departments in automatic aid agreements. Any assistance that is required is requested either based upon conditions encountered upon arrival on the incident scene, or based upon information that the dispatcher may be relaying to the responding units. As soon as an incident is determined to be a working fire the run card, or box, is filled out and additional resources requested and dispatched. However, this results in a delay in getting resources to the scene as quickly as possible.

The MRI study team feels strongly that in order for the department to meet NFPA 1710 staffing and response time benchmarks for first alarm structure responses that serious consideration should be given to entering into these agreements with surrounding communities. With a maximum of only nine (9) personnel on duty at a time, Dracut has no chance of meeting the NFPA 1710 benchmarks without the use of automatic aid. Figure 3-6 shows Dracut's mutual and automatic aid activity for 2013 through 2015. Figure 3-7 shows mutual aid that Dracut provided, by type of incident, for 2013 and 2014. Figure 3-8 shows mutual aid given and received, by town, from 2013 through 2015.

FIGURE 3-6
DRACUT FIRE DEPARTMENT MUTUAL AND AUTOMATIC AID 2013 – 2015

YEAR	2013	2014	2015
Mutual Aid Received	8	7	2
Automatic Aid Received	0	0	0
Mutual Aid Provided	25	22*	27
Automatic Aid Provided	0	0	0
Mutual/Auto Aid Involving Structure Fires	9	11	10
*Cancelled While Enroute 2 Times			

FIGURE 3-7
DRACUT FIRE DEPARTMENT MUTUAL AID GIVEN BY TYPE OF INCIDENT

INCIDENT TYPE	DESCRIPTION	TOTAL # OF INCIDENTS	2013	2014
111	Building fires	12	4	8
142	Brush, or brush and grass mixture fire	1	1	0
571	Cover assignment, standby, move up	34	20	14
611	Dispatched & canceled in route	2	0	2
	TOTAL AID GIVEN	49	25	24

FIGURE 3-8
DRACUT FIRE DEPARTMENT MUTUAL AID GIVEN/RECEIVED BY TOWN

TOWN	2013		2014		2015	
	Received	Given	Received	Given	Received	Given
Lowell	7	4	4	3	0	5
Lawrence	1	9	0	13	0	5
Pelham, NH	4	3	4	7	0	8
Tyngsborough	4	2	1	1	0	1
Methuen	3	1	2	0	0	2
Hudson, NH	0	2	0	0	0	2
Windham, NH	0	1	0	0	0	0
Nashua, NH	1	3	0	0	0	1
Salem, NH	1	0	0	0	0	0
Leominster*	0	0	0	0	0	1
Devens*	0	0	0	0	0	1
DFS Dist. 6 Haz Mat*	0	0	0	1	1	0
MA State Police EOD	1	0	0	0	0	0
MA DCR Forestry	1	0	0	0	0	0
TOTAL	23	25	11	25	1	26

It is the current policy of the Dracut Fire Department to send Engine 1, with three (3) firefighters including the officer, on all requests for mutual aid. This procedure is necessary in order to satisfy the minimum staffing response criteria established by Fire District 6. However, this implication to Dracut is this response results in the only engine staffed with three (3) personnel and the shift commander (if there is no deputy chief on duty) leaving the town. Once the town completes the enhancements to staffing they are currently working with the fire department on (and is recommended in this report) the policy should be modified so that the closest engine company should be assigned on the mutual aid response.

Recommendations

3.5-1 The Dracut Fire Department should review and update their 10 alarm response cards and mutual aid plans and agreements on a regular basis. This should be done at least annually and whenever there is a change in status to resources, or significant change within the community.

3.5-2 The Dracut Fire Department should attempt to re-establish its relationship with Border Area Mutual Aid Association in order to further cultivate mutual and automatic aid agreements with area fire departments that are outside of the formal Fire District 6 response area, especially with those located in New Hampshire.

3.5-3 In consultation and cooperation with its neighboring departments, the Dracut Fire Department should enter into automatic aid agreements that specifies the number and types of resources that should be dispatched to various types of reported emergencies. While the numbers/types of resources should be determined based upon a risk management process or pre-fire/incident plan, these processes take time. In the interim, we recommend that, at a minimum, one (1) additional engine and one (1) additional ladder be immediately dispatched to every reported structural fire incident with a goal of achieving NFPA 1710 compliance (assuming Dracut is staffing all their engines with three (3) personnel). This will decrease response times as well as increase resources at incidents in Dracut.

3.5.4 Since there are still areas of Dracut that are not covered by the municipal water supply system the Dracut Fire Department should develop automatic aid agreements for the immediate response of two (2) or more water tenders/tankers to any reported structural fire incident. Once the incident is determined to be a working incident additional tenders/tankers should be dispatched. The department should also develop standard operating guidelines (SOGs) for these types of incidents.

3.6 SPECIAL OPERATIONS

Overview

In addition to responding to the normal fires, motor vehicle accidents, and EMS incidents that occur every day, most fire departments are occasionally faced with incidents that are more complex and/or require more specialized skills to mitigate. These "special operations" incidents encompass special disciplines within the emergency services that include responses to hazardous material releases, water and ice rescues, structural collapses, and, high angle, confined space and other technical type rescues. These incidents are often very labor intensive requiring a large number of personnel with specialized training and resources to successfully mitigate.

It is nearly impossible or any fire department to be trained and equipped for every type of incident that can occur in their community. The geography, infrastructure, hazards, and construction features within the community all play a major role in determining the composition of each department's unique and individualized special operations and equipment inventory needs. Determining a community's target hazards and the probability of a potential incident at that facility often determine what special operations that a department will invest time and resources in training and preparing for.

Most fire departments will require all of their firefighters to have basic skills and knowledge to recognize the hazards present and operate safely at these incidents. Many departments will have some members with advanced training in each of these disciplines. This usually requires these members to become certified in specific specialty areas and periodically recertify their skills. In order to keep their skills up personnel with advanced training will often participate in various special operations teams that train several hours a month in addition to typical firefighting training.

Most fire departments cannot fund for these types of major, but very infrequent, incidents and few have the necessary staffing to handle them alone, so they participate in regional response teams. These regional response teams are usually comprised of members from fire departments throughout a specific region. The teams will train as a group regularly, and often will train with the fire departments within that region.

Regional emergency response teams develop and create contracts with local political entities to ensure public safety through the mitigation of hazardous materials and technical rescue incidents occurring throughout their area. Funding for these teams is often is collaboratively provided by those communities that participate on a prorated basis. In addition, funding is often available from the state government, federal grants such as those offered by FEMA, and from reimbursements by those who were responsible for an incident.

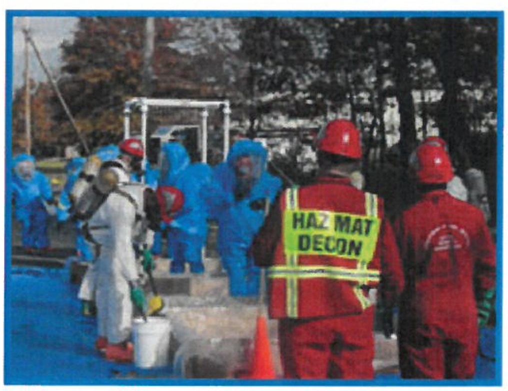


Figure 3-9: Regional hazardous materials response team training.

In 1994, through the cooperative efforts of the Executive Office of Public Safety, Fire Chiefs' Association of Massachusetts, the Professional Fire Fighters of Massachusetts, and, the Massachusetts Association of Hazardous Materials Technicians, a proposal was made to the commonwealth's administration and legislature for establishment of a funding mechanism to create a standardized regional response for the mitigation of all hazardous material incidents. It was determined that a regionalized approach to response would be the most effective. The state issued general obligation bonds to fund the creation and start-up of the program which established a statewide, standardized, hazardous materials regional emergency response plan. The funding enabled the commonwealth to provide state-of-the-art equipment and training (Figure 3-9) to the regional teams. A statewide mass casualty decontamination plan has also been created.

There are currently six (6) strategically located hazardous material teams throughout the state situated so there is a maximum of a one (1) hour response anywhere in the commonwealth. The regional teams also support local fire departments with technical information and specialized equipment. These teams are based on a partnership between local governments, the Office of State Fire Marshal, and private industry wherein resources are shared to create a program that is both economical and successful.

Larger fire departments often have a need to provide technical rescue responses on a more frequent basis, and as a result, establish their own teams or staff special rescue units. These fire departments will share their services for specialized or technical rescue incidents through mutual aid agreements. This also allows these teams to keep their skills sharp while working with surrounding communities that they often will respond with.

Observations

The Dracut Fire Department is equipped and prepared to respond for initial response to incidents that would require special operations capabilities. The department has basic equipment to respond to limited hazardous materials incidents such as gas leaks and fuel spills, ice and water rescues, basic building collapse, rope rescue, and confined spaces. This is typical of most departments this size. They are aware that they have the support of regional response teams, and they understand that their participation and partnership with these endeavors enhances the services that they provide to the citizens and businesses in Dracut.

All members of the department are certified at the hazardous material awareness level while some are certified at the operations level. The department does not have any hazardous materials technicians. Several members have received training and certification in various technical rescue disciplines.

The department is served by the Fire District 6 hazardous materials response team. As such, when it is determined that a hazardous materials incident is beyond the capabilities of the Dracut Fire Department, the incident commander will request assistance from the Fire District 6 team. This assistance required might be as simple as a technical consultation with the team leader by phone, or as complex and extensive as a turnout of the entire team with all of their resources depending on the size, complexity and risk of the incident.

The Fire District 6 team is comprised of members of fire departments through the region. The Dracut Fire Department currently has only one member of their department on the team. In discussions with the fire chief the MRI study team was informed that all costs for allowing department members to participate on the team must be borne by their department. The primary costs would be overtime payments for training when off duty, or, replacement costs when that member was on duty and there was training or an incident. The chief understands that there is a benefit to having department members trained and certified at that level and participating in regional endeavors but there are also budgetary considerations. Membership on these specialized teams often requires a significant time investment that many members are unable, or unwilling, to make.

The Dracut Fire Department has a boat and is capable of responding to water rescues. The department works in conjunction with the Methuen and Lowell fire departments for incidents on the Merrimac River. The MRI team is not aware if there have been any combined training exercises with these departments for these types of incidents.

For complex or specialized technical rescue incidents that exceed their capabilities, Dracut would initially request that the Lowell fire department respond for assistance. If still more assistance or resources are required, the Essex County Technical Rescue Team would be dispatched. This team was developed by the Essex County Fire Chiefs Association (ECFCA). The team is able to provide a wide variety of resources to enhance and supplement special operations capabilities and responses in the region through the development and utilization of regionalized assets and specialized response teams tasked with specialized firefighting and rescue skills and resources. The team is comprised of members of fire departments from the county who provide training, education, incident response and support.

Figure 3-11: Essex County Technical Rescue Team training. Photo credit: The Eagle-Tribune 9/15/2013

The Dracut Fire Department does not have any members of their department on the team. In discussions with the fire chief the MRI team was informed that the cost for allowing a department member to participate on the team was cost prohibitive because of budget restraints and time commitments.

One of the industries in town that the Dracut Fire Department is acutely aware of, and, has developed response plan for Brox Industries, an industrial paving business with large machinery, equipment, and quarries that have potential for the need of technical rescue incidents including, high angle rescue, confined space, trench and water rescue. The plant has an in-house rescue team that works with the fire department in the event of an incident at the site. This type of partnering to responses should be encouraged and expanded.

The MRI team's assessment of the capabilities of the Dracut Fire Department to respond to these types of incidents was developed primarily through conversations with the fire chief and members of the department's senior staff. The MRI study team did not observe any special operations training or responses. A review of the department's SOGs did not indicate any specific protocols or procedures regarding response to these incidents other than response cards for dispatch of resources to these incidents

Recommendations

3.6-1 The Dracut Fire Department should continue partnering with and utilizing the Fire District 6 Hazardous Material Response Team for technician level hazardous material incidents. Since this team supports and benefits the Town of Dracut, the Dracut Fire Department should encourage and support department members to join the team and actively participate in training and responses. Those members once trained will be able to have a positive impact on the level of response for the department for these types of incidents. Further, these members should be required to share their knowledge and skills with the Dracut fire department by conducting training classes for the department.

3.6-2 The Dracut Fire Department should continue partnering with and utilizing the Essex County Technical Rescue Team. Since this team supports and benefits the Town of Dracut, the Dracut Fire Department should encourage and support department members to join the team and actively participate in training and responses. Those members once trained will be able to have a positive impact on the level of response for the department for these types of incidents. Further, these members should be required to share their knowledge and skills with the Dracut fire department by conducting training classes for the department.

3.6-3 The Town of Dracut should consider providing additional funding to the fire department to enable increased members' participation with the Fire District 6 Hazardous Material Response Team and the Essex County Technical Rescue Team.

3.6-4 The Dracut Fire Department should attempt to increase their capabilities for responding to hazardous materials and specialized technical rescue incidents by increasing members' skill levels through training. The department should conduct periodic, joint training with these regional response teams, mutual aid partners, and private industry.

3.6-5 The Dracut Fire Department should attempt to increase their capabilities for responding to hazardous materials and technical rescue incidents by expanding their inventory of equipment such as specialized equipment for confined space entry, trench or building collapse, rope/high angle rescue, and rapid water. In developing a small capital plan for these purchases and investments the department must coordinate budgeting and planned purchases with their training budget and in coordination with the town.

3.6-6 The Dracut Fire Department should attempt to form partnerships with local industries and businesses for the purpose of having these stakeholders donate equipment that

the department could use at any time for special operations, but would specifically benefit those facilities.

3.6-7 Since operational level personnel can take defensive actions at a hazardous materials incident such as diking spilled materials, spreading absorbent, or vapor control, all Dracut Fire Department personnel should be trained to the hazardous materials operational level.

3.6-8 In order for them to be able to take initial actions at the scene of a technical rescue incident prior to the arrival of the county team, and support them throughout the incident, the Dracut Fire Department should consider providing operations level technical rescue training in various disciplines.

3.6-9 The Dracut Fire Department should develop SOGs regarding their roles, responsibilities, and operations at hazardous materials and technical rescue incidents. These SOGs should be developed in consultation with the appropriate specialized response team.

3.7 COMMUNICATIONS/DISPATCH

Overview

Fire Department dispatch and communications centers play an important part in delivering emergency services to a community. However, the method that they use to do this will differ from one community to another. In larger communities both police and fire departments may have separate dispatch centers, in some towns and regions they may consolidate both police and fire into a single center, and with budgets remaining tight there is increasing interest in the formation of regional emergency communications centers (RECC) as a way to reduce costs.

The initial call for emergency assistance is received at a public safety answering point (PSAP) which is a call center responsible for answering calls to 9-1-1 or other emergency telephone numbers for police, fire and EMS. A PSAP facility operates 24 hours a day, dispatching emergency services, or, passing 9-1-1 calls on to public or private safety agencies. Trained operators are responsible for taking the calls and dispatching the emergency services.

Most PSAPs can now identify caller locations for landline calls, as well as, determine the location of mobile phone callers. In Massachusetts each PSAP has between two and 12 answering point units (APUs). These receive land-line and wireless enhanced 911 emergency calls. For a land-line caller, the APU shows the name, address, and phone number of the caller. For a wireless caller, the system displays the address of the wireless tower that delivers the call, the mobile number, and the approximate location of the caller. All cities and towns in the commonwealth were required to provide complete street and number range information for their respective service area. This information is the basis for routing emergency calls to the proper PSAP.

Once the emergency services dispatcher is notified of an incident they will determine the appropriate resources in the department necessary to be initially dispatched. The dispatcher will determine what station(s) and/or apparatus should respond through the use of either a Computer Aided Dispatch (CAD) software, or, resource books and maps. Dispatch will then occur via a phone or voice notification system. Once the units are responding the dispatcher will coordinate communications with the responding units for the duration of an incident

Another important role that dispatch centers provide is collecting data and times regarding the incident. The dispatch center is also typically used by the department as a "switchboard" and will answer routine phone calls and direct them to the appropriate office. Some departments have added additional duties for dispatchers based on the emergency call volumes and the number of on duty dispatchers.

Observations

The MRI study team evaluated the Dracut fire dispatch center (also known as the "Radio Room"), which is located at the central fire station. The center is staffed by one (1) on-duty firefighter 24/7. The dispatcher is typically the firefighter with the lowest seniority. The fire chief has recently required that these firefighters also have time working at other fire stations in town for firefighting training, and, to develop familiarity with the town.

All emergency calls for fire, EMS, and police are initially received at the Dracut Police Department communications center, which is the town's PSAP. All 9-1-1 calls for fire and emergency medical incidents are either transferred to the fire dispatcher from the police dispatcher, or, the police dispatcher takes the necessary information then calls the fire dispatcher to relay it.

The fire dispatch center console has two positions but is typically staffed with a single-position. The second position can be staffed during multiple alarm fires, or, when severe weather is expected or occurs. There is no back-up system redundancy to the facility. If the fire dispatch center is disabled for any reason, the police communications center could take over the dispatching function on an emergency basis; however, they would not have the capability to receive building fire and sprinkler alarms that are transmitted over the municipal fire alarm system. The fire dispatch center is the sole receiving point for the municipal fire alarm and radio call boxes with no alternative, redundant receiving point.

In addition to the Dracut Fire Department's operational frequency, the fire dispatch center console is equipped with the mutual aid fire frequencies. All radios have been converted to "narrow-band" frequencies in accordance with FCC requirements for public safety communications. The department uses a microwave system to boost the radio signal for adequate signal propagation throughout the town. Back-up microwaves are located throughout town.

Once an emergency call or box alarm has been received at the fire dispatch center, the dispatcher transmits an alert message over the fire department radio frequency. The alarm is received at each fire station on a radio receiver and is broadcast throughout each building on a public address system. Fire department personnel who are out of quarters receive the notification via apparatus mobile radios, or, personal portable radios.

The fire dispatch center is equipped with a Zetron™ voice communications system that can transmit messages to the fire stations over the municipal alarm system. Because the municipal alarm system is powered by storage batteries, this voice communications capability is a reliable, redundant method for transmitting alarms, and, for receiving messages from the fire stations.

When a 9-1-1 call is received by the police communications center, an incident report is initiated via the IMC computer aided dispatch (CAD) system. The CAD system automatically fills in the call taker, date, and time information. When the fire department receives the call the fire dispatcher enters data into the fire department's Fire Programs software system, including responding and arrival times, situation found, "under control" time, and the times that apparatus is back in quarters. Fire officers enter additional fire incident reporting data on the report after the incident; this data is eventually submitted to the Massachusetts Department of Fire Services for inclusion in the statewide fire incident reporting data collection system.

Most fire department personnel including the firefighter dispatchers are EMTs, and, all personnel including the department's civilian administrative assistant have received training in emergency medical dispatch (EMD) procedures, which is a system for categorizing the severity of medical emergencies, and if necessary, providing step-by-step potentially lifesaving medical instructions over the phone to civilians who are on the scene of an emergency incident. The dispatcher can instruct a civilian how to perform CPR, clear an airway, stop bleeding, and even deliver a baby. However, effective EMD delivery is not possible with only one dispatcher who is also responsible for dispatching the apparatus, handling two-way radio traffic, handling incoming telephone calls, and, other critical communications functions.

The dispatch center is located in the front of the building at the central fire station. Since citizens may have to enter the building to conduct business at the fire department administrative offices, the radio room is often unsecured and the door is usually open allowing direct access to the radio room. The MRI team found security in the building to be minimal, which is a concern especially when there might be only one person remaining in the building. The on-duty dispatcher is also the "greeter" for people entering the station, as well as, answering and routing the fire department's non-emergency telephone lines.

During the course of this assessment the MRI team was informed that the Dracut Fire Department was in the process of entering into an agreement to participate in a new RECC to be located in Tewksbury. This is to be built and equipped through a grant awarded from the state 911 department. These grants, known as Support and Incentive Grants were initiated to assist various PSAPs and RECCs in providing enhanced 9-1-1 service and to encourage the development of regional PSAPs, regional secondary PSAPs, and RECCs. Unfortunately, the project was on a temporary hold due to the fact that the state 9-1-1 department was considering withholding funding for the project. The fire chief informed the MRI team that the town administration and local state representatives had met with the 9-1-1 secretary at the state house to try to persuade them to reconsider funding the building of the RECC. The fire chief believed that ultimately there would be a favorable outcome.

The plan for a new regional, consolidated fire, EMS, and police dispatch operations center located in a new Tewksbury facility will significantly improve overall incident and resource coordination throughout the region. If fire dispatch operations are moved to the RECC, the Town of Dracut will avoid the cost of upgrading the equipment and software necessary for stand-alone fire dispatch center. In addition, the time required for call handling and dispatching could be reduced because of the efficiencies provided by a single facility. Coordination of resources (fire, police, and EMS) at emergency scenes could also be improved because all communications would be coordinated through a single point-of-contact.

Communications

The Dracut Fire Department has a portable radio available for each on duty member. This is consistent with the current best practice in the fire service that every firefighter who is wearing SCBA and/or entering an atmosphere that is immediately dangerous to life and health (IDLH) should be equipped with a portable radio. The rationale is that should a firefighter become trapped, lost, disoriented, or experience any other type of emergency, he/she can summon help on the portable radio. Many departments now have a portable radio assigned to either every riding position on every piece of apparatus, and/or to every on duty member.

Mobile communications are provided by means of mobile radios in each fire department vehicle, and, portable two-way radios that are assigned to on-duty personnel. Each position on the apparatus is assigned a portable two-way radio. The department acquired new EF Johnson two-way portable radios in about 2014 as part of a radio interoperability project in the Fire District 6 mutual aid region. These radios comply with the Project 25 interoperability criteria as mandated by U.S. Department of Homeland Security (DHS) grant requirements. The department is in the process of replacing their older Motorola model HT 1000 portable radios.

The department does not utilize mobile data terminals (MDTs) in the apparatus or command and staff vehicles. These rugged laptop computers or tablets are normally installed in the fire apparatus in order to enable fire officers and firefighters to access critical information about buildings, pre-incident plans, and hazardous materials. Dracut personnel current do not have direct access to this information.

Recommendations

3.7-1 The Town of Dracut should continue to take whatever administrative and political steps are necessary relative to obtaining funding for the RECC. State 9-1-1 grant funding is available to underwrite both start-up and ongoing operational costs associated with regionally coordinated efforts such as this that will improve emergency incident communications and operations and do so in a more fiscally efficient manner. As of the writing this report, the funding has been secured to transition to a RECC with the Town of Tewksbury.

3.7-2 The combined RECC dispatch center should be staffed by civilian public safety dispatchers who have received thorough training on police, fire, and EMD dispatching procedures and operations. The dispatch center supervisor should also be a civilian who is able to focus on communications center operations, rather than a police officer who has other law enforcement duties. While the day-to-day operations of the center may fall under the management of the director of the RECC, Dracut's fire chief (along with all the other participating entities) should share responsibility for the development and implementation of dispatch and communications policies and procedures, and, evaluating dispatch personnel.

3.7-3 Once the new RECC is operational the firefighter on each shift who is assigned to dispatch duties should be reassigned to fire and EMS duties in Dracut, allowing the department's staffing level for emergency response to be increased by one (1) at no direct cost to the town.

3.7-4 The Dracut Fire Department should develop a plan to install mobile data terminals (MDTs) in all fire apparatus. In developing the MDT plan, consideration should be given to evaluating the latest technologies and software, including the use of tablets rather than laptop computers. At a minimum, the incident commander at a scene should have access to fire/incident pre-plans, building permit records (building plans and current data about renovation and construction projects), real-time weather data, and hazardous materials information.

3.7-5 The Dracut Fire Department should continue replacing its older radio equipment and perform a complete evaluation of its radio communications capabilities. All mobile and portable radios should be digital, narrow-band APCO P-25 compliant and interoperable with other city agencies, mutual aid fire departments, and mutual aid EMS agencies. If the portable radios that were received from the Fire District 6 mutual aid district are

available and functional the town should consider the development of a capital plan to replace the portable radios in the future.

3.7-6 The Dracut Fire Department should upgrade the base radio stations located at each of the town's fire stations. Base stations connect to external antennas and provide more power than typical portable radios. They are not mobile, so they should only be used in environments where they can be used from a fixed location. This is a back-up communications system that will allow each station to communicate directly with fire dispatch as well as fire units and mutual companies.

3.7-7 The Dracut Fire Department should take immediate steps to improve the security of the fire dispatch center. At a minimum, we recommend the following:

- **The door to the radio room should be closed and secured and no one except the dispatcher, including other on-duty firefighters, should be 'hanging out" in the area unless they are required to be in room for department business.**
- **Installation of an appropriate barrier on the exterior of the building to provide protection from a vehicle crash.**
- **Installation of appropriate protective material on all exterior windows to protect against entry or projectiles.**
- **Installation of secure, locked doors (with wire glass or other suitable, protected view windows) to prevent unauthorized entry into the dispatch center and require that all visitors be "buzzed" in.**
- **Installation of a "panic alarm" to enable the fire dispatcher to quickly notify the police department of an unwanted intrusion; this is especially important during periods when the fire dispatcher (especially the female department members) is the only person in the building.**
- **Installation of monitored security cameras on the perimeter of the building and in the public access areas of the facility.**

3.8 USE OF TECHNOLOGY

Overview

The fire service has experienced tremendous technological advances in equipment, procedures, and training, over the past twenty years. Like all other businesses the use of basic technology including personal computers, laptops, and tablets has positively impacted how fire departments are managed and administered and can more efficiently and effectively provide services to the community. Twenty years ago, personal computers were virtually nonexistent in the fire service. Today, that scenario is very different as the use of computers is the norm as a result of lower costs, microprocessors, smaller sizes, grant funding, and the Internet.

Management applications include things such as word processing, database management, financial spreadsheets, presentations, and website management, as well as, a fire and EMS records management system (RMS) that meets the requirements of the National Fire Incident Reporting System (NFIRS). This gathering and compilation of this data is necessary since NFIRS reporting is a requirement to be eligible for many federal grants. A comprehensive fire RMS software package is also necessary to effectively meet the documentation requirements for an Insurance Services Office (ISO) rating review.

Fire departments that are able to gather data, and then develop and analyze statistics regarding their fire and EMS incident history are much better prepared when it comes to understanding their resource needs not only in the present but also to plan and project for the future. Good data and statistics put into a form that taxpayers can easily understand can provide validation of the worth that each fire department provides to its community through its fire suppression, EMS, fire prevention, fire safety education, and training activities.
Simple personal computers and projectors can be used with training software/applications to simulate everything from emergency incidents to vehicle-driving scenarios, and provide interactive training, testing and certification, promotional preparation, and much more.

Fire departments that have introduced these tools but not provided adequate training as part of the program usually find they have not increased their effectiveness, while simultaneously frustrating many firefighters and community leaders. Training is available for firefighters through local schools, adult education, community colleges, and online courses. Many fire departments have introduced web based training that allows firefighters to remain in their station to complete both fire and EMS training. The National Fire Academy (NFA) offers online courses accessible through the Internet.

Building pre-fire plan applications capture important building information such as building construction, floor plans, occupancy types, fire suppression features, and materials storage (particularly hazardous materials). This information is very important from a fire suppression perspective, as well as, from the aspect of the ISO community rating process. Pre incident planning can be done through software applications that enable firefighters and officers to visualize and analyze the local environment prior to, during, and following an emergency event.

Geographic information systems (GIS) integrate hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. In its simplest form, GIS provides maps such as flood plains, risk zones, building pre-plans, and coverage areas. It can also be used to display important information such as fire hydrant locations and flows, rural water supply access locations, and medical helicopter landing sites. In its most advanced form, it provides a relative link to time, geospatial location and resources.

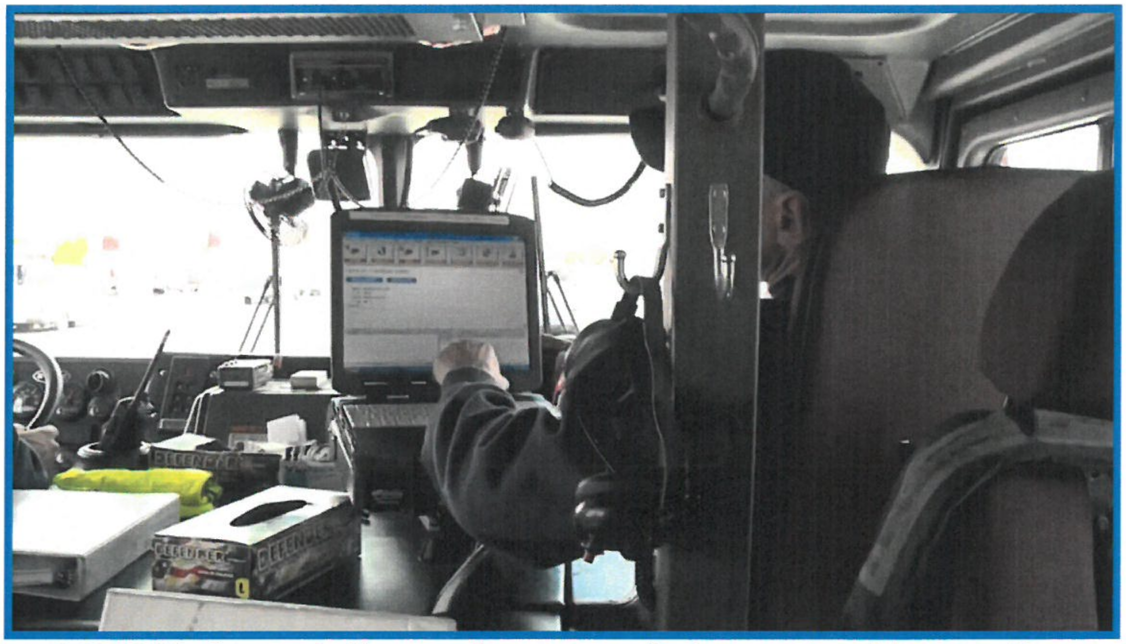


Figure 3-12: Mobile data terminal in use on fire apparatus allowing access in real time to a wide range of information including building pre-plan information.

Laptops and MDTs can provide fire prevention/building inspection applications and allow inspectors the ability to perform inspections, reference online fire prevention/building codes, and review and approve permit applications while in the field including instantaneously capturing inspection data thereby eliminating the duplicative process of data entry upon return to the fire station.

Many departments are using vehicle response tracking/routing applications often known as automatic vehicle location (AVL) applications to identify where a unit is located geospatially through the use of the GPS, receive automated incident location information, and provide the most effective response route on the computer screen combined with audio directions. These programs assist in providing date/time-stamped tracking of the unit during its travels.

A basic but extremely important use of computers for fire departments as well as any business is the ability to effectively communicate with the members of the department and the community. Today the use of emails and text messages are common methods of notifying department members of important information in timely manner. Also, the use of websites and social media has proven themselves as effective ways to communicate important information to the public.

Departments that have instituted the use of computers, assorted software, and embraced social media outlets have had success when they have provided ongoing training with members of the department and maintained their websites, twitter and face book accounts and then continued to upgrade hardware and software when appropriate.

Observations

The MRI team, through our on-site visits as well as the Dracut Fire Department's inability to provide much of the requested data, recognizes the fact that the department has deficiencies in its ability to use computer and software related technology. Throughout the study the MRI team had discussions with department staff and members regarding the needs for data and reports for review and analysis. We believe the root cause of this problem is primarily that the department currently uses an older version of the Fire Programs software for its fire records management system. It appears that this software has not been updated in many years and as a result is not meeting the evolving needs of the fire department. Typically fire departments will contract with software vendors to supply regular updates until the product is no longer able to be updated as which time replacement is the only option.

The fire chief discussed this problem with the MRI team and stated that he is attempting to upgrade or replace the current system. The new records management system/software will be a cloud base system and would be supported on tablets that will be located on the apparatus as well as personal computers in the stations. He is aware that in order to update the software will be costly and will take some time. The department recently sent two personnel for intensive training to utilize the Fire Programs software properly and to determine how the department can more effectively retrieve data and develop statistical reports.

Fire Programs Station Manager is a NFIRS certified reporting package that includes all the modules that a fire department needs to manage daily operations including tracking critical data and analyzing resource allocation. All software packages include several shared features to further enhance user versatility including mapping, calendar, database searches, user defined fields, and custom reports, in addition to, over 300 built-in system reports.

The fire dispatch center and the three fire stations currently have access to the Internet using different methods to connect. There is no town wide area network (WAN) in Dracut.

Recommendations

3.8-1 The Dracut Fire Department should make it a priority to update, purchase, and/or transition to a new fire records management system. The use of these systems to capture, store, and analyze data currently is extremely important for a fire department to most effectively and efficiently utilize the department's resources as well as provide critical data for future planning and budgeting.

3.8-2 The Dracut Fire Department should develop a replacement program for all computers in the stations and administrative offices. By replacing one-third of the computers annually it will assist the fire department in leveling the budget and insure that no fire department computer will be older than three to four years old at any time. Monitors do not need to be replaced as often.

3.8-3 The Dracut Fire Department should implement a training program for all personnel in the use of the department's current computers and the various database, management, and software programs that are being utilized.

3.8-4 The Dracut Fire Department should fully utilize the internet and all of the various training resources available on line.

3.8-5 The Dracut Fire Department in conjunction with the Town of Dracut should make it a priority to continue the plan for installing mobile data terminals (MDTs) in the fire apparatus. In developing the MDT plan, consideration should be given to evaluating the latest technologies and software, including the use of tablets rather than laptop computers. At a minimum, the incident commander at a scene should have access to fire pre-plan data, building permit data (building plans and current data about renovation and construction projects), real-time weather data, and hazardous materials data.

3.8-6 In conjunction with the recommendation for the installation of MDTs the Dracut Fire Department should explore possible uses for GIS technology to enhance the operations of the department.

3.8-7 The Dracut Fire Department should continue to place an important emphasis on evaluating new technology for use on emergency incidents particularly when it pertains to firefighter/member safety or patient care.

CHAPTER 4

FISCAL PRACTICES

4.1 FISCAL MANAGEMENT AND CONTROLS

Overview

Financial management is a key and fundamental component of the administration of any organization, public or private, and translates the public's service requirements and expectations into action. Inasmuch as government and especially the delivery of public safety services is largely a revenue consuming activity, as opposed to a revenue producing activity, the overarching goal is to maximize the impact of public revenue to achieve the mission of the organization and produce a value for the community.

The department's budget must translate funding into a service level consistent with the organizations mission and vision (see Appendix A). In Dracut the level of funding (3.292 million dollars) produces an immediate response of a single unit with two personnel that typically arrive on the incident scene within five minutes of a 911 call being dispatched. In addition, the level of funding also provides the community with numerous non-emergency services ranging from fire prevention to public education activities. Although the study team is concerned with the safety of personnel and the capability of a two-person crew this level of service appears to be in line with the residents' expectation of service.

Observations

The department's budget is formulated and largely administered by the chief and his administrative assistant. An evaluation of the finances of the Dracut Fire Department found that the Department and the Chief Brouillette are rather conservative when compared to the level of expenditure within the peer communities. A conversation relative to fiscal practices revealed the following:

- There is no free cash maintained in the department.
- The department utilizes only one credit card (Home Depot) with controlled access
- The department has relatively few open accounts with other vendors.

The Administrative Assistant reconciles all account balances with the Town on a monthly basis and does the vast majority of purchasing. There is no formalized process within the department to requisition supplies but purchase orders are inconsistently utilized. The town manager approves all non-emergency purchases over $100.

Fire apparatus and other expensive pieces of equipment are purchased by a capital appropriation. Although a capital plan exists we believe the department should update and expand this plan to include the replacement of technology, personal protective equipment, and equipment.

Recommendations

4.1-1 The Department should work with the town manager and finance office to create a separate account for overtime and monitor overtime trend analysis.

4.1-2 The administrative assistant, as the person responsible for most purchases, should become certified as the organizations procurement officer.

4.1-3 The MRI Team recommends that the fire department work with the town manager to regularly update the Capital Improvement Plan (CIP) for the fire department that includes both short and long term (ten to twenty years) planning. The plan should both large capital items as defined by the town's CIP including, but not limited to, apparatus, vehicles, and facilities. Lower cost items that are replaced at more frequent intervals (less than $10,000 and less than 5-year replacement) are often referred to as small capital items. These can include technology items, Personal Protective Equipment (PPE), and hose.

4.1-4 MRI recommends the department, in concert with the town finance director, develop and deploy an internal process for the department to document requests for the requisition of services and/or supplies. The document and process should reflect town contracting requirements, such as the threshold for purchase orders and list competing bids when required, as well as reflect the appropriate accounting classification for the program function and specific line item within that function. This internal process will assist department administration in exercising greater fiscal control and oversight.

CHAPTER 5

APPARATUS, EQUIPMENT AND FACILIITES

5.1 APPARATUS

Overview

The resources that the fire department uses to perform its core mission, and mitigate a wide range of emergency incidents, are generally divided into two major categories, apparatus, and tools/equipment. Apparatus generally includes the department's motorized vehicle fleet and includes the major emergency response apparatus such as engines (pumpers), aerial apparatus/tower ladders, rescue vehicles, and ambulances. Specialized apparatus includes emergency units such as lighting plants, brush trucks, and other off road vehicles. They also often include trailers for specialized applications such as technical rescue, hazardous materials response/equipment, hazardous material decontamination, structural collapse rescue equipment, breathing air/light support units, foam units/supplies, and mass casualty incident supplies. Support vehicles that are critical to fire department operations, both routine and emergency, include command post and emergency communications units, command/staff vehicles, and maintenance trucks.

The geography, infrastructure, hazards, and construction features within the community all play a major role in determining the composition of each department's unique and individualized apparatus fleet and equipment inventory. Dracut's environment presents the fire department with a wide variety of strategic and tactical challenges related to emergency response preparedness and mitigation. This includes firefighting, emergency medical responses, and complex incidents requiring special operations capabilities such as technical rescue and hazardous materials emergencies.

Commercial buildings and target hazards present much different hazards and challenges than those required for operations in single family dwellings. Water supply in rural sections of the town is a firefighting challenge requiring the use of tankers or tankers to transport sufficient water supplies to the incident. Congestion and access limitations can present different concerns for fire department tactical operations in other areas of the town that have narrow streets. All of these factors, as well as projected future needs, must be taken into consideration when specifying, and purchasing, fire department apparatus and equipment. Every effort should be made to make new apparatus as versatile and multi-functional/capable as is possible and practical.

Observations

The current Dracut Fire Department apparatus fleet consists of 5 pumpers (3 front line and 2 reserves), one (1) aerial ladder, one (1) rescue truck, and three (3) brush units. The age of the major firefighting apparatus currently in service ranges from 23 years old for Engine 5, a reserve engine, to one-year-old for the newest unit, Engine 3. The department also operates several other command and staff vehicles.

The department received a new E-One engine in 2015 which is in excellent condition. With the exception of the reserve engine (to be replaced) which is in fair condition, the remainder of fleet appears to be in good to very good/excellent condition. When considering apparatus usage, hours on the engine and pump must be taken into consideration. Fire apparatus typically spend more time idling while at the scene of emergencies, or when operating the fire pump at a fire. A rule of thumb that can be used is that each hour on the motor is the equivalent of 30- 35 miles of actual driving mileage.

The following tables and photos summarize the Dracut Fire Department vehicle fleet:

FIGURE 5.1

DRACUT FIRE DEPARTMENT -- APPARATUS AND VEHICLEES										
Apparatus / Vehicle		Description	Age	Location	Pump Capacity (GPM)	Tank Capacity (Gallons)	Mileage	Engine Hours	Condition	Anticipated Year of Replacement
Engine 1		2009 E-One Custom Pumper	7	Station 1	1250	750	48,780	5068	Excellent	2023
Engine 2		1999 E-One Custom Pumper	17	Station 2	1250	880	139,684		Good	2019
Engine 3		2015 E-One Custom Pumper	1	Station 3	1250	750	4,426		NEW	2030
Engine 4		1995 E-One Custom Pumper	21	Station 1	1250	750	114,089		Good	No Replacement
Engine 5		1993 E-One Custom Pumper	23	Station 1	1250	750	98,429		Good	No Replacement
Ladder 1		1999 E-One Aerial	17	Station 1			36,283		Excellent	Not Scheduled
Forestry 1		2002 Chevrolet	14	Station 1	250	300	8,667		Good	No Replacement
Forestry 2		1995 Ford	21	Station 2	250	250	17,763		Good	No Replacement
Forestry 3		2004 Chevrolet	12	Station 3	250	300	2,451		Excellent	No Replacement
Rescue 1		1999	17	Station 1			42,852		Good	2015/16
Spare Rescue		1986 Chevrolet	30	Station 1			23,093		Good	
Car 1		2015 Ford Explorer	1	Station 1			1,840		NEW	2018
Car 2		2014 Ford Explorer	2	Station 1			11,354		Excellent	2015
Car 3		2005 chevrolet Tahoe	11	Station 1			143,909		Good	No Replacement
Engine 6		1953 Diamond T		Station 2	500	250	17,829		Good	No Replacement
Truck 4		1953 Ferrara		Station 2	500	350	17,552		Fair/Poor	No Replacement

FIGURE 5-2
DRACUT FIRE DEPARTMENT TRAILERS AND EQUIPMENT

Specialty Units and Trailers	Description	Location	Condition	Anticipated Year of Replacement
Rescue Boat	1975 Dura	Station 1	Good	N/A
Rescue Boat	2004 Zodiac	Station2	Good	N/A
MCI Trailer	2004 Atlas	Station 1	Excellent	N/A
Lighting Unit	2005 Magnum Trailer	Station 2	Excellent	N/A
OEM Cargo Trailer	2013 Lark Trailer	Station 2	NEW	No Replacement
Utility Trailer	2004 Yacht Club Trailer	Station 2	Good	No Replacement

Figure 5-3: Engine 1 – 2009 E-One
1250 GPM fire pump, 750-gallon water tank

Figure 5-4: Engine 2 – 1999 E-One
1250 GPM fire pump, 880-gallon water tank

Figure 5-5: Engine 3 - 2015 E-One
1250 GPM fire pump, 750-gallon water tank

Figure 5-6: Engine 4 (reserve) – 1995 E-One
1250 GPM fire pump, 750-gallon water tank

Figure 5-7: Engine 5 (reserve) – 1993 E-One
1250 GPM fire pump, 750-gallon water tank

Figure 5-8: Ladder 1 – 1999 E-One
100' rear mount aerial ladder

Figure 5-9: Rescue 1 – 1999 International/1986 E-One
Medium Rescue

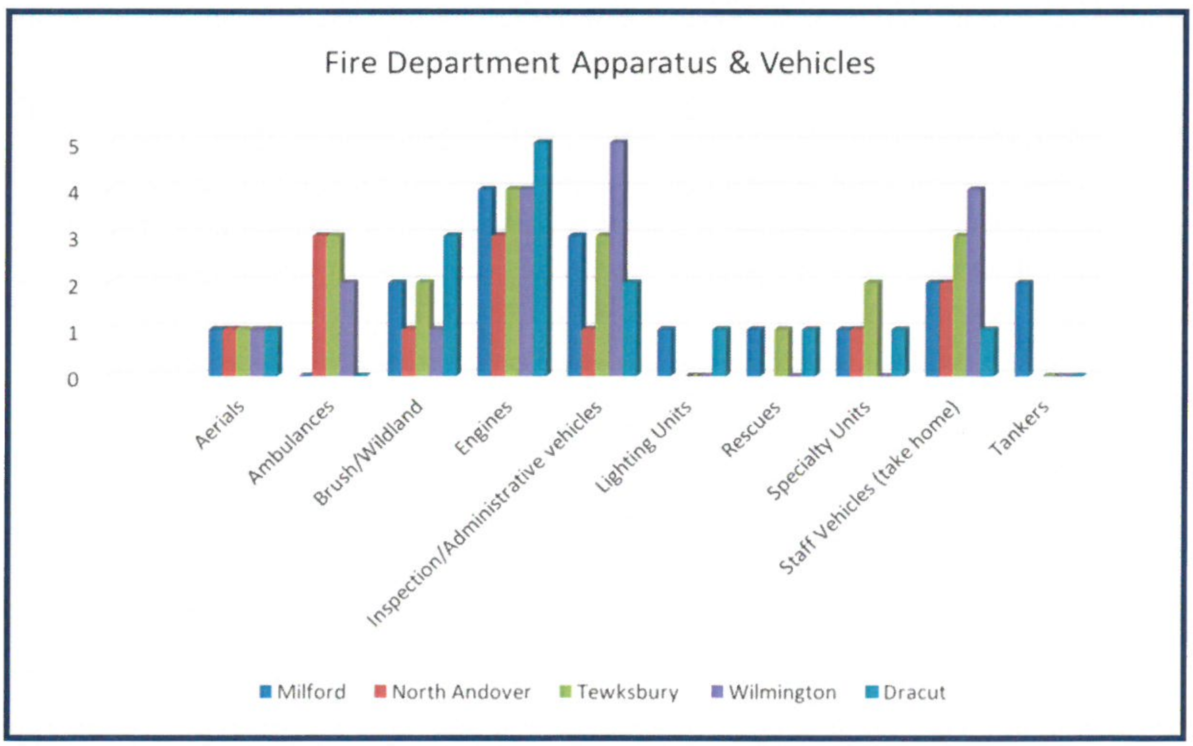
Figure 5-10: Engine 8/Forestry 2 – 1995 Ford F-550
250 GPM fire pump, 250-gallon water tank

Figure 5-11: Engine 9/Forestry3 – 2004 Chevrolet 3500
250 GPM fire pump, 300-gallon water tank

Figure 5-12: Engine 11/Forestry 1 – 2002 Chevrolet 3500
250 GPM fire pump, 300-gallon water tank

Dracut is fairly close to national averages regarding the current size and configuration of its apparatus fleet when compared to communities with comparable populations. In reviewing the other communities Dracut's fleet is similar in size to those communities with two exceptions. First, Dracut does not have any ambulances since they do not currently provide transport ambulance service. Second, they do not have a water tender/tanker and rely on a regional response with tankers from mutual aid fire departments for fires in the non-hydrant areas of the town. Figure 5-13 illustrates comparisons with local communities.

FIGURE 5-13



In surveying the fleet, the MRI team found the apparatus to be well maintained and the equipment was stored in an orderly manner on every apparatus.

Two of the department's current vehicles, Engine 6 and Truck 4, officially remain in the fleet although they are what typically would be designated as "parade pieces "(Figures 5-14 & 5-15). These are antique vehicles that do not meet any of the current day safety requirements, or NFPA standards, and are no longer considered to be in service for any type of emergency service or response.

Figure 5-14: Engine 6 – 1953 Diamond T

Figure 5-15: Truck 4 – 1953 Ferrara

The MRI study team reviewed the Dracut Fire Department apparatus and vehicle capital improvement and/or purchase plan. If the plan is funded and maintained as currently proposed, the apparatus should be able to continue to meet the needs of the town for the next ten to fifteen years. A possibility that the fire department might consider when replacing their next engine is to combine that pumper and the aerial ladder into a 75' single axle "Quint" which will contribute to what we believe will be an effective and appropriate apparatus set for the town. A quint is a fire service apparatus that serves the dual purpose of an engine and a ladder truck (Figure 5-16). This type of fire apparatus provides the ability to perform five functions: pump, water tank, fire hose, aerial device, and ground ladders. Combining an engine/pumper and aerial ladder into a single unit can satisfy operational needs that cannot be met by staffing two separate pieces of apparatus. Long term, having one of the pumpers and the ladder combined into a quint, Dracut will have a diverse firefighting resource that provides maximum operational flexibility and options for safe, effective and efficient options, particularly when operating with minimal staffing levels that the department operates with. In addition, by combining the two vehicles into one the town will reduce the size of its apparatus fleet and thus probably reduce its long term maintenance costs. It will also eliminate the need to replace another vehicle a few years down the road. However, as this does reduce a unit, and limits available reserve apparatus, it is important that all units in the primary apparatus set be well equipped, properly maintained, and replaced in accordance with a reasonable life expectancy.

Figure 5-16: Example of a quint with a 1500 GPM fire pump, 500-gallon water tank and 75' aerial ladder.

Dracut uses the Department of Public Works (DPW) to provide most of the fire department's maintenance needs while basic repairs (such as bulb replacements identified during daily mechanical checks) are done by on duty fire personnel. Utilizing DPW mechanics to perform routine repairs and preventive maintenance activities as well as some major repairs to emergency vehicles is a cost effective manner to maintain the operating fleet. More complex tasks and specialized repairs are contracted out to specialized repair shops (i.e. drive train, fire pumps, aerial ladder systems, etc.). This practice is common for fire departments that are similar in size to Dracut. Records for these repairs are maintained by the fire department electronically, as well as hard copies in the deputy chiefs' office. DPW also maintains a full file on each vehicle. Maintenance records were available for the MRI Team for review. They appeared complete for the past ten years.

Pump and ladder tests on all apparatus are performed on an annual basis as required by NFPA and ISO. The DPW mechanics are on site when these tests are being performed so they can make any necessary repairs, including pump valve replacements, at the time an issue is noted. This system allows the vehicle to be quickly retested and certified.

The DPW staff reported that they have an excellent relationship and very good communications with the fire department. At the beginning of each month the mechanics receive a report from the deputy fire chiefs regarding what services are due for apparatus and if there are any outstanding maintenance issues. The shop tries to make fire department needs a priority, particularly with regards to safety issues. The fire department pays for any required training for the DPW personnel.

The DPW foreman informed the study team that although he is not a certified emergency vehicle technician (EVT) that he has taken courses on fire apparatus maintenance. He is a member of the New England Fire Apparatus Mechanics Association. The DPW mechanic has also taken classes on apparatus maintenance although he is not EVT certified either. He is also ASE certified for brake repairs.

Each of the comparable communities surveyed differs in how they maintain their apparatus fleet. This is typically based on the size of the department, the size of the fleet, and if the town's repair facility and its mechanics are capable of performing the specialized mechanical repairs that are required with fire apparatus and emergency vehicles.

FIGURE 5-17
COMPARABLE COMMUNITY APPARATUS MAINTENANCE PRACTICES

	Milford	North Andover	Tewksbury	Wilmington	Dracut
Department vehicles are maintained by:	Private Vendor	the Dept; Private Vendor	DPW; Dealership; Private Vendor	DPW	the Dept; DPW; Dealership;

The MRI Team reviewed the fire department's policy for apparatus and maintenance (Policy # ADM -08 Fire Department Fleet and Equipment Maintenance) and found it to be adequate, based on our review of records, visual inspection of apparatus, and interviews with department members. The fire department's procedures and personnel responsibilities for daily shift checks, preventative maintenance, and placing apparatus out of service until it can be inspected and repaired by a mechanic are appropriate. As the department upgrades its record management system the process as well as the recordkeeping would be expected to improve even farther.

Recommendations

5.1-1 The Dracut Fire Department should review the recommendations contained in NFPA Standard 1911, Standard for the Inspection, Maintenance, Testing, and Retirement of In-Service Automotive Fire Apparatus (National Fire Protection Association, 2012 Edition) and use it as a guide to revise and update the vehicle fleet maintenance program.

5.1-2 The Dracut Fire Department should develop a program to transfer manual record keeping to a suitable electronic system/database for the documentation of inventories, maintenance, and testing programs. A comprehensive fire department management program would be the preferred choice.

5.1-3 The Dracut Fire Department should revise their daily apparatus and serviceability inspection procedure to include an electronic report form. This inspection is the equivalent of a daily pre-trip inspection as outlined in commercial driver manuals and should continue to be performed each and every day immediately after shift change. The inspection should include all spare/reserve apparatus. NFPA 1911 also contains a section with suggestions for routine vehicle and component

inspection and testing. The daily inspection should also include an inventory and serviceability check of the tools, equipment, and SCBA that is carried on the apparatus.

5.1-4 The Dracut Fire Department should update their current SOG for fleet and equipment maintenance and establish a procedure that specifies what safety items that are found to be out of compliance on an apparatus would place it out of service. The procedure should include a process of notification to the appropriate supervisory and management staff that the apparatus is out of service including the specific reason. This procedure would be an initial step in documenting repairs and service requirements, as well as tracking out of service times for equipment.

5.1-5 The Dracut Fire Department should continue its current practice of annual pump testing in accordance with NFPA and ISO standards. Pump tests should be performed at intervals no greater than twelve months apart. All tests, deficiencies, and repairs/corrective actions performed should be fully documented.

5.1-6 The Dracut Fire Department should continue its current practice of annual hose testing in accordance with NFPA and ISO standards. Hose tests should be performed at intervals no greater than twelve months apart. All tests, deficiencies, and repairs/corrective actions performed should be fully documented.

5.1-7 The Dracut Fire Department should continue its current practice of annual ground ladder and aerial apparatus testing in accordance with NFPA standards. Ladder and aerial tests should be performed at intervals no greater than twelve months apart. All tests, deficiencies, and repairs/corrective actions performed should be fully documented.

5.1-8 The Dracut Fire Department should develop a procedure that specifies how the above tests shall be performed and documented, including placing equipment out of service, performing repairs, and documenting the entire process.

5.1-9 The Town of Dracut and the Dracut Fire Department should continue to evaluate and closely monitor the department's apparatus needs, both current and future. The department should continue to update its long-range vehicle replacement and capital plan for all fire apparatus, other vehicles, and major equipment. Apparatus replacement needs can be projected out as long as necessary. The fire department's capital budget needs should be incorporated into the town's overall plan and prioritized appropriately.

5.1-10 The Town of Dracut and Dracut Fire Department should consider the future consolidation of a pumper and the ladder into a single "quint" that has a 75' aerial ladder and is configured to also fully function as a fire pumper.

5.1-11 While the fire chief should set direction/parameters and obviously must retain the right of final approval on all major apparatus and equipment purchases, it is recommended that members of the department be involved in a specifications development committee. The committee should encompass a cross-section of the department's personnel: firefighters, officers, and mechanics.

5.1-12 The Town of Dracut should take advantage of the fire apparatus and ambulance group purchasing system that is sponsored by the Fire Chiefs Association of Massachusetts (FCAM). Municipalities may select a specific design and manufacturer from a pre-determined bid list and are not required to establish their own bid process. It is estimated that this group purchasing system will save approximately five to ten percent of the cost of a fire truck or ambulance

5.1-13 The Dracut Fire Department should adopt a policy of purchasing new NFPA 1901 compliant equipment when new apparatus is purchased. This policy will ensure that equipment is the most technologically up-to-date and that it is safe and functional. It will also make it possible to keep reserve apparatus fully equipped for immediate use.

5.1-14 The Dracut Fire Department should consider having all existing department vehicles retrofitted with reflective safety striping in accordance with NFPA 1901. All future vehicles should also be appropriately striped including command, staff, and utility vehicles. The Emergency Vehicle Visibility and Conspicuity Study (Federal Emergency Management Agency, FA-323, August 2009) provides valuable information about vehicle marking (see http://www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf). Consideration should be given to equipping any new apparatus with lighted traffic arrow devices mounted high enough on the vehicle to permit visibility by approaching vehicles, especially during responses on the interstate highway system.

5.1-15 The town should support and encourage the key DPW personnel that work on fire apparatus to be emergency vehicle technician (EVT) certified.

5.2 EQUIPMENT

Overview

The tools and equipment that a fire department utilizes covers a wide assortment of resources necessary to effectively, efficiently, and safely respond to, and mitigate, a wide range of emergency incidents. These resources include, but are certainly not limited to, the firefighters' personal protective equipment (PPE), self-contained breathing apparatus (SCBA), hose, nozzles, adapters, master stream appliances, ground ladders, radios, hydraulic rescue tools and equipment, and various hand and power tools. The technology and standards for fire department equipment are constantly evolving to improve the effectiveness, efficiency, and safety of firefighters.

The fire service has experienced tremendous technological advances in equipment, procedures, and training, over the past fifty years. Improved personal protective equipment (PPE), the mandatory use of self-contained breathing apparatus (SCBA), large diameter hose, better and lighter hose lines and nozzles, and thermal imaging cameras are just a few of the numerous advances in equipment that have enabled firefighters to perform their duties more effectively, efficiently, safely, and with fewer personnel. However, the fact still remains that emergency scenes present a dynamic, dangerous, frequently unpredictable, and rapidly changing environment where conditions can deteriorate very quickly and place firefighters in extreme personal danger.

Today's fire departments are obligated to establish and document formal programs and procedures to ensure that equipment is replaced regularly, maintained properly, and deployed in accordance with accepted standards and department procedures. Proper training on the use and maintenance of equipment is essential to effective and safe firefighter performance and minimizes the city's risk exposure.

NFPA 1901, *Standard for Automotive Fire Apparatus* (National Fire Protection Association, Quincy MA, 2009 edition) and ISO (formerly the Insurance Services Office) provide standards for the minimum complement of equipment that should be carried on fire apparatus. It is important to recognize that each agency has different requirements for apparatus and equipment. NFPA focuses broadly on the safety and performance of the apparatus, while ISO focuses specifically on the fire suppression capabilities of the apparatus. These differences are most significant for equipment carried on pumpers and aerials. Differences between NFPA and ISO equipment for pumpers include hose, monitors, ground ladders, foam, and radios. Differences for aerial equipment include self-contained breathing apparatus (SCBA), ground ladders, and radios.

Observations

The MRI study team found the equipment located on each piece of Dracut apparatus to be well maintained and ready for use. The Dracut Fire Department's apparatus has a typical selection of portable hand, power, and service tools and equipment utilized for firefighting and other emergency operations. For the most part, the equipment appears to be organized and serviceable. Based on a recent ISO survey it appears that the apparatus fully meets the minimum NFPA and ISO requirements for equipment to be carried.

The Dracut Fire Department currently has two complete sets of hydraulic extrication tools (Jaws of Life) with a full complement of accessory tools that are carried on first response units. These hydraulic rescue tools are used by emergency rescue personnel to assist in extrication of motor vehicle crash victims, as well as, other rescues of various types. The tool sets include hydraulic cutters, spreaders, door busters, and rams. This equipment is very important to the department's overall operations due to the traffic in the town. The MRI team was informed that all gas powered extrication equipment is scheduled for replacement with battery operated units over the next few years. The current rescue tools appear to be well maintained. There is an annual service/maintenance contract in place for all of these units. When the new equipment is purchased, the equipment currently on the rescue will be replaced and be redeployed to the ladder as a back-up rescue unit.

FIGURE 5-18
SPECIALIZED RESCUE EQUIPMENT

Extrication Equipment	Model	Age	Located	Replacement Year
RAM 20"	Rescue Tech Model 20	1990	Ladder	2016*
RAM 60"	Rescue Tech Model 20	1990	Ladder	2016*
RAM	Hurst Model T-41	2000	Rescue	
Spreader	Hurst Model JL32A	1980	Rescue	2016*
Spreader	Hurst Model ML32	1998	Ladder	
Cutter	Extractor Model MOCII	2009	Rescue	
Cutter	Extractor Model MOCII	2003	Ladder	
Airbags	Jaws of Life, Various sizes	2006	Ladder	2020
Stabilization Jacks	Res- Q- Jacks	2003	Rescue	
*If awarded a grant or end of year funding.				

Thermal imaging cameras (TICs) are valuable pieces of equipment used by firefighters during fire incidents. By rendering infrared radiation as visible light, such cameras allow firefighters to see areas of heat through smoke, darkness, or heat-permeable barriers. Thermal imaging cameras pick up body and other types of heat, and are used to more quickly locate and remove trapped fire victims. They are also often used to find hidden fire behind closed walls. Most thermal imaging cameras are handheld, but may also be helmet-mounted.

The Dracut Fire Department has four handheld thermal imaging cameras. Each front line engine has one, as does the ladder truck. The TICs appeared to be well maintained. The fire department has an annual service/maintenance contract in place for these units and they are serviced on an annual basis.

FIGURE 5-19
THERMAL IMAGING CAMERAS

Model	Age	Located	Replacement Year
MSA Evolution 6000X	NEW (2015)	Engine 1	TBD
Bullard Eclipse T3 Max	2012	Engine 2	TBD
Bullard Eclipse T3 Max	2012	Engine 3	TBD
Bullard T3 Max	2005	Ladder 1	TBD

Automated external defibrillators (AED) are portable electronic devices that automatically diagnose the life-threatening cardiac arrhythmias of ventricular fibrillation and ventricular tachycardia in a patient and is able to convert (treat) them through delivery of an electrical shock. They have become a critically important life-saving tool.

All front line apparatus and the deputy chief/command vehicle are equipped with newer, state of the art AEDs, allowing certified personnel to more effectively treat certain cardiac patients. Reserve engines, the ladder truck, and staff/command vehicle are also equipped with older AEDs. There are no spare AEDs available.

FIGURE 5-20
FIRE DEPARTMENT AEDs

AED	Located		AED	Located
Physio-Control Lifepacks NEW 2014	Engine 1 Engine 2 Engine 3 Rescue 1 Car 2		Physio-Control Lifepacks 12 Years Old	Engine 4 Engine 5 Ladder 1

The Dracut Fire Department responds to hazardous material incidents and operates primarily at the operational level. Larger incidents require the response of the regional Fire District 6 hazardous material team. The department's apparatus carries equipment and supplies that allow them to mitigate minor incidents such as fuel leaks, and includes basic monitoring equipment such as natural gas leak and carbon monoxide (CO) detection meters. All engines and ladders are equipped with multi-gas combustible gas detectors.

The multi-gas meter is a small hand-held device that can detect natural gas, CO, and oxygen depleted environments allowing firefighters to identify and monitor hazardous environments. The fire department's four (4) Bascom-Turner combustible gas indicators are 16 years old and though maintained should be replaced. However, this model of gas meter is still in production and serviced by Bascom-Turner. The fire department has trained personnel that can calibrate these meters and each meter is annually inspected by a certified vendor.

The department's recent switch to MSA self-contained breathing apparatus (SCBA) has afforded an opportunity to upgrade the department's current meters to newer, more technologically advanced ones which have blue tooth technology and can communicate readings back to the command computer in the same manner as the SCBA. The plan is to purchase three (3), four (4) gas meters, one (1) for each engine and one (1) five (5) gas meter for the command car. The existing meters will be placed on the ladder and spare apparatus. The department hopes to accomplish this transition by the end of FY17.

Each apparatus also carries booms, pads, and absorbent material that can be used to contain minor spills and leaks.

Personal protective equipment (PPE) includes the full ensemble that encapsulates a firefighter who will be engaging in firefighting operations. It includes a helmet, Nomex® hood, turnout coat, turnout pants, boots, SCBA, gloves, eye shield, and station uniform. The specifications and related requirements for PPE can be found in various NFPA standards. The MRI team examined a number of sets of firefighter PPE and found them to be relatively clean and ranged in condition from very good to poor condition. Much of it showed the effects of routine wear.

The department supplies two sets of turnout pants and coat for each firefighter. Though each firefighter currently does not have two sets of NFPA compliant turnout gear, the department is attempting to provide them through a planned purchase program that will allow the acquisition of sufficient sets annually for the next three years.

The regular cleaning of PPE ensures that dangerous and unhealthy contaminants from fire scenes, accidents, medical calls, and hazardous materials incidents are removed from PPE in order to avoid long-term exposure to firefighters and their families. The MRI team saw an extractor; a heavy duty commercial washing machine used for PPE, at the central station. It appeared to the MRI team that this equipment was used regularly.

The MRI study team noted that the department does not conduct annual inspections of turn out gear, nor was there any Standard Operating Procedure/ Guideline (SOP/SOG) regarding inspection, repairs, or cleaning of PPE as required by NFPA Standard 1851 *Standard on Selection, Care, and Maintenance of Protective Ensemble for Structural Firefighting and Proximity Firefighting*. The department does not maintain PPE records.

The fire chief has a policy of replacing PPE for personnel as needed. Based on a review of the fire department budget it appears that funds are available for purchasing up to six sets of turnout gear annually. It should be noted that the current edition of NFPA 1851, recommends that firefighter PPE be replaced at no greater than ten year intervals.

Self-contained breathing apparatus (SCBA) is a device worn by firefighters to provide breathable air in an IDLH (Immediately Dangerous to Life and Health) atmosphere such as fires and hazardous material incidents. This is an integral and critically important piece of life safety equipment that a firefighter must use in order to safely perform their job.

During the process of this study the MRI team learned that the Dracut Fire Department had received a grant that allowed the department to purchase replacement SCBA. The department was in the process of training with the equipment before placing them into service. The new SCBA are state of the art with a key fob and Bluetooth software for each firefighter so that officers can track which firefighters are on duty, whether they have inspected their equipment, and, most importantly, monitor the use of his/her air whenever they utilizing the SCBA.

The grant allowed the department to purchase forty (40) complete sets of new MSA™ breathing apparatus with 40 spare cylinders/bottles. All SCBA are equipped with integrated personal alert safety system (PASS) devices. They are equipped with heads-up displays (HUD) that allow the user to monitor his/her air supply through an electronic display in the wearer's face piece. All units are equipped with voice amplification that assist in communications when firefighters are wearing their facepiece. The department also has rapid intervention team (RIT) SCBA's. The rapid intervention team (RIT) equipment (a portable air supply for providing air to a downed or trapped firefighter) and is outfitted with emergency buddy breathing attachments.

Members of the department have been issued their own individual SCBA masks. Departments issue individual facemasks in order to minimize the chance of exposure/ transmission of infectious and/or communicable diseases and other illnesses (even the common cold) between members. Each member having their own personal mask also ensures that they are wearing a correctly sized, properly fitting mask, not just the mask that happened to be available. Firefighters who have been fit tested are able to be issued a face piece that is of the appropriate size.

The OSHA *Respiratory Protection Standard*, 29 CFR 1910.134, and NFPA Standard 1500, *Standard on Fire Department Occupational Safety and Health Program* mandate that annual fit testing be completed, after personnel have been medically cleared to wear SCBA. Dracut performs these tests on an annual basis and it appears is fully compliant with this regulation.

In the past the fire department used firefighters who were assigned additional duties to maintain and repair the SCBA. These personnel had completed required training and were certified by the manufacturer as field level technicians in order to perform these functions.

When the new SCBAs are placed into service this will no longer be required as the units include a full warranty and contract for repairs and maintenance.

Annual flow testing of SCBA is required by NFPA Standard 1852, *Standard on Selection, Care, and Maintenance of Open-Circuit Self-Contained Breathing Apparatus (SCBA)*. All of the current SCBA are in compliance with the flow testing requirement. They are all reported to be compliant with a current hydrostatic test that must be performed every three years. The department contracts with a certified vendor to perform these tests and inspections. The new SCBA will all be compliant also once they are placed into service.

During the MRI site visit it was determined that the department is not compliant with NFPA Standard 1901, *Standard on Automotive Fire Apparatus,* and ISO requirements that require one SCBA with cylinder and one spare cylinder for each riding position on the apparatus. For example, if a piece of apparatus has six riding positions for firefighters, that vehicle must have six SCBA with cylinders and six spare cylinders. During the visit, the fire chief assured the MRI team that they would immediately assign the appropriate number of SCBA and spare bottles on all apparatus.

FIGURE 5-21
SCBA INVENTORY

UNIT	RIDING POSITIONS	REQUIRED SCBA	ASSIGNED SCBA	REQUIRED SPARE CYLINDERS	ASSIGNED SPARE CYLINDERS
ENGINE 1	5	5	5	5	6
ENGINE 2	4	4	4	4	4
ENGINE 3	4	4	5	5	4
ENGINE 4	4	4	4	4	4
ENGINE 5	4	4	4	4	4
LADDER 1	4	4	4	4	20
RESCUE 1	2	2	6	6	12
CAR 2		1	1	0	0
CAR 1		1	1	0	0

SCBA breathing air refilling is accomplished with a compressor/cascade system located at the central station. The compressor obtains its intake air from the exterior of the station, as is proper. Air quality sampling/testing is done on a quarterly basis to insure that the air quality being produced by the compressor is at least Grade "D" as required by the OSHA Respiratory Protection Standard. The certificate for the most recent test is posted next to the compressor. Complete test results for each test, as well as previous certificates, are maintained in a central file. The records for maintaining the filling station, including the makeup air, were available and reviewed by the MRI team. The department uses a mobile cascade system for refilling SCBA cylinders at the scene of incidents.

Communications

The Dracut Fire Department has a portable radio available for each on duty member. It is the current best practice in the fire service that every firefighter who is wearing SCBA and/or entering an atmosphere that is immediately dangerous to life and health (IDLH) should be equipped with a portable radio. Should a firefighter become trapped, lost, disoriented, or experience any other type of emergency, he/she can summon help on the portable radio.

Recommendations

The MRI study team found that most of the fire department's equipment was up to date, or in the process of being replaced. The equipment was maintained adequately but the issue remains that the department needs a records management software update and/or replacement in order to properly track numerous tasks, inspections, repairs, etc.

5.2-1 The Dracut Fire Department should inventory all equipment, review compliance with NFPA and ISO criteria, and assess the department's own operational and equipment needs. The inventory should be updated at least annually to ensure that it is current.

5.2-2 The department should establish a formal replacement plan for equipment. The regular replacement of large cost items such as hose, ladders, and SCBA on an incremental basis will avoid major one-time increases in the operating budget. The life expectancy of these items can be estimated based on usage and manufacturer's recommendations. The fire department should establish a "small cap" Capital Improvement Program (CIP) plan in which equipment such as meters, AEDs, SCBA, and PPE are included in a planned update and replacement program.

5.2-3 The department should develop an operational procedure, and an inspection form, and train all officers to conduct annual turnout gear (PPE) inspections as required by NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensemble for Structural Firefighting and Proximity Firefighting*. The procedure should also address repairing, maintaining and cleaning PPE.

5.2-4 The Dracut Fire Department continue with the plan to supply each member with two full sets of personal protective equipment (PPE). This replacement program will allow each firefighter to have a spare set of PPE. In the future the department could consider the replacement of PPE through an application for an Assistance to Firefighters Grant (AFG). The department should maintain a supply of spare turnout gear (coats, pants, gloves, hoods, helmets, etc.) for use when turnout gear is damaged,

is being cleaned, or has been placed temporarily out of service for drying/thawing during winter operations.

5.2-5 The annual schedule of fit-testing for SCBA masks should be continued in accordance with the requirements of the OSHA Respiratory Protection Standard, 29 CFR 1910.134, and NFPA 1500, Standard Fire Department Occupational Safety and Health Program. The development of a Respiratory Protection Plan should include procedures for completing this mandatory testing.

5.3 FACILITIES

Overview

Fire and EMS/rescue stations are critical community assets. The station facilities of modern fire departments and emergency medical services providers are designed to do much more than simply provide a garage for apparatus or vehicles and a place for personnel to respond to or to wait for a call. Well-designed fire and EMS facilities enable staff to perform their duties effectively, efficiently, and safely. As facilities age, they may no longer meet the needs of an evolving department and/or community, thus negatively affecting morale, efficiency, safety, security, technology and overall efforts to provide quality fire, rescue, and emergency medical services. Older and/or obsolete facilities are also expensive to maintain due to inefficient energy systems and the need for frequent repairs.

Fire stations support the needs of the fire department and the community in which they are located. Fire stations that meet those needs now and in the future are built and maintained with quality products and systems. An attractive, well-maintained, functional, clean, and well-designed fire station can contribute to the morale, productivity, and operational effectiveness of the fire department. Most citizens have little contact with the fire service and often make judgments that are, at least partially, based upon their impression of fire station facilities. It follows then, that a good image of the department must be maintained not only by proper deportment of the individual officers and firefighters, but also by the appearance of their physical surroundings.

Fire stations are unique facilities in that they must accommodate extremely diverse functions, including living quarters, recreation, administration, training, community education, equipment and vehicle storage, equipment and vehicle maintenance, and hazardous materials storage. While it is usually only occupied by fire department personnel, the facility may also need to accommodate the members of the public who visit for station tours, public education presentations, and to discuss building projects, or apply for permits. Many fire stations are occupied twenty-four hours a day, seven days a week, by on duty personnel standing by to respond to emergency incidents. It is important that existing fire stations are properly maintained, and any future stations are designed and constructed in such a manner that employees can perform their duties efficiently and effectively.

A fire station should, at a minimum, provide adequate, efficiently designed space for the following functions:

- Housing of fire apparatus, with adequate space for apparatus length and height (and the housing of all equipment, including staff, service, and support vehicles including trailers)
- On-duty crew quarters, with sufficient toilet/shower/locker room space for both men and women
- Kitchen area
- Training and meeting space
- Administrative/supervisor office(s)
- Vehicle maintenance (as necessary)
- Hose drying and storage (as necessary)
- Supply and equipment storage
- Public entrance/reception area

There is no specific template for fire station design and construction. Each station must be designed to meet the unique needs of the community it will serve. National best practices, such as guidance provided by the National Fire Protection Association (NFPA) and the Federal Emergency Management Agency (FEMA), recommend that the following features be included in fire station capabilities:

- Seismic-resistant construction (based on local risk assessment)
- Flood hazard protection (based on local risk assessment)
- Automatic fire sprinkler system and smoke detection system
- Carbon monoxide detectors
- Adequate parking for on duty personnel, administrative staff, and visitors
- Compliance with the Americans with Disabilities Act (ADA)
- Compliance with current fire and building codes
- Adequate storage for supplies and equipment, including emergency medical and disaster supplies
- Capability for future expansion
- Vehicle exhaust extraction system
- Capability to decontaminate, launder, and dry personal protective equipment and station uniforms
- Facility security
- Emergency power supply
- Exercise and training area(s)

The locations of fire stations in every community are typically based on a historical need at the time the station was built, as well as the town's infrastructure at that time. Today communities are taking into consideration their master planning documents, regional economic growth patterns, and potential demographic changes when determining fire station locations. Changes in a community often require a station to be replaced and/or relocated.

Observations

The Dracut Fire Department currently operates from three stations. Two of the stations are adequate for the current staffing, apparatus, and equipment deployed from them. The MRI team found the stations to be relatively well maintained from a housekeeping and general maintenance perspective. Both the central station and Station 2 on Jones Avenue appeared to be fully code compliance, and there were no major capital improvement concerns that were identified. However, the Collinsville Station, Station 3, revealed a facility that is woefully inadequate to be used as a fire station. The building is severely undersized, not at all adequate for its current use and did not appear to be in compliance with current building or fire codes.

In regards to all the fire stations, routine daily maintenance and housekeeping is conducted by on duty fire personnel. This is typical of most fire departments. Major projects are budgeted and overseen by the fire department. The priorities for these projects are based on input from the fire chief, department members, and budgetary constraints. The MRI team is unaware of a written fire department facility capital improvement program specific to the fire stations other than the Town of Dracut's capital plan. The current plan for the department was based on a 1999 Master Plan by John Brown Associates that included a fire station master plan, which resulted in the suggested placement/location of the fire stations for optimum response time/service which was four (4) minutes or less by the first due unit to any location in the town. The suggested locations are:

- Station I -Pleasant Street - Dracut Center
- Station 2 –Jones Avenue - East Dracut
- Station 3 –Collinsville - Lakeview Avenue

Since that time both Stations I and Station 2 have been constructed. The MRI study team reviewed the number and locations of Dracut's fire stations and believes that the size and locations of these stations will meet the needs and provide services for a number of years for the Town of Dracut.

Central Station (Station 1)

The Central Fire Station is located at 488 Pleasant Street and serves as the main focal point of department operations. The station was built in 2002, is approximately 16,400 square feet in area, and consists of five double deep, drive through bays in the middle. Visitors to the station and contractors meeting with staff use the main entrance located in the front of the building.

The fire departments dispatch center as well as its administration offices are also located at this station. One side of the facility houses the department's administrative offices including the fire chief's office, office space for administrative staff, on duty deputy chief's office, and the training room, which functions as the emergency operations center (EOC) for the town. It is also sometimes used for meetings by the general public. The opposite side of the building houses the living quarters for the on duty personnel. This includes kitchen, dining, and day room areas, individual bunk rooms, a physical fitness room, a utility/laundry room that can be used as a decontamination area, a bathroom/shower facility, a separate female bathroom/shower facility, and the EMS equipment storage room.

Engine 1, Ladder 1, and Rescue 1 all operate from this station. When on duty, the deputy fire chief also responds from this central location. In addition, a forestry unit and a spare apparatus are stored here.

The building is equipped throughout with automatic fire alarm (including smoke detectors) and fire suppression (sprinkler) systems.

Daily staffing is typically four (4) personnel; two (2) firefighters and one (1) officer on duty for response, with a third firefighter assigned as the fire and ambulance dispatcher. When a deputy chief is working, staffing is five (5). The MRI team found the facility's general condition to be well maintained and with adequate space to fulfill its mission.

The administrative side of the station has a security system requiring visitors to be "buzzed" in. after hours. Most times that the MRI team was on site for our field visits all other building doors, including the apparatus bay overhead doors, were secured.

The station is equipped with a diesel-fired emergency standby generator that starts automatically upon an interruption in the power. While it was reported to the MRI team that the generator is tested and run on a periodic basis, written test/inspection records were not reviewed.

The station is not equipped with a vehicle exhaust extraction system due to the fact that all Dracut apparatus use the most up to date diesel engine internal technology stems, or Ward Diesel Exhaust Filter System. These units are designed to limit the exposure of building occupants to exhaust fumes from diesel units currently assigned/stored here. No records were available for the MRI Team to review regarding the air quality.
Due to the almost constant use, most furnishings showed reasonable wear. The kitchen area has been updated, but due to the volume of use was again showing signs of wear. The crew quarters are adequate. Bunk rooms appeared adequate. Storage areas in the station were adequate.

The exterior of the site is adequate for the operational needs of the department. The rear area had a large parking lot that on occasion could be an adequate space for training evolutions. There is adequate parking for employees, staff, and visitors.
The fire department property is well maintained and was landscaped. Overall, this station is in very good condition.

<u>Station 2</u>

Station 2, located on Jones Avenue in East Dracut was built in 2000. The fire station is unique in that unlike most fire stations this facility is a two story building that utilizes the basement level as a garage area to store additional apparatus, vehicles, and equipment. The MRI team that visited the site felt that not only the facilities location but its placement on the lot was a good use of the property.

Engine 2 operates from this station. In addition, a forestry unit and a spare apparatus are stored here.

The building is equipped throughout with automatic fire alarm (including smoke detectors) and fire suppression (sprinkler) systems.

Daily staffing is typically two (2) personnel; one (1) firefighter and one (1) officer The MRI team found the facility's general condition to be well maintained and with adequate space to fulfill its mission. It appeared to meet all code requirements.

The station is equipped with an emergency standby generator that does start automatically upon an interruption in the power. While it was reported to the MRI study team that the generator is tested and run on a periodic basis, written test/inspection records were not available for review.

The station is not equipped with a vehicle exhaust extraction system due to the fact that all Dracut apparatus use the most up to date diesel engine internal technology stems or Ward Diesel Exhaust Filter System. These units are designed to limit the exposure of building occupants to exhaust fumes from diesel units currently assigned/stored here. No records were available for the MRI Team to review regarding the air quality.

The station is also used to store Dracut Emergency Management supplies and a Fire District 6 special operations response vehicle and equipment. It is also the location of the department's archives and is where the department's two antique apparatus are stored along with old equipment.

Station 3

The Collinsville Station is located at 1990 Lakeview Avenue in the west end of Dracut. This two bay fire station occupies only 1500 square feet and was built in 1954. The building was originally constructed as a garage and was intended to be used as a station for the call fire department. Today there is no longer a call/volunteer department in Dracut and the fire department is staffing the fire station. The facility has received some modification to serve as a full time career fire station, even though it was never constructed for that purpose. It should also be noted that this is the busiest station in town.

The MRI study team found this station to be completely inadequate to be used as a fire station. There is inadequate space for the apparatus and equipment and it was really in deplorable condition for personnel to be permanently assigned. During the site visit the MRI team found firefighters attempting to work out on a treadmill that was squeezed into a space on the apparatus garage floor, no space for members on duty to properly workout, no adequate sleeping quarters, inadequate vehicle exhaust systems, totally inadequate bathroom/shower facilities located just feet from the eating area, and no office space. The space to park apparatus in the building was extremely tight and the new engine could barely fit to go out the doors.

The site that the station is located on has minimal parking and virtually no front apron for the apparatus to safely back into the fire station or be parked outside for daily inspections or maintenance. The MRI study team found that much work had been done to this station in order to try and keep it operational including recent roof repairs. Even with these updates, renovations and maintenance, priority consideration should be given to the future, long-term viability of this station.

The station has ssignificant life safety code concerns. In addition, due to its age, location, and limitations to any type of expansion/addition, it is our opinion that it would not be economically feasible to attempt to continue to renovate and/or upgrade this facility.

Some specific concerns regarding this facility include, but are not limited to:

- The facility is not in full compliance with the requirements and recommendations of **NFPA 1500:** *Standard on Fire Department Occupational Safety and Health Program* (National Fire Protection Association, Quincy, MA, 2013 edition) which provides requirements for facility safety, maintenance, and inspections.

- The facility is not in compliance with the requirements and recommendations **NFPA 1581:** *Standard on Fire Department Infection Control Program* (National Fire Protection Association, Quincy, MA) which has requirements to provide minimum criteria for infection control in the fire station, in the fire apparatus, during procedures at an incident scene, and at any other location where fire department members are involved in routine or emergency operations.

- The facility is not in compliance with the requirements and recommendations **NFPA 1851:** *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting* (National Fire Protection Association, Quincy, MA). This standard provides safety requirements for storage and cleaning of personal protective equipment.

- The apparatus bays are very small for a modern fire station. This limits the amount of apparatus and/or equipment that can be stored in the station. In addition, hose and equipment cannot be efficiently loaded/unloaded inside during cold or inclement weather, nor can equipment be removed from the apparatus and set up for training and maintenance activities.

- The exterior of the site is totally inadequate for the operational needs of the department. The front ramp area does not provide enough room for the turning radius for apparatus exiting or re-entering the station, or for parking apparatus on the ramp. The front apron of the station is so small that if apparatus is parked in front of the station (and is not even fully out of the station) it blocks the entire walking area and sticks out into the street. This situation not only creates a potential traffic hazard; it creates a pedestrian safety issue because pedestrians must step out into the street to walk around the apparatus.

- There is inadequate parking for personnel and visitors requiring the use of on street parking. The MRI team noted that there was potential for falling snow and ice to damage vehicles in the side parking lot.

- Furniture, including beds, tables, desks, and chairs, are old and components were noted as being worn out and/or broken and in need of replacement.

- The station is not equipped with an automatic fire suppression system. It is equipped with limited smoke detection capabilities.

- There is no fire protection system over the stove in the kitchen.

- There is no vehicle exhaust removal system.

The MRI team was notified that a piece of property has been for purchased in the Collinsville section for a future fire station and that a land swap with a neighboring property was possible in order to provide space to replace the station.

The MRI team felt strongly that the current station was inadequate and priority consideration should be given to its replacement. Ultimately, personnel cannot be comfortably housed at this station and safety is a concern. However, because of the location of this fire station in the town, the number of emergency calls that occur in this part of the community, and no other good options for an alternative deployment location, the MRI team reluctantly recommends that this fire station remain open until such time as a new station can replace the current one.

Recommendations

5.3-1 The Town of Dracut should seriously consider expediting the CIP plan to make replacement of the Collinsville Station a high priority. The proposed location is appropriate and will meet the needs of the fire department and the Town regarding response patterns in Dracut.

5.3-2 The design of the new fire station should, to the extent practical, be a "green" facility, and include, but not necessarily be limited to, the following:

a. Adequate space for fire apparatus, both current and future;
b. Compliance with nationally recognized standards for fire station design and operation;
c. Energy efficiency;

d. A complete, automatic fire sprinkler system and smoke detection system;
e. Modern training capabilities;
f. Adequate, secure office space;
g. Adequate, secure storage for equipment and records;
h. Safe and secure living quarters for duty crew personnel;
i. Adequate apparatus exhaust system;
j. Handicapped accessibility for all areas;
k. Capability for decontamination and cleaning of firefighter protective clothing and equipment;
l. Adequate parking for staff vehicles and personal vehicles of duty crew personnel and other responding personnel;
m. Adequate space for outside training;
n. Dedicated physical fitness area;
o. Adequate social and meeting spaces;
p. Building integrity and capability for continuity of operations during disasters (e.g. emergency power, seismic protection, protection from flood and high winds, food storage, emergency medical supplies, redundant systems for water supply, sewage, and communications, etc.);
q. Building "sustainability" which means employing design and construction practices that significantly reduce or eliminate the negative impact of the building on the environment and occupants.

5.3-3 The Town of Dracut and Dracut Fire Department should include a wide range of stakeholders in the process of designing the new fire station to ensure that all of the fire department's needs and interests are appropriately addressed, and included, to the extent feasible.

5.3-4 The Dracut Fire Department should increase security at all fire stations through the use of an access control system (key card system for example). Because of the assets that are stored a t a fire station and based on recommendations from the Department of Homeland Security these types of facilities should always be in a secure state.

5.3-5 The MRI team recommends that the fire department consider installing surveillance camera systems at each fire station that can be monitored by the fire dispatch "radio room" and the Dracut Police Department. When apparatus is out of quarters this would allow a dispatcher to monitor the facility and communicate with visitors to the station that may require assistance.

CHAPTER 6

ORGANIZATIONAL RELATIONSHIPS

6.1 COMMUNICATIONS

Overview

From a broad perspective the main function of organizational communications is to keep personnel informed and to make sure that everyone is on the proverbial "same page" and "rowing in the same direction". The flow of communication could be either formal or informal. Communication flowing through formal channels are downward, horizontal and upward whereas communication through informal channels are generally termed as grapevine.

In any successful fire department/emergency service organization there must be open and effective lines of intra-department communications between the chief's office, the deputy fire chief, the captains and lieutenants, and down to the firefighters. Each of these groups, both individually and collectively, has a major stake in the operation of, and ultimately, the department's level of success. In addition, no one person has all the answers, knows everything, or in the modern era can do it all without assistance.

Subordinate personnel need to be empowered, provided with an appropriate "ownership" stake, and have duties and authority delegated to them. Recognizing that *"they can very easily fail on their own, but need a lot of assistance from their 'team' to be effective and successful"* has led most successful leaders today to adopt an inclusive style of management and decision making. A major component of being an effective leader is to not be afraid to identify, address, and/or correct problems and issues within the department, particularly those that may have existed for an extended period of time.

Observations

Numerous members of the Dracut Fire Department that were interviewed by the MRI study team cited a lack of basic communication throughout the department as one of the major issues confronting it. Multiple members informed the team that information does not get passed down or exchanged among personnel and there appears to be a real communications gap between the various ranks. This leads to either no communication, or miscommunication, between the shifts and at change of shifts resulting in a lack of continuity of operations and creating four different departments, one on each unit. In fact, several members identified the need for open lines of communication in the department as the number one issue confronting it (staffing is usually the number one issue in most career departments) and the first thing they would attempt to change if given the opportunity.

The chief did inform the study team that he holds periodic officer's meetings to review information with the department's supervisors including a review of SOGs that are in the process of being developed. However, a number of officers informed the team that these officer meetings are often rather one sided with the chief, most members believe that the chief utilizes an autocratic style of management based upon his military background, dictating how things are going to be done rather than seeking an open exchange of information and ideas.

It is important for us to note that a number of members of the department did inform the study team that it appears that the chief has recently tried to include department members more in the department's management process which they believed was a positive step toward more open communications.

It does not appear that many of the electronic communications mediums that are available today to facilitate rapid and widespread dissemination of information are being utilized. Electronic media including a member's only area of the department's web site, e-mail, and even social media platforms can all be utilized to assist with the dissemination of information. However, face to face communications remains the most effective and reliable medium. The command staff must make sure that they facilitate the accurate and complete exchange of information, in both direction, throughout all levels of the organization.

<u>Recommendations</u>

6.1-1 Communications within the Dracut Fire Department must be improved. Efforts to develop a new sense of shared and common vision, maintaining open lines of communication, attempting to address the issues identified in this report and through the on-line survey, delegating responsibility and authority, enhancing training and professional development programs, and instilling a sense of team and esprit de corps will all help to instill an increased sense of pride in the organization.

6.1-2 The chief should continue his efforts to adopt a more inclusive management style and should make the department's officers meetings more for an open and honest exchange of information between the participants. While the chief still reserves the right, by virtue of his rank, to make the final decision, being more open to the ideas of his other officers will ultimately make him more successful to the significant benefit of the department as a whole.

6.1-3 The Dracut Fire Department should look for various ways to improve the flow and dissemination of information within all levels of the department. Possible ways to accomplish this include, but are certainly not limited to:

- **The distribution of important department information via blast e-mails to all personnel. Sub e-mail lists can also be created and utilized for just officers, each unit, etc. allowing information that may be pertinent only to them to be quickly disseminated as well.**

- **The use of a department member's only section of the website where personnel can log on the access necessary information and communications.**
- **The use of social media platforms such as Facebook and text messaging.**
- **The implementation of written communications such as training, safety and informational bulletins which are issued as needed. These documents can be distributed electronically and also posted on a 30-day board in each station before being placed in a binder for future reference.**
- **The use of a pass along book or log where members can record information that should be passed along to other personnel particularly at shift change.**

Department members can provide input on what they believe may be the most effective mediums.

6.1-4 Face to face communications is still the most effective method. The Dracut Fire Department should ensure that a daily unit briefing is conducted by the officer in each station at shift change to review pertinent information. Information that should be covered would include any new communications, anything posted on the 30-day board and/or logged in the pass along book.

6.1-5 The fire chief should consider scheduling periodic meetings, perhaps quarterly, with each of the department's four units for the purpose of providing updates, answering questions directly, and soliciting ideas, concerns, and feedback.

6.2 INTERNAL STRIFE

Overview

Disagreements, misunderstandings, and personality conflicts are nothing new in in any aspect of life including every organization. So long as human beings work in and manage organizations, there will be internal strife—and no entity is immune to such distractions.

Internal strife takes on many different forms in the organizational environment. Conflicts can be veiled with biting sarcasm, harsh words, tense meetings, or even infantile bickering. But its senior management's approach to conflict that dictates the parameters of behavior and the long-term effect strife will have on the organization. When management confronts conflict as soon as they observe serious disagreements, they can help the individuals work through their problem to find resolution. But if management doesn't confront internal strife and offer legitimate opportunities for resolution, it becomes akin to a germ that can infect the entire organization[2].

[2] https://salesandmarketing.com/article/motivating-behavior-causes-and-cures-internal-company-strife

Observations

The MRI study team believes that the Dracut Fire Department is an organization that is experiencing significant internal strife at the present time. There is definitely a prevalent atmosphere of distrust and paranoia between the chief and the members of the department. There is no doubt this atmosphere is having a negative impact on the department and its personnel. Unfortunately, this is not unique to Dracut and is often quite prevalent in fire service organizations across Massachusetts.

Perhaps the best example of the disconnect within the department is the infighting back and forth that occurred over where and how department personnel would be interviewed in conjunction with MRI's evaluation. In most cases we conduct these interviews at either the fire station, or, another municipal facility such as town hall. In keeping with that practice we requested the chief make arrangements for us to be able to conduct these interviews. As part of this process he hung a sign-up sheet with available dates and times for personnel to be interviewed in the dispatch center. No one signed up.

The president of the union then contacted MRI informing us that their personnel would not participate if the interviews were held at either a fire station or in town hall. They were concerned about the chief "knowing who was being interviewed and what they might be saying" and the potential ramifications of that. The union subsequently arranged for these interviews to be conducted at the local American Legion Hall. This prompted the chief to threaten disciplinary action for insubordination against the Union President for his actions outside of the chain of command. Ultimately the town manager, in consultation with MRI, made the decision to allow the interviews to be conducted at the American Legion Hall. This prompted the chief to openly question MRI's methods and ultimately the validity of the study findings. In the end, more than 20 members of the department (not counting the chief and two deputies) were interviewed including several officers.

This appears to be symptomatic of an internal power struggle based on organizational history and conflict. Although not a productive relationship, this attitude is not uncommon when the fire chief is the only non-union member of the department and in a way is an isolated island where no one is covering his back. Several members reported that they were intimidated by the chief's style while others indicated that the chief was keeping the department moving forward.

Recommendations

6.2-1 One of the Town of Dracut's first, most important, and ongoing, priorities with regard to implementing the recommendation contained within the report should be to attempt to rebuild fractured relationships. An inclusive, team-based approach will be essential to moving the department forward.

6.2-2 The MRI study team recommends that the town and the fire union should participate in the Labor-Management Initiative (LMI) that is co-sponsored by the International Association of Fire Chiefs (IAFC) and the International Association of Fire Fighters (IAFF). The LMI program is designed to help develop and improve cooperative and collaborative relationships, thereby avoiding critical labor-management issues, disputes, and costly arbitrations.

6.3 EMPLOYEE PERSPECTIVES

Overview

Having a sense of common vision is important in any organization to ensure that the organization and its personnel are moving in unison toward a common goal(s). Having a common vision is not only about making sure that all parties are aware that they are in the same boat and rowing, but even more importantly, that they are rowing in the same direction. The impact of not sharing a common vision will be very noticeable in the quality and quantity of work performed, but also with the spirit and passion that the work of the organization is accomplished.

The perceptions shared by members of an organization can be extremely important in either establishing, or conversely, distorting that sense of a unified common vision. Whether accurate or not, and regardless of the myriad of factors that can influence them, the individual and/or shared perceptions of members of an organization can, and often do, become their reality. If there is a perception of distrust, or, lack of mutual respect, between members of the organization, and/or between management and labor, the goal of successfully achieving that sense of common vision will be difficult, if not impossible.

Observations

Concerns over conflict between the chief and the rest of the department notwithstanding, overall the members' impression of the department and its current environment was positive. Most members the MRI team interviewed seemed to have a lot of pride in their department. As is often the case these personnel identified their fellow department members and their work schedule as real positive attributes. They believe the department provides excellent service to the community. Several also mentioned that they felt they were fairly compensated.

However, most also discussed concern with the direction that the department is headed in, both today and in the future. There was also mention made of the divide between the older members of the department who are content with the status quo, and the newer members who want to initiate change. Several stated that things started going in the wrong direction about three years ago which we perceive as a veiled reference to the current chief assuming command of the department. As previously mentioned, although recently the chief has included department members to participate in the department decision making process this was perceived as a welcome and progressive step toward working as a team.

It was evident that the Chief manages in a para-military style and requires members to adhere to the rules and regulations. This is approach is consistent with his training and service as an officer in the Marine Corps. The chief was a member of the department and worked his way up through the ranks to his current position. Some of the personnel interviewed had worked with him in the past and found that this style today is not significantly different than when he was a lower ranking officer. While many have adjusted or even appreciate the chief's military background and management style others indicated that they are intimidated and stifled by it.

As was previously mentioned, the chief's style may be misunderstood or misinterpreted at times. This obviously impacts his effectiveness as a leader and can create negative morale issues within the department. Several members described the atmosphere within the department as horrible. Several, including a couple of officers, informed the study team they had actually contemplated transferring to other departments.

Many members questioned the town's real commitment to safety based on some management decisions that have been made such the decision continue apparatus usage at the Collinsville Station when there was no vehicle exhaust system. While this makes for a good sound bite there have at least been discussions regarding the replacement of this station and usually removing a station from service for an issue such as vehicle exhaust issues is not a viable option. Of greater concern from a safety perspective is an issue with regard to an apparatus that was purportedly allowed to operate for a period of time with bald tires. Once again, whether accurate or not there is a perception of neglect that could be alleviated by effective communications.

Another complaint that was made consistently is that the chief is not fighting hard enough for staffing and "giving money back to the town" instead of hiring overtime personnel to increase daily staffing. This is common complaint during these studies where the members feel that the department is underfunded (interpretation: understaffed) and that most of the problems of the agency will be resolved if the town provides increases in the budget and thus staffing. Some members did recognize that many of the improvements that can and should be made are not dependent upon an increase in the budget.

All of the members felt that the chief's ability to command an incident was more than adequate and that on the scene he acted appropriately and within safe operating guidelines. In that regard he still maintains a high level of confidence from his personnel.

Although our review of the department's training program indicated that, at least on paper, it was a pretty good program, a number of members expressed concern about a lack of "good training". The department has formal training most duty days but many members felt that it was going through the motions and that there was no long term and short term planning goals and objectives. Several expressed the sentiment that there was "too much" training. The members felt that often what they did throughout the day was intended to "keep them busy" rather than being meaningful. They believe there could be better use of training and their time throughout the shift. Several also expressed the fact that there is little to no outside training available to members except the chief and deputy chiefs.

Several officers expressed to the team that there has never been any efforts to mentor or develop the members of the department, particularly the officers. They also stated that many of the department's officers are really unsure what their jobs entail, or what the town and fire department leadership's expectations are for them. Several mentioned they were handed as badge and basically told "you are now an officer". As has been previously noted, the team believes that the department has suffered from a lack of involvement in external professional development and training opportunities. As a result, the members have not had the opportunity to learn about and institute creative programs and solutions that may have been implemented by fire departments faced with fiscal and operational challenges similar to those in Dracut. Regrettably, this also has resulted in numerous missed opportunities to provide development for the department's officers.

As was previously discussed in detail previously in this section 6.1 of this chapter the issue that was raised almost unanimously by those interviewed was the basic lack of communications throughout the Department. This leads to no communications or miscommunications especially between the shift s and at change of shifts. Ultimately, we believe this deficiency within the Dracut Fire Department has directly and indirectly led to a significant number of the issues that are impacting the department and the perceptions and concerns of its membership.

<u>**Recommendations**</u>

6.3-1 The fire chief should develop a formal process that will enable employees to provide input into the department's operations. Once submitted, employees must understand that not every idea will be utilized. When input is received, the employee should receive feedback relative to his/her idea. The fire chief should communicate examples of ideas that have been utilized/implemented as examples of success.

6.3-2 Efforts to develop a new sense of shared and common vision, maintaining open lines of communication, attempting to address the issues identified in this report and through the on-line survey, delegating responsibility and authority, enhancing training and professional development programs, and instilling a sense of team and esprit de corps should be utilized to instill an increased sense of pride in the organization.

6.3-3 An updated manual of department policies and procedures is one of the keys to achieving a shared vision for department operations. This process should be a team effort that involves input and participation from a wide cross-section of the department's internal stakeholders. Once completed, all personnel must be trained on

the contents of the manual, and held accountable to accomplish department goals by established means. Lieutenants must supervise, captains must administer and manage, and the command staff must provide necessary vision, direction, and leadership.

CHAPTER 7

COMPARATIVE ANALYSIS

7.1 OVERVIEW

The communities of Franklin, Milford, North Andover, Tewksbury, West Springfield and Wilmington were chosen by the town manager to be subject to peer review as compared to Dracut. It is noted that West Springfield did not respond to repeated phone and e-mail requests to cooperate with the study.

Following our field work in Dracut, a survey was developed and distributed to the six comparable communities identified above. This survey focused on funding, equipment, personnel, facilities, operations and service demand. Once the survey data was compiled responses were averaged and then compared to the current operations of the Dracut Fire Department. The purpose of this benchmarking exercise is to provide the Town of Dracut with a perspective on how their fire services compare to the averaged responses of five similar communities. The benchmarking data provided by the communities selected is detailed within the tables on the following pages:

7.2 DATA TABLES

FUNDING	Franklin	Milford	North Andover	Tewksbury	Wilmington	Average	Dracut
Budget figure for each municipality, including School Dept for FY16:	$113,464,650	$96,000,000	$89,348,722	$94,629,970	$100,520,702	$98,792,809	$72,729,095
Overall Fire Budget FY16:	$5,178,660	$3,800,000	$4,975,524	$4,588,398	$3,790,464	$4,466,609	$3,292,922
Includes costs such as liability insurance and employee benefits:	No	No	No	No	No		No
FY16 property tax rate:							
Residential	$14.50	$17.18	$14.27	$16.35	$14.63	$15.39	$14.84
Commercial	$14.50	$29.57	$20.47	$27.46	$33.17	$25.03	$14.84
FY15 population estimate:	33,590	27,999	28,350	30,613	24,000	28,910	33,000
Square Miles within the community:	27.01	15	27.8	21	17	21.562	21
Road miles in the community:	200	120	150	163.5	126	152	154
Estimated dollar amount of fire only grant funds awarded during FY15:	$400,000	$0	$7,754	$7,400	$8,033	$84,637	$244,845

EQUIPMENT	Franklin	Milford	North Andover	Tewksbury	Wilmington	Average	Dracut
Number of pieces of fire apparatus and vehicles currently in the fire fleet:							
Aerials	0	1	1	1	1	1	1
Ambulances	0	0	3	3	2	1.6	0
Brush/Wildland	3	2	1	2	1	1.8	3
Engines	5	4	3	4	4	4	5
Inspection/Admin vehicles	3	3	1	3	5	3	2
Lighting Units	0	1	0	0	0	0.2	1
Rescues	3	1	0	1	0	1	1
Specialty Units	1	1	1	2	0	1	1
Staff Vehicles (take home)	2	2	2	3	4	2.6	1
Tankers	0	2	0	0	0	0.4	0
Department vehicles maintained by:	the Dept; Private Vendor; Dealership; DPW	Private Vendor	the Dept; Private Vendor	DPW; Dealership; Private Vendor	DPW		Dept.; DPW; Dealership
Fire apparatus and command vehicles have Mobile Data Terminals/laptops, which connect to the department's records management system and the internet:	Yes	No	No	Yes	No		No
Community or Dept. has an emergency notification system:	Yes- Reverse 911	Yes- Connect CTY	Yes- Reverse 911	Yes- Code Red via internet interface, text for fire call backs, Reverse 911, cable TV	Yes- Everbridge		Yes- Reverse 911
Computer program utilized for records management:	Alpine Software, Red Alert, AmbuPro	IMC	Fire Server-PAMET; EMS - AMBUPRO	Fire/Police/CAD-IMC/Tri-Tech; Ambulance-AMBUPRO	Dispatch/NFIRS-IMC; Ambulance-AMBUPRO		Fire Programs

PERSONNEL	Franklin	Milford	North Andover	Tewksbury	Wilmington	Average	Dracut
Number of actual Sworn Personnel as of 7/1/15: All Dept's reported 0 PT	51	40	53	55	40	48	40
Number of on-call or volunteer personnel:	0	0	0	0	0	0	0
Number of Civilian Personnel as of 7/01/15:	5 FT 0 PT	0	0	1 FT	0		1 FT 1 PT
Dispatch	4 FT 3 PT	0	9 FT	0	12 FT		0
Non Dispatch	1 FT 0 PT	1 FT? 0 PT	0	0	1 FT 1 PT		
Average number of hours per week for firefighters/officers:	48	42	42	42	42	43.2	Deputies - 42; all other ranks 48
Schedules firefighters work:	1 on, 1 off, 1 on, 5 off	3 & 1	1 on, 2 off, 1 on, 4 off	1 on, 1 off, 1 on, 5 off	1 on, 2 off, 1 on, 4 off		1 on, 2 off, 1 on 4 off
Number of hours per shift:	10/14	24	24	24	24		24
Minimum staffing level:	9 day & night	6 FF & 1 Lt. for day & night	10 day & night (8 suppression, 2 EMS by contract, 12 on duty norm)	12 day & night	9 day & night		No Minimum Staffing Level- try to maintain 8
Number of personnel in the following positions:							
Deputy Chiefs	1	1	1	1 (operations)	1	1	2
Battalion Chiefs	0	0	0	0	0	0	0
Captains	5	0	0	5	0	2	4
Lieutenants	4	6	9	12	6	7.4	8
Firefighters	46	32	44	36	32	38	25
Number of sworn personnel assigned to the following functions:							
Fire Prevention/Fire Investigation	1 FPO, 1 FI	1	1 FPO, 4 FIU	1 FT FPO; 1 investigator assigned to shift	2		1 FP/ 2 FI
Training on a full-time basis	0	1	0	0 (1 assigned to shift)	1		1
Other administrative positions	11	2	1	0	0	2.8	0
FY15 Overtime:							
Budgeted	$629,550	$400,000	$539,809	$465,200	$800,000	$566,912	$500,000
Actual	$454,476	$375,000	$589,000	$672,910	$938,099	$605,897	$534,625

FIRE FACILITIES	Station Name or Number	Approximate year facility was constructed	Square footage of usable space	Number of bays	Other facilities within station
Franklin	Headquarters	2008	22,000	4	Dispatch, Emergency Operations Center, Conference Room
	Station 2	2000	12,000	3	Old Dispatch, Meeting Room
Milford	STA 1	2003		3	Training Room
	STA 2	1990		5	Training Room/Training Grounds
North Andover	1	2015		4	Training room, gym, EMS supply
	2	1970		2	
Tewksbury	Center	1966	8,600	4	
	South	2001	7,480	4	Community Room
Wilmington	North	1976	1,886	2	
	Public Safety	2001	41,000	5	Fire Police Dispatch
Dracut	Headquarters (1)	2002	16,400	5	Dispatch, training, Admin
	Jones Ave (2)	2000	8,400	5	Emergency Management storage
	Collinsville (3)	1954	1,500	2	Built as call station

FIRE FACILITIES	Franklin	Milford	North Andover	Tewksbury	Wilmington	Dracut
Working surveillance cameras:						
Inside	Yes	No	No	No	Yes	No
Outside	Yes	No	No	No	No	Sta 1 only
Access control system at each facility:	Yes	No	Yes	No	Yes	Yes
Number of fire stations:	2	2	2	3	1	3

OPERATIONS	Franklin	Milford	North Andover	Tewksbury	Wilmington	Dracut
Total number of actual NFIRS fires in 2015:	87	98	124		364	80
Total NFIRS Coded Structure Fires in 2015:	22	35	19	90	11	18
Fire related dollar loss listed in 2015 NFIRS Report:	N/A	$800,000	$341,233 property; $173,995 Contents	$1,089,745		$283,200
Average response time to actual structure fires in 2015:	5 minutes in Town; 10-13 out of town mutual aid calls					4.9 min
Average number of personnel assigned to actual structure fires in 2015:	6	7 on duty; ? Off duty	13	12	9 per shift	7
Engaged in Regional or shared services:	No	No	No	Yes- Fire Investigation; Fire District 6 Mutual Aid	No	Yes
Dept. provides EMS transport services:	Yes	No	Yes	Yes	Yes	No
If yes... ALS	Not able to separate	N/A		No - Lowell General Hosp. Paramedics are primary ALS service		N/A
BLS	Not able to separate	N/A	2 Ambulance in service 24hrs	Yes	Yes	N/A
Annual Transports	1,843	N/A		FY15- 2,673; FY14- 2,351	2015: 1,637	N/A
Revenue Collected	$834,429	N/A		FY15- $1,273,075; FY14- $922,608	2015: $740,055	N/A
Another agency dispatches for the Dept.:	No	Yes	Yes	Yes- Tewksbury PD - combined dispatch	No	No
Annual Expenditure	N/A	0	$472,130			
Dept's dispatchers are:	Civilian	Civilian	Civilian	Civilian	Civilian	Sworn
Community has combined dispatch for both PD and FD:	No	Yes	Yes	Yes	Yes	No- entered into regional dispatch with Tewksbury 2015
Dept. is Nationally Accredited:	No	No	No	No	No	No
Pursuing Accreditation:	No	No	No		No	No
Dept.'s ISO:	4	4	3	4	4	04/4x

ANNUAL CALL VOLUME		CALENDAR YEAR 2013	2014	2015
Franklin	***Responses***			
	Fire	87	96	88
	EMS	2,404	2,565	2,732
	Transports	1,790	1,768	1,917
	Mutual/Auto Aid			
	Automatic Aid Received	22	17	19
	Automatic Aid Given	3	0	2
	Mutual Aid Received	96	111	107
	Mutual Aid Given	103	56	60
Milford	***Responses***	4,577	4,560	4,759
	Fire	147	102	98
	EMS	2,952	3,028	3,136
	Transports			
	Mutual/Auto Aid	Did not report any Auto Aid received; reported remainder in		
	Automatic Aid Given; Mutual Aid Received & Given	39	5	10
North Andover	***Responses***	4,011	4,164	4,215
	Fire	1,760	1,792	1,755
	EMS	2,251	2,372	2,460
	Transports	1,919	1,935	2,027
	Mutual/Auto Aid			
	Automatic Aid Received	6	5	10
	Automatic Aid Given			
	Mutual Aid Received	25	33	62
	Mutual Aid Given			
Tewksbury	***Responses***			
	Fire	3,999	4,253	4,608
	EMS	3,010	3,312	3,288
	Transports (Fiscal Year)	2,199	2,351	2,673
	Mutual/Auto Aid	Did not report any given or received		
Wilmington	***Responses***	3,744	3,624	3,640
	Fire			
	EMS	2,084	2,413	2,416
	Transports	1,579	1,674	1,637
	Mutual/Auto Aid	Did not report any Auto Aid given or received		
	Mutual Aid Received			
	Mutual Aid Given (EMS only)	164	164	215
Dracut	**Responses**			
	Fire	82	69	80
	EMS	2317	2,182	2,306
	Transports	0	0	0
	Mutual/Auto Aid			
	Automatic Aid Received	0	0	0
	Automatic Aid Given	0	0	0
	Mutual Aid Received	8	7	2
	Mutual Aid Given	25	24	27

7.3 OBSERVATIONS

The survey revealed the following:

- The overall municipal budget in Dracut is 26 million or 25% below the average of the five respondents.
- The budget of the Dracut Fire Department is 27% below average.
- The tax rate in Dracut is 3% below average on the residential side and as Dracut utilizes a single tax rate, 41% below the average of the tax rate imposed on commercial properties.
- Despite have a smaller budget the population in Dracut is 14% above average.
- The square mileage and road miles in Dracut were almost exactly that of the average of the five responding communities.
- The Dracut Fire Department far exceed the average grant revenue and was second only to Franklin.
- 4 of the 5 comparable communities provide transport EMS.
- The Dracut Fire Department operates one engine and one brush truck above the average of those units operated by other communities. However, Dracut does not have a tanker to protect areas beyond the confines of the water district.
- The Dracut Fire Department operates the fewest staff vehicles as the only take home staff vehicle is currently operated by the Chief.
- Dracut has 40 personnel which is 17% below the average of 48.
- The average shift strength was 9.4 personnel while Dracut operates with a minimum shift strength of 7 personnel (25% below average).
- Most of the respondents utilize civilian personnel in dispatch and to provide administrative services.
- Dracut has 20% more officers than the average and 34% fewer firefighters.
- Overtime is 12% below the average budgeted and 12% below the average amount actually expended within the peer communities.

- The majority of the respondents operate 2 stations while Dracut operates 3 stations.
- Station 3 is the oldest and smallest facility of all responses.
- Dracut experiences ½ of the actual fires compared to the average fire experience in the peer communities.
- Dracut experiences ½ of the actual structure fires of the peer community average. However, the number in Dracut approaches the number in three other communities as Tewksbury's fire experience skews the data.
- Dracut is one of two communities that track response times to structure fires. Dracut's performance was the best with an average response of 4.9 minutes.
- The fire loss reported in Dracut was a fraction of the average of the communities that responded to this question.
- One half of the responding communities have another agency provide dispatch services.
- Dracut is the only agency utilizing sworn personnel as dispatcher.
- 4 of the 5 peer communities utilize a combined police/fire public safety dispatch.
- None of the departments surveyed had or were pursuing accreditation.
- Dracut's Insurance Service Office Public Protection Classification of 4/4X is in line with the average and only one of the peer communities had a better rating of 3.
- The vast majority of responses in Dracut are EMS related.
- If Dracut operated transport EMS, they could expect 1,650 transports that would produce approximately $850,000 in annual revenue.

7.4 Recommendations

7.4-1 The Dracut Fire Department should investigate the possibility of developing a backup basic life support transport EMS capability as a first step in evaluating the feasibility of providing transport EMS to the community. However, Patriot Ambulance is the private provider utilized for patient transport within the Town of Dracut. Rather than charging the Town of Dracut to provide this service, Patriot pays the Town $14,000 per year. Given the payer mix and Demographics present within Dracut, ambulance billing must factor in both write offs and adjustments. As we are aware that the fire department would like to enhance its service in the community and possibly expand

into transport EMS, any investigation should consider the fiscal equation noted above, produce no sustained fiscal impact that requires the Town of Dracut to subsidize operations on an ongoing basis. Any fire based EMS venture should be transparent to the public and developed through an enterprise account to ensure that any EMS endeavor would be sustainable without additional support from the community.

7.4-2 The Dracut Fire Department should consider reducing one engine and within the confines of the capital plan acquiring a tanker pumper to serve as a backup engine and provide additional water to those areas beyond the confines of the water district.

7.4-3 The Dracut Fire Department should consider providing staff vehicles to the deputy chiefs, developing an on-call rotation and facilitating the rapid off duty response of chief officers to significant incidents.

CHAPTER 8

INTERNAL EMPLOYEE SURVEY

8.1 Overview

As part of this organizational assessment process, MRI interviewed numerous Dracut Fire Department stakeholders. The study team spent numerous hours in the town over a number of days and assessed the attitudes and performance of the members of the department. Data of all sorts was gathered and analyzed in order to paint a picture of what motivates and directs the members of the department. An important part of this process involved administering an anonymous survey instrument to members of the department to obtain feedback from them on a wide range of issues that impacts them daily in their jobs.

As part of this study, MRI administered an internal survey developed by MRI. In order to maintain confidentiality and fairness all employees of the fire department were provided with a survey and a self-addressed envelope to MRI. The surveys were then entered into an electronic database (Survey Methods) so the responses could be compiled. In addition, MRI staff summarized common themes found throughout the written comments respondents included in the survey. The survey results and summary of written comments can be found in Appendix C.

The survey instrument resulted in 37 responses; 36 from full-time sworn members; 1 full-time civilian staff). The survey analysis and comments can be found in Appendix C.

8.2 Observations

During the period January to March 2016, MRI developed and delivered a written survey to obtain perspectives from the members of the Dracut Fire Department. Participation was both anonymous and voluntary.

Thirty-seven (90.2% of the forty-one current personnel) stakeholders completed the survey. This is an extremely high percentage of response to this type of survey which is significant in itself. Most times a response rate of around 50% to 60% is considered to be very good. Of those thirty-seven who participated in the survey, all (100%) completed it in its entirety. All of the department's chiefs, captains and lieutenants completed the survey along with the department's single civilian employee. Twenty firefighters (80%) completed it also. Of those who completed the survey, 54.1%) were firefighters, 24.3% were lieutenants, 10.8% were captains, 8.1% were chief officers and 2.7% were civilian. (lieutenant/captain/deputy chief), twenty-five (55.6%) were firefighter/EMTs, and five (11.1%) were firefighters.

Based on the extent of the response, this survey provides a comprehensive perspective on the organization from the rank and file members and officers. As the MRI study team has concluded and discussed throughout this report, this survey paints a picture of an organization in considerable turmoil. Based on the results of the survey, it is our impression that partisan groups and factions, with divided loyalties, have formed within the organization and are contributing to a growing concern about dysfunctionality. The responses to the survey also seemed in certain instances to be contrary to information that was provided to the study team during our stakeholder interviews.

The survey revealed the following:

- 48.6% of the respondents disagreed or strongly disagreed facilities provided for the Dracut Fire Department are adequate and provide a clean and safe work environment while 35.1% agreed or strongly agreed that they were.

- Just 18.9% of respondents believe that the organization is well managed, while 59.4% believe it is not.

- The majority of department personnel that responded to the survey do not feel that there is a high level of mutual respect across ranks. In fact, nearly 1 in 3 responses (32.4%) strongly disagreed with the idea that there is mutual respect.

- Approximately 24.3% of respondents believe that they receive support and encouragement necessary to be successful while nearly half (48.6%) do not.

- The majority of respondents do not believe that there is either a common vision or that the department operates with a set of common goals.

- Nearly one in three respondents (32.3%) feel that expectations within the organization are unclear. However, a larger percentage (43.2%) believe they are.

- 62.1% of respondents believe that internal discipline is not fairly and consistently administered.

- 56.7 % of respondents believe that training is adequate, while the remainder are neutral (18.9%) or believe training is not adequate (24.3%).

- Most respondents (56.7%) agree that training opportunities are distributed equitably and fairly.

- 72.9% of respondents received personal and professional satisfaction from the job that they do within the Dracut Fire Department.

- A significant number of respondents (45.9%) do not believe that they receive timely and quality feedback from their supervisors. Of the remainder, 37.8% felt they did while 16.2% were neutral.

- Just 29.7% of the department members believe that the leadership team (chief and deputy chiefs) advocates for the needs of the department while 43.2% do not feel they do.

- The majority of respondents (62.1%) do not feel personnel are treated fairly and equitably relative to the opportunity to obtain job assignments and specialty positions while just 21.6% felt they were.

- 64.8% of respondents have not witnessed acts of discrimination; however nearly one in five (18.9%) answered that they have.

- Respondents were fairly evenly split with regard to their belief that the apparatus within the Dracut Fire Department has been well maintained. 35.1% agree that it has, 21.6% are neutral, while 43.2% disagree.

- 59.4% of respondents do not believe policies, procedures, rules and regulations provide clear guidance to employees while 21.6% do.

- Just 16.2% of those who responded believe the department's internal communications are adequate while 64.8% do not feel they are.

- A slight majority (52.7%) of respondents believe promotions are made fairly.

- 62.1 % of respondents have felt threatened or intimidated, at least occasionally, by coworkers or supervisors with 18.9% reporting it happened often. One out of three members (33.3%) reported they have witness or been the victim of harassment.

- 25% of respondents believe that salary and benefits within the Dracut Fire Department are both fair and adequate, 25% are neutral and 50% disagree.

- 57.5% of the department disagree that department is keeping pace with technology.

- Just 27% of respondents believe that the administration of the Dracut Fire Department provides fair and equal treatment to all employees while 51.3% disagree and 21.6% were neutral.

- Just one (1) respondent rated their level of trust in the command staff as high, five (5) rated them above average, twenty-one (21) average, five (5) below average, and three (3) poor.

- 54% believe that the Town of Dracut and the Dracut Fire Department are good employers.

- Over 65% of respondents believe that labor management relations are poor. This is reflective of the high level of turmoil found throughout the study and within other parts of this survey.

- The department is evenly divided as some feel that fire service administration welcomes suggestions and input while others feel that the proverbial door is closed to new ideas.

- Nearly half (48.6%) of the respondents believe the administration of the department recognizes their service to the agency.

- An overwhelming majority (91.8%) of the department would support efforts to expand the level and scope of emergency medical services offered to the community.

- 81% of respondents are proud to be members of the Dracut Fire Department.

- 40.5% believe the town manager and board of selectmen support the department while 37.8% are neutral and 21.6% disagree.

- 78.3% of respondents believe that residents of Dracut value the service that the respondents provide.

- The respondents were split on whether that supervisors provide quality guidance and support with 24.3% agreeing and 40.5% disagreeing. More than one in three (35.1% were neutral.

- If offered another comparable job with the same pay and benefits, nearly one half (48.6%) of respondents would leave the Dracut Fire Department while just less than one in three (32.4%) would definitely stay.

8.3 Recommendations

8.3-1 The Town of Dracut and Dracut Fire Department should take the results of this survey very seriously and utilize it as one more important component necessary for successfully developing a roadmap for the department's future direction through the collaborative establishment of benchmarks, and, a long range strategic plan.

CHAPTER 9

SUMMARY OF CONCLUSIONS

9.1 Introduction

MRI found the Dracut Fire Department to be a well equipped and deployed organization. The department should be proud that our overall impression is that the Dracut Fire Department is an effective and relatively productive contemporary fire service organization. It appears that the level of service provided meets the needs of the community and that overall the department is a solid and functional organization. In this context the risks to the town are more forward looking operational, safety and capability issues rather than crises that require immediate intervention to avoid further liability.

All organizations experience internal strife and conflict. As noted earlier in this report, some level of conflict is part of the human condition. However, in Dracut the level of interpersonal conflict is moderate and has started to erode teamwork. Given the increasing level of conflict this should be addressed through a labor/management initiative.

As the Dracut Fire Department is a functional organization this report should be viewed as a compilation of ideas relative to how the town and members of the department could invest in an even more productive future. It is essential that the department work together to prioritize this investment and be realistic when considering the fiscal ability of the community.

MRI has assessed the risk arising from the administration of fire services by the Dracut Fire Department AVERAGE AND EQUAL TO THE LEVEL OF RISK EXPERIENCED IN PEER COMMUNITIES.

9.2 Observations

It should be recognized that many risks are also opportunities. To meet the Scope of work associated with this project, we have divided the major risks to the community into four subject areas which are detailed below:

Operations

- Standard operating guidelines need to be updated and expanded through an inclusive process.
- Standard operating guidelines and policies should be reviewed during each shift and training session. This would facilitate a high level of knowledge and implementation as opposed to having numerous policies and procedures that are rarely followed.

- The department needs to expand the use of and harness the benefit of technology.

- A chief officer rotation should be established to ensure the immediate response of the command staff to significant incidents. This is especially important given the current level of staffing in the two substations.

- Rural water supply operation and response should be strengthened.

Safety

- Station 3 should be replaced as soon as possible and an exhaust system that could be transitioned to a new station should be installed while the new station is under construction.

- Utilizing SAFER grants, staffing should be increased to provide a three-person company at each of the sub stations

Capability

- The dispatch operation should be transitioned to a regional emergency communication center (RECC) and the firefighter on the desk should be redeployed to operations.

- Station 3 should be replaced as soon as possible based on its current condition and inherent operational issues.

- The Department should consider reducing risk to the community by developing a transport EMS capability.

Organizational Practice

- A formal progressive discipline policy should be developed and implemented to ensure consistent personnel practice.

- The chief's position should be removed from civil service in that leaving it under civil service will constrain the potential applicant pool and pose a risk that the town may not be able to attract and recruit the best possible candidate when the chief retires.

- Many employees feel disenfranchised and need to have the opportunity to become more involved in the operations of the department. In the absence of inclusion, relationships would further deteriorate and the organizational culture would become more conflict oriented.

CHAPTER 10

THE PROJECT TEAM

PROJECT MANAGER

Brian P. Duggan recently retired from the Fire Department in Northampton, Massachusetts, where he has instituted substantial changes to modernize and restructure the entire department including equipment, facilities, personnel, and training. In conjunction with his staff, Brian has created a regional Advanced Life Support Program that currently serves eighteen communities within the Northampton Area. He formerly commanded the Northborough, Massachusetts, Fire Department, and has significant experience with the Massachusetts Department of Fire Services where he held several key positions. Mr. Duggan developed and directed the Graduate and Undergraduate Fire Science Programs at Anna Maria College in Paxton Massachusetts from 1995 - 2003. Mr. Duggan has a Business Management/Fire Science degree from Providence College and a Master's Degree of Business Administration (MBA) from Nichols College in Dudley, Massachusetts. He is also a graduate of the National Fire Academy Executive Fire Officer Program and the Senior Executive Program for State and Local Leaders at Harvard University. In December 2012, Mr. Duggan received a Master's Degree in Homeland Security through the Naval Post Graduate School based in Monterey, California, where his thesis entitled *"Enhancing Decision-making during the First Operational Period of Surge Events"* was selected as an outstanding thesis. He is one of only a few fire service professionals to be designated as a Chief Fire Officer by the Commission on Fire Accreditation International. He leads the Massachusetts fire service through his affiliation as Chairman of the Fire Chief Association of Massachusetts Technology Committee and as a Regional Director on the Massachusetts State Fire Mobilization Committee. Mr. Duggan has authored several publications, inclusive of writing Section 7, Chapter 3, Fire Department Information Systems, in the Nineteenth and Twentieth Editions of the National Fire Protection Association's Fire Protection Handbook. Chief Duggan has served as a subject advisor to MRI since 2002.

TEAM MEMBERS

Peter J. Finley, Jr. most recently served as Chief of the Winslow Township Fire Department in New Jersey, where he was responsible for the planning, establishment, and initial deployment of the career component of the department. He previously served for 4 ½ years as the Chief of Department for the City of Vineland, New Jersey Fire Department where he initiated significant changes within the department including updating and modernizing equipment, providing the department's first ever formal officer training, and significantly increasing the capabilities of the regional hazardous materials response team. During his tenure the department received more than one million dollars in various grants. He formerly commanded the Vineland Rescue Squad gaining significant EMS operations and command experience, as well as completing an overhaul of that organization's operations. Chief Finley serves as an Adjunct Professor in the Fire Science

Program at Camden County College. Chief Finley received his Associate in Applied Science degree from Atlantic Community College in New Jersey, and earned his Bachelor of Science degree in Fire Science/Administration from the University of Maryland. He is a graduate of the National Fire Academy's Executive Fire Officer Program, earning perfect scores on three of his four Applied Research Projects. He was awarded an Outstanding Research Award for his 2002 paper titled, "Residential Fire Alarm Systems: The Verification and Response Dilemma". Chief Finley holds nearly two dozen state and national certifications and is a member of a number of fire service organizations, including achieving the prestigious Chief Fire Officer designation from the Commission on Fire Accreditation International. He is a member of a number of fire service organizations and is currently serving as President of the New Jersey Career Fire Chiefs Association where he has been involved in the development and administration of fire service promotional examinations. From 2003–2005 he served on the Training and Education Committee of the Governor's Fire Service and Safety Task Force. He also previously served on the state committee that developed New Jersey's first Firefighter I Instructor Manual

George Klauber is a Senior Public Safety Consultant with MRI; he graduated from Charter Oaks State College with a BS in Fire Science and Technology, and has taken numerous courses at the National Fire Academy. Chief Klauber retired as the Fire Chief in Derry, New Hampshire, where he served since 2003. His retirement capped a career of almost 40 years in the Fire Service. George began his career in the Waterbury CT Fire Department where he served with distinction and rose through the ranks to become Chief of the Department, a position he held for 3 years before accepting the position of Chief in Derry NH. Chief Klauber is a Certified Fire Officer in accordance with NFPA 1021; a Certified Fire Service Instructor in accordance with NFPA 1501; and a Certified Safety Officer in accordance with NFPA 1521. Chief Klauber is a member of the International Association of Fire Chiefs; the New England Association of Fire Chiefs, the New Hampshire Fire Chiefs Association; the National Fire Protection Association, and the International Association of Emergency Managers. Chief Klauber has served as a subject expert and consulting advisor to MRI clients since 2001.

Robert C. Craig most recently served as Interim Director of Fire and Emergency Medical Services for the Town of Acton, Massachusetts. Immediately prior to this he had served the Town of Acton during his entire career of almost 44 years of service as a member of the Acton Fire Department which included his last 22 years as Fire Chief. The Town of Acton Fire Department is staffed by 42 career personnel, housed in three Fire/EMS stations and provides full fire, rescue and emergency services including EMS for approximately 23,000 residents. During his career Bob administered an annual fire department budget of approximately 3 million dollars. Together with the Acton Police Chief, he also managed a joint Public Safety Dispatch Center. Bob holds an Associate Degree in Fire Science and Technology as well as a Bachelor of Arts Degree and is a graduate of the Executive Fire Officer Program of the National Fire Academy. He is a member of the International Association of Fire Chiefs; the New England Association of Fire Chiefs; the Fire Chief's Association of Massachusetts and the National Fire Protection Association. Bob has served for over twenty (20) years as a member of the Massachusetts Fire Training Council as one of the representatives of the Fire Chiefs Association of Massachusetts and now continues to serve as appointed by the Governor to represent the Citizens of the Commonwealth. He has attained professional status and recognition as a credentialed fire chief in Massachusetts. Bob has a diverse background and expertise in Firefighting, EMS, Dispatch, Fire Prevention and Investigation, Emergency Planning and Operations, Municipal Finance and Government and Labor/Management relations. During his career he has also participated in the study of and /or implementation of a number of regional programs including Fire Investigation, Dispatch, and EMS to include ALS services. In addition, he has been instrumental with the planning and construction of a public safety facility which included a joint dispatch center and Fire/EMS station construction and renovations. He has also participated in a number of Fire/EMS management studies.

APPENDIX A

Municipal
Resources

Mission Statement of the Dracut Fire Department

To effectively and efficiently protect the lives and property of the town of Dracut against all emergencies, natural or man made. Through our diligence in training we will excel in Fire Suppression, Fire Prevention, Public Education and be second to none in our Emergency Medical Services.

Vision Statement of the Dracut Fire Department

The Dracut Fire Department is to be a key team player with citizens of Dracut, local businesses and other government agencies working to maintain a Community we can all be proud of with a strong sense of safety and security.

Provide responsive services to the citizens by investing in training, education, staffing and equipment. Through these continued efforts we will strive to achieve a level of service that is viewed as a benchmark within the Fire Service and shall be second to none.

We are a Team of Dedicated and Compassionate Professionals, who are Leaders in our Profession and Community role Models.

APPENDIX B

Municipal Resources

NIST

Report on Residential Fireground Field Experiments

NIST Technical Note 1661

Jason D. Averill
Lori Moore-Merrell
Adam Barowy
Robert Santos
Richard Peacock
Kathy A. Notarianni
Doug Wissoker

Edited by Bill Robinson

U.S. Department of Commerce
Gary Locke, Secretary

National Institute of Standards and Technology
Patrick D. Gallagher, Director

April 2010

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Chief Ronald Mastin

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NIST
National Institute of
Standards and Technology
U.S. Department of Commerce

IAFC
INTERNATIONAL
FIRE CHIEFS
ASSOCIATION
ORG 1873

IAFF
AFL-CIO
CLC

WPI

CFAI RISK

Table of Contents

Abstract

Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.

For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire — a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m^2), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.

Executive Summary

Both the increasing demands on the fire service - such as the growing number of Emergency Medical Services (EMS) responses, challenges from natural disasters, hazardous materials incidents, and acts of terrorism — and previous research point to the need for scientifically based studies of the effect of different crew sizes and firefighter arrival times on the effectiveness of the fire service to protect lives and property. To meet this need, a research partnership of the Commission on Fire Accreditation International (CFAI), International Association of Fire Chiefs (IAFC), International Association of Firefighters (IAFF), National Institute of Standards and Technology (NIST), and Worcester Polytechnic Institute (WPI) was formed to conduct a multiphase study of the deployment of resources as it affects firefighter and occupant safety. Starting in FY 2005, funding was provided through the Department of Homeland Security (DHS) / Federal Emergency Management Agency (FEMA) Grant Program Directorate for Assistance to Firefighters Grant Program — Fire Prevention and Safety Grants. In addition to the low-hazard residential fireground experiments described in this report, the multiple phases of the overall research effort include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and on property losses.

The first phase of the project was an extensive survey of more than 400 career and combination (both career and volunteer) fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project. The survey results will constitute significant input into the development of a future software tool to quantify the effects of community risks and associated deployment decisions on resultant firefighter and civilian injuries and property losses.

The following research questions guided the experimental design of the low-hazard residential fireground experiments documented in this report:

1. How do crew size and stagger affect overall start-to-completion response timing?

2. How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the 22 critical fireground tasks?

3. How does crew size affect elapsed times to achieve three critical events that are known to change fire behavior or tenability within the structure:
   a. Entry into structure?
   b. Water on fire?
   c. Ventilation through windows (three upstairs and one back downstairs window and the burn room window).

4. How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene vary between crew sizes of four and five?

In order to address the primary research questions, the research was divided into four distinct, yet interconnected parts:

- Part 1 — Laboratory experiments to design appropriate fuel load
- Part 2 — Experiments to measure the time for various crew sizes and apparatus stagger (interval between arrival of various apparatus) to accomplish key tasks in rescuing occupants, extinguishing a fire, and protecting property
- Part 3 — Additional experiments with enhanced fuel load that prohibited firefighter entry into the burn prop – a building constructed for the fire experiments
- Part 4 — Fire modeling to correlate time-to-task completion by crew size and stagger to the increase in toxicity of the atmosphere in the burn prop for a range of fire growth rates.

The experiments were conducted in a burn prop designed to simulate a low-hazard[1] fire in a residential structure described as typical in NFPA 1710® *Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. NFPA 1710 is the consensus standard for career firefighter deployment, including requirements for fire department arrival time, staffing levels, and fireground responsibilities.

Limitations of the study include firefighters' advance knowledge of the burn prop, invariable number of apparatus, and lack of experiments in elevated outdoor temperatures or at night. Further, the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

Primary Findings

Of the 22 fireground tasks measured during the experiments, results indicated that the following factors had the most significant impact on the success of fire fighting operations. All differential outcomes described below are statistically significant at the 95 % confidence level or better.

Overall Scene Time:

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crews. On the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the

1 A low-hazard occupancy is defined in the NFPA Handbook as a one-, two-, or three-family dwelling and some small businesses. Medium hazards occupancies include apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or firefighting forces. High-hazard occupancies include schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other highlife hazard or large fire potential occupancies.

benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and is recognized in industry standards.[2]

Time to Water on Fire:

There was a 10% difference in the “water on fire” time between the two- and three-person crews. There was an additional 6% difference in the "water on fire" time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two person crews). There was an additional 6% difference in the “water on fire” time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).

Ground Ladders and Ventilation:

The four-person crews operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 % faster than the two-person crews and 25 % faster than the three-person crews.

Primary Search:

The three-person crews started and completed a primary search and rescue 25 % faster than the two-person crews. The four- and five-person crews started and completed a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. A 10 % difference was equivalent to just over one minute.

Hose Stretch Time:

In comparing four-and five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to the two-person crews the differences are more distinct. Two-person crews took 57 seconds longer than three-person crews to stretch a line. Two-person crews took 87 seconds longer than four-person crews to complete the same tasks. Finally, the most notable comparison was between two-person crews and five-person crews — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:

As defined by NFPA 1710, the “industry standard achieved” time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.[3] An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. Based on the study protocols, modeled after a typical fire department apparatus deployment strategy, the total number of firefighters on scene in the two- and three-person crew scenarios never equaled 15 and therefore the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:

Three different “standard” fires were simulated using the Fire Dynamics Simulator (FDS) model. Characterized in the *Handbook of the Society of Fire Protection Engineers* as slow-, medium-, and fast-growth rate[4], the fires grew exponentially with time. The rescue scenario was based on a non-ambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by early-arriving crews had less exposure to combustion products than occupants rescued by late-arriving crews. The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting them to an increasingly toxic atmosphere. For a slow-growth rate fire with two-person crews, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the general population. For a fast-growth rate fire with two-person crews, the FED was well above the median level at which 50 % of the general population would be incapacitated. Larger crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

Conclusion:

More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires.

Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events, such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities, responses to large-scale non-fire incidents, or technical rescue operations.

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2 NFPA Standard 1710 - A.5.2.4.2.1 …Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.

3 NFPA 1710 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. Section 5.2.1 – Fire Suppression Capability and Section 5.2.2 Staffing.

4 As defined in the handbook, a fast fire grows exponentially to 1.0 MW in 150 seconds. A medium fire grows exponentially to 1 MW in 300 seconds. A slow fire grows exponentially to 1 MW in 600 seconds. A 1 MW fire can be thought-of as a typical upholstered chair burning at its peak. A large sofa might be 2 to 3 MWs.

Background

The fire service in the United States has a deservedly proud tradition of service to community and country dating back hundreds of years. As technology advances and the scope of service grows (e.g., more EMS obligations and growing response to natural disasters, hazardous materials incidents, and acts of terrorism), the fire service remains committed to a core mission of protecting lives and property from the effects of fire.

Firefighting is a dangerous business with substantial financial implications. In 2007, U.S. municipal fire departments responded to an estimated 1,557,500 fires. These fires killed 3,430 civilians (non-firefighters) and contributed to 17,675 reported civilian fire injuries. Direct property damage was estimated at $14.6 billion dollars (Karter, 2008). In spite of the vigorous nationwide efforts to promote firefighter safety, the number of firefighter deaths has consistently remained tragically high. In both 2007 and 2008, the U.S. Fire Administration reported 118 firefighter fatalities (USFA 2008).

Although not all firefighter deaths occur on the fireground — accidents in vehicles and training fatalities add to the numbers — every statistical analysis of the fire problem in the United States identifies residential structure fires as a key component in firefighter and civilian deaths, as well as direct property loss. Consequently, community planners and decision-makers need tools for optimally aligning resources with the service commitments needed for adequate protection of citizens.

Problem

Despite the magnitude of the fire problem in the United States, there are no scientifically based tools available to community and fire service leaders to assess the effects of prevention, fixed sprinkler systems, fire fighting equipment, or deployment and staffing decisions. Presently, community and fire service leaders have a qualitative understanding of the effect of certain resource allocation decisions. For example, a decision to double the number of firehouses, apparatus, and firefighters would likely result in a decrease in community fire losses, while cutting the number of firehouses, apparatus, and firefighters would likely yield an increase in the community fire losses, both human and property. However, decision-makers lack a sound basis for quantifying the total impact of enhanced fire resources on the number of firefighter and civilian lives saved and injuries prevented.

Studies on adequate deployment of resources are needed to enable fire departments, cities, counties, and fire districts to design an acceptable level of resource deployment based upon community risks and service provision commitment. These studies will assist with strategic planning and municipal and state budget processes. Additionally, as resource studies refine data collection methods and measures, both subsequent research and improvements to resource deployment models will have a sound scientific basis.

Review of Literature

Research to date has documented a consistent relationship between resources deployed and firefighter and civilian safety. Studies documenting engine and ladder crew performance in diverse simulated environments as well as actual responses show a basic relationship between apparatus staffing levels and a range of important performance variables and outcome measurements such as mean on-scene time, time-to-task completion, incidence of injury among fire service personnel, and costs incurred as a result of on-scene injuries (Cushman 1981, McManis 1984, Morrison 1990, Ontario 1991, Phoenix 1991, Roberts 1993).

Reports by fire service officials and consulting associates reviewing fire suppression and emergency response by fire crews in U.S. cities were the first publications to describe the relationship between adequate staffing levels and response time, time to completion of various fireground tasks, overall effectiveness of fire suppression, and estimated value of property loss for a wide range of real and simulated environments. In 1980, the Columbus Fire Division's report on firefighter effectiveness showed that for a predetermined number of personnel initially deployed to the scene of a fire, the proportion of incidents in which property loss exceeded $5,000 and horizontal fire spread of more than 25 sq ft (2.3 m^{2}) was significantly greater for crews whose numbers fell below the set thresholds of 15 total fireground personnel at residential fires and 23 at large-risk fires (Backoff 1980). The following year, repeated live experiments at a one-family residential site using modern apparatus and equipment demonstrated that larger units performed tasks and accomplished knockdown more quickly, ultimately resulting in a lower percentage of loss attributable to factors controlled by the fire department. The authors of this article highlighted that the fire company is the fire department's basic working unit and further emphasized the importance of establishing accurate and up-to-date performance measurements to help collect data and develop conclusive strategies to improve staffing and equipment utilization (Gerard 1981).

Subsequent reports from the United States Fire Administration (USFA) and several consulting firms continued to provide evidence for the effects of staffing on fire crews' ability to complete tasks involved in fire suppression efficiently and effectively. Citing a series of tests conducted in 1977 by the Dallas Fire Department that measured the time it took three-, four-, and five-person teams to advance a line and put water on a simulated fire at the rear of the third floor of an old school, officials from the USFA underscored that time-to-task completion and final level of physical exhaustion for crews markedly improved not after any one threshold, but with the addition of each new team member. This report went on to outline the manner in which simulated tests exemplify a clear-cut means to record and analyze the resources initially deployed and finally utilized at fire scenes (NFA 1981). A later publication detailing more Dallas Fire Department simulations — ninety-one runs each for a private residential fire, high-rise office fire, and apartment house fire — showed again that increased staffing levels greatly enhanced the coordination and effectiveness of crews' fire suppression efforts during a finite time span (McManis Associates 1984). Numerous studies of local departments have supported this conclusion using a diverse collection of data, including a report by the National Fire Academy (NFA) on fire department staffing in smaller communities, which showed that a company crew staffed with four firefighters could perform rescue of potential victims approximately 80 % faster than a crew staffed with three firefighters (Morrison 1990).

During the same time period that the impact of staffing levels on fire operations was gaining attention, investigators began to question whether staffing levels could also be associated with the risk of firefighter injuries and the cost incurred as a result of such injuries at the fire scene. Initial results from the Columbus Fire Division showed that "firefighter injuries occurred more often when the total number of personnel on the fireground was less than 15 at residential fires and 23 at large-risk fires" (Backoff 1980), and mounting evidence has indicated that staffing levels are a fundamental health and safety issue for firefighters in addition to being a key determinant of immediate response capacity. One early analysis by the Seattle Fire Department for that city's Executive Board reviewed the average severity of injuries suffered by three-, four-, and five-person engine companies, with the finding that "the rate of firefighter injuries expressed as total hours of disability per hours of fireground exposure were 54 % greater for engine companies staffed with 3 personnel when compared to those staffed with 4 firefighters, while companies staffed with 5 personnel had an injury rate that was only one-third that associated with four-person companies" (Cushman 1981). A joint report from the International Association of Fire Fighters (IAFF) and Johns Hopkins University concluded, after a comprehensive analysis of the minimum staffing levels and firefighter injury rates in U.S. cities with populations of 150,000 or more, that jurisdictions operating with crews of less than four firefighters had injury rates nearly twice the percentage of jurisdictions operating with crews of four-person crews or more (IAFF, JHU 1991).

More recent studies have continued to support the finding that staffing per piece of apparatus integrally affects the efficacy and safety of fire department personnel during emergency response and fire suppression. Two studies in particular demonstrate the consistency of these conclusions and the increasing level of detail and accuracy present in the most recent literature, by looking closely at the discrete tasks that could be safely and effectively performed by three- and four-person fire companies. After testing drills comprised of a series of common fireground tasks at several fire simulation sites, investigators from the Austin Fire Department assessed the physiological impact and injury rates among the variably staffed fire crews. In these simulations, an increase from a three- to four-person crew resulted in marked improvements in time-to-task completion or efficiency for the two-story residential fire drill, aerial ladder evolution, and high-rise fire drill, leading the researchers to conclude that loss of life and property increases when a sufficient number of personnel are not available to conduct the required tasks efficiently, independent of firefighter experience, preparation, or training. Reviews of injury reports by the Austin Fire Department furthermore revealed that the injury rate for three-person companies in the four years preceding the study was nearly one-and-a-half that of crews staffed with four or more personnel (Roberts 1993). In a sequence of similar tests, the Office of the Fire Marshal of Ontario, Canada likewise found that three-person fire companies were unable to safely perform deployment of backup protection lines, interior suppression or rescue operations, ventilation operations that required access to the roof of the involved structure, use of large hand-held hose lines, or establish a water supply from a static source without additional assistance and within the time limits of the study. Following these data, Fire Marshal officials noted that three-person crews were also at increased risk for exhaustion due to insufficient relief at fire scenes and made recommendations for the minimum staffing levels per apparatus necessary for suppression and rescue related tasks (Office of the Fire Marshal of Ontario 1993).

The most comprehensive contemporary studies on the implications of fire crew staffing now include much more accurate performance measures for tasks at the fireground, in addition to the basic metric of response time. They include environmental measures of performance, such as total water supply, which expand the potential for assessing the cost-effectiveness of staffing not only in terms of fireground personnel injury rates but also comparative resource expenditure required for fire suppression. Several examples from the early 1990s show investigators and independent fire departments beginning to gather the kind of specific, comprehensive data on staffing and fireground tasks such as those suggested and outlined in concurrent local government publications that dealt with management of fire services (Coleman 1988). A report by the Phoenix Fire Department laid out clear protocols for responding to structure fires and response evaluation in terms of staffing, objectives, task breakdowns, and times in addition to outlining the responsibilities of responding fire department members and the order in which they should be accomplished for a full-scale simulation activity (Phoenix 1991). One attempt to devise a prediction model for the effectiveness of manual fire suppression similarly reached beyond response time benchmarks to describe fire operations and the step-by-step actions of firefighters at incident scenes by delineating the time-to-task breakdowns for size-up, water supply, equipment selection, entry, locating the fire, and advancing hose lines, while also comparing the predicted time-to-task values with the actual times and total resources (Menker 1994). Two separate studies of local fire department performance, one from Taoyuan County in Taiwan and another from the London Fire Brigade, have drawn ties between fire crews' staffing levels and total water demand as the consequence of both response time and fire severity. Field data from Taoyuan County for cases of fire in commercial, business, hospital, and educational properties showed that the type of land use as well as response time had a significant impact on the water volume necessary for fire suppression, with the notable quantitative finding that the water supply required on-scene doubled when the fire department response increased by ten minutes (Chang 2005).

Response time as a predictor of residential fire outcomes has received less study than the effect of crew size. A Rand Institute study demonstrated a relationship between the distance the responding companies traveled and the physical property damage. This study showed that the fire severity increased with response distance, and therefore the magnitude of loss increased proportionally (Rand 1978). Using records from 307 fires in nonresidential buildings over a three-year period, investigators in the United Kingdom correspondingly found response time to have a significant impact on final fire area, which in turn was proportional to total water demand (Sardqvist 2000).

Recent government and professional literature continues to demonstrate the need for more data that would quantify in depth and illustrate the required tasks, event sequences, and necessary response times for effective fire suppression in order to determine with accuracy the full effects of either a reduction or increase in fire company staffing (Karter 2008). A report prepared for National Institute of Standards and Technology (NIST) stressed the ongoing need to elucidate the relationship between staffing and personnel injury rates, stating that "a scientific study on the relationship between the number of firefighters per engine and the incidence of injuries would resolve a long-standing question concerning staffing and safety" (TriData 2005). While not addressing staffing levels as a central focus, an annual review of fire department calls and false alarms by the National Fire Protection Association (NFPA) exemplified the need to capture not only the number of personnel per apparatus for effective fire suppression but also to clarify the demands on individual fire departments with resolution at the station level (NFPA 2008).

In light of the existing literature, there remain unanswered questions about the relationships between fire service resource deployment levels and associated risks. For the first time this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical advisors involved. Additionally, the structure used in the field experiments included customized instrumentation for the experiments; all related industry standards were followed; robust research methods were used; and the results and conclusions will directly inform the *NFPA 1710* Technical Committee, as well as public officials and fire chiefs. [5]

5 NFPA is a registered trademark of the National Fire Protection Association, Quincy, Massachusetts. NFPA 1710 defines minimum requirements relating to the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by substantially all career fire departments. The requirements address functions and objectives of fire department emergency service delivery, response capabilities, and resources. The purpose of this standard is to specify the minimum criteria addressing the effectiveness and efficiency of the career public fire suppression operations, emergency medical service, and special operations delivery in protecting the citizens of the jurisdiction and the occupational safety and health of fire department employees. At the time of the experiments, the 2004 edition of NFPA 1710 was the current edition.

Purpose and Scope of the Study

This project systematically studies deployment of fire fighting resources and the subsequent effect on both firefighter safety and the ability to protect civilians and their property. It is intended to enable fire departments and city/county managers to make sound decisions regarding optimal resource allocation to meet service commitments using the results of scientifically based research. Specifically, the residential fireground experiments provide quantitative data on the effect of crew size, first-due engine arrival time, and subsequent apparatus stagger on time-to-task for critical steps in response and fire fighting.

The first phase of the multiphase project was an extensive survey of more than 400 career and combination fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project, but they will constitute significant input into future applications of the data presented in this document.

This report describes the second phase of the project, divided into four parts:

- Part 1 — Laboratory experiments to design the appropriate fuel packages to be used in the burn facility specially constructed for the research project
- Part 2 — Field tests for critical time-to-task completion of key tasks in fire suppression
- Part 3 — Field tests with real furniture (room and contents experiments)
- Part 4 — Fire modeling to apply data gathered to slow-, medium-, and fast-growth rate fires

The scope of this study is limited to understanding the relative influence of deployment variables on low-hazard, residential structure fires, similar in magnitude to the hazards described in NFPA® 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. The standard uses as a typical residential structure a 2,000 sq ft (186 m^2) two-story, single-family dwelling with no basement and no exposures (nearby buildings or hazards such as stacked flammable material).

The limitations of the study, such as firefighters' advance knowledge of the facility constructed for this experiment, invariable number of apparatus, and lack of experiments in extreme temperatures or at night, will be discussed in the Limitations section of this report. It should be noted that the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, and response to hazardous material incidents, acts of terrorism, and natural disasters or other technical responses has not been assessed and should not be extrapolated from this report.

A Brief Overview of the Fireground Operations

Regardless of the size of a structure on fire, firefighting crews identify four priorities: life safety of occupants and firefighters, confinement of the fire, property conservation, and reduction of adverse environmental impact. Interdependent and coordinated activities of all fire fighting personnel are required to meet the priority objectives.

NFPA 1710 specifies that the number of on-duty fire suppression personnel must be sufficient to carry out the necessary fire fighting operations given the expected fire fighting conditions. During each fireground experiment, the following were dispatched to the test fire building:

- three engine companies
- one truck company
- a command vehicle with a battalion chief and a command aide

Staffing numbers for the engine and truck crews and response times were varied for the purposes of the tests. Additional personnel available to ensure safety will be described later in this report.

The following narrative account describes the general sequence of activities in part 2 of the experiments (time-to-task), when the fuel load permitted firefighter entry:

> The first arriving engine company conducts a size-up or initial life safety assessment of the building to include signs of occupants in the home, construction features, and location of the original fire and any extension to other parts of the structure. This crew lays a supply line from a hydrant close to the building for a continuous water supply.
>
> The truck company usually arrives in close proximity to the first engine company. The truck company is responsible for gaining access or forcing entry into the building so that the engine company can advance the first hose line into the building to locate and extinguish the fire. Usually, they assist the engine company in finding the fire. The NFPA and OSHA 2 In/2 Out[6] crew is also assembled prior to anyone entering an atmosphere that is immediately dangerous to life or health (IDLH). This important safety requirement will have a large impact on availability of firefighters to enter the building when small crews are deployed.
>
> Once a door is opened, the engine crew advances a hose line (attack line) toward the location of the fire. At the same time, members from the truck crew accompany the engine crew and assist in ventilating the building to provide a more tenable atmosphere for occupants and firefighters. Ventilation also helps by improving visibility in an otherwise "pitch black" environment, but it must be coordinated with the attack line crew to ensure it helps control the fire and does not contribute to fire growth. The truck crew performs a systematic rapid search of the entire structure starting in the area where occupants would be in the most danger. The most dangerous area is proximate to the fire and the areas directly above the fire.
>
> Depending upon the travel distance, the battalion chief and command aide will have arrived on the scene and have taken command of the incident and established a command post. The role of the incident commander is to develop the action plan to mitigate the incident and see that those actions are carried out in a safe, efficient, and effective manner. The command aide is responsible for situational assessment and communications, including communications with crew officers to ensure personnel accountability.
>
> Depending on response time or station location, the second (engine 2) and possibly the third engine company (engine 3) arrive. The second arriving engine (engine 2) connects to the fire hydrant where the first engine (engine 1) laid their supply line. Engine 2 pumps water from the hydrant through the supply line to the first engine for fire fighting operations. According to *NFPA 1710*, water should be flowing from the supply line to the attack engine prior to the attack crew's entry into the structure.
>
> The crew from the second engine advances a second hand line as a backup line to protect firefighters operating on the inside and to prevent fire from spreading to other parts of the structure.
>
> The third engine crew is responsible for establishing a Rapid Intervention Team (RIT), a rescue team staged at or near the command post or as designated by the Incident Commander (in the front of the building) with all necessary equipment needed to locate and/or rescue firefighters that become trapped or incapacitated. The RIT plans entry/exit portals and removes hazards, if found, to assist interior crews.
>
> As the fire fighting, search and rescue, and ventilation operations are continuing, two members of the truck company are tasked with placing ground ladders to windows and the roof to provide a means of egress for occupants or firefighters. The truck crew is responsible for controlling interior utilities such as gas and electric after their ventilation, search, and rescue duties are completed.
>
> Once the fire is located and extinguished and occupants are

6 The "2 In/2 Out" policy is part of paragraph (g)(4) of OSHAs revised respiratory protection standard, 29 CFR 1910.134. This paragraph applies to private sector workers engaged in interior structural fire fighting and to Federal employees covered under Section 19 of the Occupational Safety and Health Act. States that have chosen to operate OSHA-approved occupational safety and health state plans are required to extend their jurisdiction to include employees of their state and local governments. These states are required to adopt a standard at least as effective as the Federal standard within six months.

OSHAs interpretation on requirements for the number of workers required to be present when conducting operations in atmospheres that are immediately dangerous to life and health (IDLH) covers the number of persons who must be on the scene before fire fighting personnel may initiate an attack on a structural fire. An interior structural fire (an advanced fire that has spread inside of the building where high temperatures, "heat" and dense smoke are normally occurring) would present an IDLH atmosphere and therefore, require the use of respirators. In those cases, at least two standby persons, in addition to the minimum of two persons inside needed to fight the fire, must be present before fire fighters may enter the building.
Letter to Thomas N. Cooper, Purdue University, from Paula O. White, Director of Federal-State Operations, U.S. Department of Labor, Occupational Safety & Health Administration, November 1, 1995.

removed, the incident commander reassesses the situation and provides direction to conduct a very thorough secondary search of the building to verify that the fire has not extended into void spaces and that it is fully extinguished. (In a nonexperimental fire situation, salvageable property would be covered or removed to minimize damage.)

Throughout the entire incident, each crew officer is responsible for the safety and accountability of his or her personnel along with air management. The location and wellness of crews is tracked by the command aide through a system of personal accountability checks conducted at 20-minute intervals.

Following extinguishment of the fire, an onsite review is conducted to identify actions for improvement. Crews are monitored, hydrated and rested before returning to work in the fire building.

The Relation of Time-to-Task Completion and Risk

Delayed response, particularly in conjunction with the deployment of inadequate resources, reduces the likelihood of controlling the fire in time to prevent major damage and possible loss of life and increases the danger to firefighters.

Figure 1 illustrates a hypothetical sequence of events for response to a structure fire. During fire growth, the temperature of a typical compartment fire can rise to over 1,000° F (538° C). When a fire in part of a compartment reaches flashover, the rapid transition between the growth and the fully developed fire stage, flame breaks out almost at once over the surface of all objects in the compartment, with results for occupants, even firefighters in full gear, that are frequently deadly.

Successful containment and control of a fire require the coordination of many separate tasks. Fire suppression must be coordinated with rescue operations, forcible entry, and utilities control. Ventilation typically occurs only after an attack line is in place and crews are ready to move in and attack the fire. The incident commander needs up-to- the-minute knowledge of crew activities and the status of task assignments which could result in a decision to change from an offensive to a defensive strategy.

Standards of Response Cover

Developing a standard of response cover — the policies and procedures that determine the distribution, concentration, and reliability of fixed and mobile resources for response to fire (as well as other kinds of technical response) — related to service commitments to the community is a complex task. Fire and rescue departments must evaluate existing (or proposed) resources against identified risk levels in the community and against the tasks necessary to conduct safe, efficient and effective fire suppression at structures identified in these various risk levels. Leaders must also evaluate geographic distribution and depth or concentration of resources deployed based on time parameters.

Recognition and reporting of a fire sets off a chain of events before firefighters arrive at the scene: call receipt and processing, dispatch of resources, donning protective gear, and travel to the scene. *NFPA 1710* defines the overall time from dispatch to scene arrival as the *total response time*. The standard divides total

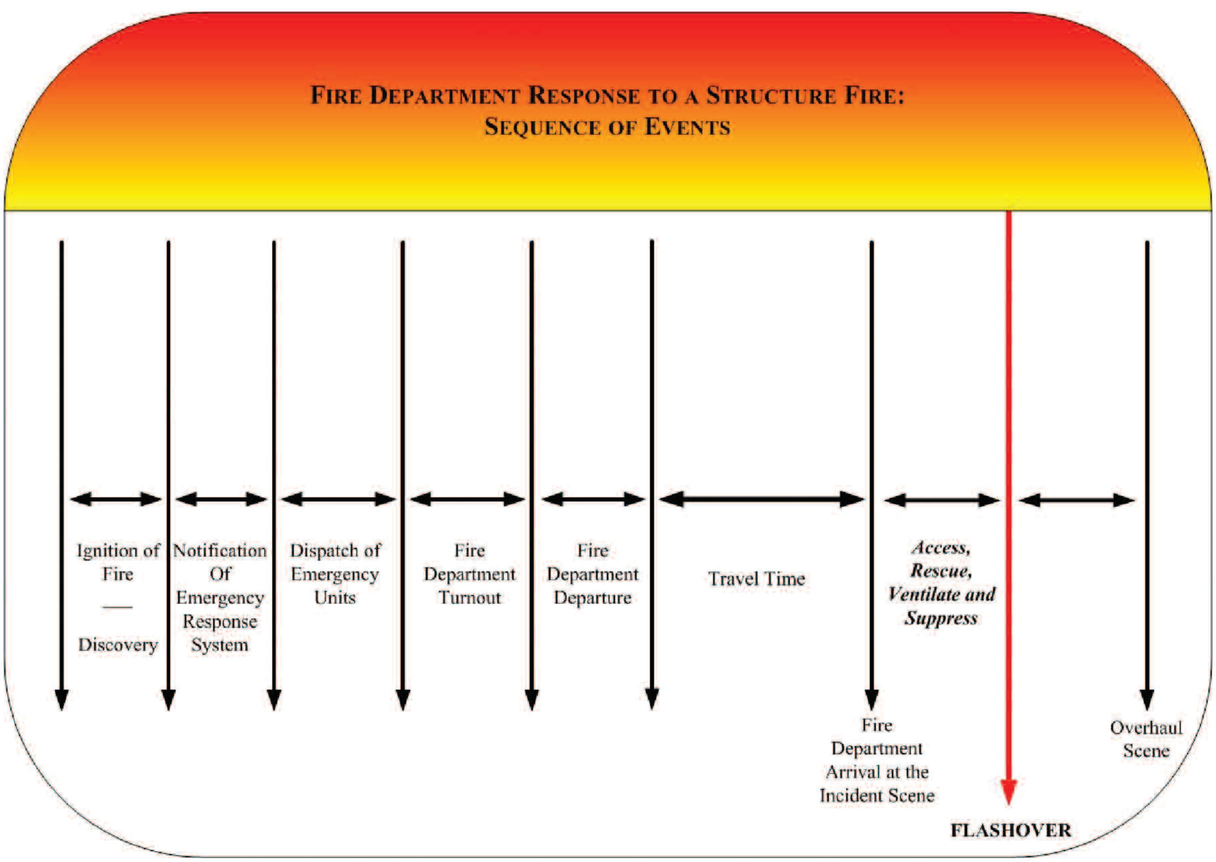


Figure 1: Hypothetical Timeline of Fire Department Response to Structure Fire

response time into a number of discrete segments, of which travel time — the time interval from the beginning of travel to the scene to the arrival at the scene — is particularly important for this study.

Arrival of a firefighting response force must be immediately followed by organization of the resources into a logical, properly phased sequence of tasks, some of which need to be performed simultaneously. Knowing the time it takes to accomplish each task with the allotted number of personnel and equipment is critical. Ideally crews should arrive and intervene in sufficient time to prevent flashover or spread beyond the room of origin.

Decision-making about staffing levels and geographic distribution of resources must consider those times when there will be simultaneous events requiring resource deployment. There should be sufficient redundancy or overlap in the system to allow for simultaneous calls and high volume of near simultaneous responses without compromising the safety of the public or firefighters.

Policy makers have long lacked studies that quantify changes in fireground performance based on apparatus staffing levels and on-scene arrival time intervals. These experiments were designed to observe the impact of apparatus staffing levels and apparatus arrival times on the time it takes to execute essential fireground tasks and on the tenability inside the burn prop for a full initial alarm assignment response. It is expected that the results of this study will be used to evaluate the related performance objectives in *NFPA 1710*.

Part 1: Planning for the Field Experiments

Laboratory Experiments

The purpose of the first segment, the laboratory experiments, was to characterize the burning behavior of the wood pallets as a function of:

- number of pallets and the subsequent peak heat release rate (HRR)
- compartment effects on burning of wood pallets
- effect of window ventilation on the fire
- effect on fire growth rate of the loading configuration of excelsior (slender wood shavings typically used as packing material)

Characterization of the fuel package was critical in order to ensure that the field experiments would not result in a flashover condition, one of the primary safety considerations in complying with the protocols in *NFPA 1403: Standard on Live fire Training Evolutions*.[7] Appendix A of this report contains the methods and full results for the laboratory experiments, which are summarized below. Figure 2 shows a test burn of pallets in the laboratory.

Figure 2: Test Burn of Pallets in Laboratory

Results of Laboratory Experiments

The objective of the laboratory experiments was to quantify the spread of heat and smoke throughout the planned burn prop in order to ensure that the fuel package would result in a fire large enough to generate heat and smoke consistent with a residential structure fire, yet not so large as to transition to flashover. The full results of the laboratory experiments and modeling are shown in Appendix A and Appendix B. To summarize briefly, a four-pallet configuration, which produced a peak of approximately 2 MW, was determined to be the largest fuel load the room could support without the threat of transitioning to flashover. The compartment produced a negligible effect on the heat release rate of the fire compared to open burning conditions. The presence of an open window in the burn room reduced the production of carbon monoxide and carbon dioxide gases, primarily through enhanced oxygen availability and dilution, respectively. The location and quantity of excelsior had a significant impact on the growth rate of fire. More excelsior located nearer the bottom of the pallets resulted in a more rapid achievement of peak burning.

The results of the fuel load experiments to inform the building and experimental design indicated development of untenable conditions in the field experiments between 5 min and 15 min, depending upon several factors: fire growth rate, ventilation conditions, the total leakage of heat into the building and through leakage paths, and manual fire suppression. This time frame allowed for differentiation of the effectiveness of various fire

7 NFPA 1403 contains the minimum requirements for training all fire suppression peronnel engaged in firefighting operations under live fire conditions.

Part 2: Field Experiment Methods

department response characteristics.

In part 2, fire experiments were conducted in a residential-scale burn prop at the Montgomery County Public Safety Training Academy in Rockville, MD.

Field Site

Montgomery County (MD) Fire and Rescue Department provided an open space to construct a temporary burn prop, with ready access to water and electrical utilities, at the Montgomery County Fire and Rescue Training Facility in Rockville, MD.

The burn prop was constructed as a two-story duplex with a common stairwell and movable walls between the sections to allow for multiple experiments daily. Symmetrically dividing the structure about the short axis allowed one side of the test structure to cool and dry out after a fire test with suppression. The burn prop contained two mirror-image, two-story units each totaling 2,000 ft^2 (186 m^2), without basement or nearby exposures — each therefore a typical model of a low-hazard single-family residence identified in *NFPA 1710*. An exterior view of the burn prop is shown in Figure 3. For each experiment there was a confirmed fire in the living room in the first floor rear of one unit of the structure.

Figure 3: Exterior View of Burn Prop

Details and dimension are shown in the floor plan in Figure 4.

The black lines in Figure 4 indicate load-bearing reinforced concrete walls and red lines indicate the gypsum over steel stud partition walls. The ceiling height was 94 in (2.4 m) throughout the entire structure except in the burn compartments, where additional hardening was installed to protect against repeated exposure to fire during the experiments. This additional fire proofing slightly reduced the ceiling height. Complete details about the building construction are included in Appendix C.

Noncombustible furniture (angle iron and gypsum board construction) was fashioned to represent obstacles of realistic size and location for firefighters navigating the interior of the structure. The dimensions were typical of residential furnishings. Figure 5 shows an example of the noncombustible furniture used in the time-to-task experiments.

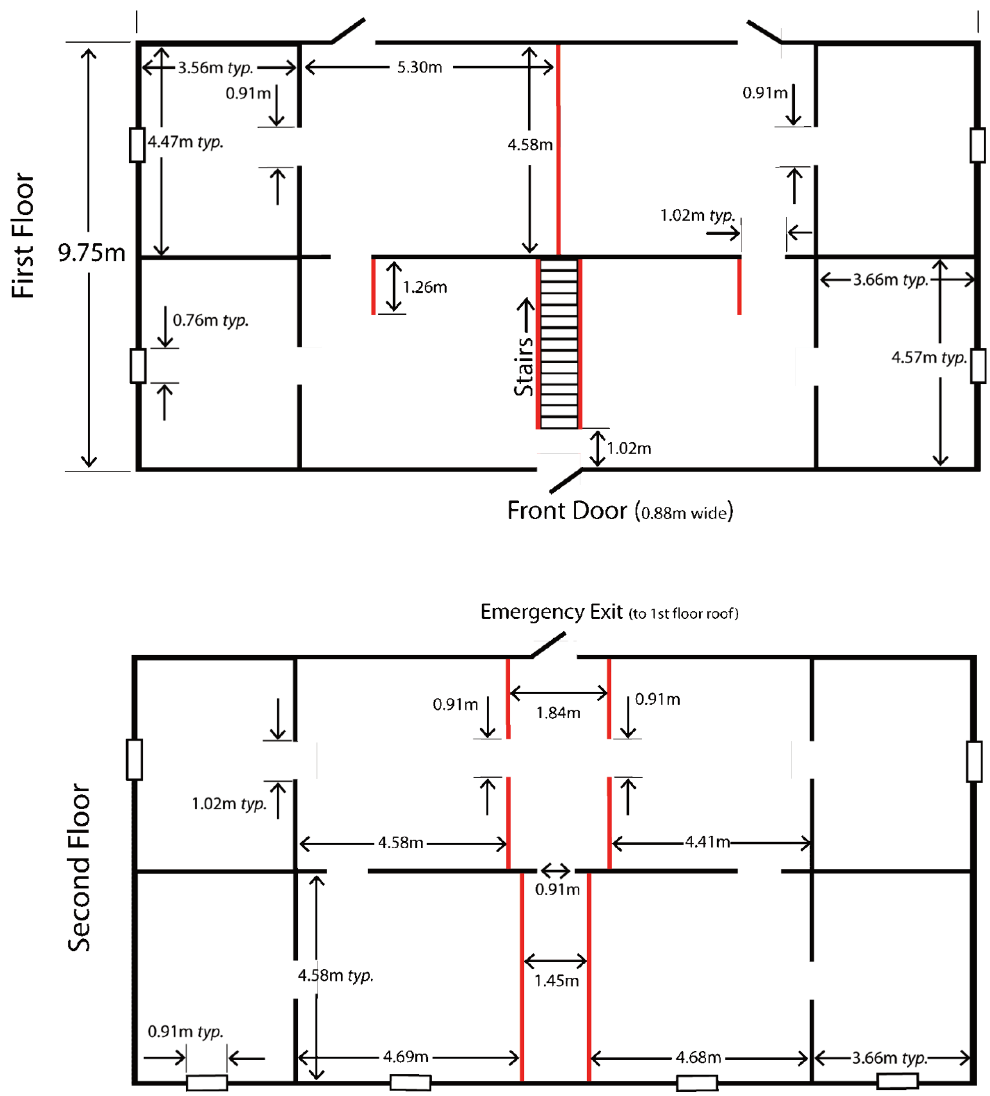


Figure 4: Dimensions of the Burn Prop Floor Plan

Overview of Field Experiments

In order to evaluate the performance representative of a *NFPA 1710*-compliant fire department, the field experiments consisted of two parts (the second and third parts of the four described in this report). In the first of the two parts of the field experiments, firefighter participants from Montgomery County (MD) and Fairfax County (VA) Fire Departments simulated an initial alarm assignment response to a structure described in *NFPA 1710* as a low-hazard residential structure to which firefighters respond on a regular basis. The staffing level of fire apparatus was varied incrementally from two to five personnel per piece. The interval between apparatus on-scene arrival times was varied at either 60 s or 120 s. Trained timing staff were used to record the start and completion times of 22 tasks deemed essential for mitigation of a residential fire incident by the study's technical experts. The pallet and excelsior configuration chosen from the laboratory experiments repeatably produced a consistent and realistic quantity of heat and smoke, similar to what firefighters encounter at a residential structure fire.

Although the fire source used in part 2 of the field experiments created a realistic amount of heat and smoke, the requirements of *NFPA 1403* prevented use of a fire source which could potentially reach flashover within the structure. Therefore, part 3 of the fire experiments was conducted in order to change the fuel package to be representative of realistic fuel loading that could be found in a living room in a residential structure (sleeper-sofa, upholstered chairs, end tables, etc). The intent of this part of the study was to determine how the times of firefighter interactions, averaged with respect to the staffing and arrival intervals, impacted the interior tenability conditions. Fire fighting tactics were performed in a manner which complied with *NFPA 1403*; ventilation was performed with proper personal protective equipment (PPE) and hand tools from the exterior of the burn prop. Suppression was performed with an interior remote suppression device operated from the exterior of the burn prop.

Instrumentation

Instrumentation to measure gas temperature, gas concentrations, heat flux, visual obscuration, video, and time during the experiments was installed throughout the burn prop. The data were recorded at 1-second intervals on a computer-based data acquisition system. Figure 6 presents a schematic plan view of the instrumentation. All instruments were wired to a centralized data collection room attached as a separate space on the west side of the building, which is described later in this report ensuring physical separation for the data collection personnel from the effects of the fire, while minimizing the wire and tube lengths to the data logging equipment. See Appendix C for additional details about the instrumentation.

Figure 5: Noncombustible Furniture Used in the Time-to-Task Experiments

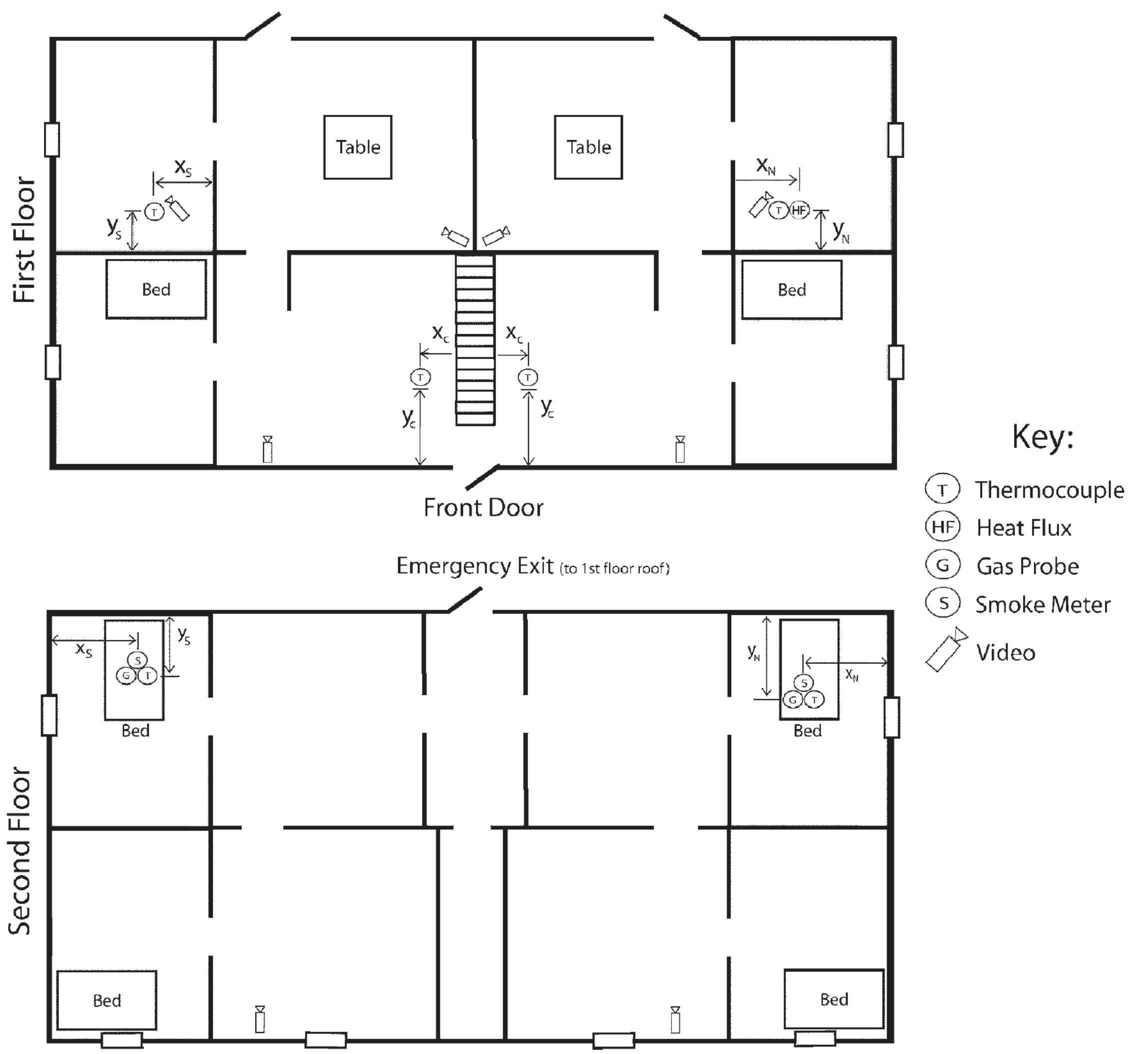


Figure 6: Instrumentation and Furniture Prop Layout

Figure 7: Fireground Safety Officer

Safety Protocols

Firefighter safety was always a primary concern in conducting the research. Participants were drawn from two departments — Fairfax County, VA and Montgomery County, MD — that regularly conduct NFPA 1403 compliant live fire training for their staff and recruits.

A safety officer was assigned to the experiments by the Montgomery County Fire and Rescue Department to assure compliance with *NFPA 1403*. The safety officer (Figure 7) participated in all orientation activities, daily briefings, and firefighter gear checks and was always actively involved in overseeing all experiments. The safety officer had full authority to terminate any operation if any safety violation was observed. In addition to the safety officer, a rapid intervention team (RIT), assigned from dedicated crews not in the actual experiment, was in place for each experiment, and a staffed ambulance was on standby at the site. Radio communication was always available during the experiments should a "mayday" emergency arise.

Experiments were stopped for any action considered to be a protocol breach or safety concern. For example, all ladders — 24 ft (7.3 m) or 28 ft (8.5 m) — were to be raised by two firefighters. As crew sizes were reduced, some firefighters attempted to place ladders single-handedly in an effort to complete the task more quickly. This procedure, while vividly illustrating how firefighters try to do more with less in the field, is unsafe and could potentially result in strain or impact injuries.

Additional safety features were built in to the field structure. A deluge sprinkler system oriented to the known location of the fuel package could be remotely activated for rapid fire suppression. All first floor rooms had direct access to the exterior of the building through either doors or windows. The second story had an emergency exit to the roof of the attached instrumentation room.

A closely related concern to ensure firefighter safety and readiness to repeat experiments with equivalent performance was adequate rehabilitation (see Figure 8). At the beginning and end of each day, crews completed a health and safety check. The importance of staying well-hydrated before and during experiments was especially emphasized.

Figure 8: Crew Rehabilitation

Time-to-Task Experiments

On-Scene Fire Department Tasks

The on-scene fire department task part of the study focused on the tasks firefighters perform after they arrive on the scene of a low-hazard residential structure fire. A number of nationally recognized fire service experts were consulted during the development of the on-scene fire department tasks in order to ensure a broad applicability and appropriateness of the task distribution.[8] The experiments compared crew performance and workload for a typical fire fighting scenario using two-, three-, four-, and five-person crews. 24 total experiments were conducted to assess the time it took various crew sizes to complete the same tasks on technically similar fires in the same structure. In addition to crew sizes, the experiments assessed the effects of stagger between the arriving companies. Close stagger was defined as a 1-minute time difference in the arrival of each responding company. Far stagger was defined as a 2-minute time difference in the arrival of each responding company. One-minute and two-minute arrival stagger times were determined from analysis of deployment data from more than 300 U.S. fire departments responding to a survey of fire department operations conducted by the International Association of Fire Chiefs (IAFC) and the International Association of Fire Fighters (IAFF). Considering both crew size and company stagger there were eight experiments conducted in triplicate totaling twenty-four tests, as shown in the full replicate block in Table 1. A full replicate was completed in a randomized order (determined by randomization software) before a test configuration was repeated.

Crew Size	Apparatus Stagger
2 Person	Close Stagger (One minute)
3 Person	Close Stagger (One minute)
4 Person	Close Stagger (One minute)
5 Person	Close Stagger (One minute)
2 Person	Far Stagger (Two minutes)
3 Person	Far Stagger (Two minutes)
4 Person	Far Stagger (Two minutes)
5 Person	Far Stagger (Two minutes)

Table 1: Primary Variables for Time-to-Task Experiments

Crew Size

For each experiment, three engines, a ladder-truck and a battalion chief and an aide were dispatched to the scene of the residential structure fire. The crew sizes studied included two-, three-, four-, and five-person crews assigned to each engine and truck dispatched. Resultant on-scene staffing totals for each experiment follow: (FF = firefighter)

- Two Person crews = 8 FFs + Chief and Aide = 10 total on-scene
- Three Person crews = 12 FFs + Chief and Aide= 14 total on-scene
- Four Person crews = 16 FFs + Chief and Aide = 18 total on-scene
- Five Person crews = 20 FFs + Chief and Aide = 22 total on-scene[9]

Department Participation

The experiments were conducted in Montgomery County, MD at the Montgomery County Fire Rescue Training Academy during the months of January and February 2009. All experiments took place in daylight between 0800 hours and 1500 hours. Experiments were postponed for heavy rain, ice, or snow and rescheduled for a later date following other scheduled experiments.

Montgomery County (MD) and Fairfax County (VA) firefighters participated in the field experiments. Each day both departments committed three engines, a ladder truck and associated crews, as well as a battalion chief to the experiments. The two battalion chiefs, alternated between the roles of battalion chief and aide. Firefighters and officers were identified by participating departments and oriented to the experiments. Each experiment included engine crews, truck crews and command officers from each participating department. Participants varied with regard to age and experience. Crews that normally operated together as a company were kept intact for the experiments to assure typical operation for the crew during the scenarios. However, in all experiments crews were used from both departments, including engine crews, truck crews, and officers.

This allocation of resources made it possible to conduct back-to-back experiments by rotating firefighters between field work and rehabilitation areas.

Crew Orientation

All study participants were required to attend an orientation prior to the beginning of the experiments (see Figure 9, page 25). The orientations were used to explain experiment procedures, task flows, division of labor between crews, and milestone events in the scenario.

Daily orientations were conducted for all shifts to assure every participant attended. Orientations included a description of the overall study objectives as well as the actual experiments in which they would be involved. Per the requirements of *NFPA 1403*, full disclosure regarding the structure, the fire, and the tasks to be completed were provided. Crews were also oriented to the fireground props, instrumentation used for data collection, and the specific scenarios to be conducted. Every crew member was provided a walkthrough of the structure during the orientation and each day prior to the start of the experiments.

8 Technical experts included Dennis Compton, Russell Sanders, William "Shorty" Bryson, Vincent Dunn, David Rohr, Richard Bowers, Michael Clemens, James Walsh, Larry Jenkins and Doug Hinkle. More information about the experts is presented in the Acknowledgments later in this report.

9 Note that the on-scene totals account for only the personnel assigned to "work" the fire. Additional personnel were provided for an RIT team, a staffed ambulance on site, and a safety officer specific to the experiments. The additional personnel are not included in thee staffing described above.

Tasks

Twenty-two fireground tasks were completed in each experiment. Meticulous procedures gathered data to measure key areas of focus, such as individual task start times, task completion times, and overall scenario performance times. Each task was assigned a standardized start and end marker, such as crossing the threshold to enter the building with a hose line or touching a ladder to raise it to a second story window. The 22 tasks, with the events for measuring start and stop times, are shown in Table 2 (page26). Figures 10 — 19 illustrate firefighter activity in a number of the tasks to complete experiments or prepare for the next experiment.

For reasons of both safety and cost efficiency, two tasks — forcible entry of the front door and ventilation of the windows on the first and second stories — required special procedures.

The study could not accommodate replacing the doors and windows daily for the fire suppression experiments. Before the start of experiments with the full sequence of tasks, these two tasks were measured in a realistic manner using training props constructed at the site of the fireground experiments. As with the overall experiments, these two tasks were repeated in triplicate and the times averaged. The average time to complete the tasks was then used in the larger scale experiment. As firefighters came to the point of breaching the door or windows, the timers would hold them for the time designated by the earlier experiments and then give them the approval to open the door or windows. The start and end times were then recorded just as other tasks were.

Figure 9: Crew Orientation and Walkthrough

Figure 10: Ground Ladders

Figure 11: Ventilation

Figure 12: Ground Level Window Breakage Prop

Figure 13: Second Story Window Breakage Prop

Figure 14: Door Forcible Entry Prop

Figure 15: Crew Preparation and Cue Cards

Table 2: Tasks and Measurement Parameters

Tasks	Measurement Parameters
1. Stop at Hydrant, Wrap Hose	START - Engine stopped at hydrant STOP - Firefighter back on engine and wheels rolling
2. Position Engine 1	START - Wheels rolling from hydrant STOP - Wheels stopped at structure
3. Conduct Size-up (360-degree lap), transmit report, establish command	START - Officer off engine STOP - Completes radio transmission of report
4. Engage Pump	START - Driver off engine STOP - Driver throttles up pump
5. Position Attack Line (Forward Lay)	START - Firefighter touches hose to pull it from engine STOP - Flake, charge and bleed complete (hose at front door prepared to advance)
6. Establish 2 In/2 Out	Company officer announces – "2 In/2 Out established" (4 persons assembled on scene OR at the call of the Battalion Chief/Company Officer)
7. Supply Attack Engine	START - Firefighter touches hydrant to attach line STOP - Water supply to attack engine
8. Establish RIT	Time that Company Officer announces RIT is established
9. Gain/Force Entry	START - Action started (HOLD time= 10 seconds) STOP - Door opened for entry
10. Advance Attack Line	START – Firefighter touches hose STOP – Water on fire
11. Advance Backup Line (stop time at front door)	START - Firefighter touches hose to pull from engine bed STOP - Backup line charged to nozzle
12. Advance Backup Line/Protect Stairwell	START - Firefighter crosses threshold STOP - Position line for attack at stairwell
13. Conduct Primary Search	START - Firefighters enter front door STOP - Firefighters transmit "search complete"
14. Ground Ladders in Place	START - Firefighter touches ladder to pull it from truck STOP - 4 Ladders thrown: 3 ladders on the 2nd-story windows and 1 to the roof
15. Horizontal Ventilation (Ground)	START- Firefighter at 1st window to begin ventilation (HOLD for 8 seconds) STOP - Hold time complete - window open
16. Horizontal Ventilation (2nd Story)	START - Firefighter grabs ladder for climb. (Firefighter must leg lock for ventilation. HOLD time at each window is 10 seconds) STOP - All 2nd-story windows open - descend ladder - feet on ground.
17. Control Utilities (Interior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
18. Control Utilities (Exterior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
19. Conduct Secondary Search	START - Firefighters enter front door STOP - Firefighters transmit "secondary search complete"
20. Check for Fire Extension (walls)	START- Firefighters pick up check-for-extension prop STOP- Completion of 4 sets total (1 set = 4 in and 4 out) This task may be done by more than one person.
21. Check for Fire Extension (ceilings)	START - Firefighters pick up check-for-extension prop STOP - Completion of 4 sets total (1 set = 3 up and 5 down) This task may be done by more than one person.
22. Mechanical Ventilation	START - Firefighters touch fans to remove from truck STOP - Fans in place at front door and started

Data Collection: Standardized Control Measures

Several control measures were used to collect data, including crew cue cards, radio communications, task timers, and video recording. Performance was timed for each task in each scenario including selected milestone tasks such as door breach, water-on-fire, and individual window ventilation. Data were collected for crew performance on each task, and individual firefighter performance was not considered.

Task Flow Charts and Crew Cue Cards

Task procedures were standardized for each experiment/scenario. Technical experts worked with study investigators to break down crew tasks into individual tasks based on crew size. Task flow charts were created and then customized for the various crew sizes. The carefully designed task flow ensured that the same overall workload was maintained in each experiment, but was redistributed based on the number of personnel available for the work. See Appendix D for additional details.

All tasks were included in each scenario and cue cards were developed for each individual participant in each scenario. For example, a four-person crew would have a cue card for each person on the crew including the officer, the driver, and the two firefighters. Cards were color coded by crew size to assure proper use in each scenario.

Figure 16: Connecting to the Hydrant

Figure 17: Crews Responding

Figure 18: Ceiling Breach/Molitor Machine

Figure 19: Incident Command

Figure 20: Task Timers

Figure 21: Video Recording for Quality Control

Radio communications

Interoperability of radio equipment used by both participating departments made it possible to use regular duty radios for communication during the experiments. Company officers were instructed to use radios as they would in an actual incident. Montgomery County Fire and Rescue Communications recorded all radio interaction as a means of data backup. Once all data quality control measure were complete, the records were then overwritten as a routine procedure.

Task Timers

Ten observers/timers, trained in the use of a standard stop watch with split-time feature, recorded time-to-task data for each field experiment. To assure understanding of the observed tasks, firefighters were used as timers, each assigned specific tasks to observe and to record the start and end times.

To enhance accuracy and consistency in recording times, the data recording sheets used several different colors for the tasks (see Appendix D). Each timer was assigned tasks that were coded in the same color as on the recording sheet. All timers wore high-visibility safety gear on the fireground (see Figure 20).

Video records

In addition to the timers, video documentation provided a backup for timed tasks and for quality control (see Figure 21). No less than six cameras were used to record fireground activity from varied vantage points. Observer/timer data were compared to video records as part of the quality control process.

Crew Assignment

Crews from each department that regularly operated together were assigned to work as either engine or truck companies in each scenario. Both Fairfax County and Montgomery County crews participated in each experiment.

Crews assigned to each responding company position in one scenario were assigned to another responding company position in subsequent scenarios, with the objective of minimizing learning from one experiment to another. For example, crews in the role of engine 1 in a morning scenario might be assigned to the engine 3 position in the afternoon, thus eliminating learning from exact repetition of a task as a factor in time to completion. Additionally, participating crews from both Montgomery County and Fairfax County were from three different shifts, further reducing opportunities for participant repetition in any one position.

Response Time Assumptions

Response time assumptions were made based on time objectives set forth in the *NFPA 1710*. Time stagger allocations were set by the project technical advisors in order to assess the impact of arriving unit time separation on task start and completion times, as well as the overall scene time.

Below are the values assigned to the various time segments in the overall response time. The total of the response time segments may also be referred to as the total reflex time.

1. Fire ignition = time zero
2. 60 s for recognition (detection of fire) and call to 9-1-1
3. 60 s for call processing/dispatch
4. 60 s for turnout[10]
5. Close Stagger = 240 s travel time FIRST engine with 60 s ladder-truck lag and 90 s lag for each subsequent engine
   a. Truck arrives at 300 s from notification
   b. Second engine at 330 s from notification
   c. Third engine at 420 seconds from notification
6. Far Stagger = 240 s travel time FIRST engine with 120 s ladder-truck lag and 150 s lag for each subsequent engine
   a. Truck arrives at 360 s from notification
   b. Second engine arrives at 390 s from notification
   c. Third engine arrives at 540 s from notification.

The design of this part of the experiments allowed firefighter entry into the burn building. The next part of the experiments required a modified methodology.

10 After the experiments were complete, the NFPA 1710 technical committee released a new edition of the standard that prescribes 80 seconds for turnout time.

Part 3: Room and Contents Fires

As previously discussed, *NFPA 1403* prohibits firefighters in a training exercise from entering a structure with sufficient fuel load to result in room flashover. But the value of the data from the time-to-task experiments lies not just in the duration and time-of-completion statistics for tasks, but also in measuring the tenability of the atmosphere for occupants urgently needing firefighter assistance. Therefore Part 3 of the experiments (room and contents fires) used a larger fuel load to focus on the seven of the 22 tasks that cause a change in the fire behavior through ventilation or active suppression:

The Tornado Remote Controlled Monitor is Produced by Task Force Tips, Valparaiso, Indiana, USA. Permission to publish courtesy of Task Force Tips

Figure 22: Remotely Controlled Fire Suppression Nozzle for Room and Contents Fires

1. Forced entry of the front door
2. Water on fire
3. Second floor window #1 ventilated (burn room window)
4. Second floor window #2 ventilated (front window, near corner)
5. Second floor window #3 ventilated (front window, near front door)
6. First floor window #1 ventilated (window beside the fire room)
7. First floor window #2 ventilated (self-ventilated at flashover)

Because the fuel load was sufficient for flashover, all firefighter activity was conducted outside the building. Tasks that in Part 3 required entry into the building, such as search or interior utility control, were factored into this part by delaying the next task for the average duration of the task from Part 2. Firefighters in full gear opened the door with a gloved hand or opened windows from the ground with a tool such as a pike pole or angle iron, again at the time specified by the averages from Part 2. Averages were derived from the three iterations of each scenario. The different number of iterations in Part 3 will be explained later in this report.

Because firefighters could not enter the building, a nozzle controlled from the instrumentation room was installed. The nozzle was placed in the room directly outside the burn room and oriented toward the burn room near the doorway in order to best emulate the nozzle location of live firefighter suppression (see Figure 22). The nozzle was encased with mineral wool and heavy-duty aluminum foil (bottom picture in Figure 22) to protect the electronics and wiring from the intense radiation energy emitted by the fire. Blocks were used to anchor the nozzle against the lateral forces exerted by the momentum of the water supply. The activation time for suppression was determined by the data from the time-to-task test results.

A 15º spray pattern was directed toward the seat of the fire and swept horizontally from side to side. While the remotely controlled hose line knocked down the majority of the fire, it was not as effective as a live firefighter with a better view into the room of origin. Therefore, after the fire was diminished, a supplemental stream was applied through the burn room window in order to control the fire (see Figure 23). All personnel on the hose line were in full turnout gear and self-contained breathing apparatus during the exterior application of water.

Fuel Packages for the Room and Contents Fires

In order to maximize the repeatability of the fire development, nominally identical rooms of furniture of identical manufacturer, style, and age were used for each test. A plan-view schematic of the furniture is shown in Figure 24 and pictures of the burn room prior to testing are shown in Figure 25. Key dimensions, mass, and materials for combustible furnishings are detailed in Appendix C.

Figure 23: Supplemental Suppression Applied for Room and Contents Tests

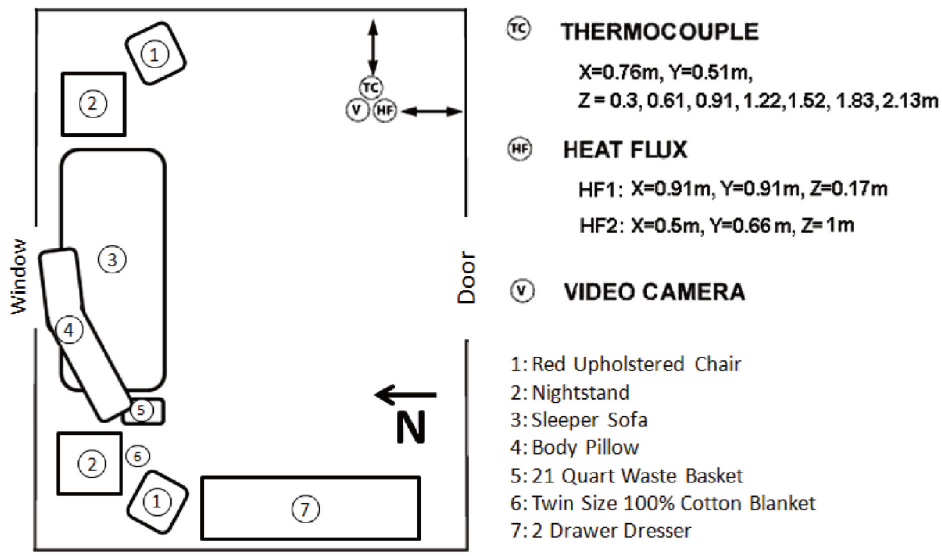


Figure 24: Configuration of Furnishings in Burn Room (Room and Contents Fires)

Figure 25: Pictures of the Room and Contents Furnishings

The ignition source consisted of a cardboard book of 20 matches that was ignited by an electrically heated wire, often referred to as an electric match. The electric match was placed near the bottom of a 21 qt (19.9 L) polypropylene waste container. The height of the waste container was 15.5 in (394 mm) with interior dimensions at the top opening of 14.5 in (368 mm) by 11.3 in (287 mm). Approximately 0.7 lbs (0.3 kg) of dry newspaper was added to the waste container. The majority of the newspaper was folded flat, and placed on edge along the sides of the waste container. Four sheets of newspaper, 22 in (559 mm) by 25 in (635 mm) were crumpled into "balls" approximately 3.9 in (100 mm) diameter and placed on top of the electric match in the center of the waste container.

Experimental Matrix for Room and Contents Fires

Sufficient amounts of furniture for 16 rooms were available for the room and contents fires, so eight experiment scenerios were conducted — each with a replicate. Because the time to untenable conditions was a primary variable of interest in the room and contents fires, the arrival time of the first due engine was a paramount consideration. Because the effects of the subsequent apparatus stagger were explored in the time-to-task tests, the stagger was fixed at the "close arrival" time. Additionally, a baseline measurement was required to compare the effectiveness of response to the absence of a fire department response. Therefore, a five-person, later arrival combination was eliminated in favor of a no-response scenario (with replicate). Table 3 summarizes the 16 tests conducted.

The first due engine arrival times were determined using the following assumptions: ignition of the fire occurs at

Crew Size	First Due Arrival Time
2-Person	Early Arrival of First Engine (6.5 min) – close stagger
3-Person	Early Arrival of First Engine (6.5 min) – close stagger
4-Person	Early Arrival of First Engine (6.5 min) – close stagger
5-Person	Early Arrival of First Engine (6.5 min) – close stagger
2-Person	Later Arrival of First Engine (8.5 min) – close stagger
3-Person	Later Arrival of First Engine (8.5 min) – close stagger
4-Person	Later Arrival of First Engine (8.5 min) – close stagger
No Response (Baseline)	N/A

Table 3: Experimental Matrix for Room and Contents Tests (Each Conducted in Replicate)

time zero. Smoke detector activation and a call to 9-1-1 occurs at 60 seconds after the fire starts. Call intake and processing requires an additional 90 seconds. The firefighters take 60 seconds to complete their turnout at the station and begin travel to the scene. Thus travel time begins 3.5 minutes into experiment. The two levels of arrival time are then determined by two different travel times: early arrival assumes a three-minute travel time, while later arrival assumes a five-minute travel time. For all scenarios in the room and contents experiments, the close stagger (60 seconds) between subsequent apparatus times was used.

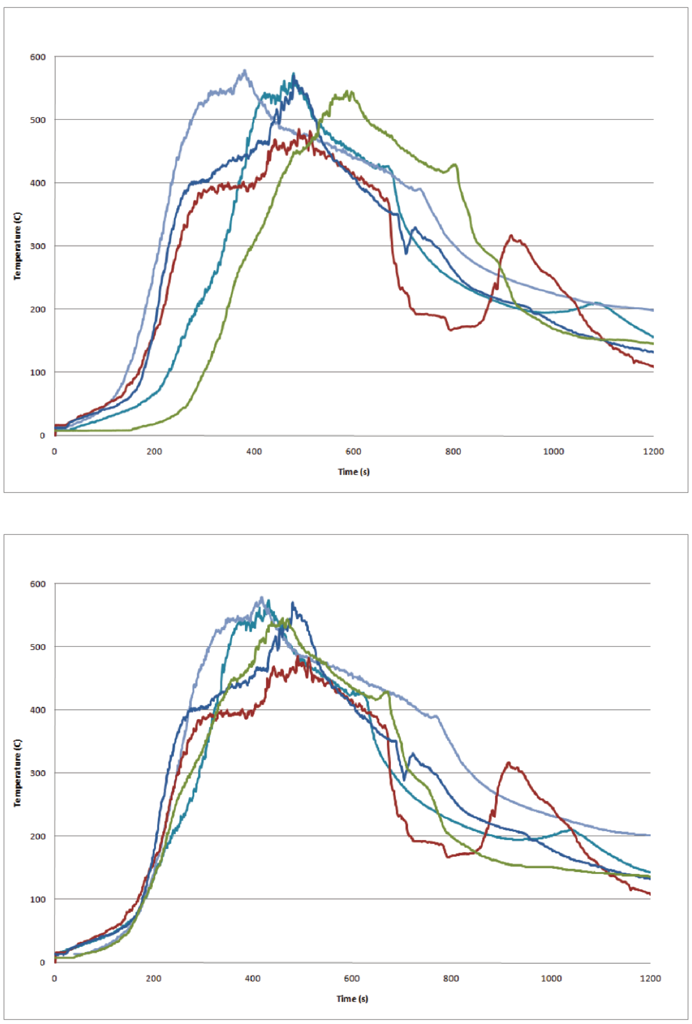


Figure 26: Direct Comparison of Temperatures, Before (Top) and After Adjustment (Bottom)

Procedure for Minimizing the Effect of Variance in Fire Growth Rate

Fires involving furnishings have inherent variance in burning behaviors. Factors such as humidity and minor variations in materials (particularly worn furnishings that may have different foam compression or fabric wear patterns), can result in uncertainty of 20 % or more, despite significant efforts to enhance repeatability. The early growth period of fire development is often associated with the greatest variance, since minor factors (as discussed above) can influence the thermal environment more easily when the fire is small. Therefore, the room and contents fires were normalized to the 212 °F (100 °C) temperature near the ceiling in the burn room in order to minimize the variance of the room and contents fires. The time at which the burn room reached this temperature (usually in approximately 180 seconds) rather than the actual ignition time, was designated as the "zero time."

Figure 26 shows the time-temperature curves before and after normalizing at 100°C. This approach was implemented during the experiments by watching the time temperature data in real-time from the instrumentation room and announcing the "zero-time" over the fireground radio system. The normalization procedure did not negatively affect tenability measurements in the target room because when the fire is small, products of combustion do not reach the room because of lack of momentum. Therefore, adjusting all room and contents tests to the same upper layer temperature was an appropriate way to minimize variance.

Milestone Times for Critical Tasks

As stated earlier, firefighters could not enter the burn building during the room and contents experiments because of the danger for potential flashover in an experimental scenario. Therefore, prescribed tasks were performed at specified times based on data from part 2. In this section we report on significant data gathered from instrumentation and describe an additional part of the experiments designed to extend our understanding of the effect of crew size and stagger on the tenability of the atmosphere in a burning structure.

Table 4 (page 32) identifies significant tasks selected as key milestones because of the way they affect fire behavior and atmospheric tenability inside the structure.

Milestone Tasks	2-Person Close Stagger
	Time from ignition (min : s)
Breached Door	8:44
Water On Fire	9:56
Upper Fire Window	13:01
Ground Non-fire Window	14:51
Upper Corner Window	17:55
Upper Front Door Window	19:55
Ground Fire Window	4:30
Milestone Tasks	**3-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:48
Water On Fire	8:54
Upper Fire Window	11:26
Ground Non-fire Window	13:31
Upper Corner Window	15:54
Upper Front Door Window	17:58
Ground Fire Window	4:30
Milestone Tasks	**4-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:46
Water On Fire	8:41
Upper Fire Window	9:23
Ground Non-fire Window	10:32
Upper Corner Window	11:46
Upper Front Door Window	13:45
Ground Fire Window	4:30
Milestone Tasks	**5-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:35
Water On Fire	8:03
Upper Fire Window	10:11
Ground Non-fire Window	10:54
Upper Corner Window	12:31
Upper Front Door Window	12:47
Ground Fire Window	04:30

Table 4: Tasks That Affect Fire Behavior and Atmospheric Tenability

Analysis of Experimental Results

This section describes the analytic approaches used to address the research objectives of the study. First the statistical methods used to analyze the fireground time-to-task observations are presented. Then the time-to-task data and the room and contents data were combined to assess crew performance in relation to tenability within the structure.

Time-to-Task Analysis

Time-to-task data were compiled into a database and assessed for outliers and missing entries. Because all time-to-task experiments were conducted in triplicate, missing data were apparent and were reviewed via video and radio tapes. Missing data attributable to timer error were replaced by a time observed in the video. Where video and/or radio documentation was not adequate, missing data were recoded to the mean of the task times from the other two experiments.

Data Queries

The statistical methods used to analyze the time-to-task data were driven by a principal goal of this research project — to assess the effect of crew size, first-due engine arrival time, and subsequent apparatus stagger on time-to-task for critical steps in response and fire fighting. This research goal motivated the development of four specific research questions (see Figure 27) that in turn pointed to specific statistical analyses for generating inference and insight.

Statistical Methods – Time-to-Task

The analysis of the time-to-task data involved a sequence of multiple linear regressions using Ordinary Least Squares to generate and test the effects of staffing and stagger on timings. The regressions were of the form:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + \varepsilon_i$$

where the x_{ik} reflect factors such as stagger and crew size, and the y represents our dependent/outcome variable.

Time-related outcomes (i.e., the dependent variables in the regression equations) could include task duration, elapsed time to start the task, and elapsed time until task completion, all measured in seconds. Table 5 (page 34) lists the time-related outcomes used to test the effect of crew size and stagger for the tasks in the field experiments.

The effects of crew size and stagger were explored using indicator variables in the regression analyses. The coefficient for a given indicator (for example, crew size of four relative to a crew size of two) indicated the number of seconds the larger crew size added or reduce the timing outcome of a task. Crew sizes were collapsed in some regressions to test whether the timings of "larger" crew sizes of four and five were significantly different than "smaller" crew sizes of two and three. Interaction terms were not assessed in these regression analyses because of the small number of experiments available for analysis.

Standard t-tests examined statistical significance (i.e., to see if the hypothesis of "no impact" could be rejected) to estimate the impact of several specific configurations:

- crew sizes of three versus two
- crew sizes of four versus three
- crew sizes of five versus four
- (occasionally) five versus two, and four versus two
- larger (four & five combined) versus smaller (two & three combined) and
- stagger

The specific tests for each task (regression analysis) are shown in the Appendix E. The actual coefficients of each regression and their corresponding standard errors are presented in Appendix F. To infer impact, significant tests were conducted at the 0.05 significance level. Only statistically significant contrasts of crew size and/or stagger are included in this section of the report. Graphic expositions of relevant time/task related findings are then presented as well. Where stagger was statistically significant, the effects are graphed separately. Where stagger was not statistically significant, the data for crew size were combined.

Time-to-Task Research Questions

1) How do crew size and stagger (i.e., timing of between first engine and subsequent apparatuses) affect overall (i.e., start to completion) response timing?

   a. To what extent do variations in crew size affect overall response timing?

   b. To what extent do variations in both crew size and stagger affect overall response timing?

2) How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the tasks comprising the suite of 22 tasks?

   a. To what extent do variations in crew size affect timings across the suite of tasks?

   b. To what extent do variations in both crew size and stagger affect response timings across the suite of tasks?

3) How does crew size affect elapsed times to achieve three critical events known to change fire behavior or atmospheric tenability for occupants?

   a. Entry into structure

   b. Water on fire

   c. Ventilation of each window (three upstairs and one downstairs window and the burn room window)

4) How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene (measured using "at hydrant" as the start time) vary by crew sizes of 4 and 5?

Figure 27: Research Questions for Time-to-Task Experiments

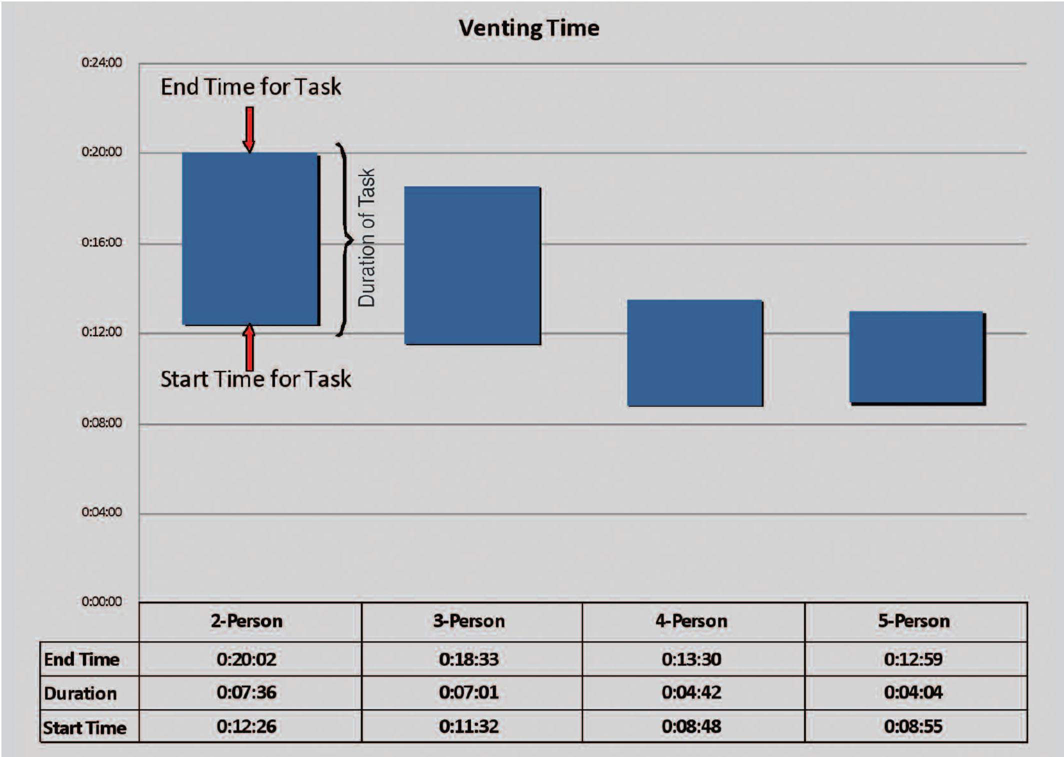


Figure 28: Example Time-to-Task Graph

Task:	Time-to-Task Outcome Measures: *Elapsed Time Until Start**	*Elapsed Time for Task Completion**	*Duration**
Conduct size-up	X	X	X
Position attack line	X		X
Establish 2 in - 2 out		X	
Establish RIT		X	
Gain forced entry	X		
Advance line	X		
Advance line		X	
Advance backup line to door	X	X	
Advance backup line to stairwell	X		
Advance backup line 2		X	
Conduct primary search 1	X		
Ground ladders in place		X	X
Horizontal ventilation, second story, window 3	X	X	
Horizontal ventilation, second story, window 2	X	X	
Horizontal ventilation, second story, window 1	X	X	
Horizontal ventilation, first story, window 2	X	X	
Control utilities interior	X		
Control utilities exterior	X		
Conduct secondary search	X		
Check for fire extension walls	X		
Check for fire extension ceiling	X		

* The columns of this table show the dependent variables, and the rows indicate the Tasks; an 'X' in a cell indicates that a separate regression analysis was conducted for a given dependent variable.

Table 5: Dependent Variables Used in a Regression Analysis of the Effect of Crew Size and Stagger on Time-to-Task Outcomes

Regression analyses

Appendix F presents the regression results for each task and relevant outcome, along with their corresponding standard errors. The results of conducting significance tests at the 0.05 level of significance are shown in Appendix E. Rather than detailing each of the lengthy lists of coefficients found to be significant, only the answers to the primary research questions are presented for each task.

Measurement Uncertainty

The measurements of length, temperature, mass, moisture content, smoke obscuration, and stopwatch timing taken in these experiments have unique components of uncertainty that must be evaluated in order to determine the fidelity of the data. Appendix G summarizes the uncertainty of key measurements taken during the experiments. Importantly, the magnitudes of uncertainties associated with these measurements have no impact on the statistical inferences presented in this report.

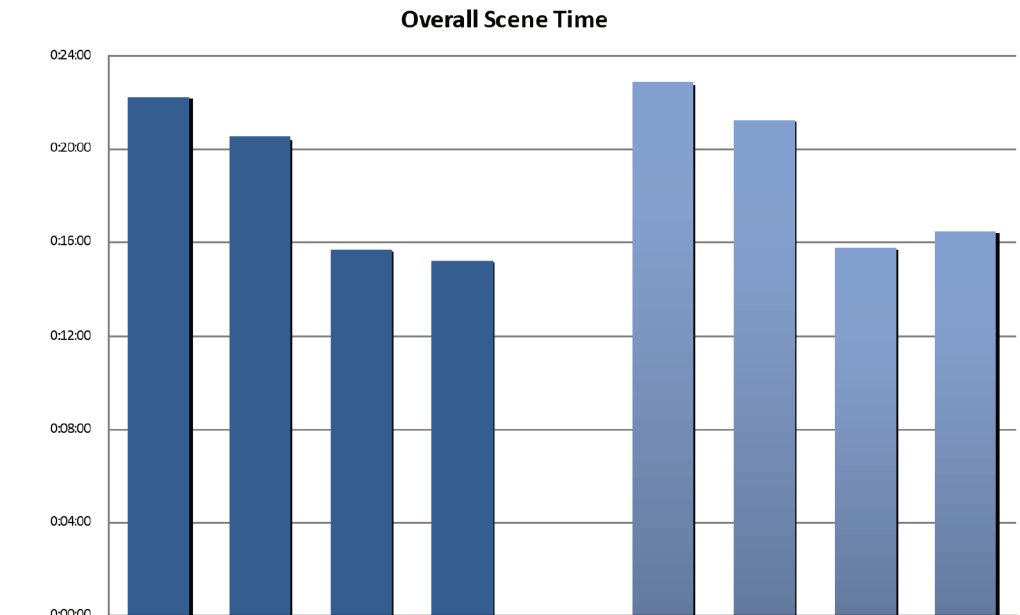
How to Interpret Time-to-Task Graphs

Figure 28 presents a sample time-to-task analysis, in this case results for venting time. Each crew size has a column graphic showing the start time and completion time for the task. Visually, columns starting lower on the graph depict deployment configurations that resulted in earlier start times. The height of the column graphic is a visualization of the duration of the task, taller columns indicating longer times to task completion. Time data are also shown in a table below the graph. Where stagger was statistically significant, the effects are graphed separately. Where stagger was *not* statistically significant, as in the illustration, the data for crew size were combined.

Time-to-Task Graphs

Overall Scene Time (Time to Complete All 22 Tasks)

The four-person crews operating on a low-hazard structure fire completed the same number of tasks on the fireground (on average) 7 minutes faster than the two-person crews (see Figure 29). The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster than the three-person crew. The four-person crews were able to complete necessary fireground tasks on a low-hazard residential structure fire nearly 30 % faster than the two-person crews and nearly 25 % faster than the three-person crews. Although on the low-hazard residential structure fire, adding a fifth person to the crews did not show any additional decrease in fireground task times, the benefits of a five-person vs. a four-person crew are significant in other measurements, particularly the “water-on-fire” time. Additionally, the greater need for five-person crews for medium- and high-hazard structures, particularly in urban settings, has been documented in other studies (Backoff et al., 1980; Cushman, 1982; McManis Associates et al., 1984) and five-person crews are required for areas that contain medium and high-hazard structures in fire protection consensus standards.[11]



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:22:16	0:20:30	0:15:44	0:15:13		0:22:52	0:21:17	0:15:48	0:16:31
Start Time	0:00:00	0:00:00	0:00:00	0:00:00		0:00:00	0:00:00	0:00:00	0:00:00

Figure 29: Overall Scene Time

11 NFPA 1710, Section 5.2.3.1.2 and Section 5.2.3.2.2: In jurisdictions with tactical hazards, high-hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the AHJ, these companies shall be staffed with a minimum of five or six on duty members.

Overall Scene Time and Crew Sizes

The graphs in Figure 30 show average times for each task by crew size.

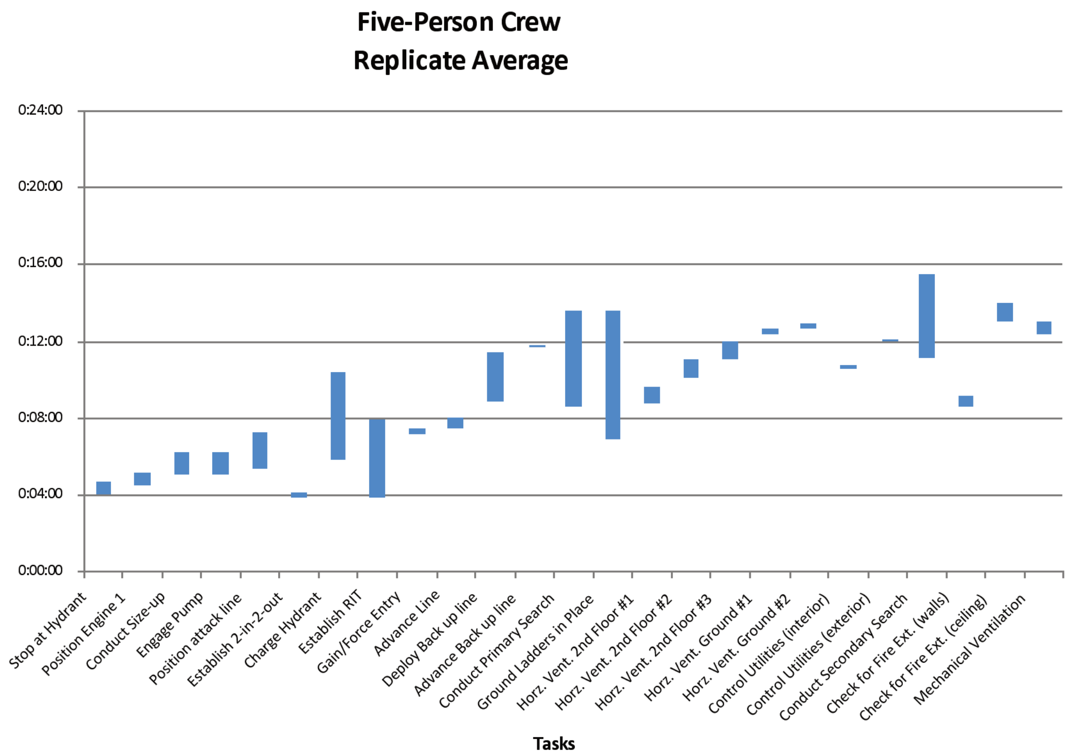


Figure 30 a: Overall Scene Time-FIve Person Crew

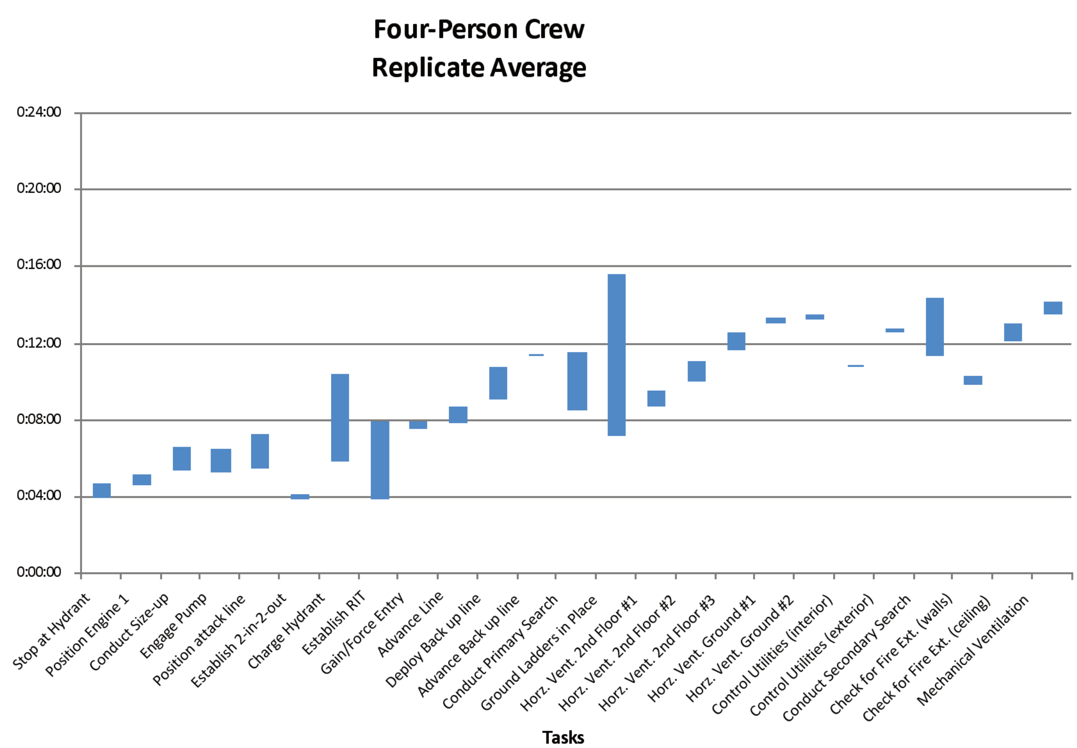


Figure 30 b: Overall Scene Time-Four Person Crew

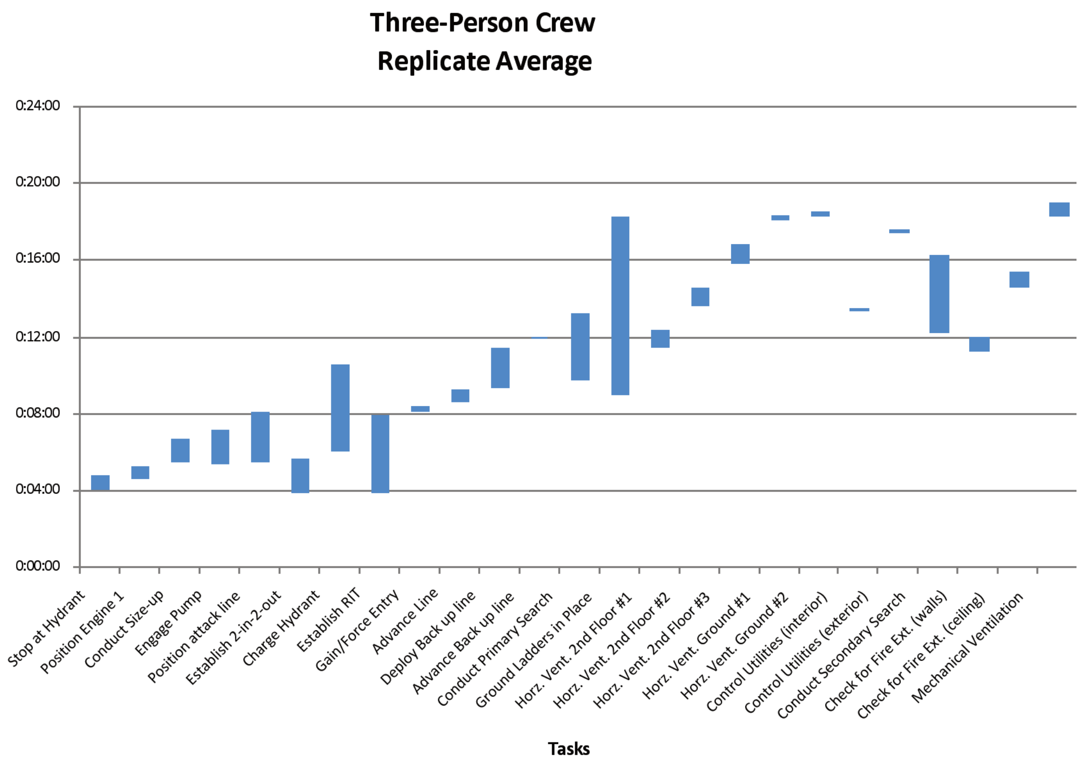


Figure 30 c: Overall Scene Time-Three Person Crew

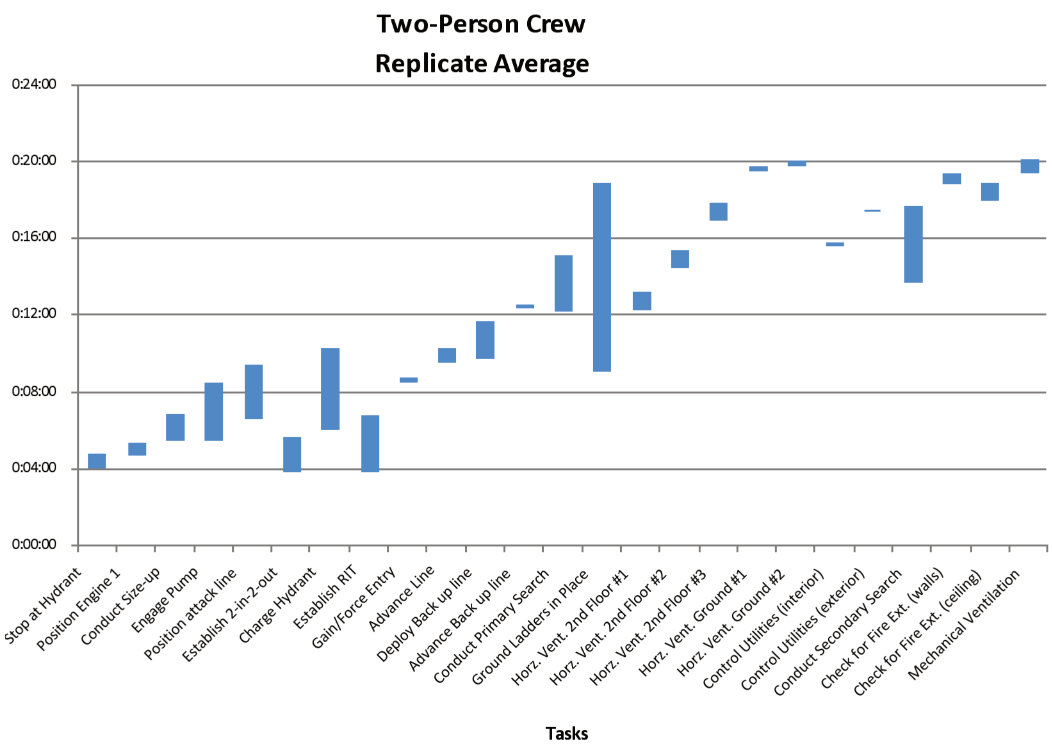
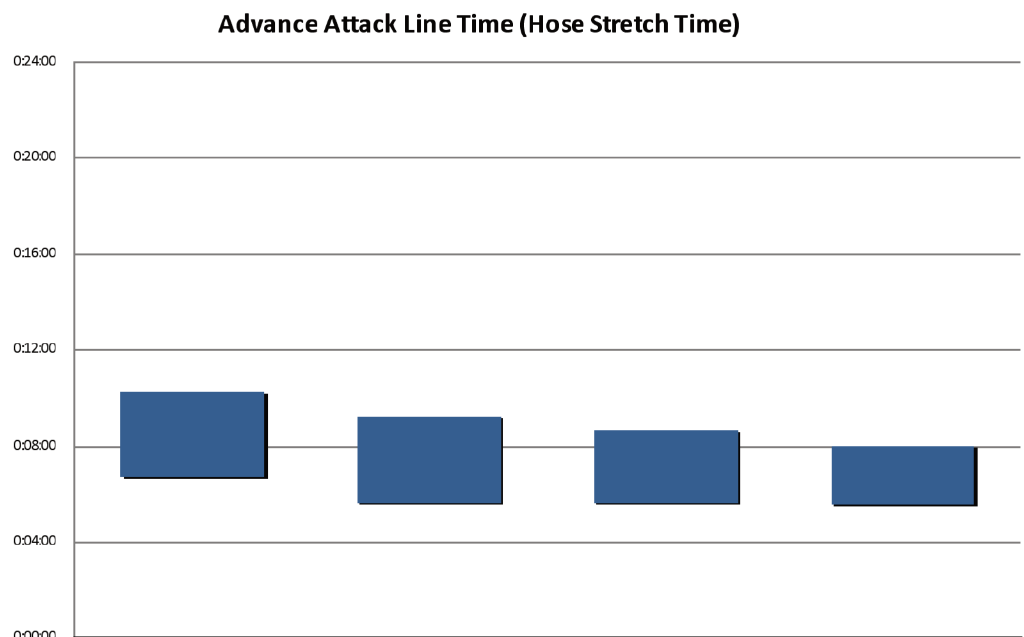


Figure 30 d: Overall Scene Time-Two Person Crew

Advance Attack Line Time (Hose Stretch Time)

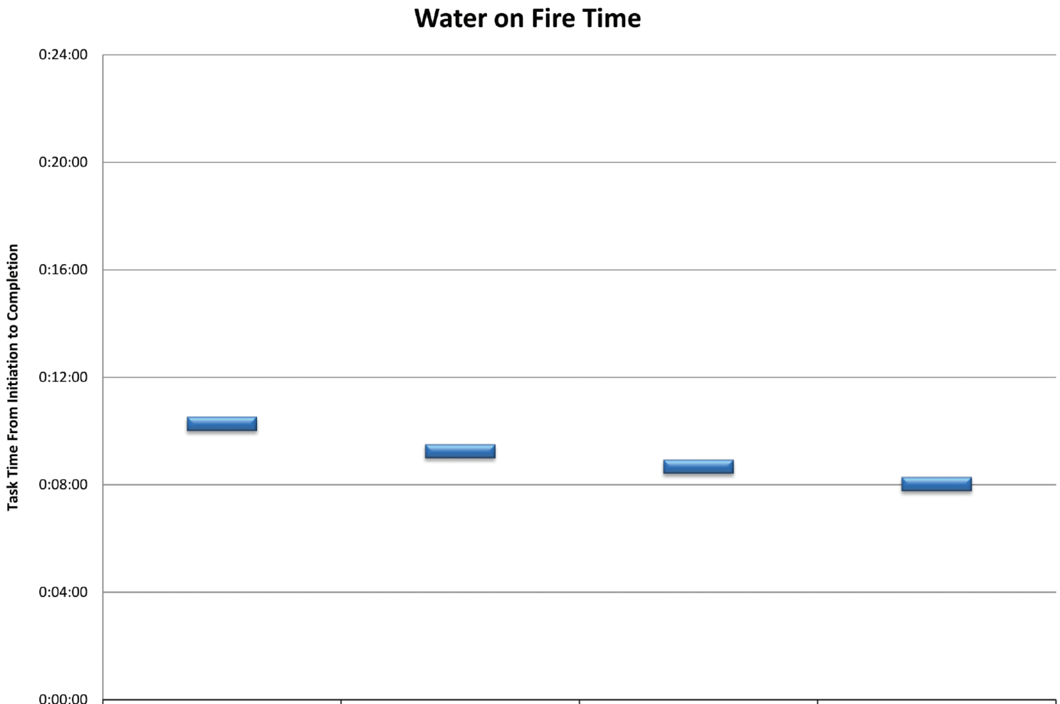
Figure 31 measures the interval from the start of the task "Position Attack Line" to the end of the task "Advance Attack Line." In comparing four- and five-person crews to two and three-person crews collectively, the time difference for this measure was statistically significant at 76 seconds (1 minute 16 seconds). In conducting more specific analysis comparing all crew sizes to a two-person crew the differences are more distinct. A two-person crew took 57 seconds longer than a three-person crew to stretch a line. A two-person crew took 87 seconds longer than a four-person crew to complete the same task. Finally, the most notable comparison was between a two-person crew and a five-person crew, with a 122-second difference in task completion time.[12, 13]



	2-Person	3-Person	4-Person	5-Person
End Time	0:10:16	0:09:15	0:08:41	0:08:01
Duration	0:03:34	0:03:36	0:03:02	0:02:29
Start Time	0:06:43	0:05:39	0:05:39	0:05:33

Figure 31: Advance Line Time (Hose Stretch Time) by Crew Size

12 Apparatus stagger was not statistically significant, so the data for crew size were combined.
13 Where subtracting the start time from the end time yields a result that differs from the duration noted in the chart by one second, it is the result of rounding fractional seconds to the nearest whole second.

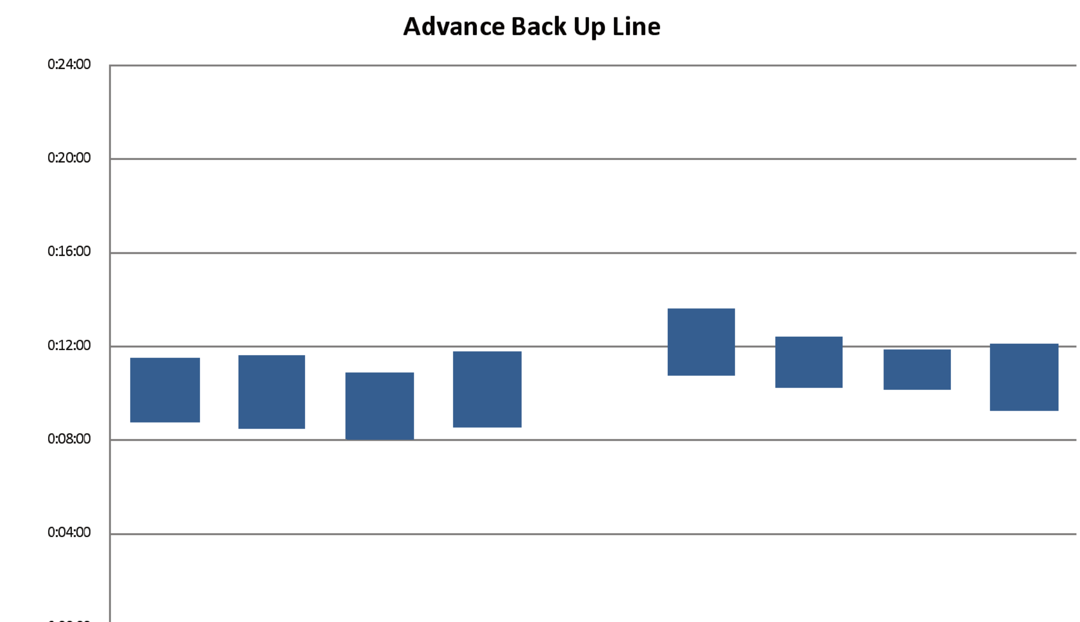


	2-Person	3-Person	4-Person	5-Person
End Time	0:10:16	0:09:15	0:08:41	0:08:01

Figure 32: Water on Fire Time by Crew Size and Stagger

Time to Water on Fire

There was a 10% difference in the “water on fire” time between the two- and three-person crews. There was an additional 6% difference in the "water on fire" time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two person crews). There was an additional 6% difference in the “water on fire” time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:11:28	0:11:33	0:10:55	0:11:48		0:13:37	0:12:23	0:11:54	0:12:04
Duration	0:02:34	0:02:58	0:02:46	0:03:09		0:02:45	0:02:04	0:01:41	0:02:44
Start Time	0:08:54	0:08:35	0:08:08	0:08:39		0:10:52	0:10:19	0:10:13	0:09:20

Figure 33: Times to Advance Backup Line by Crew Size and Stagger

Advancing a Backup Line

Advancing a backup line to the door and stairwell was started 16 % faster and completed 9 % for replicates with shorter staggers between company arrivals. Advancing a backup line is typically a task completed by the third arriving engine on a full alarm assignment and is critical to the safety of firefighters already in the building on the initial attack line. For this task, stagger of arrival was statistically significant and is an important consideration for overall station location and full alarm response capability. The differences can be seen in Figure 33, which shows the time from the start for the task “Deploy Backup Line” to the end of the task “Advance Backup Line.”

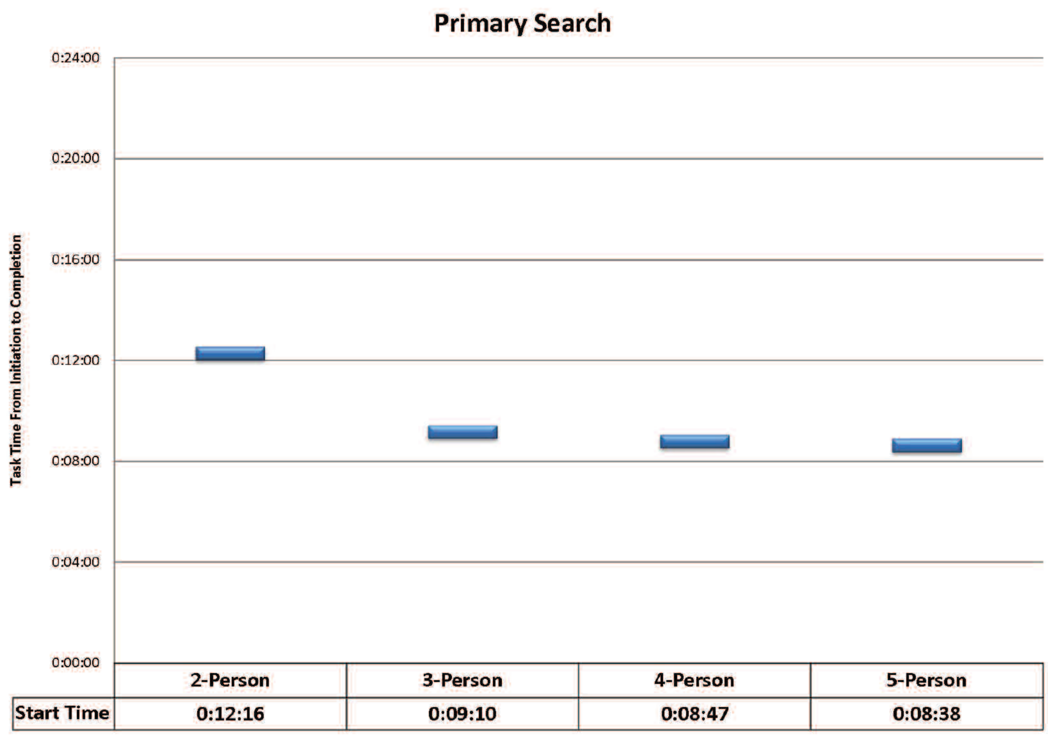
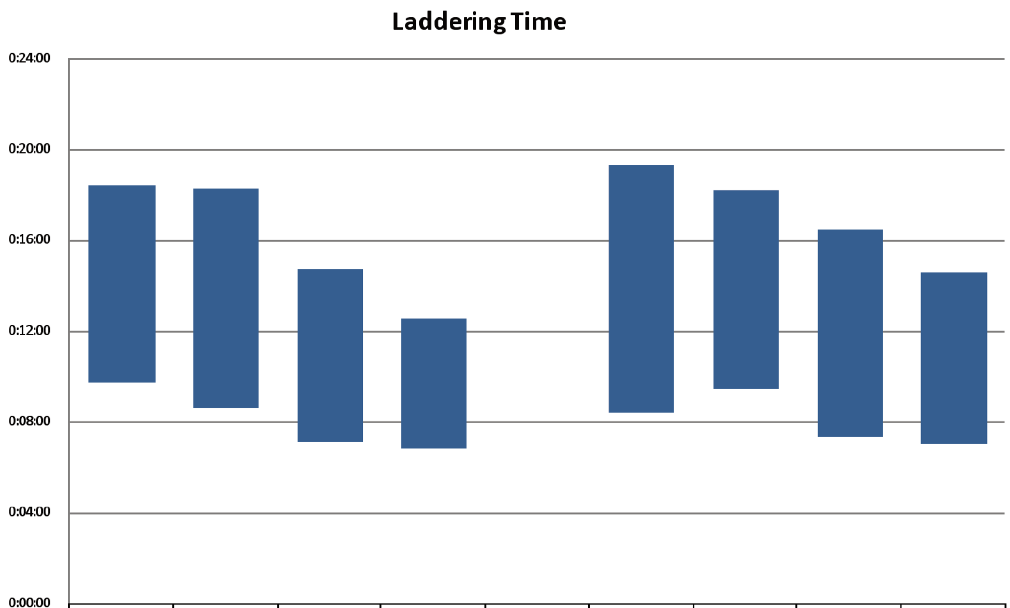


Figure 34: Times to Conduct Primary Search by Crew Size

14 Stagger was not significant, so data from close and far were combined to increase statistical power.

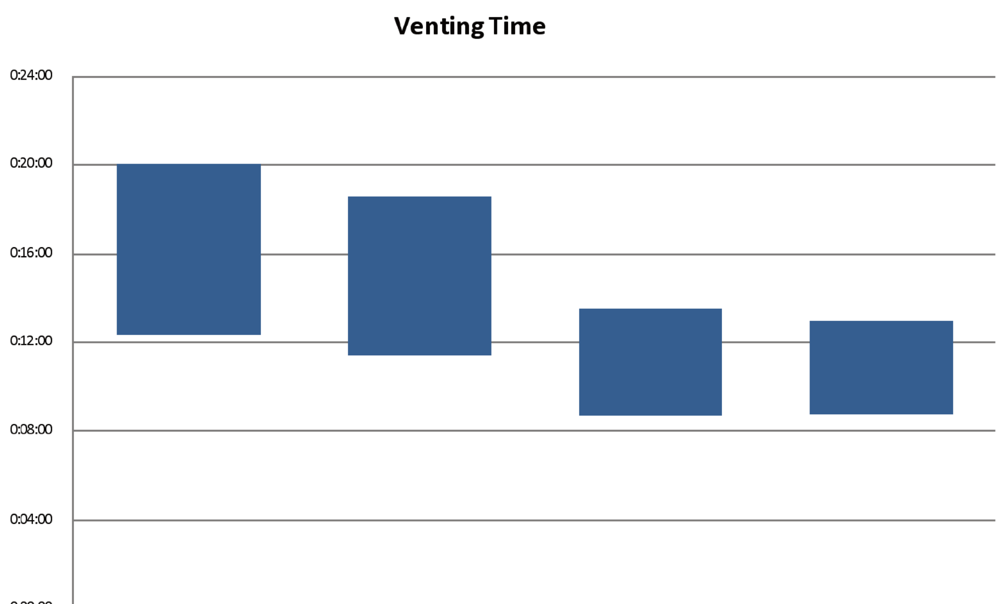


	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:18:24	0:18:19	0:14:45	0:12:34		0:19:23	0:18:12	0:16:29	0:14:38
Duration	0:08:31	0:09:35	0:07:31	0:05:40		0:10:51	0:08:40	0:09:03	0:07:31
Start Time	0:09:54	0:08:44	0:07:14	0:06:54		0:08:31	0:09:32	0:07:26	0:07:07

Figure 35: Laddering Time by Crew Size

Primary Search

Figure 34 summarizes the times that crews took to start the primary search. On the low-hazard, two-story single-family dwelling 2,000 sq ft (186 m^2) , the three-person crew started a primary search/rescue more than 25 % faster than the two-person crew. In the same structure, the four- and five-person crews started a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. Note that there is no end time included in this figure. Primary search end times were reliant upon radio communication by firefighters inside the structure. On occasion this communication did not occur or was delayed. Therefore data reliability was insufficient for analysis of task duration and end time.[14]



	2-Person	3-Person	4-Person	5-Person
End Time	0:20:02	0:18:33	0:13:30	0:12:59
Duration	0:07:36	0:07:01	0:04:42	0:04:04
Start Time	0:12:26	0:11:32	0:08:48	0:08:55

Figure 36: Ventilation Times by Crew Size[15]

Laddering and Venting Time

A four-person crew operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 % faster than a two-person crew and 25 % faster than a three-person crew.

Ground laddering time started with the removal of the first ladder from the truck and stopped at end time of the last ladder put in place. A total of four ladders were raised on each experiment.

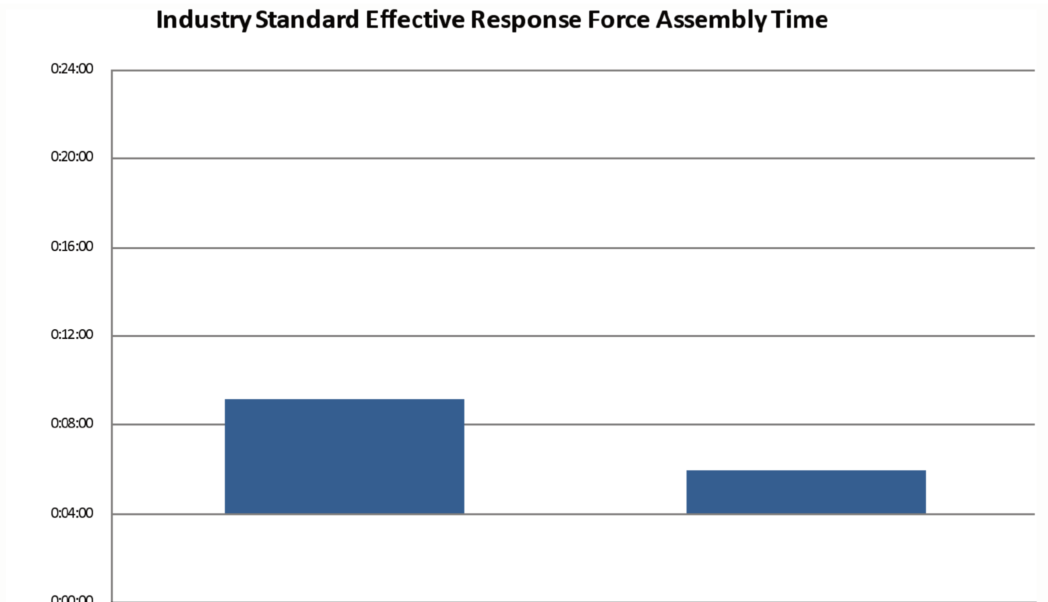
Truck operations ventilation time is the time from the start time of ventilation of the first window until the last window ventilation was complete.

The differences in start times and duration of the tasks can be seen in Figure 35 and Figure 36.

15 Stagger was not statistically significant, so the data for crew size were combined.

Industry Standard Effective Response Force Assembly Time

NFPA 1710 requires that a fire department have the capability to deploy an initial full-alarm assignment to a scene within eight-minutes (480 seconds). The number of people required falls between 15 and 17, depending on whether an aerial apparatus is used, and/or if two engines are being used to provide a continuous water supply. In these experiments, the measurement for an effective response force assembly time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene. Figure 37 reveals the differences in assembly times between the four and five-person crews. An effective response force was assembled by the five-person crews a full three minutes faster than the four-person crews. It is important to note that (by definition), the two-and three-person crews were unable to meet this standard at any time during the experiments.[16]



	4-Person	5-Person
End Time	0:09:10	0:05:57
Duration	0:05:02	0:01:48
Start Time	0:04:09	0:04:09

Figure 37: Industry Standard Effective Response Force Assembly Time

16 Stagger was not statistically significant, so the data for far and near stagger were combined.

Part 4: Fire Modeling

In the room and contents experiments conducted in Part 3 of the study, instrumentation measured oxygen, carbon dioxide, and carbon monoxide concentrations. Data were grouped by the type of experiment conducted with respect to crew size and first due engine arrival time. As previously shown in the experimental matrix, each group contained two replicate tests. In each group of data the results of the replicates were averaged to simplify the data for further comparison. Figure 38 and Figure 39 show the typical concentration curves for the experiments.

These two graphs show the ranges representative of those found in the experiments. Charts of gas curves for the remainder of the experiments — for both the burn room and the target room — can be found in Appendix H.

Fire Modeling Methods

A primary goal of fire department response is to prevent civilian injuries and deaths. Because the significant majority of fire deaths in the United States occur in residences, a rapid fire service response provides the last line-of-defense against civilian fire deaths. Further, because the fire service is less likely to rescue occupants intimate with the fire (i.e., inside the room of origin where conditions deteriorate rapidly), tenability measurements were taken in a remote bedroom on the second floor of the residential burn structure. The gas and temperature measurements were taken at the 5 ft (1.5 m) height above the floor, 3 ft (0.9 m) from the west wall in order to simulate a nonambulatory occupant (e.g, someone asleep, under the influence of alcohol or drugs, or otherwise mobility impaired).

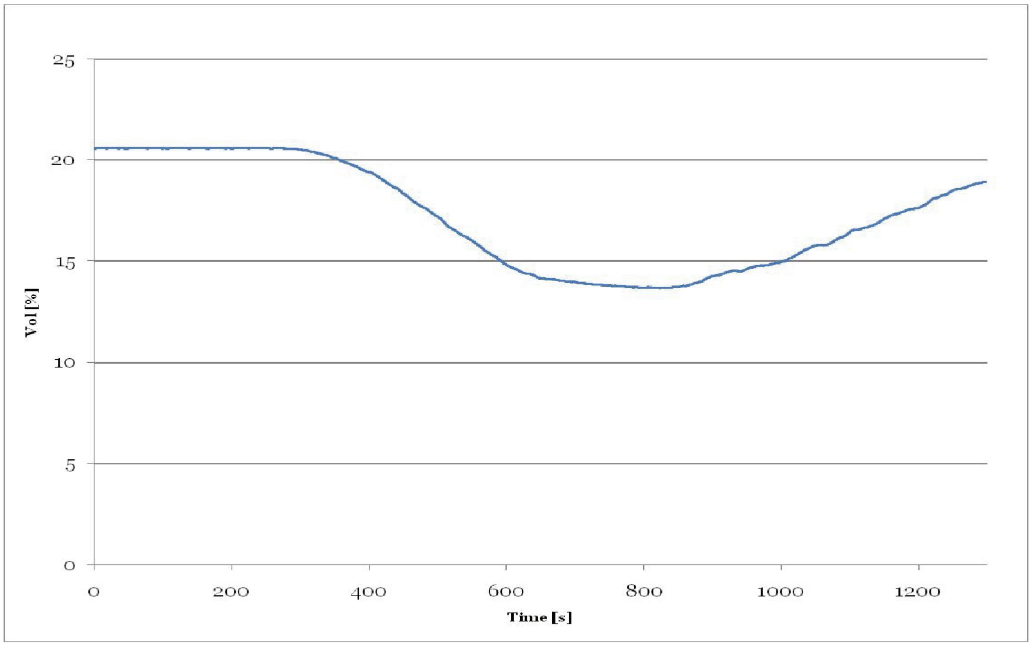


Figure 38: Representative Oxygen Concentration

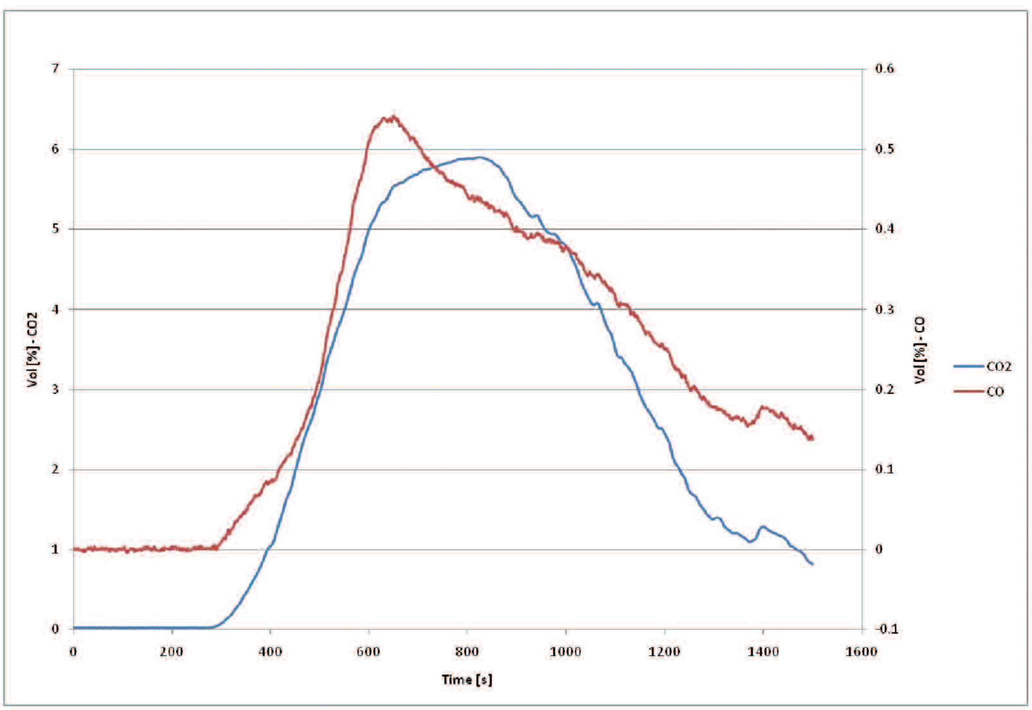


Figure 39: Representative Carbon Monoxide and Carbon Dioxide Concentrations

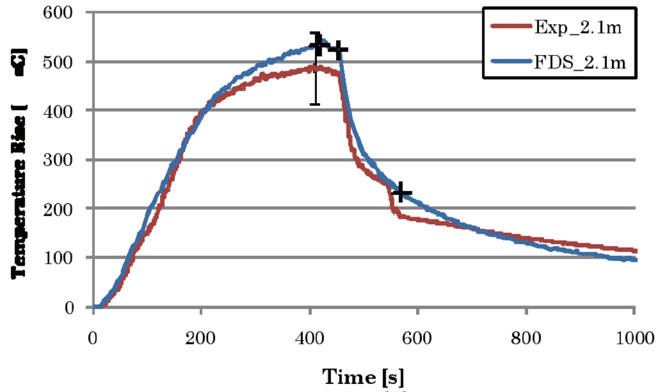


Figure 40: Measured vs. Predicted Temperature at the 2.1 m (6.9 ft) Thermocouple Location in the Burn Compartment

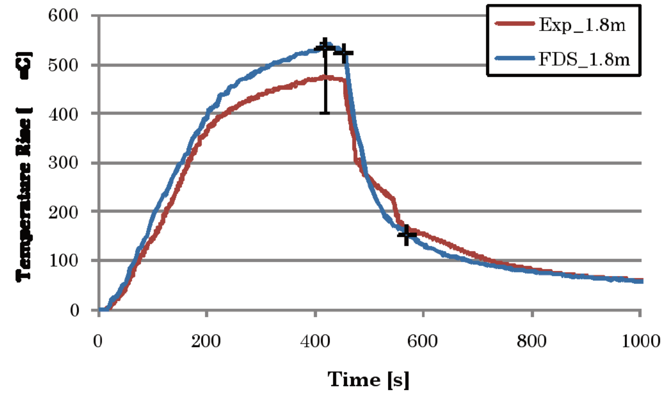


Figure 41: Measured vs. Predicted Temperature at the 1.8 m (5.9 ft) Thermocouple Location in the Burn Compartment

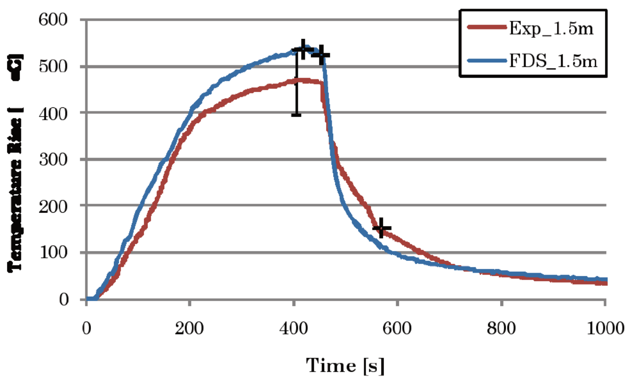


Figure 42: Measured vs. Predicted Temperature at the 1.5 m (4.9 ft) Thermocouple Location in the Burn Compartment

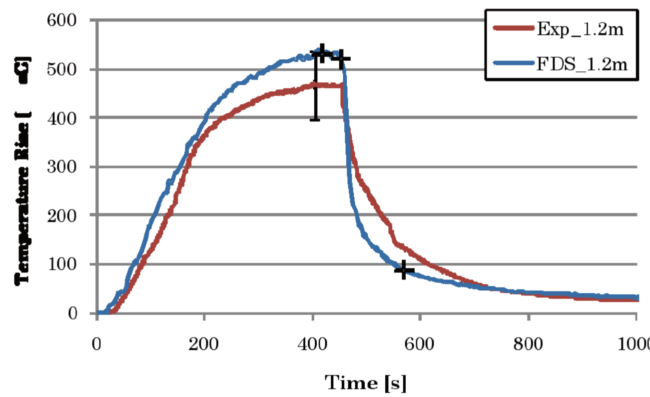


Figure 43: Measured vs. Predicted Temperature at the 1.2 m (3.9 ft) Thermocouple Location in the Burn Compartment

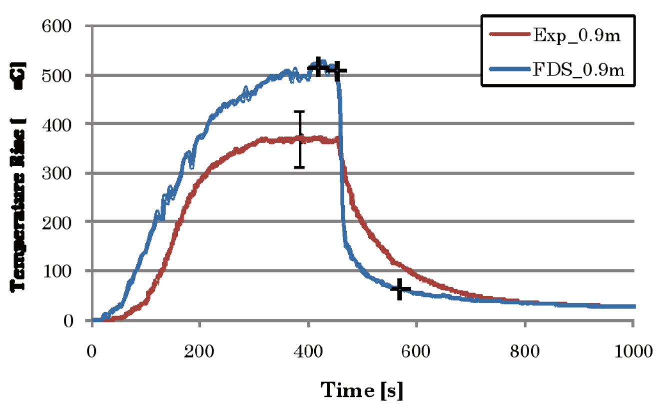


Figure 44: Measured vs. Predicted Temperature at the 0.9 m (2.9 ft) Thermocouple Location in the Burn Compartment

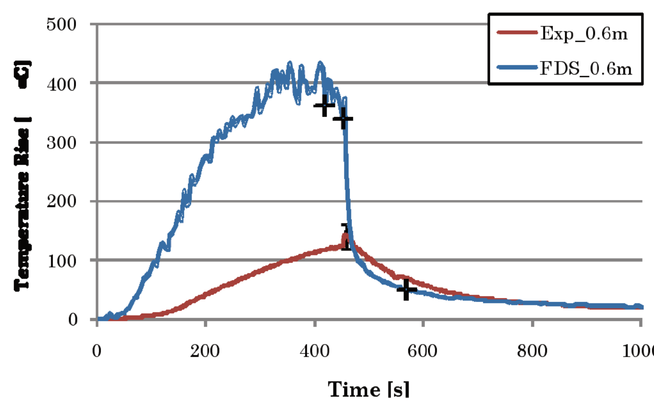


Figure 45: Measured vs. Predicted Temperature at the 0.6 m (1.9 ft) Thermocouple Location in the Burn Compartment

Computational fire models used the average suppression timings obtained from the time-to-task experiments under specific deployment configurations as inputs to the model. This quantitative approach eliminated the experimental variance of the fire. The resulting "computational" fire is repeatable, and therefore, any differences in occupant exposure to toxic gases will be due to the intervention times associated with a specific deployment configuration rather than the random variation that naturally occurs from fire to fire.

Fire simulations were completed using the NIST Fire Dynamics Simulator (FDS). FDS is a computational fluid dynamics model of fire-driven fluid flow. The first version of the FDS was released in 2000. FDS has been extensively verified and validated (USNRC 2007). Since the initial release, numerous improvements have been made and new features added. This study used FDS version 5.4.2 (Sub-version #4957), which was released on October 19, 2009. In order to calibrate the model, simulations were performed to replicate the experimental results observed in the room-and-contents fires. Once the ability of the model to replicate experimental results was established, the different fire growth rates and deployment configurations were simulated to characterize the effectiveness of different responses relative to different fire growth rates.

The occupant exposure to toxic gases was assumed to occur until the occupant is rescued by the truck crew (start time of primary search plus one minute). Table 6 shows the "rescue time" for the various crew sizes that correspond to the test matrix for the room and contents experiments.

Part 4 of the experiments used fire modeling to correlate response times to atmospheric tenability in a burning structure. In order to calibrate the computer fire model, simulations were performed to replicate the experimental results observed in the room-and-contents fires. Model inputs include building geometry and material properties, ventilation paths (doors, windows, leakage paths), and heat release rate of the fuel package. While the building geometry is easily measured and material properties (such as the thermal properties of drywall and concrete) are readily estimated, the heat release rate was not directly measured during the experiments. The heat release rate of the fuel package is the primary determinant of the production rate of heat, smoke, and gas species (e.g., carbon dioxide, carbon monoxide).

Figures 40 through 45 compare the experimental and simulated burn room temperatures using the burn room thermocouple tree. The tree contained thermocouples located at 0.6 m (1.9 ft), 0.9 m (2.9 ft), 1.2 m (3.9 ft), 1.5 m (4.9 ft), 1.8 m (5.9 ft), and 2.1 m (6.9 ft) above the floor. For additional information about the instrumentation type location, see Appendix C. The results for thermocouples located in the hot gas layer show excellent agreement. The temperature at the lower two thermocouples show an overprediction of the hot gas layer depth in the computer simulation. A small difference in the location of the interface height (the steep temperature gradient between the relatively cool lower gas layer and the hot upper gas layer), can result in significant predicted temperature differences with relatively little effect on the bulk heat and mass transport accuracy. This explanation is supported by the agreement of the temperatures in the remote bedroom.

Figure 46 compares the experimental and predicted oxygen concentration levels in the upstairs bedroom (measured at 5 ft (1.5 m) above the floor, centered above the bed). Figures 47 through 52 compare the experimental and simulated temperatures in the upstairs (target room) bedroom. As expected, the temperatures are moderated by mixing (cool ambient air mixes with hot combustion gases during transport between the burn room and the target room) and by thermal losses to the (cooler) surfaces between the two rooms.

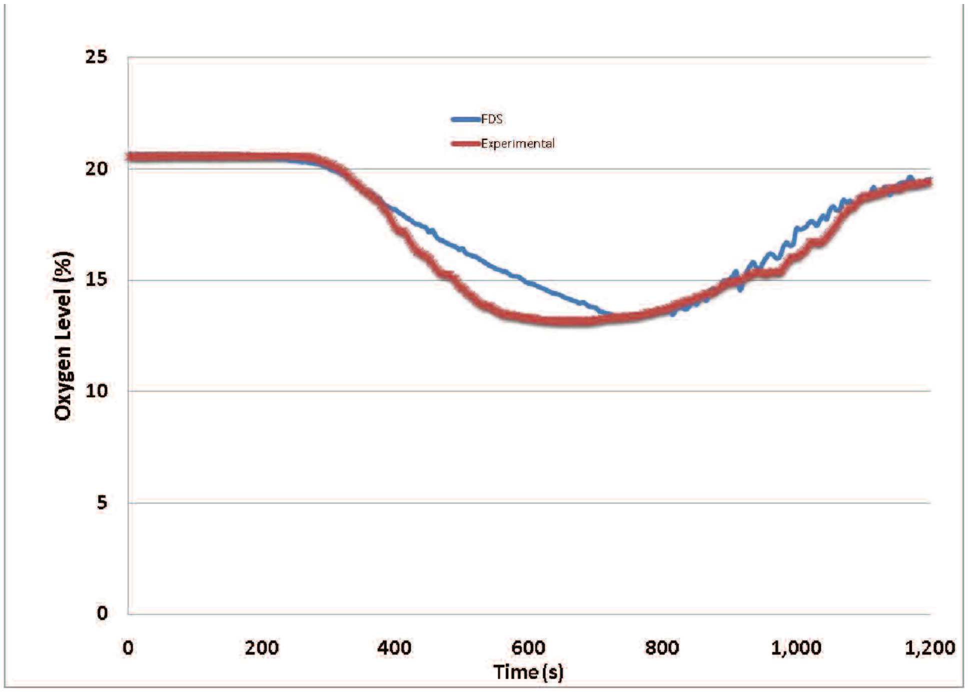


Figure 46: Measured Versus Predicted Oxygen Levels in the Upstairs Bedroom at 5 ft (1.5 m)

Once the model inputs were determined to agree with the experimental results, the input heat release rate was changed to represent three fire growth rates representative of a range of fire hazard development – slow, medium, and fast, which are described in greater detail in the following sections.

Time to Untenable Conditions: Research Questions

In the real world, fires grow at many different rates – from very slow, smoldering fires all the way to ultra-fast, liquid fuel or spray fires. In order to extend the applicability of the findings of this report beyond the one fire growth rate observed in part 3 of this report (residential room and contents fires), computer fire modeling was used to quantify the effectiveness of fire department operations in response to an idealized range of fire growth rates (characterized as slow, medium, and fast). Based on the research questions shown in Figure 53, fire modeling methods were then selected to maximize the applicability of the times to task results.

1) How do performance times relate to fire growth as projected by standard fire time/temperature curves?

2) How do these performance times vary by crew size, first due arrival time, and stagger?

3) How do crew size, stagger, and arrival time affect occupant tenability within the structure?

Figure 53: Research Questions for Time to Untenable Conditions

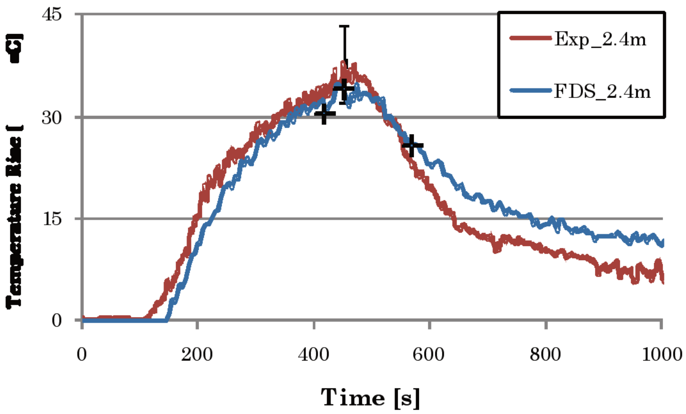


Figure 47: Measured vs. Predicted Temperature at the 2.4 m (7.8 ft) Thermocouple Location in the Bedroom

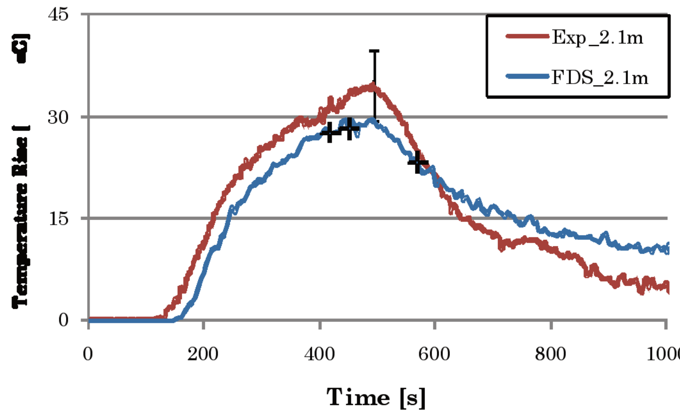


Figure 48: Measured vs. Predicted Temperature at the 2.1 m (6.8 ft) Thermocouple Location in the Bedroom

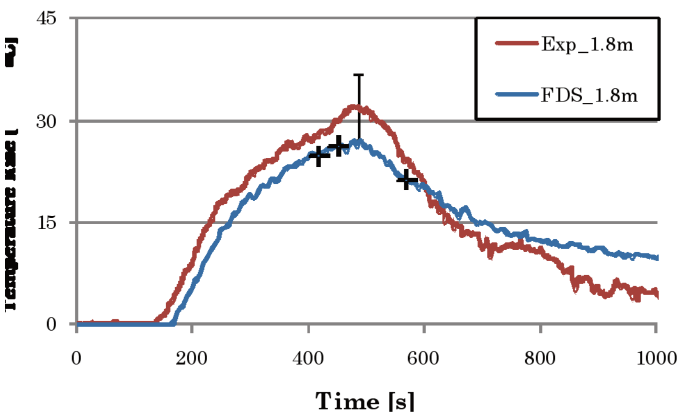


Figure 49: Measured vs. Predicted Temperature at the 1.8 m (5.9 ft) Thermocouple Location in the Bedroom

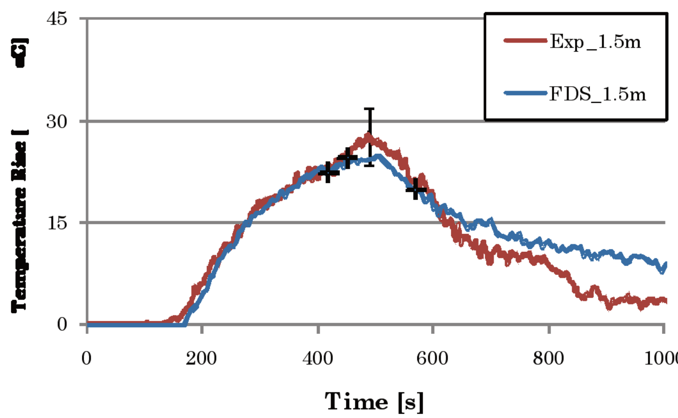


Figure 50: Measured vs. Predicted Temperature at the 1.5 m (4.9 ft) Thermocouple Location in the Bedroom

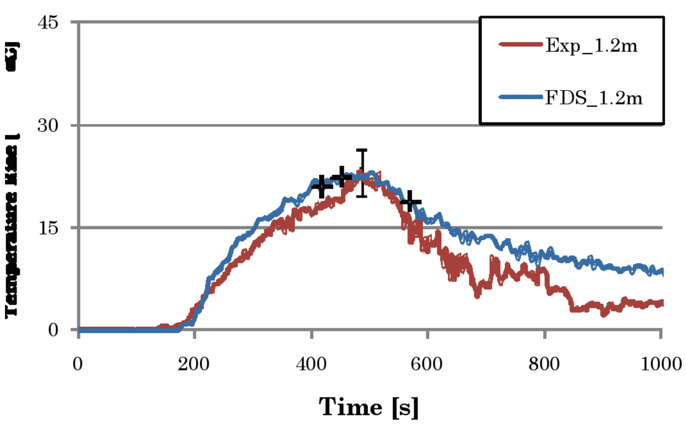


Figure 51: Measured vs. Predicted Temperature at the 1.2 m (3.9 ft) Thermocouple Location in the Bedroom

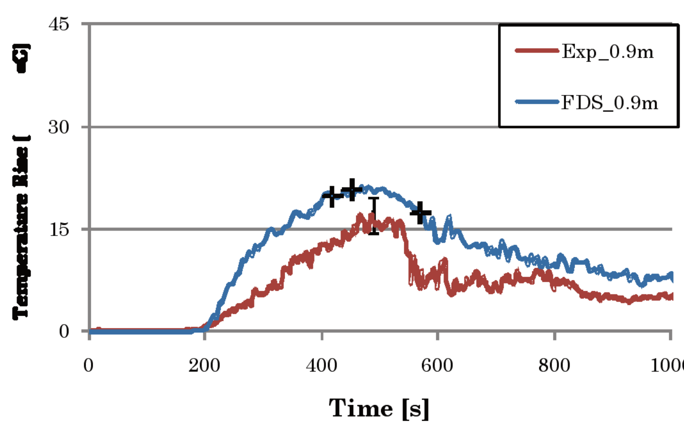


Figure 52: Measured vs. Predicted Temperature at the 0.9 m (2.9 ft) Thermocouple Location in the Bedroom

Fire Growth Rates

Three fire growth rates were used in the computer fire modeling to assess the effectiveness of different fire department deployment configurations in response to fires that were similar to, faster growing, and slower growing than the fires observed in the room-and-contents fires. The slow, medium, and fast fire growth rates are defined by the Society of Fire Protection Engineers according to the time at which they reach 1 megawatt (MW). A typical upholstered chair burning at its peak would produce a 1-MW fire, while a large sofa at its burning peak would produce roughly a 2-MW fire.

The growth rate of fires is often approximated by simple correlation of heat release rate to the square of time. If a fire is not suppressed before full-room involvement, the probability of spread beyond the room of origin increases dramatically if there is nearby fuel load to support fire spread. If a nearby fuel load is available, the 12 ft (3.7 m) by 16 ft (4.9 m) compartment used in the fire experiments would become fully involved at approximately 2 MW. Table 7 shows the time in seconds at which 1-MW and 2-MW (fully involved) fires in this compartment would be reached in the absence of suppression.

Fire Growth Rate	Time in Seconds Reach 1 MW	Time in Seconds to Reach to 2 MW
Slow	600	848
Medium	300	424
Fast	150	212

Table 7: Time to Reach 1 MW and 2 MW by Fire Growth Rate In the Absence of Suppression

A fire department rescue operation is a race between the deteriorating interior conditions inside the structure and the rescue and suppression activities of the fire department. Each fire growth rate was used as a baseline heat release rate for the simulation. Intervention times (window and door opening times and suppression time) from the time-to-task tests were systematically input into the model to evaluate the effects on interior tenability conditions. The interior tenability conditions were calculated in a remote upstairs bedroom (above the room of fire origin on the first floor) in order to maximize the opportunity for differentiation among different crew configurations.

Fractional Effective Dose (FED)

In order to convert instantaneous measurements of local gas conditions, the fractional effective dose (FED) formulation published by the International Standards Organization (ISO) in document 13571 *Life-threatening Components of Fire – Guidelines for the Estimation of Time Available for Escape Using Fire Data* (ISO 2007) were used. FED is a probabilistic estimate of the effects of toxic gases on humans exposed to fire effluent. The formulation used in the simulations accounts for carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) depletion. Other gases, including hydrogen cyanide (HCN) and hydrogen chloride (HCl), were not accounted for in this analysis and may alter FED for an actual occupant.

$$FED = \sum_{i=1}^{n} \frac{C_i}{(C_t)_i} \Delta t \qquad \text{Eq.1}$$

Where C_i is the concentration of the ith gas and $(C_t)_i$ is the toxic concentration of ith gas and Δt is the time increment.

There are three FED thresholds generally representative of different exposure sensitivities of the general population. An FED value of 0.3 indicates the potential for certain sensitive populations to become incapacitated as a result of exposure to toxic combustion products. Sensitive populations may include elderly, young, or individuals with compromised immune systems. Incapacitation is the point at which occupants can no longer effect their own escape. An FED value of 1.0 represents the median incapacitating exposure. In other words, 50 % of the general population will be incapacitated at that exposure level. Finally, an FED value of 3.0 represents the value where occupants who are particularly tolerant of combustion gas exposure (extremely fit persons, for example) are likely to become incapacitated.

These thresholds are statistical probabilities, not exact measurements. There is variability in the way individuals respond to toxic atmospheric conditions. FED values above 2.0 are often fatal doses for so-called typical occupants. There is no threshold so low that it can be said to be safe for every exposed occupant.[17]

Deployment Configuration (All times with close stagger adjusted for early and late arrival of first due engine)	Rescue Time for Deployment Configuration (Min : Sec)
2-Person Early	12:47
3-Person Early	9:03
4-Person Early	9:10
5-Person Early	8:57
2-Person Late	14:47
3-Person Late	11:03
4-Person Late	11:10

Table 6: Rescue Time for Different Deployment Configurations

17 See the following sections of ISO Document 13571:
5.2 Given the scope of this Technical Specification, FED and/or FEC values of 1,0 are associated, by definition, with sublethal effects that would render occupants of average susceptibility incapable of effecting their own escape. The variability of human responses to toxicological insults is best represented by a distribution that takes into account varying susceptibility to the insult. Some people are more sensitive than the average, while others may be more resistant (see Annex A.1.5). The traditional approach in toxicology is to employ a safety factor to take into consideration the variability among humans, serving to protect the more susceptible subpopulations.
5.2.1 As an example, within the context of reasonable fire scenarios FED and/or FEC threshold criteria of 0,3 could be used for most general occupancies in order to provide for escape by the more sensitive subpopulations. However, the user of this Technical Specification has the flexibility to choose other FED and/or FEC threshold criteria as may be appropriate for chosen fire safety objectives. More conservative FED and/or FEC threshold criteria may be employed for those occupancies that are intended for use by especially susceptible subpopulations. By whatever rationale FED and FEC threshold criteria are chosen, a single value for both FED and FEC must be used in a given calculation of the time available for escape.

Results from Modeling Methods

Table 8 shows the FED for slow-, medium-, and fast-growth rate fires correlated to rescue times based on crew size and arrival time in the study. As with the room-and-contents fire in part 3, results in Table 8 included only the close-stagger rescue time data. The effect of far-stagger rescue times on occupant tenability should be investigated in future studies. Values above 0.3 are shown in yellow, and those above the median incapacitating exposure of 1.0 are shown in red.

Figure 54 shows that with slow-growth fires in the experimental residential structure, all crew configurations could achieve rescue time before FED reached incapacitating levels. Figure 55 illustrates the greater danger of medium-growth fires, where the FED at rescue time for two-person crews is well above the 0.3 level, and almost to that level for the other crews.

Figure 56 (page 49) vividly illustrates the extreme danger of fast-growth fires. By the time a two-person crew is able to facilitate a rescue, the FED has far exceeded the median 1.0 level. For other crew sizes, the FED has exceeded 0.3, which is a threshold level for vulnerable populations.

Crew Configuration	Rescue Time	Fire Growth Rates		
		Slow	Medium	Fast
2 Early	12:47	.12	.72	1.49
2 Late	14:47	.35	1.37	2.56
3 Early	9:03	.01	.11	.40
3 Late	11:03	.04	.36	.84
4 Early	9:10	.01	.11	.42
4 Late	11:10	.05	.38	.91
5 Early	8:57	.01	.10	.38

KEY	
White	89% or more of population may be capable of effecting their own escape if they are able.
Yellow	Potential for certain sensitive populations (such as children and the elderly) to become incapacitated.
Red	More than 50% of the population would be incapable of effecting their own escape.

Table 8: FED as a Function of Deployment Configuration and Fire Growth Rate

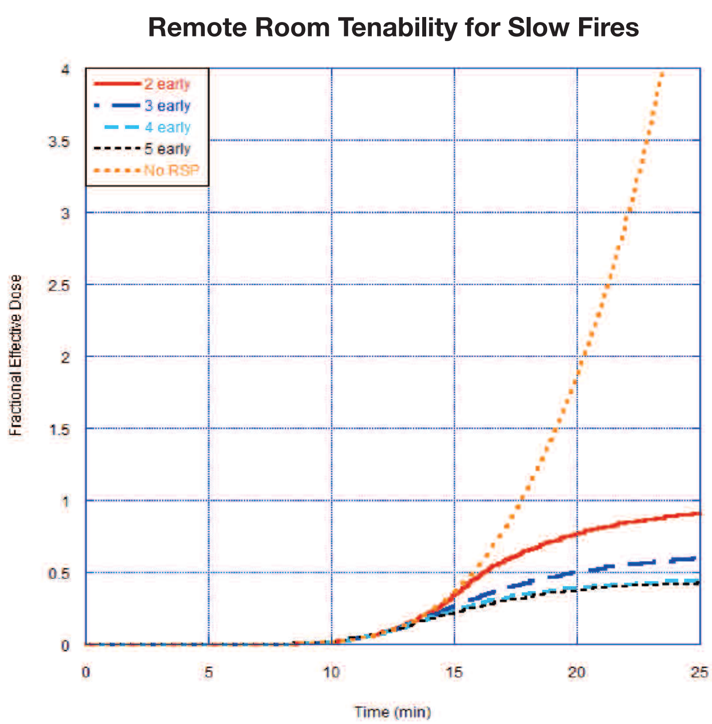


Figure 54: FED Curves for Early Arrival for All Crew Sizes at Slow-Growth Fires

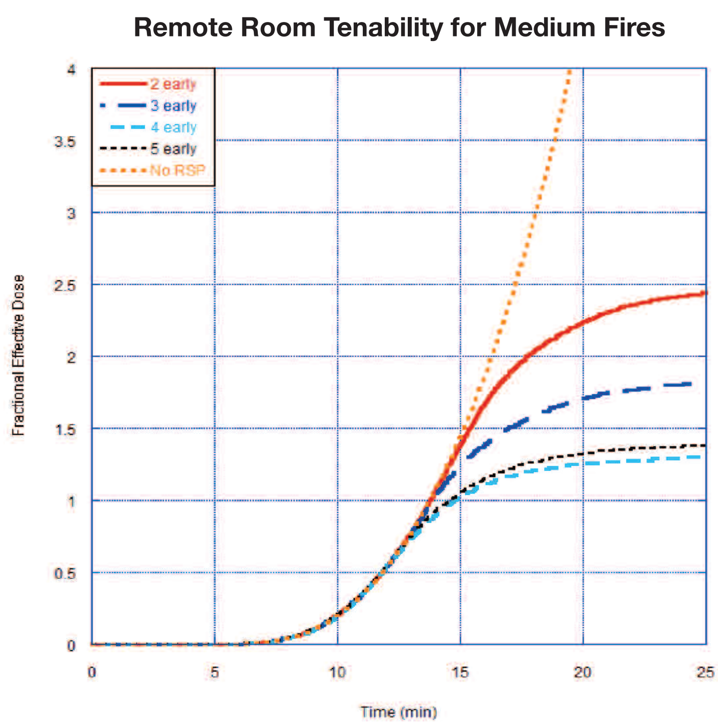


Figure 55: Average FED Curves for Early Arrival for All Crew Sizes at Medium-Growth Fires

Remote Room Tenability for Fast Fires

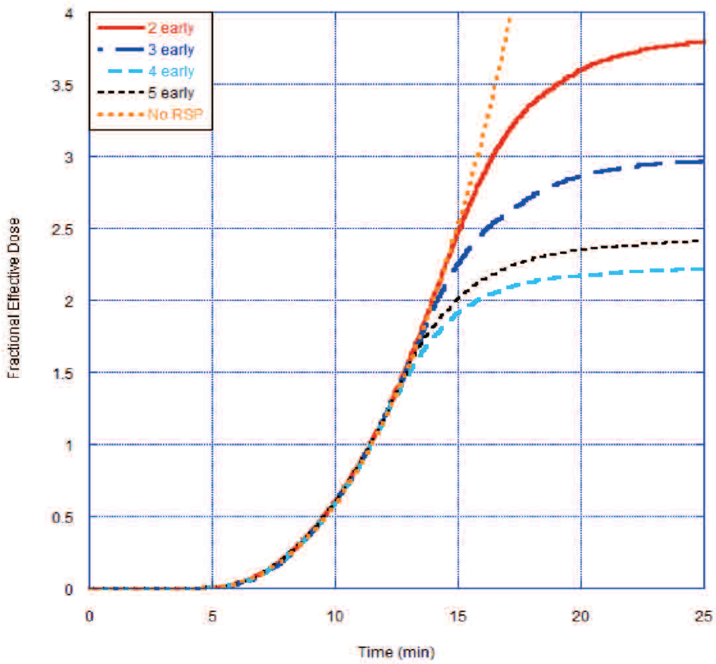


Figure 56: Average FED Curves for Early Arrival for All Crew Sizes at Fast-Growth Fires

Interior Firefighting Conditions and Deployment Configuration

The available time to control a fire can be quite small. Risks to firefighters are lower for smaller fires than larger fires because smaller fires are easier to suppress and produce less heat and fewer toxic gases. Therefore, firefighter deployment configurations that can attack fires earlier in the fire development process present lower risk to firefighters. The longer the duration of the fire development process without intervention, the greater the increase in risk for occupants and responding firefighters. Therefore, time is critical.

Stopping the escalation of the event involves firefighter intervention via critical tasks performed on the fireground. Critical tasks, as described previously, include those tasks that directly affect the spread of fire as well as the associated structural tenability.

There are windows of opportunity to complete critical tasks. A fire in a structure with a typical residential fuel load at six minutes post-ignition is very different from the same fire at eight minutes or at ten minutes post-ignition. Some tasks that are deemed "important" (e.g., scene size-up) for a fire in early stages of growth become critical if intervention tasks are delayed. Time can take away opportunities. If too much time passes, then the window of opportunity to affect successful outcomes (e.g., rescue victim or stop fire spread) closes.

For a typical structure fire event involving a fire department response, there is an incident commander on the scene who determines both the strategy and tactics that will be employed to stop the spread of the fire, rescue occupants, ventilate the structure, and ultimately extinguish the fire. Incident commanders must deal with the fire in the present and make intelligent command decisions based on the circumstances at hand upon arrival. Additionally, arrival time and crew size are factors that contribute to the incident commander's decisions and affect the capability of the firefighters to accomplish necessary tasks on scene in a safe, efficient, and effective manner.

Table 9 illustrates vividly the more dangerous conditions small crews face because of the extra time it takes to begin and complete critical tasks (particularly fire suppression). In the two minutes more it took for the two-person crew (early arrival) than the five-person crew (early arrival) to get water on the fire, a slow growth rate fire would have increased from 1.1 MW to 1.5 MW. This growth would have been even more extreme for a medium-or fast-growth rate fire. The difference is even more substantial for the two-person crew with late arrival as the fire almost doubled in size in the time difference between this crew and the five-person crew.

Based on fire modeling for the low hazard structure studied with a typical residential fuel load, it is likely that medium- and fast-growth rate fires will move beyond the room of origin prior to the arrival of firefighters for all crew sizes. Note that results in Table 8 included only the close-stagger rescue time data. The effect of far-stagger rescue times on occupant tenability should be investigated in future studies. Therefore, the risk level of the event upon arrival will be higher for all crews which must be considered by the incident commander when assigning firefighters to on-scene tasks.

Deployment Configuration	Time to Water on Fire (Min : Sec)	Fire Size at Time of Suppression for Slow-Growth Fires
2-Person, Late Arrival	14:26	2.1 MW
2-Person, Early Arrival	12:26	1.5 MW
3-Person, Late Arrival	13:24	1.8 MW
3-Person, Early Arrival	11:24	1.3 MW
4-Person, Late Arrival	13:11	1.7 MW
4-Person, Early Arrival	11:11	1.3 MW
5-Person, Late Arrival	12:33	1.6 MW
5-Person, Early Arrival	10:33	1.1 MW

Table 9: Fire Size at Time of Fire Suppression

Physiological Effects of Crew Size on Firefighters

Reports on firefighter fatalities consistently document overexertion/overstrain as the leading cause of line-of-duty fatalities. There is strong epidemiological evidence that heavy physical exertion can trigger sudden cardiac events (Mittleman et al. 1993; Albert et al. 2000). Therefore, information about the effect of crew size on physiological strain is very valuable.

During the planning of the fireground experiments, investigators at Skidmore College recognized the opportunity to conduct an independent study on the relationship between firefighter deployment configurations and firefighter heart rates. With the approval of the Institutional Review Board of Skidmore College, they were able to leverage the resources of the field experiments to conduct a separate analysis of the cardiac strain on fire fighters on the fireground.

For details, consult the complete report (Smith 2009). Two important conclusions from the report reinforce the importance of crew size:

- Average heart rates were higher for members of small crews, particularly two-person crews.
- Danger is increased for small crews because the stress of fire fighting keeps heart rates elevated beyond the maximum heart rate for the duration of a fire response, and so the higher heart rates were maintained for sustained time intervals.

Study Limitations

The scope of this study is limited to understanding the relative influence of deployment variables to low-hazard, residential structure fires, similar in magnitude to the hazards described in *NFPA 1710*. The applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

Every attempt was made to ensure the highest possible degree of realism in the experiments while complying with the requirements of *NFPA 1403*, but the dynamic environment on the fireground cannot be fully reproduced in a controlled experiment. For example, *NFPA 1403* required a daily walkthrough of the burn prop (including identifying the location of the fire) before ignition of a fire that would produce an Immediately Dangerous to Life and Health (IDLH) atmosphere, a precaution not available to responders dispatched to a live fire.

The number of responding apparatus for each fireground response was held constant (three engines and one truck, plus the battalion chief and aide) for all crew size configurations. The effect of deploying either more or fewer apparatus to the scene was not evaluated.

The fire crews who participated in the experiments typically operate using three-person and four-person staffing. Therefore, the effectiveness of the two-person and five-person operations may have been influenced by a lack of experience in operating at those staffing levels. Standardizing assigned tasks on the fireground was intended to minimize the impact of this factor, which has an unknown influence on the results.

The design of the experiments controlled for variance in performance of the incident commander. In other words, a more-or less-effective incident commander may have a significant influence on the outcome of a residential structure fire.

Although efforts were made to minimize the effect of learning across experiments, some participants took part in more than one experiment, and others did not.

The weather conditions for the experiments were moderate to cold. Frozen equipment such as hydrants and pumps was not a factor. However, the effect of very hot weather conditions on firefighter performance was not measured.

All experiments were conducted during the daylight hours. Nighttime operations could pose additional challenges.

Fire spread beyond the room of origin was not considered in the room and contents tests or in the fire modeling. Therefore, the size of the fire and the risk to the firefighter may be somewhat underestimated for fast-growing fires or slower-response configurations.

There is more than one effective way to perform many of the required tasks on the fireground. Attempts to generalize the results from these experiments to individual departments must take into account tactics and equipment that vary from those used in the experiments.

Conclusions

More than 60 laboratory and full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for low-hazard residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many factors including geography, available resources, community expectations, as well as all local hazards and risks. Though this report contributes significant knowledge to community and fire service leaders in regard to effective resource deployment for fire suppression, other factors contributing to policy decisions are not addressed.

The objective of the experiments was to determine the relative effects of crew size, first-due engine arrival time, and stagger time for subsequent apparatus on the effectiveness of the firefighting crews relative to intervention times and the likelihood of occupant rescue using a parametric design. Therefore, the experimental results for each of these factors are discussed below.

Of the 22 fireground tasks measured during the experiments, the following were determined to have especially significant impact on the success of fire fighting operations. Their differential outcomes based on variation of crew size and/or apparatus arrival times are statistically significant at the 95 % confidence level or better.

Overall Scene Time:

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crew. For the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and should be addressed according to industry standards.[18]

Time to Water on Fire:

There was a nearly 10 % difference in the "water on fire time" between the two and three-person crews and an additional 6 % difference in the "water on fire time" between the three- and four-person crews (i.e., 16 % difference between the four and two-person crews). There was an additional 6 % difference in the "water on fire'" time between the four- and five-person crews (i.e., 22 % difference between the five and two-person crews).

Ground Ladders and Ventilation:

The four-person crew operating on a low-hazard structure fire can complete laddering and ventilation (for life safety and rescue) 30 % faster than the two-person crew and 25 % faster than the three-person crew.

Primary Search:

The three-person crew started and completed a primary search and rescue 25 % faster than the two-person crew. In the same structure, the four- and five-person crews started and completed a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. A 10 % difference was equivalent to just over one minute.

Hose Stretch Time:

In comparing four-and five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to a two-person crew the differences are more distinct. A two-person crew took 57 seconds longer than a three-person crew to stretch a line. A two-person crew took 87 seconds longer than a four-person crew to complete the same tasks. Finally, the most notable comparison was between a two-person crew and a five-person crew — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:

The "industry standard achieved" time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.[19] An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. According to study deployment protocal, the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:

Three different "standard" fires (slow-, medium-, and fast-growth rate) were simulated using the Fire Dynamics Simulator (FDS) model. The fires grew exponentially with time. The fire modeling simulations demonstrated that two-person, late arriving crews can face a fire that is twice the intensity of the fire faced by five-person, early arriving crews. The rescue scenario was based on a nonambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by crews starting tasks two minutes earlier had lesser exposure to combustion products.

The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting either firefighters or occupants to an increasingly hazardous atmosphere. Even for a slow-growth rate fire, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the median sensitivity in general population. For a fast-growth rate fire, the FED was well above the median level at which 50 % of the general population would be incapacitated. Larger crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires." The new sentence is consistent with our previous description for two-person crews where we identify a threat to sensitive populations.. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

18 NFPA Standard 1710 - A.5.2.4.2.1 …Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.

19 NFPA 1710 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. Section 5.2.1 – Fire Suppression Capability and Section 5.2.2 Staffing.

Summary:

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results establish a technical basis for the effectiveness of company crew size and arrival time in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance of time-to-critical-task measures for a low-hazard structure fires. Additionally, the results provide tenability measures associated with the occupant exposure rates to the range of fires considered by the fire model.

Future Research

In order to realize a significant reduction in firefighter line-of-duty death (LODD) and injury, fire service leaders must focus directly on resource allocation and the deployment of resources, both contributing factors to LODD and injury. Future research should use similar methods to evaluate firefighter resource deployment to fires in medium- and high-hazard structures, including multiple-family residences and commercial properties. Additionally, resource deployment to multiple-casualty disasters or terrorism events should be studied to provide insight into levels of risks specific to individual communities and to recommend resource deployment proportionate to such risk. Future studies should continue to investigate the effects of resource deployment on the safety of both firefighters and the civilian population to better inform public policy.

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APPENDIX A: Laboratory Experiments

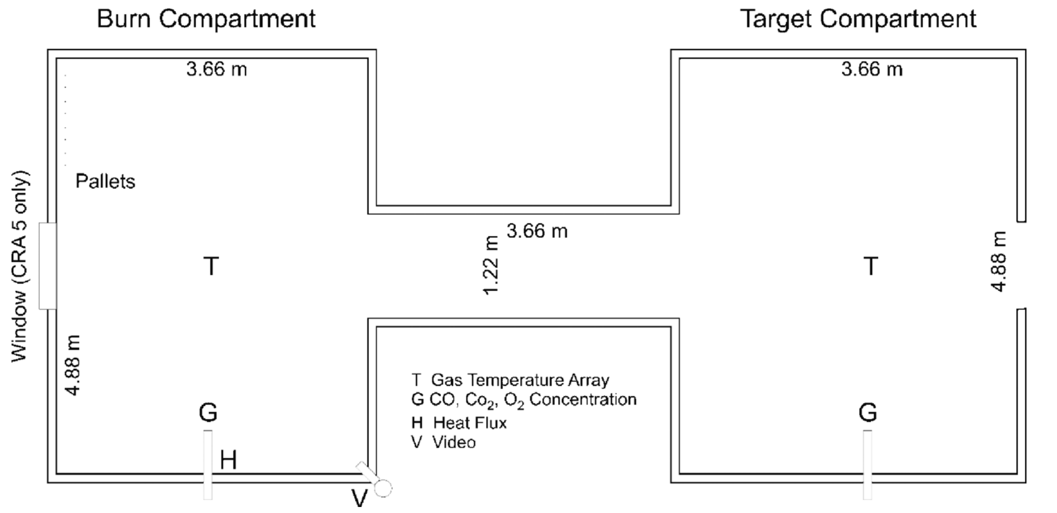


Figure A-1. Compartment Configuration and Instrumentation for Pallet Tests

The fire suppression and resource deployment experiments consisted of four distinct parts: laboratory experiments, time-to-task experiments, room and contents experiments and fire modeling. The purpose of the laboratory experiments was to assure a fire in the field experiments that would consistently meet *NFPA 1403* requirements for live fire training exercises. The laboratory experiments enabled investigators to characterize the burning behavior of the wood pallets as a function of:

- number of pallets and the subsequent peak heat release rate
- compartment effects on burning of wood pallets
- effect of window ventilation on the fire
- effect on fire growth rate of the loading configuration of excelsior (slender wood shavings typically used as packing material)

Design and Construction

Figure A-1 shows the experimental configuration for the compartment pallet burns. Two identically sized compartments (3.66 m x 4.88 m x 2.44 m) were connected by a hallway (4 m x 1 m x 2.4 m). At each end of the hallway, a single door connected the hallway to each of the compartments. In the burn compartment, a single window (3 m x 2 m) was covered with noncombustible board that was opened for some experiments and closed for others. At the end of test, it was opened to extinguish the remaining burning material and to remove any debris prior to the next test. In the second compartment, a single doorway connected the compartment to the rest of the test laboratory. It was kept open throughout the tests allowing the exhaust to flow into the main collection hood for measurement of heat release rate.

The structure was constructed of two layer of gypsum wallboard over steel studs. The floor of the structure was lined with two layers of gypsum wallboard directly over the concrete floor of the test facility. In the burn compartment, an additional lining of cement board was placed over the gypsum walls and ceiling surfaces near the fire source to minimize fire damage to the structure after multiple fire experiments. A doorway 0.91 m wide by 1.92 m tall connected the burn compartment to the hallway and an opening 1 m by 2 m connected the hallway to the target compartment. Ceiling height was 2.41 m throughout the structure, except for the slight variation in the burn room.

Fuel Source

The fuel source for all of the tests was recycled hardwood pallets constructed of several lengths of hardwood boards nominally 83 mm wide by 12.7 mm thick. Lengths of the individual boards ranged from nominally 1 m to 1.3 m. The finished size of a single pallet was approximately 1 m by 1.3 m by 0.11 m. **Figure A-2** shows the fuel source for one of the tests including six stacked pallets and excelsior ignition source. For an ignition source, excelsior was placed within the pallets, with the amount and location depending on the ignition scenario. Figure A-3 shows the pallets prior to a slow and a fast ignition scenario fire. Table A-1 details the total mass of pallets and excelsior for each of the free burn and compartment tests.

Experimental Conditions

The experiments were conducted in two series. In the first series, heat release measurements were made under free burn conditions beneath a 6 m by 6 m hood used to collect combustion gases and provide the heat release rate (HRR) measurement. A second series of tests was conducted with the fire in a compartmented structure to assess environmental conditions within the structure during the fires and determine the effect of the compartment enclosure on the fire growth. Table A-1 presents a summary of the tests conducted.

Figure A-2. Pallets and Excelsior Ignition Source Used as a Fuel Source

Table A-1. Tests Conducted and Ambient Conditions at Beginning of Each Test

Test	Test Type	Number of Pallets	Ignition Scenario	Total Pallet Mass (kg)	Excelsior Mass (kg)
PAL 1	Free burn	4	Fast	79.3	8.1
PAL 2	Free burn	6	Fast	118.8	15.1
PAL 3	Free burn	8	Fast	146.7	16.2
PAL 4	Free burn	4	Slow	51.0	1.65
PAL 5	Free burn	6	Slow	160.3	0.85
CRA 1	Compartment	6	Slow	114.0	0.83
CRA 2	Compartment	4	Slow	69.7	
CRA 3	Compartment	4	Fast	71.1	0.8
CRA 4	Compartment	4	Slow	73.9	0.83
CRA 5	Compartment	4	Slow	73.8	0.85

Notes: PAL stands for "pallet" and CRA ("Community Risk Assessment") is the designator for the configuration of pallets burned in the compartment. Efforts were made to use the same amount of excelsior mass for CRA 2 (~0.8 kg), but the value was not measured.

Figure A-3. Fuel and Excelsior Source for Slow (top) and Fast (bottom) Ignition Scenarios

Measurements Conducted

Heat release rate (HRR) was measured in all tests. HRR measurements were conducted under the 3 m by 3 m calorimeter at the NIST Large Fire Research Laboratory. The HRR measurement was based on the oxygen consumption calorimetry principle first proposed by Thornton (Thornton 1917) and developed further by Huggett (Huggett 1980) and Parker (Parker 1984). This method assumes that a known amount of heat is released for each gram of oxygen consumed by a fire. The measurement of exhaust flow velocity and gas volume fractions (O_2, CO_2 and CO) were used to determine the HRR based on the formulation derived by Parker (Parker 1984) and Janssens (Janssens 1981). The combined expanded relative uncertainty of the HRR measurements was estimated at ± 14 %, based on a propagation of uncertainty analysis (Bryant 2004).

For the compartment fire tests, gas temperature measurements were made in the burn compartment and in the target compartment connected by a hallway to the burn compartment using 24 gauge bare-bead chromel-alumel (type K) thermocouples positioned in vertical array. Thermocouples were located at the center of each compartment at locations 0.03 m, 0.30 m, 0.61 m, 0.91 m, 1.22 m, 1.52 m, 1.83 m, and 2.13 m from the ceiling. The expanded uncertainty associated with a type K thermocouple is approximately ± 4.4° C. (Omega 2004)

Gas species were continuously monitored in the burn compartment at a level 0.91 m from the ceiling at a location centered on the side wall of the compartment, 0.91 m from the wall. Oxygen was measured using paramagnetic analyzers. Carbon monoxide and carbon dioxide were measured using non-dispersive infrared (NDIR) analyzers. All analyzers were calibrated with nitrogen and a known concentration of gas prior to each test for a zero and span concentration calibration. The expanded relative uncertainty of each of the span gas molar fractions is estimated to be ± 1 %.

Total heat flux was measured on the side wall of the enclosure at a location centered on the side wall, 0.61 m from the ceiling level. The heat flux gauges were 6.4 mm diameter Schmidt-Boelter type, water cooled gauges with embedded type-K thermocouples (see Figure A-4). The manufacturer reports a ± 3 % expanded uncertainty in the response calibration (the slope in $kW/m^2/mV$). Calibrations at the NIST facility have varied within an additional ± 3 % of manufacturer's calibration. For this study, an uncertainty of ± 6 % is estimated.

Figure A-4: Heat Flux Gauge with Radiation Shielding

Test	Test Type	Number of Pallets	Ignition Scenario	Peak HRR (kW)	Time to Peak HRR (s)
PAL 1	Free burn	4	Fast	2144	205
PAL 2	Free burn	6	Fast	2961	320
PAL 3	Free burn	8	Fast	3551	301
PAL 4	Free burn	4	Slow	1889	385
PAL 5	Free burn	6	Slow	2410	986
CRA 1	Compartment	6	Slow	1705	1102
CRA 2	Compartment	4	Slow	1583	649
CRA 3	Compartment	4	Fast	1959	159
CRA 4	Compartment	4	Slow	1620	775
CRA 5	Compartment	4	Slow	1390	927

Table A-2. Peak Heat Release Rate During Several Pallet Tests in Free-burn and in a Compartment

Results

Table A-2 shows the peak HRR and time to peak HRR for the free burn tests and for the compartment tests. Figure A-5 includes images from the free burn experiments near the time of peak HRR for each of the experiments. Figure A-6 illustrates the progression of the fire from the exit doorway looking down the hallway to the burn compartment for one of the tests. Figure A-7 to Figure A-10 present graphs of the heat release rate for all of the tests. Figure A-11 through Figure A-15 shows the gas temperature, major gas species concentrations, and heat flux in the burn compartment and target compartment in the five compartment tests.

PAL 1

PAL 2

PAL 3

PAL 4

Figure A-5. Free-Burn Experiments Near Time of Peak Burning

Figure A-6. Example Fire Progression from Test CRA 1

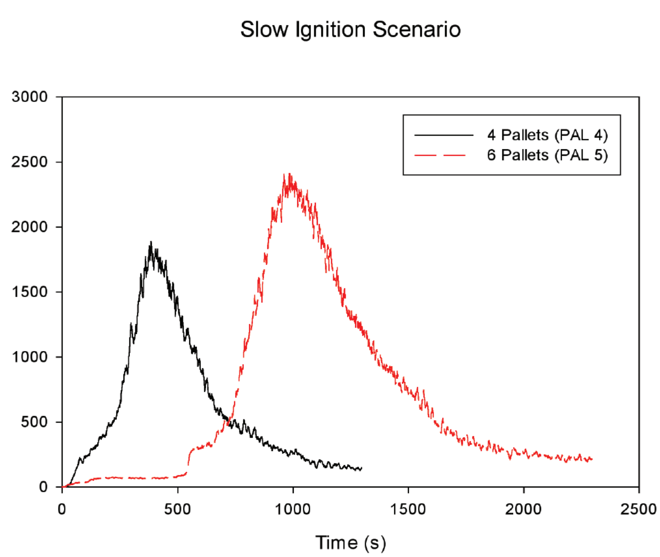


Figure A-7. HRR, Slow Ignition, Free Burn Scenario

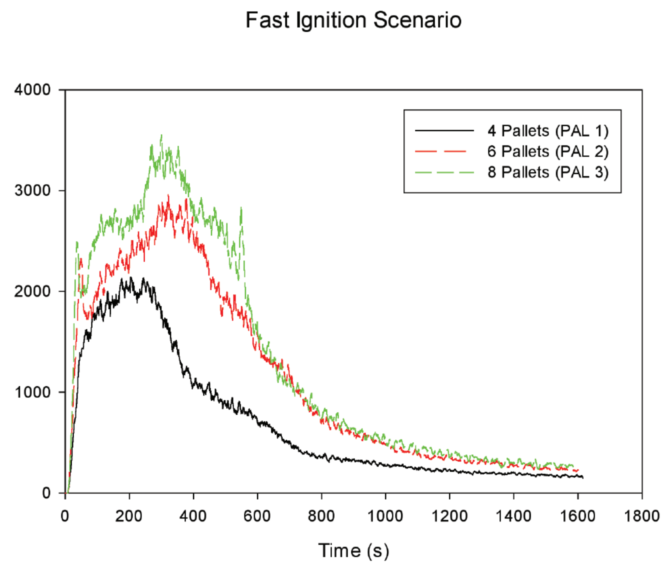


Figure A-8. HRR, Fast Igntion, Free Burn Scenario

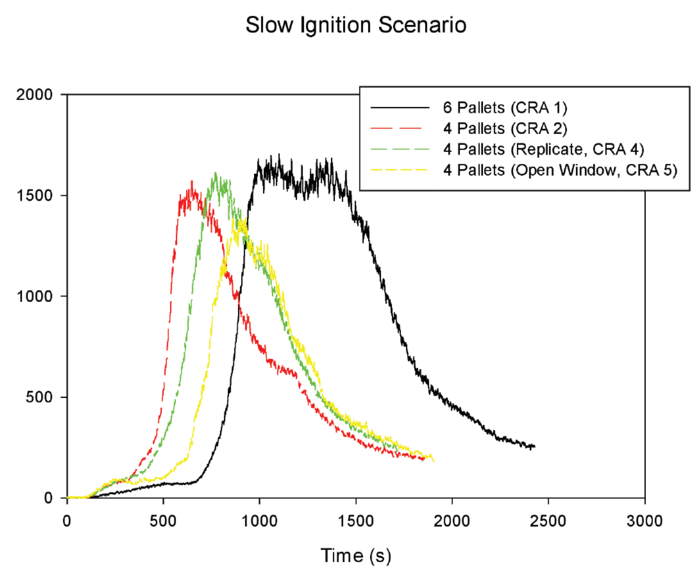


Figure A-9. HRR, Slow Ignition, Compartment Test

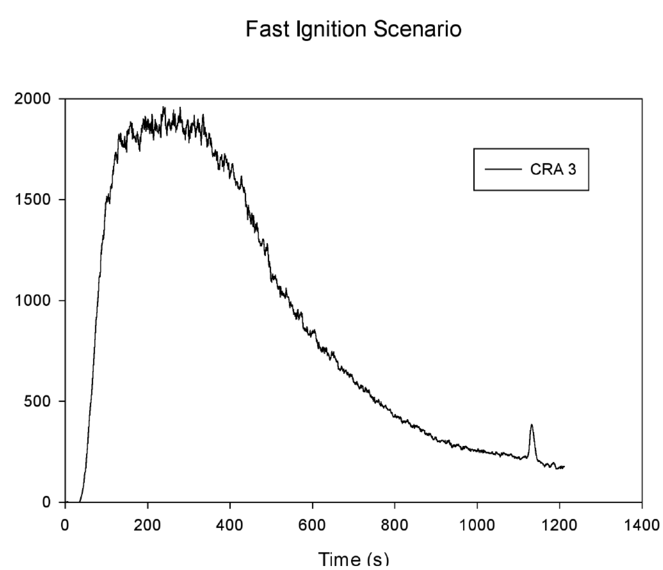
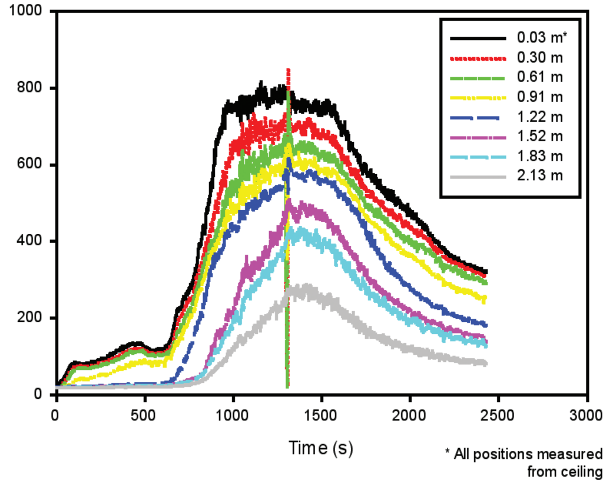
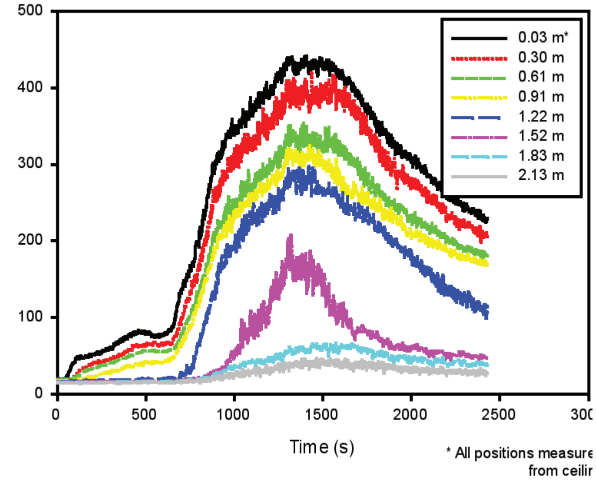


Figure A-10. HRR, Fast Ignition, Compartment Test

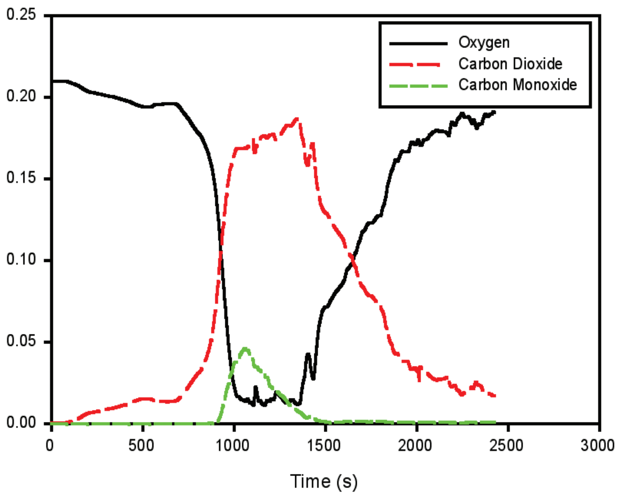
6 Pallets, Slow Ignition Scenario, Burn Room



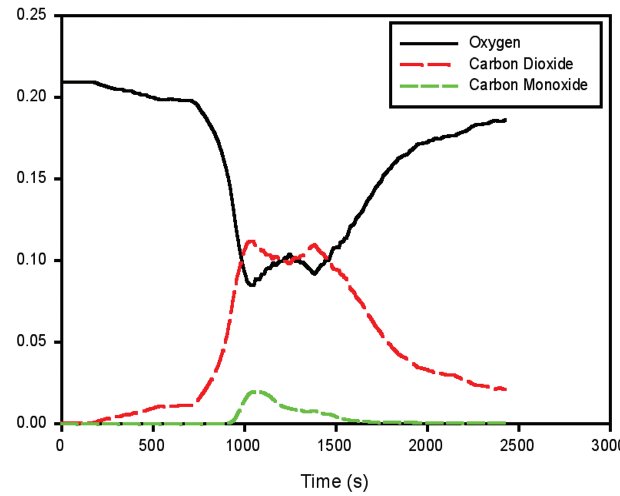
6 Pallets, Slow Ignition Scenario, Target Room



6 Pallets, Slow Ignition Scenario, Burn Room



6 Pallets, Slow Ignition Scenario, Target Room



6 Pallets, Slow Ignition Scenario, Burn Room

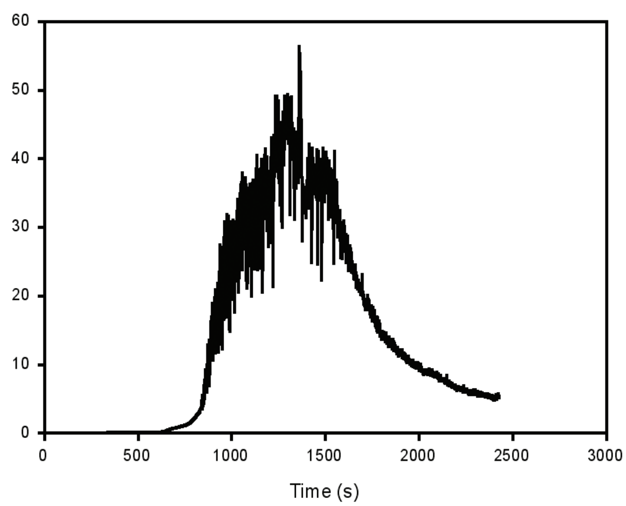


Figure A-11. Temperature, Gas Concentration, and Heat Flux During Test CRA 1, 6 Pallets, Slow Ignition Scenario

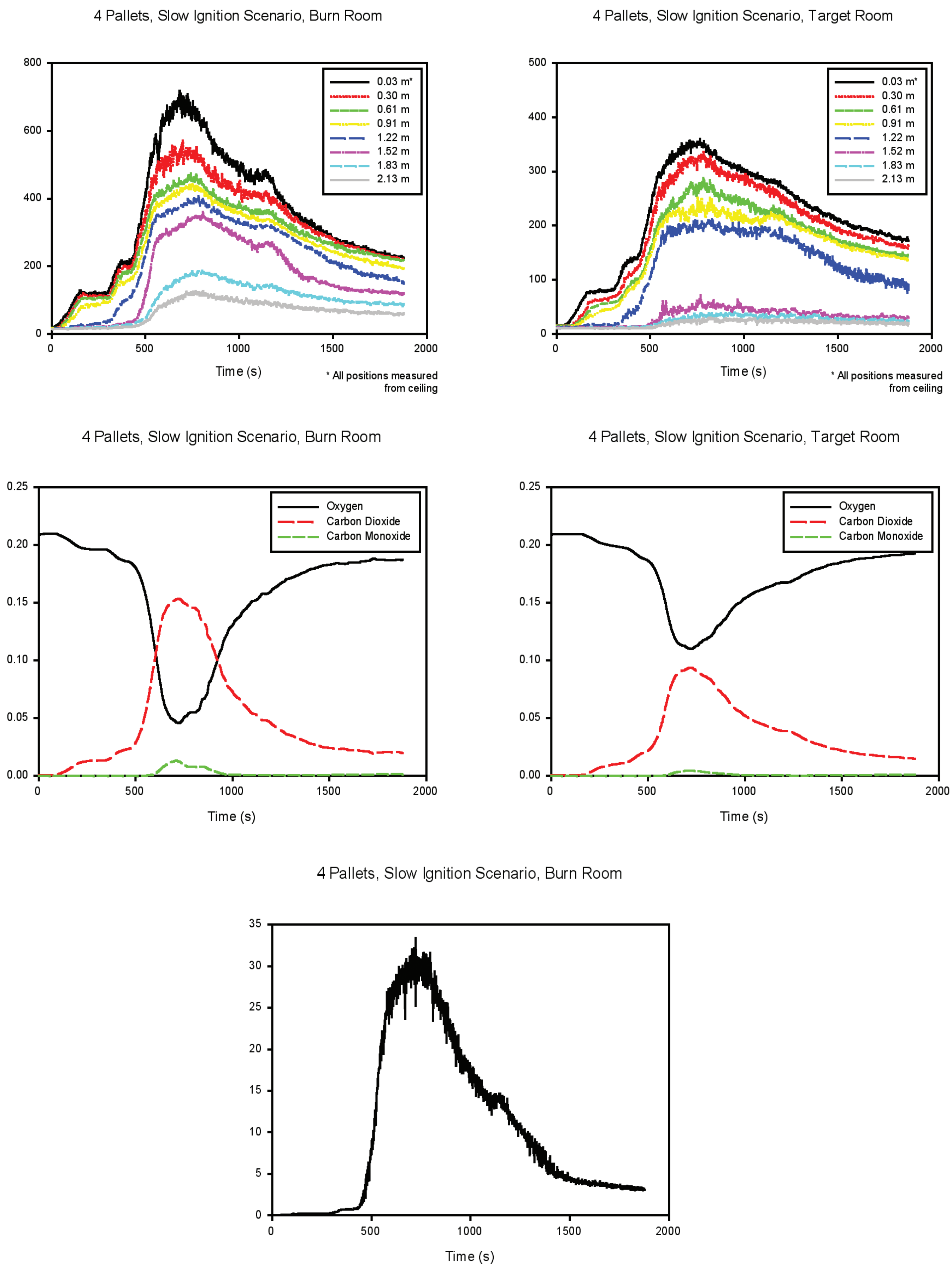
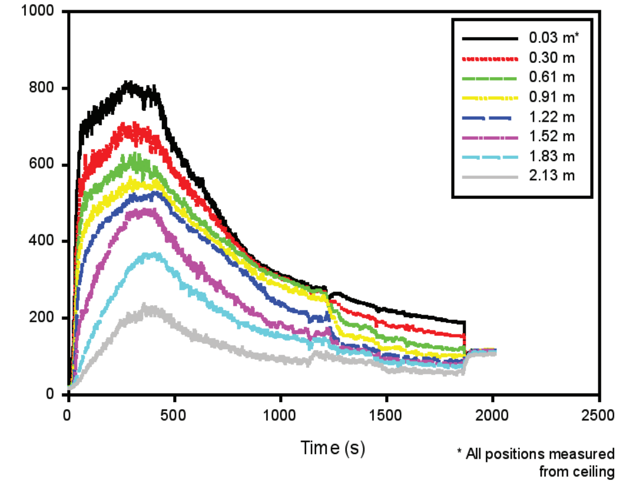
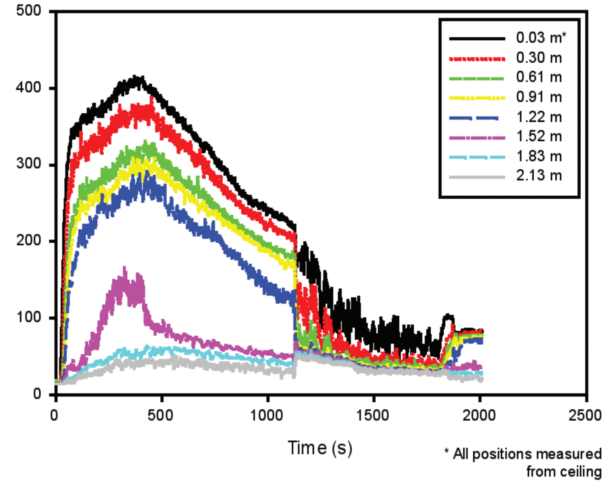


Figure A-12. Temperature, Gas Concentration, and Heat Flux During Test CRA 2, 4 Pallets, Slow Ignition Scenario

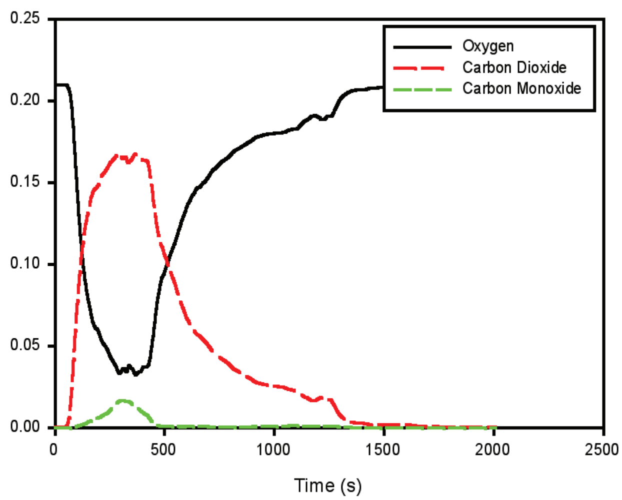
4 Pallets, Fast Ignition Scenario, Burn Room



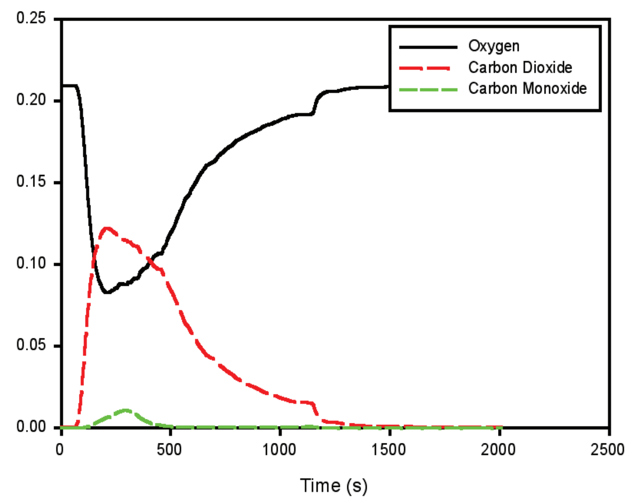
4 Pallets, Fast Ignition Scenario, Target Room



4 Pallets, Fast Ignition Scenario, Burn Room



4 Pallets, Fast Ignition Scenario, Target Room



4 Pallets, Fast Ignition Scenario, Burn Room

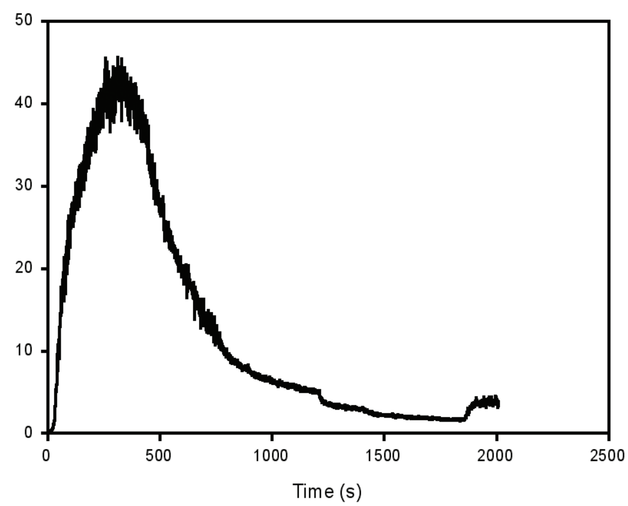


Figure A-13. Temperature, Gas Concentration, and Heat Flux During Test CRA 3, 4 Pallets, Fast Ignition Scenario

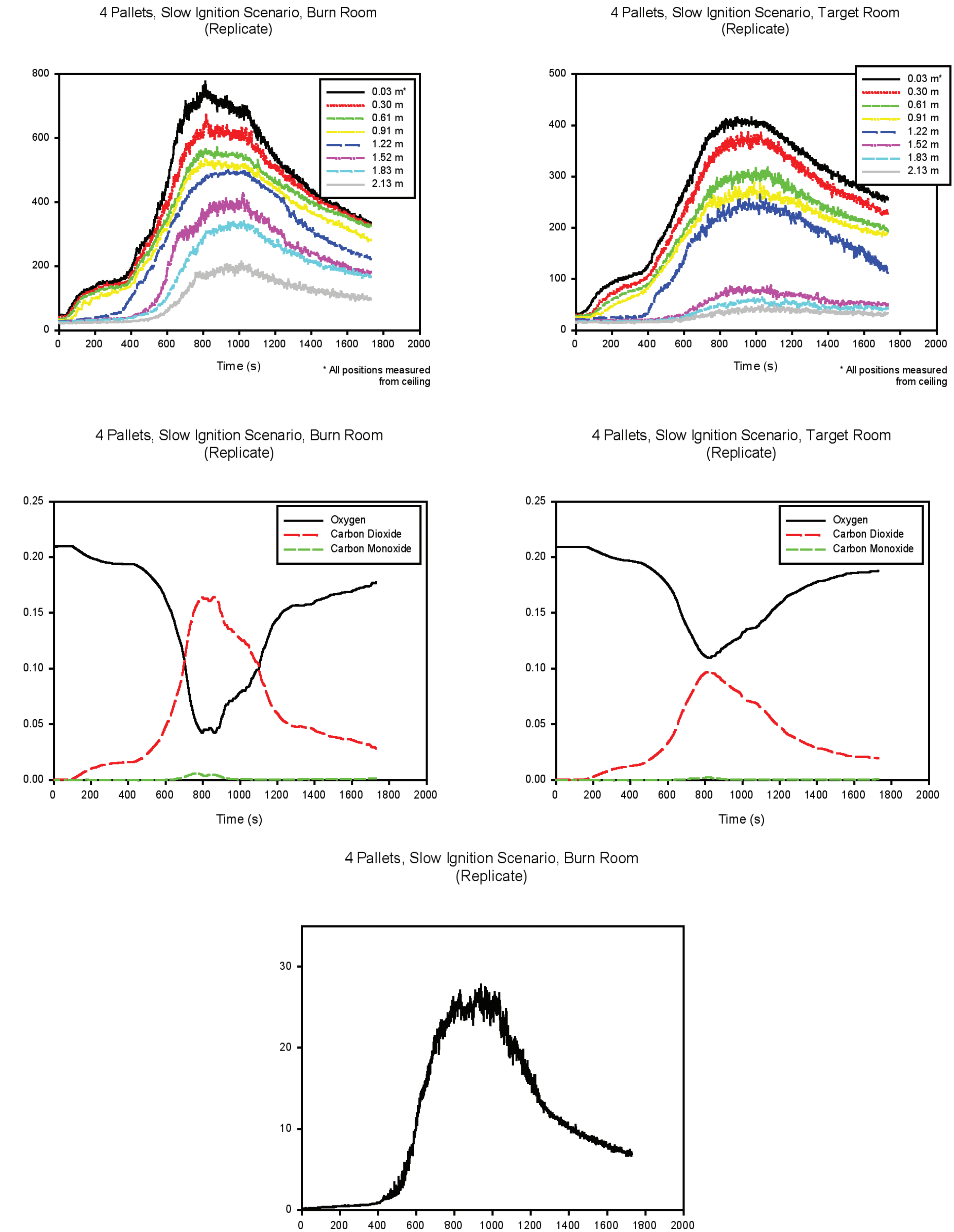
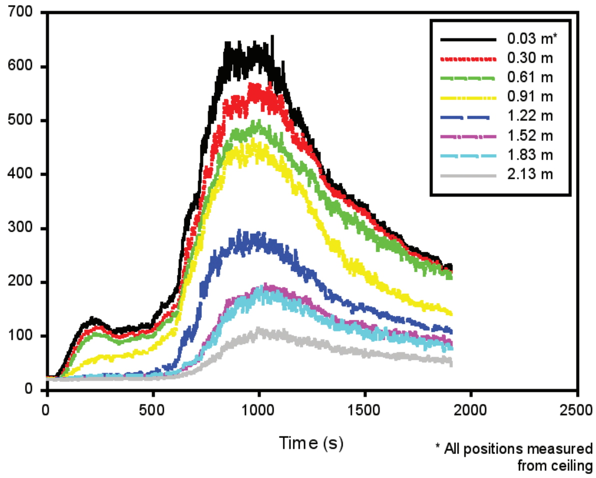
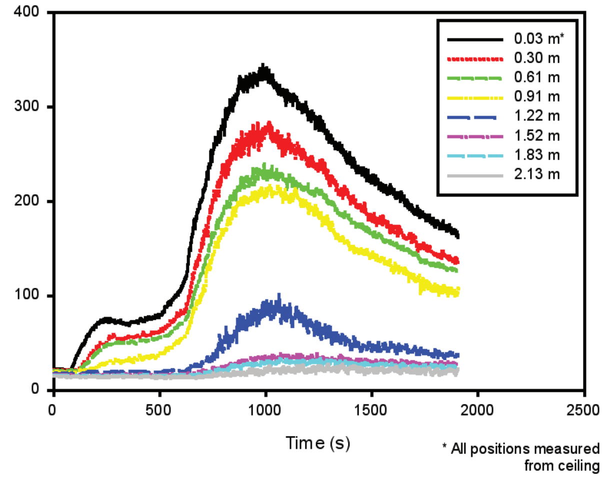


Figure A-14. Temperature, Gas Concentration, and Heat Flux During Test CRA 4, 4 Pallets, Slow Ignition Scenario (Replicate)

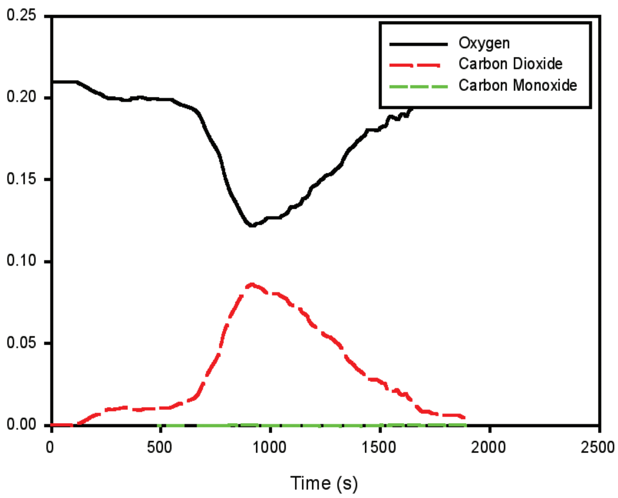
4 Pallets, Slow Ignition Scenario, Burn Room
(Open Window Venting)



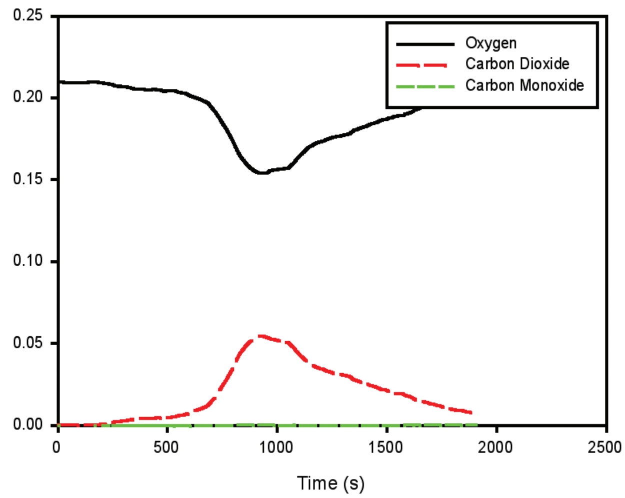
4 Pallets, Slow Ignition Scenario, Target Room
(Open Window Venting)



4 Pallets, Slow Ignition Scenario, Burn Room
(Open Window Venting)



4 Pallets, Slow Ignition Scenario, Target Room
(Open Window Venting)



4 Pallets, Slow Ignition Scenario, Burn Room
(Open Window Venting)

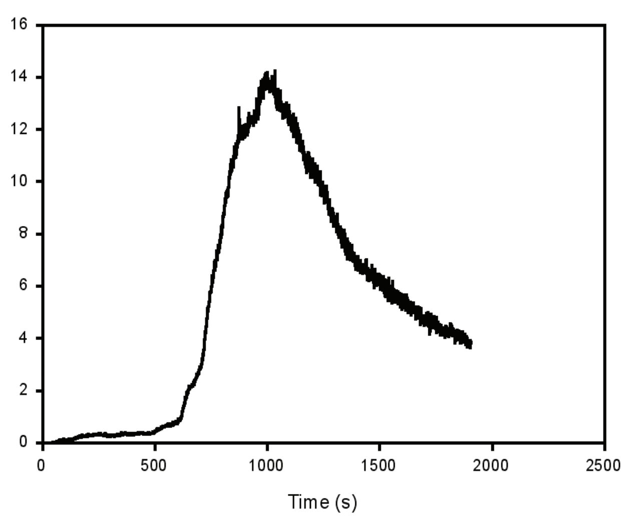
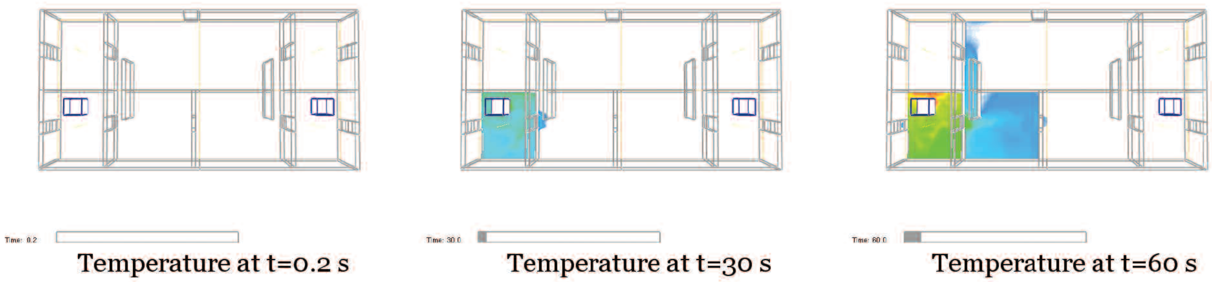


Figure A-15. Temperature, Gas Concentration, and Heat Flux During Test CRA 5, 4 Pallets, Slow Ignition Scenario (Open Window Venting)

APPENDIX B: Designing Fuel Packages for Field Experiments

Based upon the results of the laboratory experiments, the project team determined that four pallets would provide both a realistic fire scenario, as well as a repeatable and well-characterized fuel source. Varying the placement and quantity of excelsior provided significant variance in the rate of fire growth. Prior to finalization of the fuel package and construction specifications, modeling was used to ensure that the combination of fuel and residential geometry would result in untenable conditions throughout the structure without subjecting the firefighters to unsafe testing conditions. Therefore, CFAST (the consolidated fire and smoke transport model (Jones 2000)) and FDS (fire dynamics simulator model (McGrattan 2006)) were used to predict the temperatures and toxic species within the structure as a function of the experimentally determined heat release rates. The results summarized below confirmed that the building geometry and fuel package produced adequate variation in tenability conditions in the residential structure and ensured that the room of origin would not reach flashover conditions (a key provision of *NFPA 1403*). Meeting these conditions provided the foundation for experiments to meet the two primary objectives of fire department response: preservation of life and property.



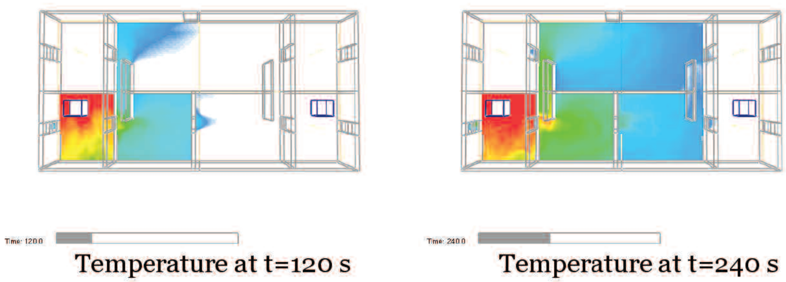


Figure B-1 and B-2 show the thermal and smoke conditions in the residential structure at different time periods using the fast growth, four pallet fuel package.

The results of the fire modeling indicated development of untenable conditions in the field experiments between 5 and 15 minutes, depending upon several factors: fire growth rate, ventilation conditions, the total leakage of heat into the building and through leakage paths, and firefighter intervention. This time frame allowed for differentiation of the effectiveness of various fire department deployment models.

Figure B-1: Time-dependent temperature contours in field structure with fast growth fire

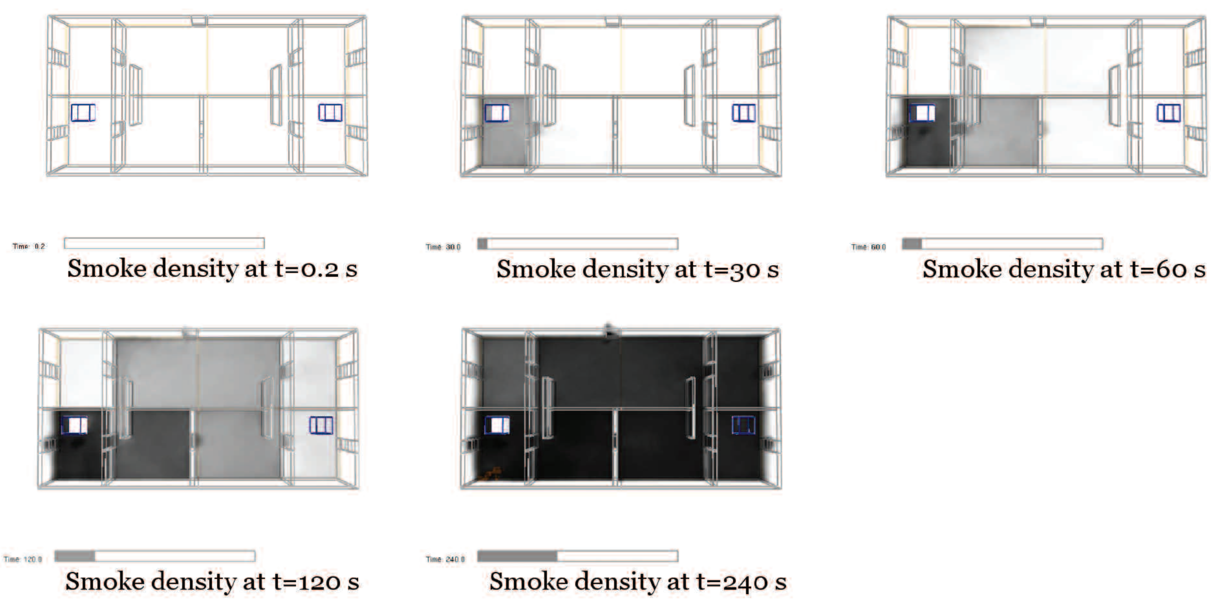


Figure B-2: Time-dependent smoke density contours in field structure with fast growth fire

APPENDIX C: Temporary Burn Prop Construction and Instrumentation

Through the generosity of the Montgomery County (MD), an open space was provided to construct a temporary burn prop at the Montgomery County Fire and Rescue Training Facility in Rockville, MD. The area had ready access to water and electrical utilities. A licensed general contractor was retained, including a structural engineer for the design of critical ceiling members, and the burn prop was constructed over a several month period in late 2008.

The burn prop consisted of two 2,000 ft.^{2} (186 m^2) floors totaling 4,000 ft.^{2} (372 m^2). An exterior view of two sides of the burn prop is shown in Figure C-1.

Additional partitions were installed by NIST staff to create a floor plan representative of a two-story, 186 m^2 (2,000 ft.^{2}) single family residence. Note that the structure does not have a basement and includes no exposures. The overall dimensions are consistent with the general specifications of a typical low hazard residential structure that many fire departments respond to on a regular basis, as described in *NFPA 1710*.

Further details about typical single family home designs are not provided in the standard. Therefore, a floor plan representative of a typical single family home was created by the project team. Details and floor plan dimensions are shown in Figure C-2.

Figure C-1: View of two sides of the burn prop

The black lines indicate load-bearing reinforced concrete walls and red lines indicate the gypsum over steel stud partition walls. The ceiling height, not shown in Figure C-2, is 94 in. (2.4 m) throughout the entire structure except in the burn compartments, where the ceiling height is 93 in. (2.4 m). The purpose of the partition walls was to symmetrically divide the structure about the short axis in order to allow one side of the test structure to cool down and dry-out after a fire test with suppression while conducting experiments on the other side.

The concrete walls original to the burn prop were 8 in. (204 mm) thick steel reinforced poured concrete and the floors on the first level and second levels were 4 in. (102 mm) thick poured concrete. The support structure for the second floor and the roof consisted of corrugated metal pan welded to open web steel joists. The dimensions of the joists are shown in Figure C-3. The ceiling was constructed from ½ in. (13 mm) thick cement board fastened to the bottom chord of the steel joists. Partition walls were constructed from 5/8 in. (17 mm) thick gypsum panels attached to 20 gauge steel studs fastened to steel track, spaced 16 in. (407 mm) on center.

Additional construction was implemented in the burn compartments to address thermal loading and hose stream impingement concerns. Spray-on fireproofing was applied to the steel joists prior to fastening the ceiling, as shown in Figure C-4. The ceilings were constructed with three layers of ½ in. (13 mm) cement board, as opposed to one layer construction in the rest of the building. Each layer was fastened in a different direction so that seams of adjacent layers ran orthogonally. The difference in ceiling heights previously

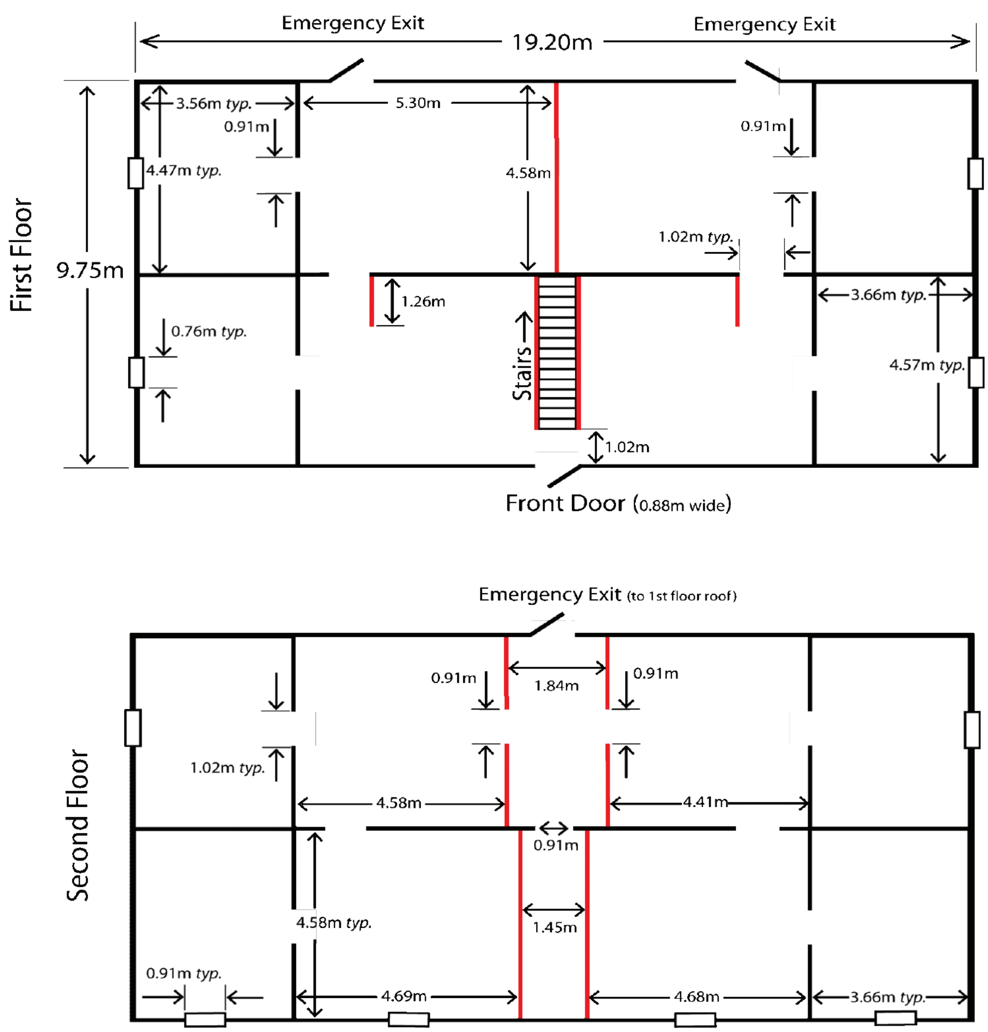


Figure C-2: Dimensions of the Burn Prop Floor Plan

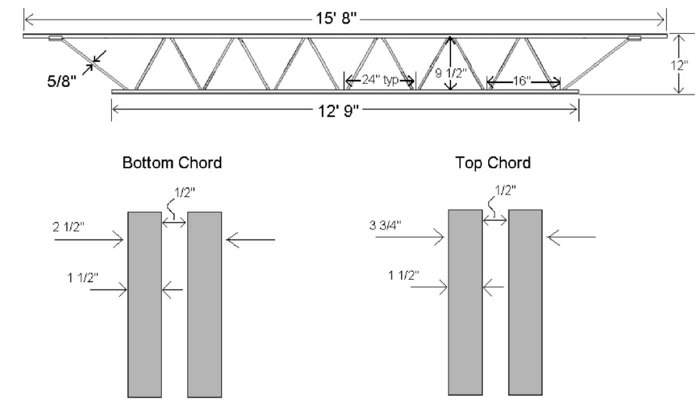


Figure C-3: Structural Steel Dimensions

mentioned is the result of the two additional sheets of cement board. The burn compartment walls were constructed from a single layer of ½ in. (13 mm) cement board over a single layer of 5/8 in. (16 mm) gypsum board, attached to 7/8 in. (22 mm) offset metal furring strips. Particular care was taken so that all ceiling and partition wall seams were filled with chemically-setting type joint compound to prevent leakage into the interstitial space between the ceiling and the floor above. After construction of the ceiling was complete, a dry-standpipe deluge system was installed with one head in each burn room to provide emergency suppression. During an experiment, a 2.5 in. (104 mm) ball valve fitting was attached and charged from a nearby hydrant. Figure C-5 was taken during the process of replacing "worn out" ceiling panels and shows the additional construction implemented in the burn room as well as the deluge sprinkler head.

Windows and exterior doors were constructed to be non-combustible. Windows were fabricated from 0.25 in. (10 mm) thick steel plate and the exterior doors were of prefabricated hollow-core steel design. The windows on the first floor were 30 in. (0.76 m) width x 36 in. (0.91 m) height and 36 in. (0.91 m) width x 40 in. (1.02 m) height on the second floor. Exterior doors were 35.8 in. (0.88 m) width x 80.5 in. (2.03 m) height. There were no doors attached to the doorways inside the structure. Figure C-6 shows the construction of the burn prop windows as well as the NFPA 1403-compliant latch mechanism. Figure C-7 is a picture of the interior of the burn prop taken just outside the burn compartment, showing the construction of the ceiling, interior doorway construction, gypsum wing wall and the joint compound used to seal seams in the ceiling and walls.

Instrumentation

After construction, the instrumentation to measure the propagation of products of combustion was installed throughout the burn prop. The instrumentation plan was designed to measure gas temperature, gas concentrations, heat flux, visual obscuration, video, and time during the experiments. The data were recorded at intervals of 1 s on a computer based data acquisition system. A schematic plan view of the instrumentation arrangement is shown in Figure C-8.

Table C-1 gives the locations of all of the instruments. Measurements taken prior to the compartment fire experiments were length, wood moisture content, fuel mass and weather conditions (relative humidity, temperature, wind speed and direction). Gas temperatures were measured with two different constructs of type K (Chromel-Alumel) thermocouples. All thermocouples outside the burn compartments were fabricated from 30 gauge glass-wrapped thermocouple wire. Vertical arrays of three thermocouples were placed near the front door on the north side and south sides of the stairwell on the first floor. On the second floor, vertical arrays of eight thermocouples were placed near the center of each target room. Inside the burn compartments, seven 3.2 mm (0.125 in.) exposed junction thermocouples and 0.76 m (30 in.) SUPER OMEGACLAD XL® sheathed thermocouple probes were arranged in a floor-to-ceiling array. Figure C-9 shows the vertical array in the burn

Figure C-4: Fireproofing added to structural steel

Figure C-5: Additional construction of burn room walls and ceiling and deluge sprinkler head.

Figure C-6: Window & Latch Construction

Figure C-7: Interior View of Burn Prop

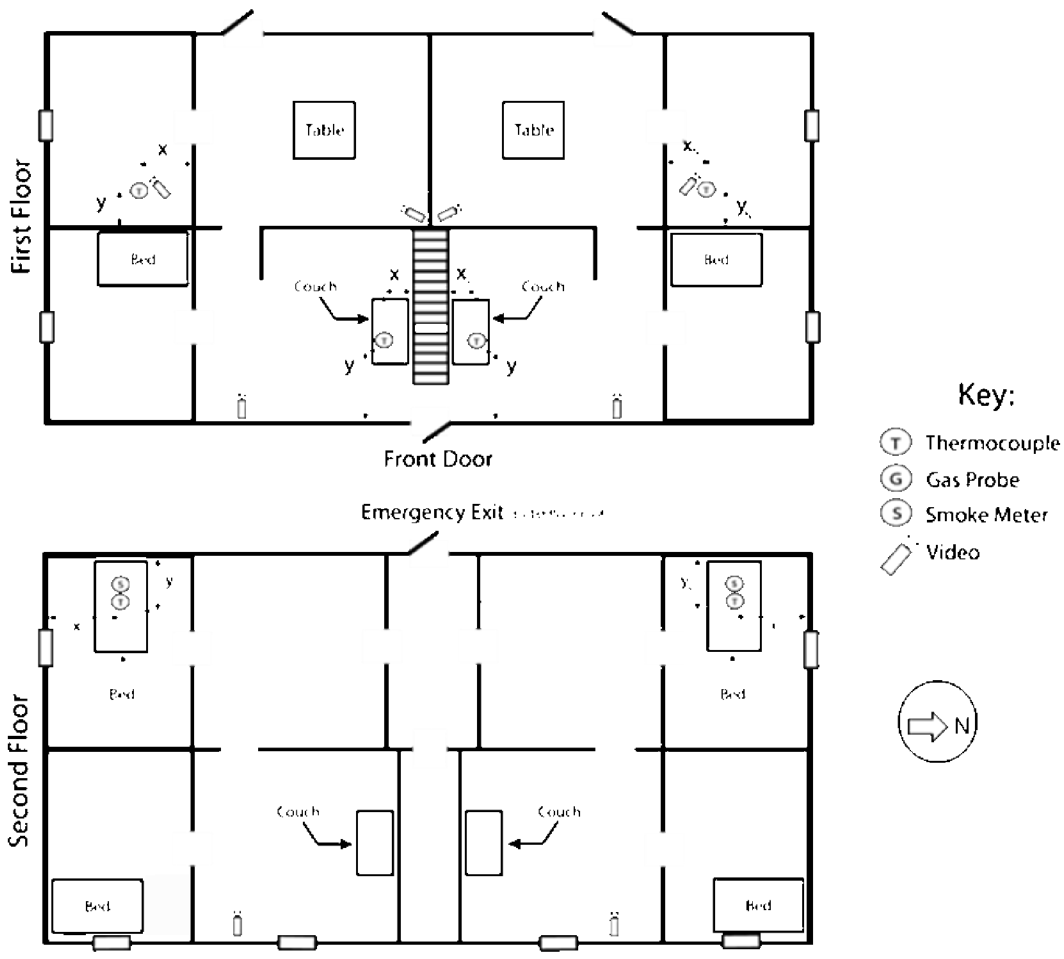


Figure C-8: Instrumentation & Furniture Prop Layout

compartment. Type K thermocouple probes were chosen because of their ability to withstand high temperature, moisture and physical abuse resulting from physical contact with hose streams and firefighters. To protect the extension wire and connectors from the effects of heat and water, through-holes were drilled in the burn compartment walls and the sheaths were passed through from the adjacent compartment. To prevent leakage through the holes, all void spaces were tightly packed with mineral wool. Inside the burn compartment the end of each probe was passed through an angle iron stand, and fastened to the floor and ceiling to provide additional protection from physical contact with firefighters and to ensure that the measurement location remained fixed throughout the experiments. In consideration of the risk associated with heating the open web steel joists, additional thermocouples were placed above each burn compartment to monitor the temperature of the interstitial space.

Table C-1: Detailed locations of instruments within respective rooms

Floor	Instrument	X_S [m]	Y_S [m]	Z_S [m]	X_N [m]	Y_N [m]	Z_N [m]	X_C [m]	Y_C [m]	Z_C [m]
1	**Thermocouple**	0.76	0.51	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13	0.76	0.51	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13	Find	Find	0.91, 1.52, 2.41
	HF Gauge 1		N/A		0.91	0.91	0.17			
	HF Gauge 2				0.5	0.66	1			
2	**Thermocouple**	1.83	0.91	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13, 2.41	1.83	0.91	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13, 2.41		N/A	
	Smoke Meter	1.7	0.49	1.52	1.64	0.43	1.5			
	Gas Probe	1.83	0.91	1.7	1.83	0.91	1.52			

Figure C-9: Burn Room Thermocouple Array

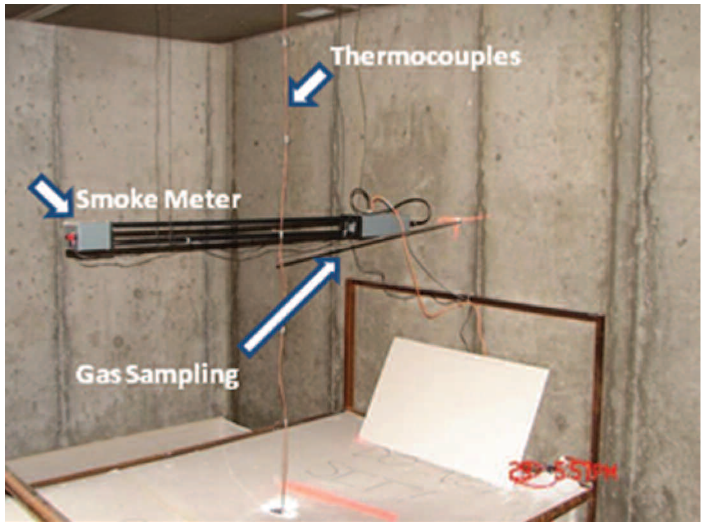


Figure C-10: Target Room Instrument Cluster

Gas concentrations were sampled at the same location in each target room. Both gas probes were plumbed to the same analyzer and isolated using a switch valve; gas was only sampled at one location during any given test. The gas sampling points were located in the center of the West wall (C Side) of both rooms, 1.5 m (5 ft.) above the floor. The sampling tubes were connected to a diaphragm pump which pulled the gas samples through stainless steel probes into a sample conditioning system designed to eliminate moisture in the gas sample. The dry gas sample was then piped to the gas analyzer setup. In all of the experiments, oxygen was measured using a paramagnetic analyzer and carbon monoxide and carbon dioxide were measured using a non-dispersive infrared (NDIR) analyzer. One floor-to-ceiling thermocouple array was also co-located with each sample port inlet.

Schmidt-Boelter heat flux gauges were placed in the North burn room. One gauge was located 1.0 m (3.3 ft.) above the floor and was oriented towards the fire origin (waste basket). This heat flux gauge was placed to characterize the radiative heat flux at the face piece level that would be experienced by a firefighter inside the room. A second flux gauge was placed on the floor in order to characterize the radiative heat flux from the upper layer and to make an estimate of how close the room was to flashing over with respect to time from ignition (using the common criteria of flashover occurring at ~20kW/m^2 at the floor level). The heat flux gauges were co-located with the thermocouple probe array.

Figure C-11: Non-combustible "Prop" Table

All length measurements were made using a steel measuring tape. Wood moisture content measurements were taken using a non-insulated-pin type wood moisture meter. Fuel mass was measured prior to each experiment using a platform-style heavy duty industrial scale. Mass was not measured after each experiment because of the absorption of fire suppression water. Publicly accessible Davis Vantage Pro2 weather instrumentation (available via http://www.wunderground.com) located approximately two miles from the experimentation site was used to collect weather data in five minute intervals for the each day that the experiments were conducted. Figure C-10 is a photograph of the West wall of the North target room, showing the thermocouple array, the smoke obscuration meter, and a gas sampling probe used during the phase two experiments. The layout is identical to that in the South target room.

Non-combustible "prop" furniture was fabricated from angle iron stock and gypsum wallboard. The purpose of the furniture was twofold. The furniture was placed inside the burn prop to simulate realistic obstacles which obscure the search paths and hose stream advancement. The second use for the furniture was so that measurement instrumentation could be strategically placed within the frame of the furniture. This served to protect instrumentation from physical damage as a result of contact with firefighters and their tools. Figure C-11 shows an example of a table placed outside the burn room.

All instruments were wired to a centralized data collection room, shown in Figure C-12, which was attached as a separate space on one side of the building. This ensured physical separation for the data collection personnel from the effects of the fire, while minimizing the wire and tube lengths to the data logging equipment. Note that the roof of the instrument room was designed to serve as an additional means of escape for personnel from the second floor of the burn prop through a metal door. A railing was installed in order to minimize the fall risk in the event that the emergency exit was required.

Outside

Inside

Figure C-12: Instrumentation Room

Table C-2: Dimensions and Mass of Furniture for Room and Contents Tests					
Furniture	Width [m]	Depth [m]	Height [m]	Mass [kg]	Material
Couch	1.8	0.8	0.9	58.1	See D-3
Dresser	1.8	0.5	0.6	72.3	Laminated Particle Board
Nightstand	0.5	0.6	0.61	22.7	Laminated Particle Board
Chair	0.5	0.7	0.6	9.2	Wood, Fabric, and Polyurethane Foam
	Back cushion = 0.1m, Bottom cushion = 0.07m				
Blanket	1.8	-	2.4	1.3	100 % Cotton
Body Pillow	0.5	-	1.4	1.3	100 % cotton cover, polyester fill
Trash Can	0.4	0.3	0.4	1.3	Polypropylene
Towel	0.8	-	1.4	0.4	100 % Cotton
Wallboard	1.2	0.003	2.4	9.0	MDF

Table C-3: Materials in Couch	
Body:	Resinated dyed fiber (unknown material) 3 %
	PU foam pad 46%
	Waste fiber batting (unknown material) 26 %
	Polyester fiber batting 25 %
Cushions:	PU foam pad 86 %
	Polyester fiber batting 14 %

Time-to-Task Data Collection Chart

Date ______________ Start Time __________ End Time (all task complete) __________

Timer Name ____

Task	Start Time	Completion Time	Duration
Stop at Hydrant-- Wrap Hose			
Position Engine 1			
Conduct Size-up - 360° lap - Transmit report - establish command			
Engage Pump			
Position attack line (stop time – at front door)			
Establish 2-in-2-out			
Charge Hydrant – supply attack Engine			
Establish RIT			
Gain/Force Entry			
Advance Line (stop time –water on fire)			
Deploy Back up line (stop time at front door)			
Advance Back up line/protect stairwell (start time at front door – Stop at stairwell)			
Conduct Primary Search			
Ground Ladders in Place			
Horizontal Ventilation (ground)			
Horizontal Ventilation (2nd story)			
Control Utilities (interior)			
Control Utilities (exterior)			
Conduct Secondary Search			
Check for Fire Extension (walls)			
Check for Fire Extension (ceiling)			
Mechanical Ventilation			

Company Protocols: Crew Size of 2

(10 total personnel on scene)

PLUS 4 RIC – 1403 = total 14 needed

Tasks/Company	Engine 1/2	Truck 1/2	Engine 2/2	Battalion Chief/ Aide	Engine 3/2
Arrive on Scene - Arrive/ stop at hydrant - Position engine ____________ - Layout report - On-scene report - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360º lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine	Driver/O Driver/O Driver/O	Position Truck	-Dry Lay – 2nd engine takes hydrant - Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - ---------------- - Advance	Officer – (Not interior—just front door) Officer	Officer			
Establish - 2 in – 2 out (Initial RIT)		O/D			
Establish RIT (Dedicated)		O/D (performs all RIT duties)			

Tasks/Company	Engine 1/2	Truck 1/2	Engine 2/2	Battalion Chief/ Aide	Engine 3/2
Gain/ Force Entry		O/D			
Advance Line - scan search fire room - suppression	Officer (if officer commits then he must pass command)		Officer		
Deploy Back-up Line and protect stairwell					O/D
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors					O/D
Ventilation (vent for fire or vent for life) - Horizontal - Ventilation		Driver/Officer			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver /Officer			
Control Utilities (Interior and exterior)					Driver/Officer
Conduct Secondary Search - Search Fire Floors - Search other Floors Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	Officer Officer		Officer Officer		 O/D
Mechanical Ventilation		Driver/Officer			

Company Protocols: Crew Size of 3

(14 total personnel on scene)

PLUS 4 RIC – 1403 = total 18 needed

Tasks/Company	Engine 1/3	Truck 1/3	Engine 2/3	Battalion Chief/ Aide	Engine 3/2
Arrive on Scene - Arrive/ stop at hydrant - Position engine ________________ - Layout report - On-scene report - Conduct size-up – 360° lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360 degree lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine	Driver Driver Driver	Position Truck	Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	D/RB				
Establish - 2 in – 2 out (Initial RIT)		O/RB			
Establish RIT (Dedicated)			O/RB— advance by foot to get to point of entry – performs all RIT duties		

Tasks/Company	Engine 1/3	Truck 1/3	Engine 2/3	Battalion Chief/ Aide	Engine 3/3
Gain/ Force Entry		O/RB			
Advance Line - scan search fire room - suppression	O/RB (if officer commits then he must pass command)				
Deploy Back-up Line and protect stairwell					O/RB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors		O/ RB -			
Ventilation (vent for fire or vent for life) - Horizontal - Ventilation		Driver			Driver
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver			Driver
Control Utilities (Interior and exterior)		Driver (exterior) O/RB (Interior)			Driver (exterior)
Conduct Secondary Search - Search Fire Floors - Search other Floors					O/RB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	O/RB	O/RB			
Mechanical Ventilation		Driver			Driver

Company Protocols: Crew Size of 4

Total on scene = 18

PLUS 4 RIC – 1403 = total 22 needed

Tasks/Company	Engine 1/4	Truck 1/4	Engine 2/4	Battalion Chief/ Aide	Engine 3/4
Arrive on Scene - Arrive/ stop at hydrant - Position engine ______________ - Layout report - On-scene report - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360 degree lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine (1 3/4")	Driver Driver Driver	Position Truck	-Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	RB/Nozzle LB/Flake Both advance line for fire attack				
Establish - 2 in – 2 out (Initial RIT)		D/LB			
Establish RIT (Dedicated)			O/LB/RB— advance by foot to get point of entry – performs all RIT duties		

Tasks/Company	Engine 1/4	Truck 1/4		Battalion Chief/ Aide	Engine 3/4
Gain/ Force Entry		O/RB			
Advance Line - scan search fire room - suppression	RB/LB Officer – not on line (if officer commits then he must pass command)				
Deploy Back-up Line and protect stairwell					O/RB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors		Officer and RB -			
Ventilation - Horizontal - Ventilation		Driver and LB			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver /LB			
Control Utilities (Interior and exterior) Conduct Secondary Search - Search Fire Floors - Search other Floors		Driver/LB (control exterior) O/RB (control interior)			D/LB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	O/RB	O/RB			
Mechanical Ventilation		D/LB			

Company Protocols: Crew Size of 5

D/O/LB/RB/CB   Total on scene = 22

PLUS 4 RIC – 1403 = total 26 needed

Tasks/Company	Engine 1/5	Truck 1/5	Engine 2/5	Battalion Chief/ Aide	Engine 3/4
Arrive on Scene - Arrive/ stop at hydrant - Position engine ______________ - Layout report - On-scene report - Locate Fire - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360 degree Size up.		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine (1 3/4")	Driver Driver Driver	Position Truck	-Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	RB/Nozzle LB/Flake CB/ Control --------------- Advance line for fire attack ---------------- The Officer responsibility is to supervise hose stretch /monitor safety and continually survey the scene				
Establish - 2 in – 2 out (Initial RIT)		D/LB			

Tasks/Company	Engine 1/5	Truck 1/5	Engine 2/5	Battalion Chief/ Aide	Engine 3/5
Establish RIT (Dedicated)			O/LB/RB—advance by foot to get to point of entry – performs all RIT duties		
Gain/ Force Entry		O/RB/CB			
Advance Line - scan search fire room - suppression	RB/LB/CB Officer – not on line (if officer commits then he must pass command)				
Insures first line flowing water— Deploy Back-up Line and protect stairwell (1 ¾")					O/RB/CB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor – Search other floors-		Officer and RB/CB			
Ventilation (vent for fire or vent for life) - Horizontal - Vertical		Driver and LB			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver /LB			
Control Utilities after search, force entry, venting and fire extinguished (Interior and exterior)		Driver/LB (control exterior) O/RB/CB (control interior)			
Conduct Secondary Search -Fire Floor -Primary and secondary search of entire floor above		D/LB			D/LB O/RB/CB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension wall breech ceiling breech-	O/RB				O/RB/CB
Mechanical Ventilation					

Appendix E: Statistical Analysis of Time to Task Test Data

Identifying Statistically Significant Differences in Crew Size and Stagger on a Number of Task Timings Using Regression Analyses of Times (Start, End and Duration) on Crew Size and Stagger

	Crew Size			Stagger	Crew Size	Stagger
Task-Based Measure of Time	**3 vs. 2**	**4 vs. 3**	**5 vs. 4**		**5/4 vs. 3/2**	
Total time	X *	X			X	
Conduct size up (start)			X		X	
Conduct size up (end)					X	
Conduct size up (duration)						
Position attack line (start)	X				X	
Position attack line (duration)		X			X	
Establish 2 in 2 out (end)		X		X	X	X
Establish RIT (end)	na	na	na	na	na	na
Gain forced entry (start)		X			X	
Advance line (start)	X	X			X	
Advance line (end)	X		X		X	
Deploy backup line (start)					X	X
Deploy backup line (end)				X		X
Advance backup line (start)				X		X
Advance backup line (end)				X		X
Conduct primary search (start)	X	X			X	
Ground ladders in place (end)		X	x	X	X	o
Ground ladders in place (duration)			X	X	X	X
Horizontal ventilation Story 2 window 3 (Start)		X			X	
Horizontal ventilation Story 2 window 3 (End)		X			X	
Horizontal ventilation Story 2 window 2 (Start)		X			X	
Horizontal ventilation Story 2 window 2 (End)		X			X	
Horizontal ventilation Story 2 window 1 (Start)		X			X	
Horizontal ventilation Story 2 window 1 (End)		X			X	
Horizontal ventilation Story 1 window 2 (Start)	o	X			X	
Horizontal ventilation Story 1 window 2 (End)		X			X	
Control utilities (interior) (Start)	X	X			X	
Conduct Secondary Search (Start)	X				X	
Check for Fire Ext (walls) (Start)	X	X			X	
Check for Fire Ext (ceiling) (Start)		X				
Stretch time**	X		o		X	

* An **'X'** denotes statistical significance at the 0.05 level; a **'o'** denotes significance at the 0.10 level.

Appendix F: All Regression Coefficients

Regression Models of Time to Task (in Seconds) as a Function of Crew Size and Stagger (Standard Errors are in Parentheses underneath coefficients)

Measure of Task Time	Time measured	Coefficients				
		Crew size of 3	Crew size of 4	Crew size of 5	Close Stagger	Constant
Total time		-100.5	**-408.33**	**-402.17**	**-40.83**	**1374.42**
		(50.29)	(50.29)	(50.29)	(35.56)	(39.77)
Conduct size up	Start	**2.5**	**-5.167**	**-18.17**	**-1.25**	**335**
		(5.97)	(5.97)	(5.97)	(4.22)	(4.72)
Conduct size up	Complete	**-5.167**	**-13.17**	**-38.33**	**-12**	**416**
		(13.60)	(13.60)	(13.60)	(9.62)	(10.75)
Conduct size up	Duration	**-7.667**	**-8**	**-20.17**	**-10.75**	**81.04**
		(12.10)	(12.10)	(12.10)	(8.56)	(9.57)
Position attack line	Start	**-63.5**	**-63.5**	**-69.67**	**-11.17**	**408.1**
		(14.09)	(14.09)	(14.09)	(9.96)	(11.14)
Position attack line	Duration	**-16**	**-63.67**	**-61.67**	**5.167**	**160.6**
		(13.79)	(13.79)	(13.79)	(9.75)	(10.90)
Establish 2in - 2 out	Complete	**-6.7E-15**	**-90**	**-90**	**-30**	**355**
		(9.73)	(9.73)	(9.73)	(6.88)	(7.69)
Establish RIT	Complete	**70**	**70**	**70**	**-60**	**435**
		0.00	0.00	0.00	0.00	0.00
Gain forced entry	Start	**-23.5**	**-54**	**-80.83**	**-20.83**	**528.6**
		(19.66)	(19.66)	(19.66)	(13.90)	(15.54)
Advance line	Start	**-54**	**-97.83**	**-123.5**	**-17.5**	**586.3**
		(18.83)	(18.83)	(18.83)	(13.31)	(14.88)
Advance line	Complete	**-61**	**-95.5**	**-134.7**	**-19.08**	**625.5**
		(20.35)	(20.35)	(20.35)	(14.39)	(16.08)
Deploy backup line	Start	**-26**	**-42.67**	**-53.5**	**-96.75**	**641.5**
		(17.11)	(17.11)	(17.11)	(12.10)	(13.53)
Deploy backup line	Complete	**-15.83**	**-56.17**	**-17.5**	**-53.75**	**728.9**
		(33.49)	(33.49)	(33.49)	(23.68)	(26.48)
Advance backup line	Start	**-33**	**-66.83**	**-34.83**	**-63**	**779.7**
		(29.65)	(29.65)	(29.65)	(20.97)	(23.44)
advancebackupline2	Complete	**-34.5**	**-68.17**	**-36.17**	**-63.75**	**784.4**
		(29.73)	(29.73)	(29.73)	(21.02)	(23.50)
conductprimarysearch1	Start	**-147**	**-215.8**	**-211.5**	**0.1667**	**736.1**
		(25.08)	(25.08)	(25.08)	(17.74)	(19.83)
Ground ladders in place	Complete	**-38**	**-196.5**	**-317.8**	**-69.83**	**1168**
		(48.38)	(48.38)	(48.38)	(34.21)	(38.24)
Ground ladders in place	Duration	**-33.83**	**-83.67**	**-185.7**	**-72.08**	**617**
		(48.12)	(48.12)	(48.12)	(34.03)	(38.04)
Horizontal ventilation, second story, window 3	Start	**-53.67**	**-217.8**	**-211**	**-26.59**	**759.1**
		(30.75)	(30.75)	(30.75)	(21.75)	(24.31)
Horizontal ventilation, second story, window 3	Complete	**-64.83**	**-316**	**-353**	**-33.58**	**1088**
		(49.74)	(49.74)	(49.74)	(35.17)	(39.32)
Horizontal ventilation, second story, window 2	Start	**-51.67**	**-265.8**	**-261.2**	**-18.83**	**885.1**
		(37.20)	(37.20)	(37.20)	(26.30)	(29.41)

All Regression Coefficients (CONTINUED)

Regression Models of Time to Task (in Seconds) as a Function of Crew Size and Stagger (Standard Errors are in Parentheses underneath coefficients)

Horizontal ventilation, second story, window 2	Complete	**-53.5**	**-259.8**	**-262.3**	**-13.33**	**931.3**
		(39.97)	(39.97)	(39.97)	(28.26)	(31.60)
Horizontal ventilation, second story, window 1	Start	**-70**	**-316.3**	**-348.8**	**-31.08**	**1038**
		(48.37)	(48.37)	(48.37)	(34.20)	(38.24)
Horizontal ventilation, second story, window 1	Complete	**-51.83**	**-219**	**-214.8**	**-24**	**805.7**
		(33.71)	(33.71)	(33.71)	(23.83)	(26.65)
Horizontal ventilation, first story, window 2	Start	**-87.17**	**-386.3**	**-428.5**	**-44.67**	**1200**
		(45.13)	(45.13)	(45.13)	(31.91)	(35.68)
Horizontal ventilation, first story, window 2	Complete	**-88.5**	**-391.5**	**-423.3**	**-44.17**	**1224**
		(47.02)	(47.02)	(47.02)	(33.25)	(37.17)
Control utilities interior	Start	**-136.5**	**-287.8**	**-300**	**-6.333**	**946.3**
		(45.57)	(45.57)	(45.57)	(32.22)	(36.02)
Control utilities exterior	Start	**6.667**	**-281.8**	**-312.8**	**-38.17**	**1063**
		(70.21)	(70.21)	(70.21)	(49.65)	(55.51)
Conduct secondary search	Start	**-92.5**	**-143**	**-152.7**	**-28.25**	**846**
		(38.97)	(38.97)	(38.97)	(27.56)	(30.81)
Check for fire extension walls	Start	**-453.8**	**-535.3**	**-608.7**	**-38.25**	**1155**
		(38.28)	(38.28)	(38.28)	(27.07)	(30.26)
Check for fire extension ceiling	Start	**-206.3**	**-349.7**	**-292.7**	**-2.833**	**1086**
		(48.29)	(48.29)	(48.29)	(34.14)	(38.17)

Regression Models of Time to Task (in Seconds) as a Function of Combined Crew Size and Stagger (Standard Errors appear in Parentheses)

Measure of Task Time*	Time measured	Coefficients: Crew size of 4/5 vs. 3/2	Coefficients: Close Stagger	Coefficients: Constant
Total time		**-355**	**-40.83**	**1324.00**
		(37.23)	(37.23)	(32.24)
Conduct size up	Start	**-12.92**	**-1.25**	**336.2**
		(4.50)	(4.50)	(3.90)
Conduct size up	Complete	**-23.17**	**-12**	**413.4**
		(9.97)	(9.97)	(8.64)
Conduct size up	Duration	**-10.25**	**-10.75**	**77.21**
		(8.44)	(8.44)	(7.31)
Position attack line	Start	**-34.83**	**-11.17**	**376.3**
		(13.66)	(13.66)	(11.83)
Position attack line	Duration	**-54.67**	**5.167**	**152.6**
		(9.60)	(9.60)	(8.31)
Establish 2in - 2 out	Complete	**-90**	**-30**	**355**
		(6.55)	(6.55)	(5.67)
Establish RIT	Complete	**35**	**-60**	**470**
		(10.80)	(10.80)	(9.35)
Gain forced entry	Start	**-55.67**	**-20.83**	**516.8**
		(14.32)	(14.32)	(12.40)
Advance line	Start	**-83.67**	**-17.5**	**559.3**
		(15.67)	(15.67)	(13.57)
Advance line	Complete	**-84.58**	**-19.08**	**595**
		(17.67)	(17.67)	(15.31)
Deploy backup line	Start	**-35.08**	**-96.75**	**628.5**
		(12.30)	(12.30)	(10.65)
Deploy backup line	Complete	**-28.92**	**-53.75**	**721**
		(23.43)	(23.43)	(20.29)
Advance backup line	Start	**-34.33**	**-63**	**763.2**
		(21.17)	(21.17)	(18.33)
advancebackupline2	Complete	**-34.92**	**-63.75**	**767.1**
		(21.27)	(21.27)	(18.42)
conductprimarysearch1	Start	**-140.2**	**0.1667**	**662.6**
		(28.28)	(28.28)	(24.49)
Ground ladders in place	Complete	**-238.2**	**-69.83**	**1149**
		(37.99)	(37.99)	(32.90)
Ground ladders in place	Duration	**-117.7**	**-72.08**	**600.1**
		(36.37)	(36.37)	(31.49)
Horizontal ventilation, second story, window 3	Start	**-187.6**	**-26.59**	**732.3**
		(22.31)	(22.31)	(19.32)
Horizontal ventilation, second story, window 3	Complete	**-302.1**	**-33.58**	**1056**
		(35.38)	(35.38)	(30.64)

Regression Models of Time to Task (in Seconds) as a Function of Combined Crew Size and Stagger (CONTINUED) (Standard Errors appear in Parentheses)

Horizontal ventilation, second story, window 2	Start	**-237.7**	**-18.83**	**859.3**
		(26.27)	(26.27)	(22.75)
Horizontal ventilation, second story, window 2	Complete	**-234.3**	**-13.33**	**904.6**
		(28.12)	(28.12)	(24.36)
Horizontal ventilation, second story, window 1	Start	**-297.6**	**-31.08**	**1003**
		(34.64)	(34.64)	(30.00)
Horizontal ventilation, second story, window 1	Complete	**-191**	**-24**	**779.8**
		(24.05)	(24.05)	(20.83)
Horizontal ventilation, first story, window 2	Start	**-363.8**	**-44.67**	**1156**
		(33.83)	(33.83)	(29.30)
Horizontal ventilation, first story, window 2	Complete	**-363.2**	**-44.17**	**1180**
		(34.80)	(34.80)	(30.14)
Control utilities interior	Start	**-225.7**	**-6.333**	**878.1**
		(37.23)	(37.23)	(32.25)
Control utilities exterior	Start	**-300.7**	**-38.17**	**1066**
		(47.48)	(47.48)	(41.12)
Conduct secondary search	Start	**-101.6**	**-28.25**	**799.7**
		(29.88)	(29.88)	(25.88)
Check for fire extension walls	Start	**-345.1**	**-38.25**	**927.9**
		(75.46)	(75.46)	(65.35)
Check for fire extension ceiling	Start	**-218**	**-2.833**	**983.1**
		(46.32)	(46.32)	(40.12)
Stretch time = advance line minus position engine	Duration	**-75.7**	**-17.2**	**273.3**
		(16.68)	(16.68)	(14.44)

*** Standard errors are in parentheses below coefficient value**

		Crew size of 3	Crew size of 4	Crew size of 5	Close Stagger	Constant
Stretch time = advance line minus position engine	Duration	**-57.3**	**-86.7**	**-122.0**	**-17.2**	**301.9**
		(19.39)	(19.39)	(19.39)	(13.71)	(15.33)

APPENDIX G: Measurement Uncertainty

The measurements of length, temperature, mass, moisture content, smoke obscuration, and time taken in these experiments have unique components of uncertainty that must be evaluated in order to determine the fidelity of the data. These components of uncertainty can be grouped into two categories: Type A and Type B. Type A uncertainties are those evaluated by statistical methods, such as calculating the standard deviation of the mean of a set of measurements. Type B uncertainties are based on scientific judgment using all available and relevant information. Using relevant information, the upper and lower limits of the expected value are estimated so that the probability that the measurement falls within these limits is essentially 100 %. After all the component uncertainties of a measurement have been identified and evaluated it is necessary to use them to compute the combined standard uncertainty using the law of propagation of uncertainty (the "root sum of squares"). Although this expresses the uncertainty of a given measurement, it is more useful in a fire model validation exercise to define an interval for which the measurement will fall within a certain level of statistical confidence. This is known as the expanded uncertainty. The current international practice is to multiply the combined standard uncertainty by a factor of two (k=2), giving a confidence of 95 %.

Length measurements of room dimensions, openings and instrument locations were taken using a steel measuring tape with a resolution of 0.02 in (0.5 mm). However, measurement error due to uneven and unlevel surfaces results in an estimated uncertainty of ± 0.5 % for length measurements taken on the scale of room dimensions. The estimated total expanded uncertainty for length measurements is ± 1.0 %.

The standard uncertainty of the thermocouple wire itself is 1.1°C or 0.4 % of the measured value, whichever is greater (Omega 2004). The estimated total expanded uncertainty associated with type K thermocouples is approximately ± 15 %. Previous work done at NIST has shown that the uncertainty of the environment surrounding thermocouples in a full-scale fire experiment has a significantly greater uncertainty (Blevins 1999) than the uncertainty inherent with thermocouple design. Furthermore, while a vertical thermocouple array gives a good approximation of the temperature gradient with respect to height, temperatures cannot be expected to be uniform across a plane at any height because of the dynamic environment in a compartment fire. Inaccuracies of thermocouple measurements in a fire environment can be caused by:

- Radiative heating or cooling of the thermocouple bead
- Soot deposition on the thermocouple bead which change its mass, emissivity, and thermal conductivity
- Heat conduction along thermocouple wires
- Flow velocity over the thermocouple bead

To reduce these effects, particularly radiative heating and cooling, thermocouples with smaller diameter beads were chosen. This is particularly important for thermocouples below the interface because the radiative transfer between the surrounding room surfaces will be significantly less uniform than if the thermocouple were in the hot gas layer. It is suggested in [Pitts] that it may be possible to correct for radiative transfer given enough sufficient knowledge about thermocouple properties and the environment. However, measurements of local velocity and the radiative environment were not taken. Additionally, the probes were located away from the burn compartment walls in order to avoid the effects of walls and corners.

The gas measurement instruments and sampling system used in this series of experiments have been demonstrated to have an expanded (k = 2) relative uncertainty of ± 1 % when compared with span gas volume fractions (Matheson). Given the limited set of sampling points in these experiments, an estimated uncertainty of ± 10 % is being applied to the results.

The potential for soot deposition on the face of the water-cooled total heat flux gauges contributes significant uncertainty to the heat flux measurements. Calibration of heat flux gauges was completed at lower fluxes and then extrapolated to higher values and this resulted in a higher uncertainty in the flux measurement. Combining all of component uncertainties for total heat flux resulted in a total expanded uncertainty of -24 % to +13 % for the flux measurements.

Prior to experimentation, ten of the wooden pallets used in the fuel packages were randomly selected for measurement. Two measurements were taken, moisture content and mass. Moisture content was measured using a pin-type moisture meter with a moisture measurement range of 6 % to 40% and an accuracy of <0.5 % of the measured value between 6 % and 12 % moisture content. Mass measurements were made with an industrial bench scale having a range of 0kg to 100 kg, a resolution of 0.1 kg and an uncertainty of ± 0.1 kg.

All timing staff were equipped with the same model of digital stopwatch with a resolution of 0.01 seconds and an uncertainty of ± 3 seconds per 24 hours; the uncertainty of the timing mechanism in the stopwatches is small enough over the duration of an experiment that it can be neglected. There are three components of uncertainty when using people to time fire fighting tasks. First, timers may have a bias depending on whether they record the time in anticipation of, or reaction to an event. A second component exists because multiple timers were used to record all tasks. The third component is the mode of the stimulus to which the staff is reacting: audible (firefighters announcing task updates over the radio) or visual (timing staff sees a task start or stop).

Milestone events in these experiments were recorded both audibly and visually. A test series described in the *NIST Recommended Practice Guide for Stopwatch and Timer Calibrations* found the reaction times for the two modes of stimulus to be approximately the same, so this component can be neglected. Because of the lack of knowledge regarding the mean bias of the timers, a rectangular distribution was assumed and the worst case reaction time bias of 120 ms was used, giving a standard deviation of 69 ms. The standard deviation of the reaction time was assumed to be the worst case of 230 ms. The estimated total expanded uncertainty of task times measured in these experiments is 240 ms.

An additional component of uncertainty exists for the time measurement of the application of water on the fire. In order to measure this time, timing staff were required to listen for radio confirmation that suppressing water had been applied by the interior attack crew. This process required a member of the interior crew to find and manipulate their microphone, wait for the radio to access a repeater, and transmit the message. Because of the lack of knowledge about the distributions of time it takes for each part of this process, all parts are lumped into a single estimate of uncertainty and a rectangular distribution is assumed. This is most reasonably estimated to be 2.5 seconds with a standard deviation of ±2.89 seconds and an expanded uncertainty of ± 5.78 seconds.

Weather measurement uncertainty was referenced to the published user's manual for the instrumentation used. The weather instrumentation has calibration certificates that are traceable to NIST standards. A summary of experimental measurement uncertainty is given in Table G-1.

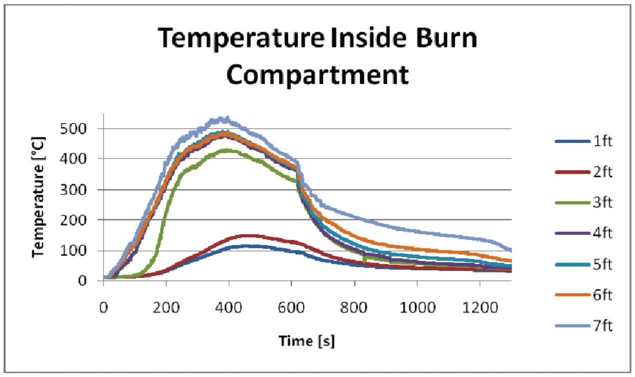
Table G-1: Summary of Measurement Uncertainty

Measurement	Component Standard Uncertainty	Combined Standard Uncertainty	Total Expanded Uncertainty
Length Measurements			
Instrumentation Locations	± 1 %	± 3 %	± 6 %
Building Dimensions	± 1 %		
Repeatability[1]	± 2 %		
Random[1]	± 2 %		
Gas Temperature – Lower Layer			
Calibration	± 1 %	± 8 %	± 15 %
Radiative Cooling	- 5 % to + 0 %		
Radiative Heating	0 % to + 5 %		
Repeatability [1]	± 5 %		
Random [1]	± 3 %		
Wood Moisture Content			
	± 0.5 %	± 0.5 %	± 1%
Wood Pallet Mass			
	± 0.2%	± 0.1%	± 0.1%
Weather			
Relative Humidity	± 3%		
Barometric Pressure	± 0.03" Hg		
Wind Speed	± 5%		
Wind Direction	± 5%		
Outside Temperature	±0.5°C		
Time			
Timer Bias	± 0.069s	± 2.90s	
Reaction Time	± 0.230s		± 5.80 s
Radio Operation	± 2.890s		
Notes: 1. Random and repeatability evaluated as Type A, other components as Type B.			

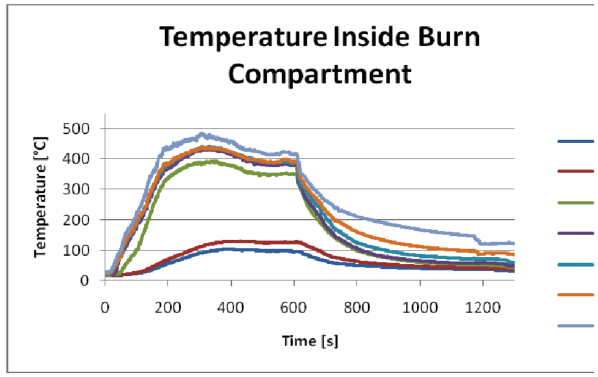
APPENDIX H: Charts of Gas and Temperature Data

Examples of Gas and Temperature Data for Time-to-Task Tests

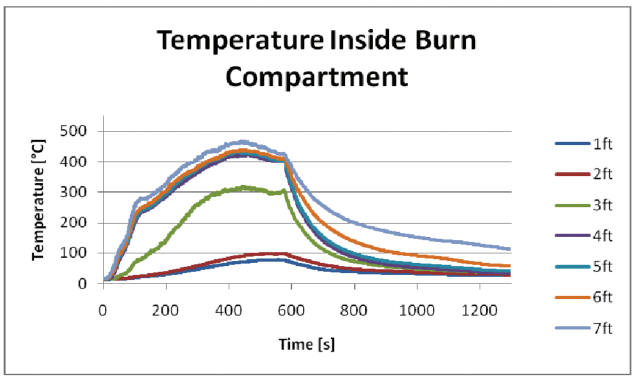
Burn Room Data



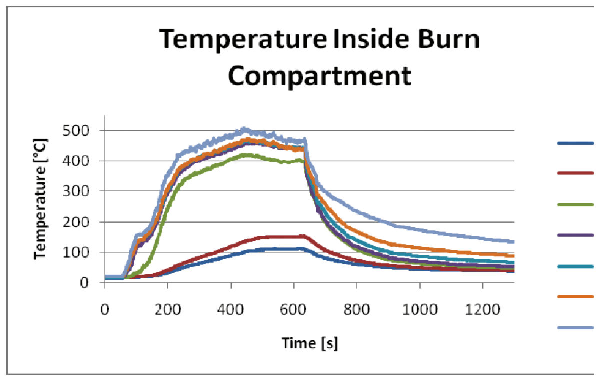
2 Person, Close Stagger



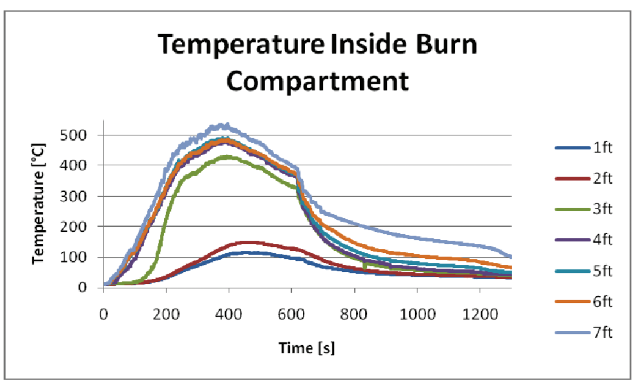
2 Person, Far Stagger



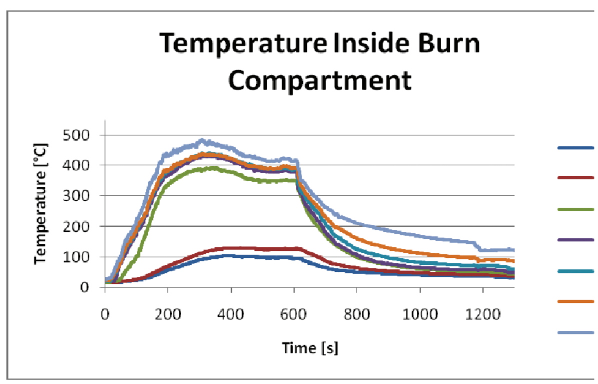
3 Person, Close Stagger



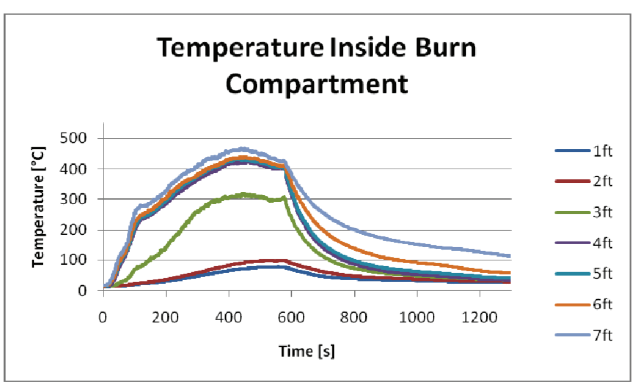
3 Person, Far Stagger



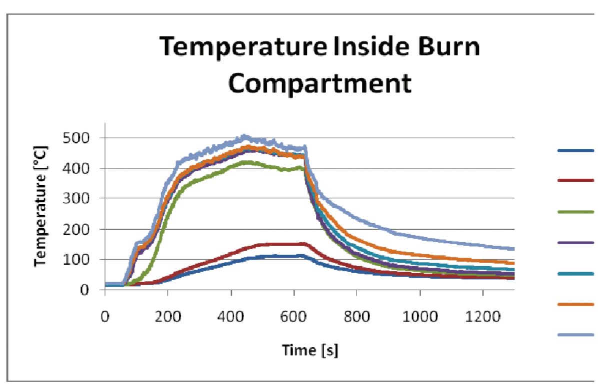
2 Person, Close Stagger



2 Person, Far Stagger

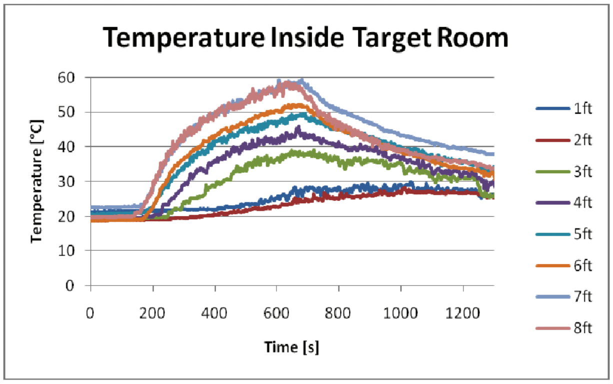


3 Person, Close Stagger

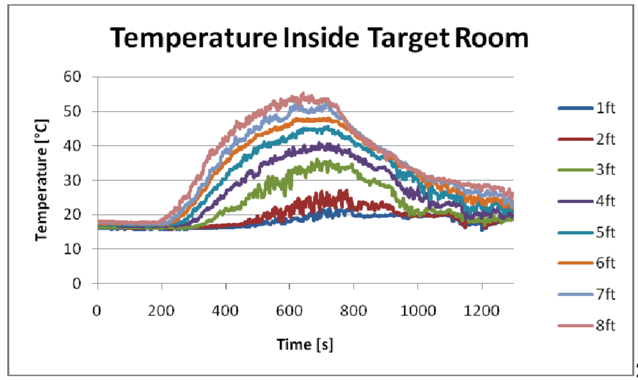


3 Person, Far Stagger

Target Room Data

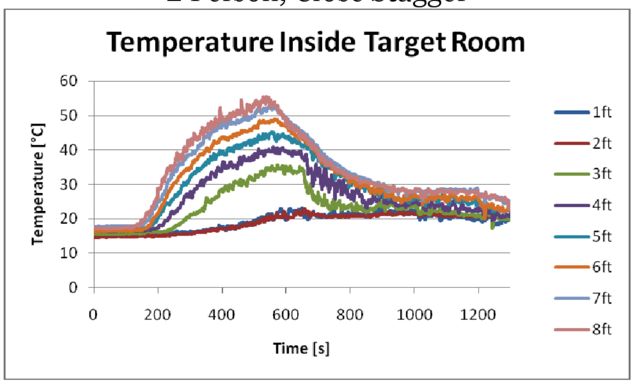


2 Person, Close Stagger

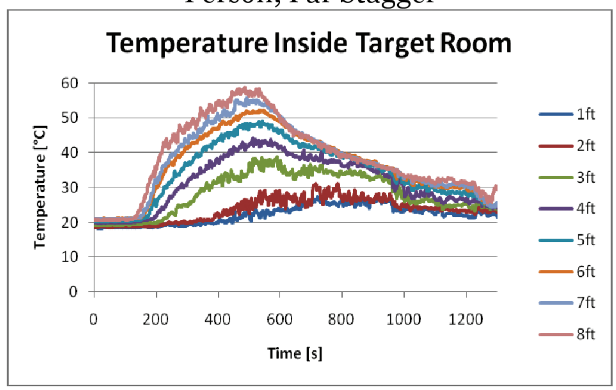


2

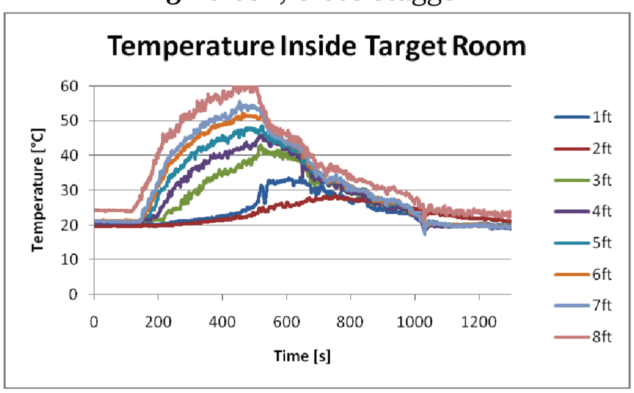
Person, Far Stagger

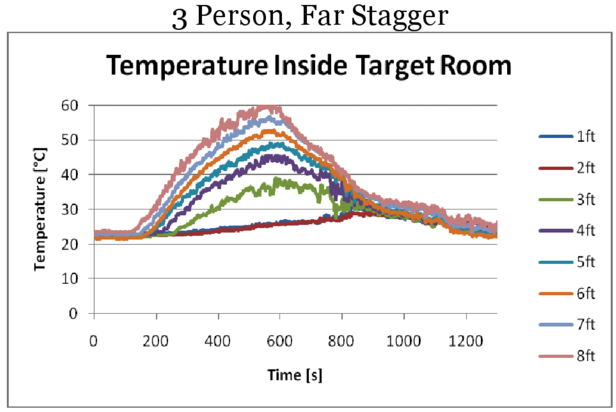


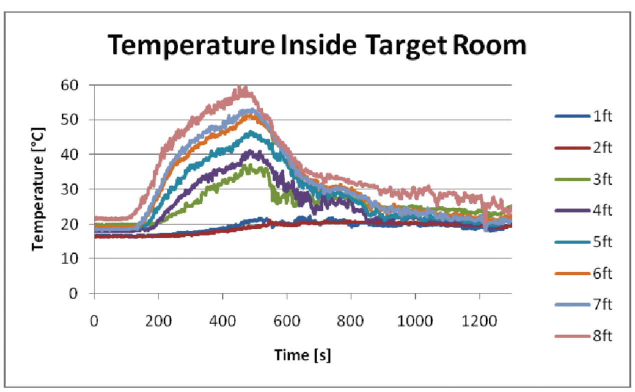
3 Person, Close Stagger



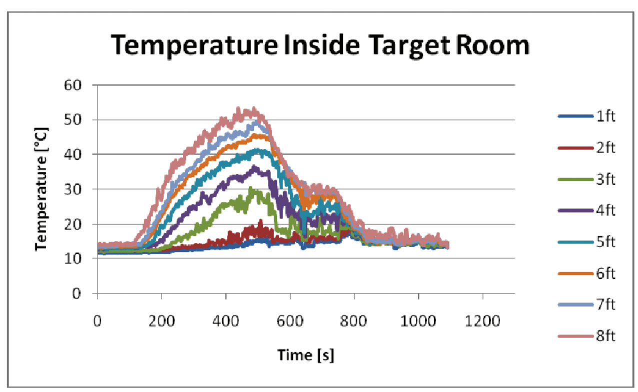
3 Person, Far Stagger





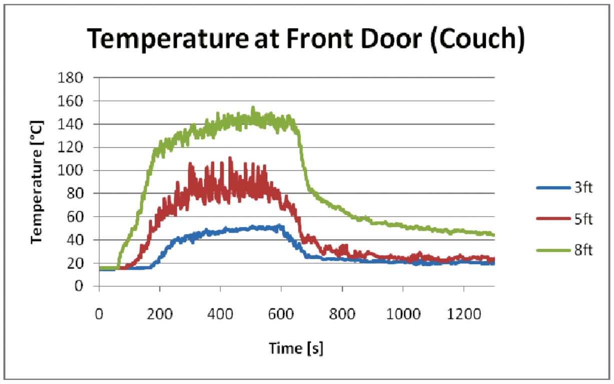


5 Person, Close Stagger

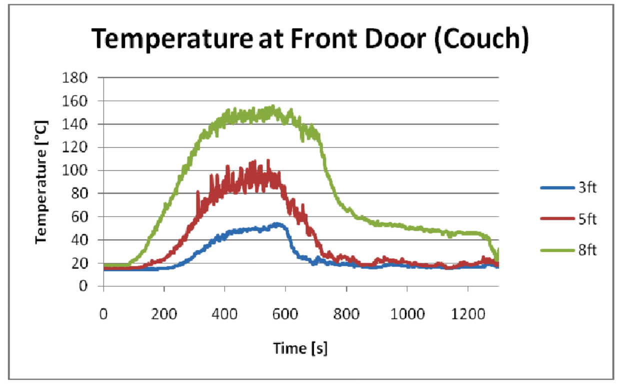


5 Person, Far Stagger

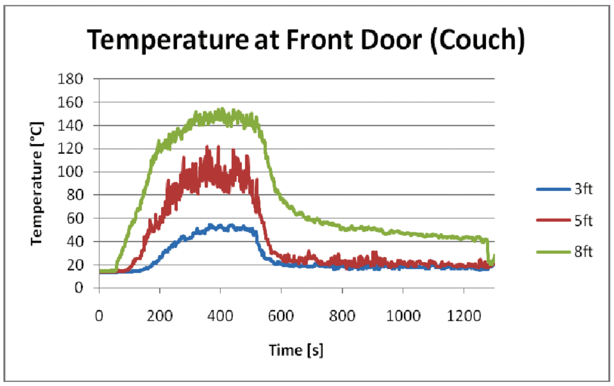
Temperature Near Front Door (Couch)



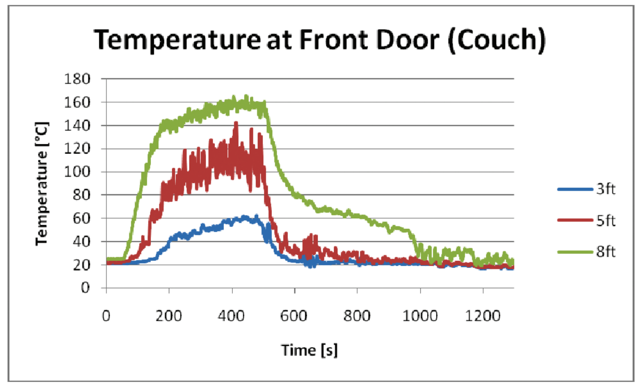
2 Person, Close Stagger



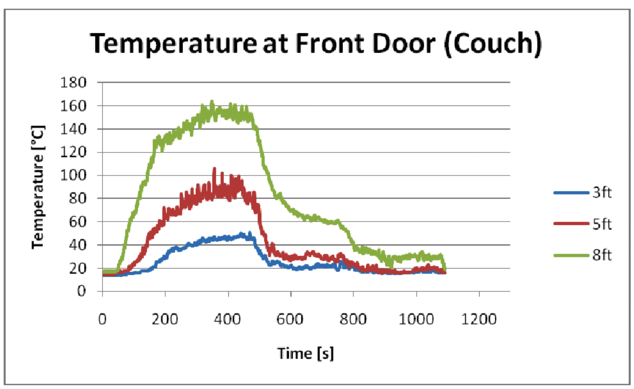
2 Person, Far Stagger



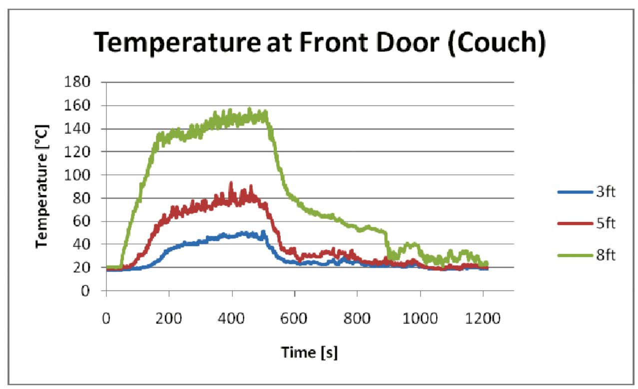
3 Person, Close Stagger



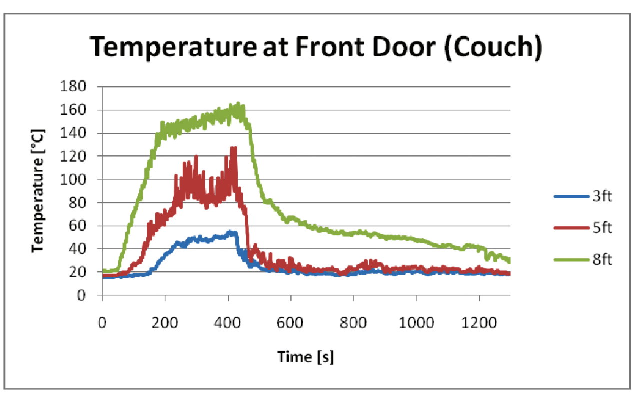
3 Person, Far Stagger



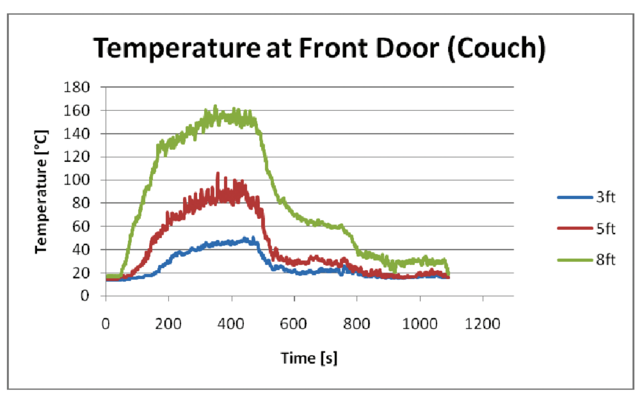
4 Person, Close Stagger



4 Person, Far Stagger



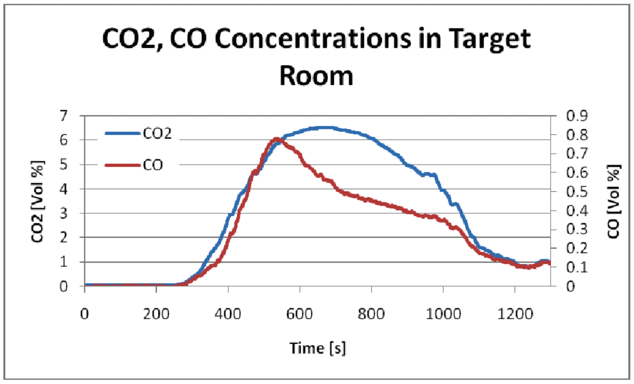
5 Person, Close Stagger



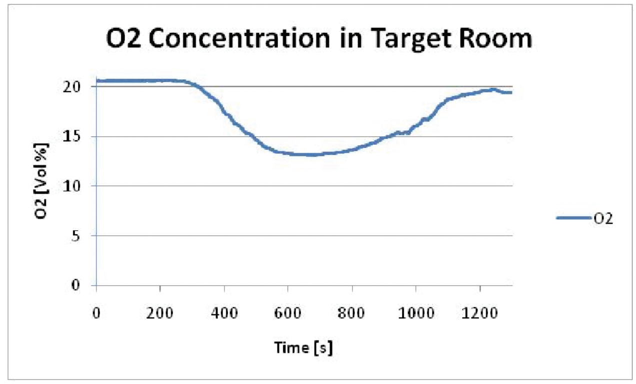
5 Person, Far Stagger

Gas and Temperature Data for Room and Contents Tests

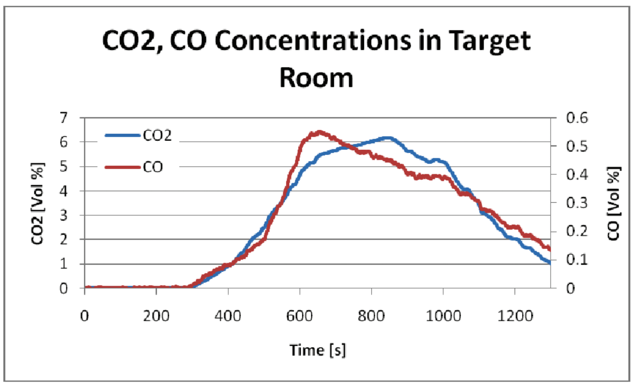
Examples of Gas Data in Target Room



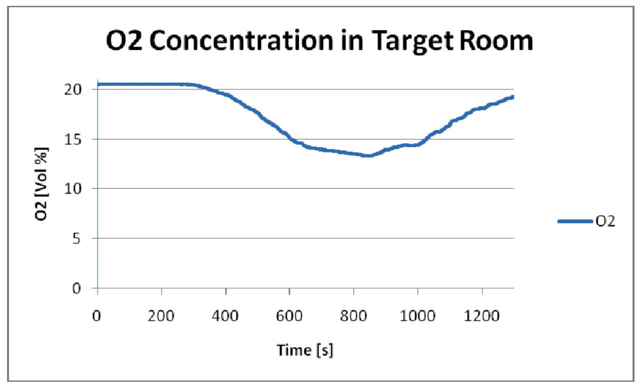
2-Person, Early Arrival



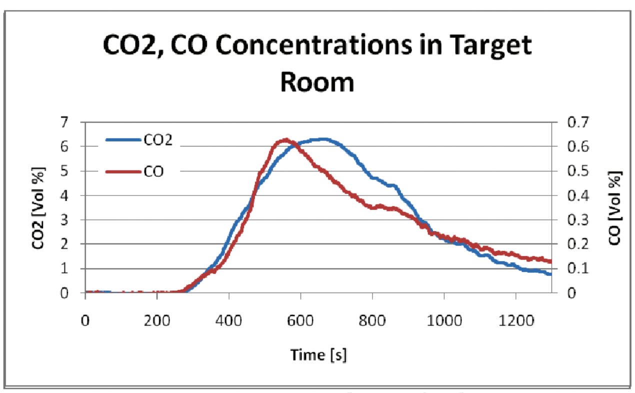
2-Person, Early Arrival



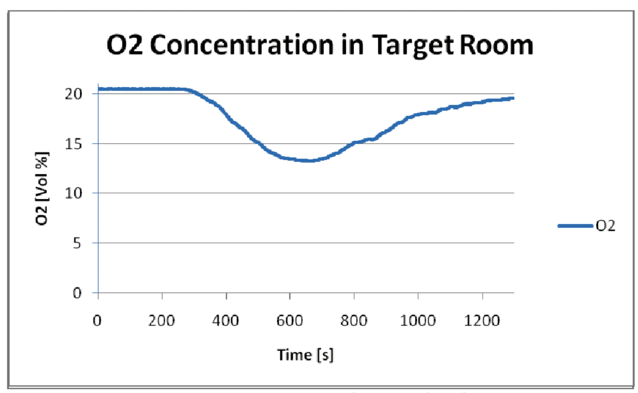
2-Person, Late Arrival



2-Person, Late Arrival



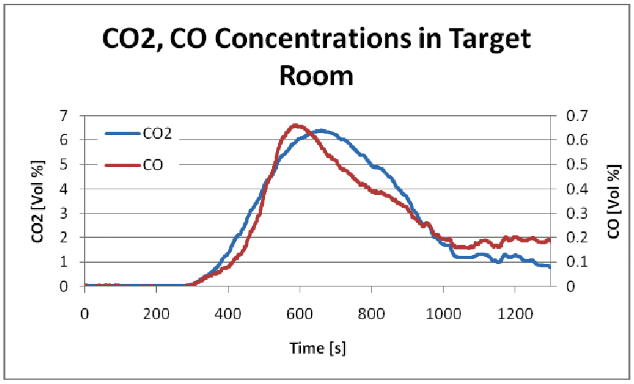
3-Person, Early Arrival



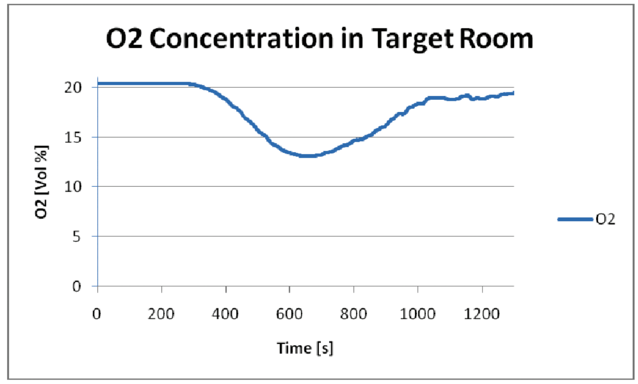
3-Person, Early Arrival

Gas and Temperature Data for Room and Contents Tests

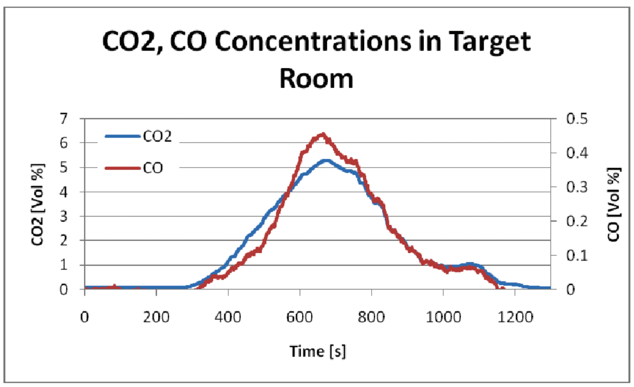
Examples of Gas Data in Target Room



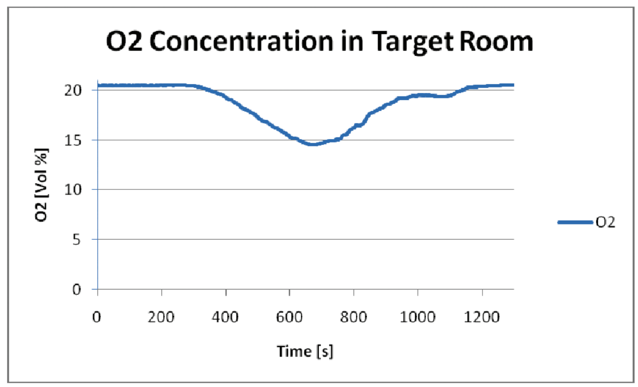
3-Person, Late Arrival



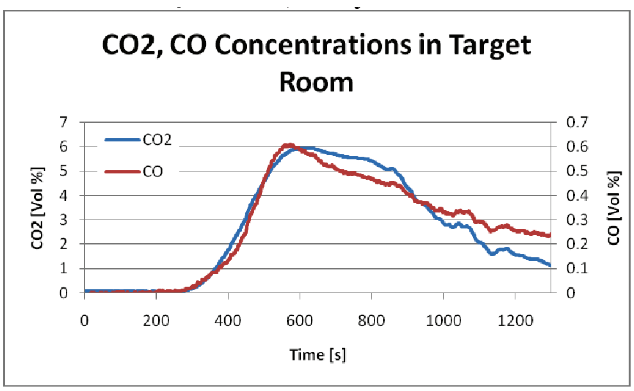
3-Person, Late Arrival



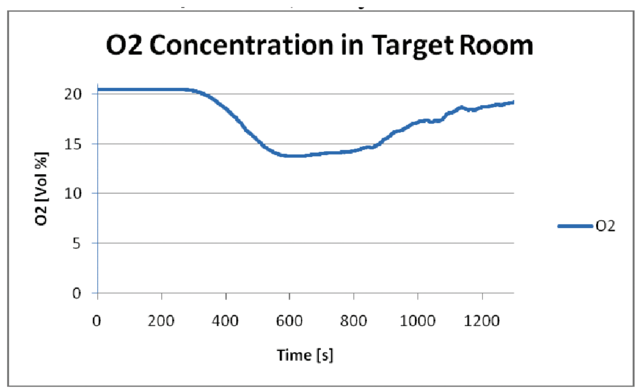
4-Person, Early Arrival



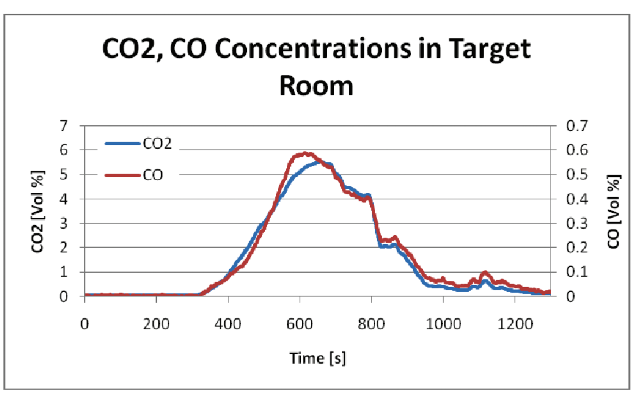
4-Person, Early Arrival



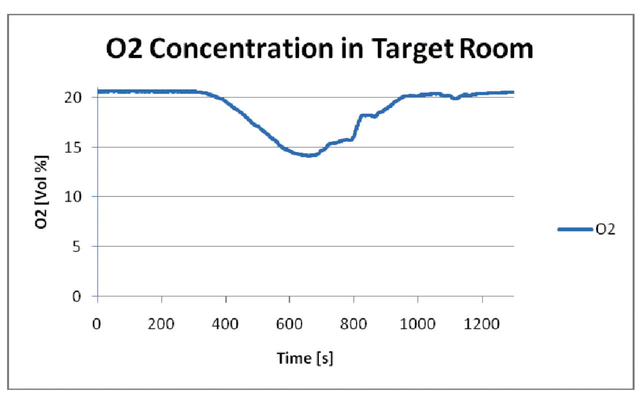
4-Person, Late Arrival



4-Person, Late Arrival

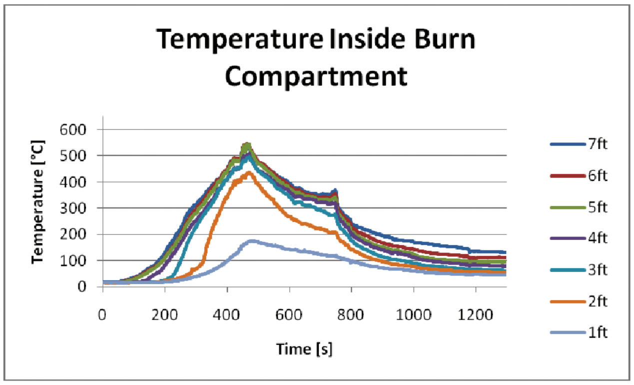


5-Person, Early Arrival

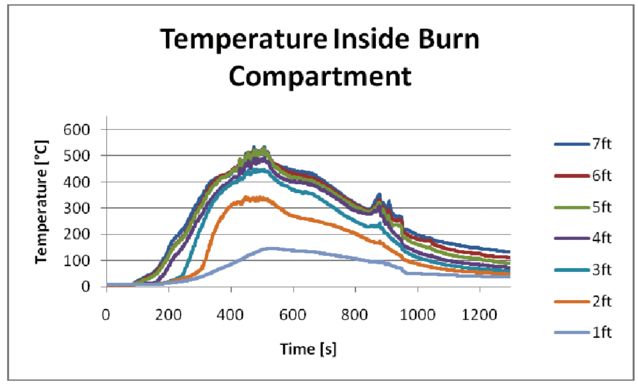


5-Person, Early Arrival

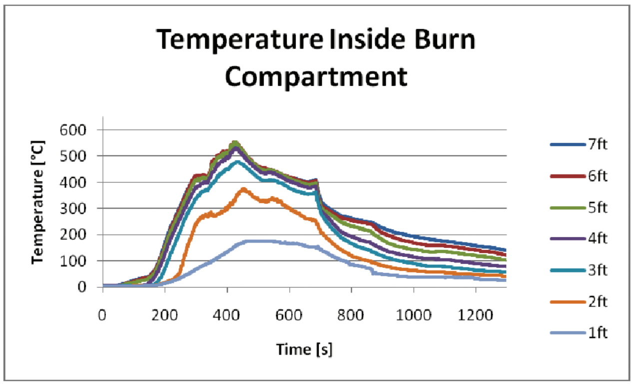
Temperatures in Burn Room



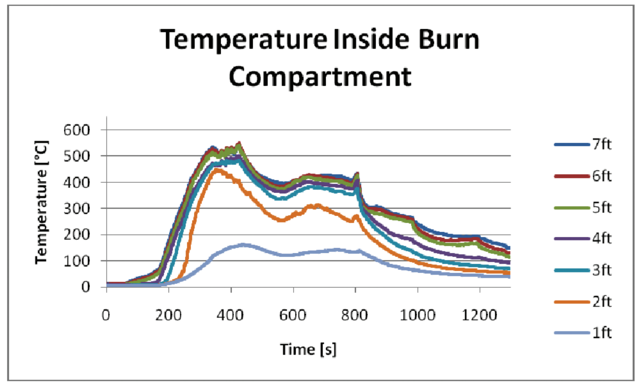
2-Person, Early Arrival



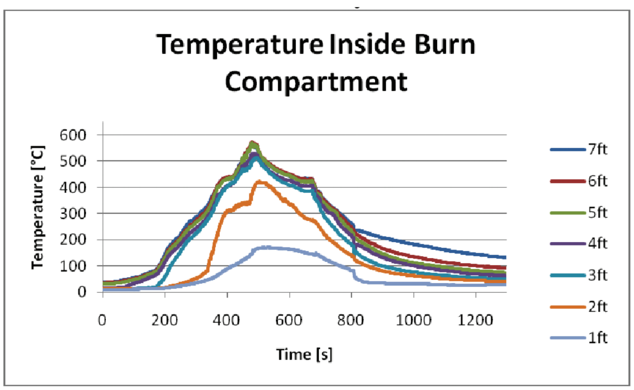
2-Person, Late Arrival



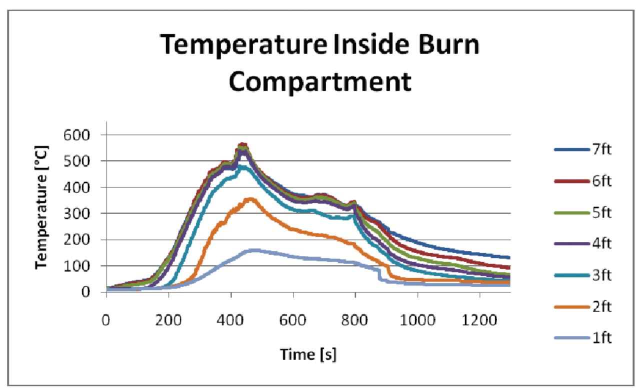
3-Person, Early Arrival



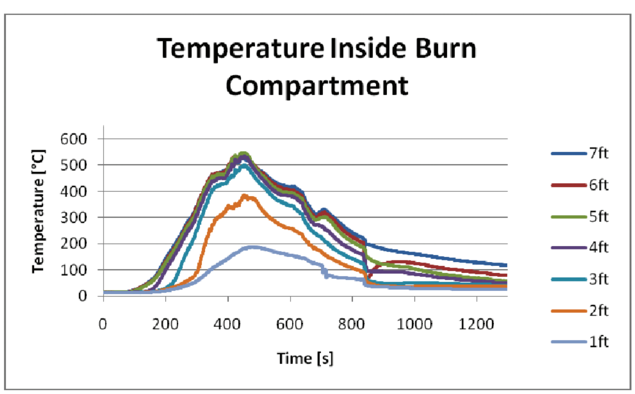
3-Person, Late Arrival



4-Person, Early Arrival

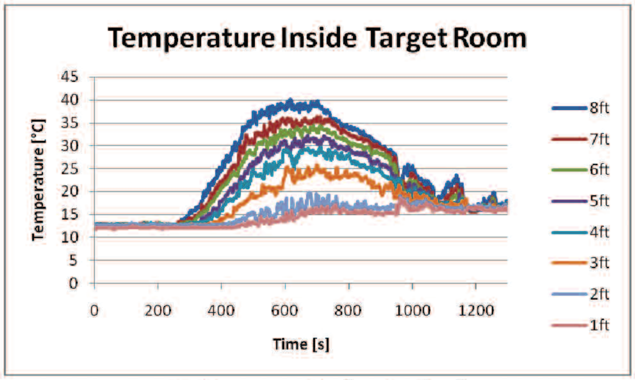


4-Person, Late Arrival

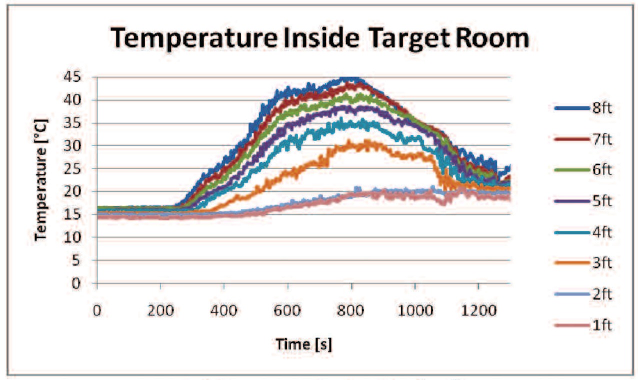


5-Person, Early Arrival

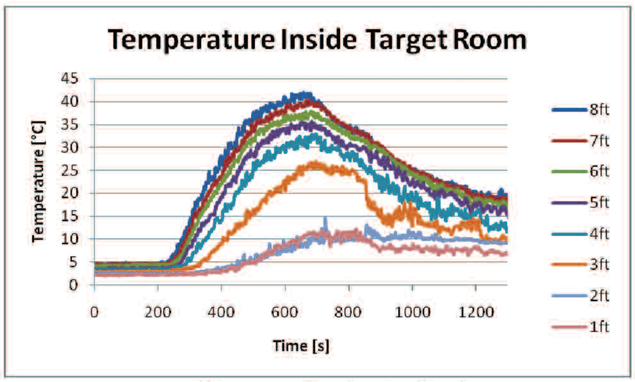
Temperatures in Target Room



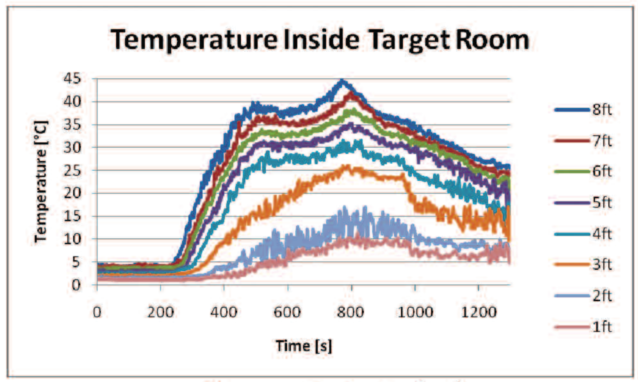
2-Person, Early Arrival



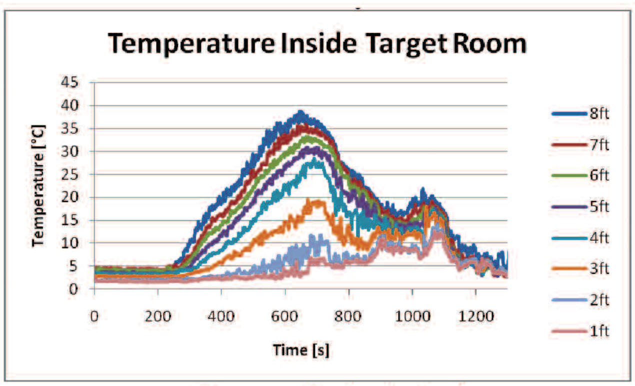
2-Person, Late Arrival



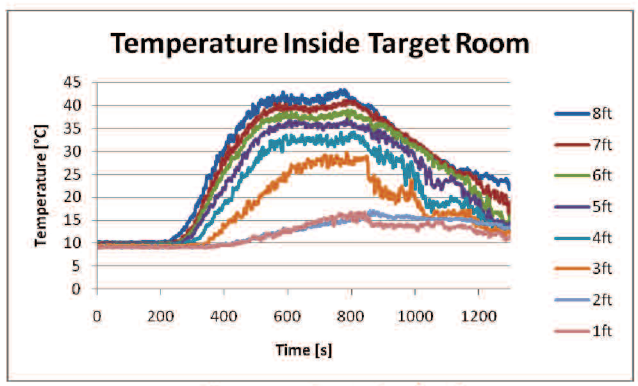
3-Person, Early Arrival



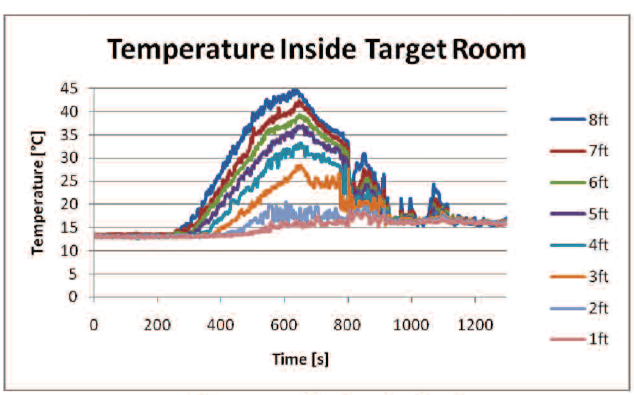
3-Person, Late Arrival



4-Person, Early Arrival

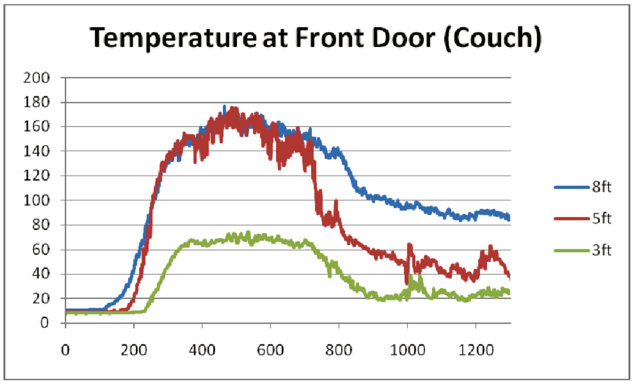


4-Person, Late Arrival

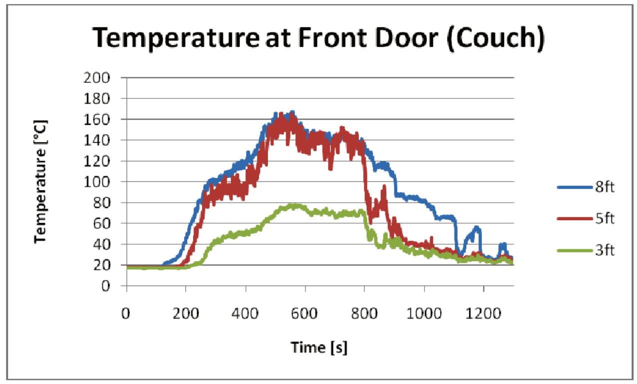


5-Person, Early Arrival

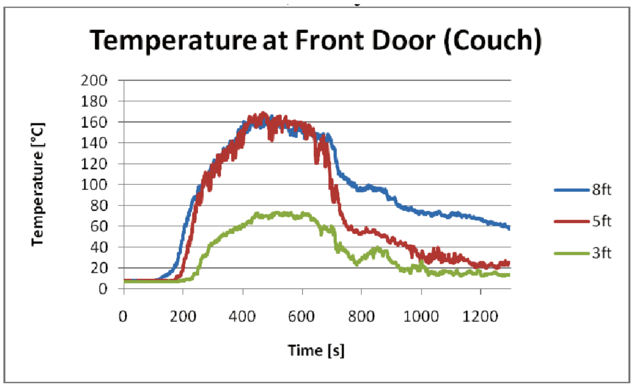
Temperatures Near Front Door (Couch)



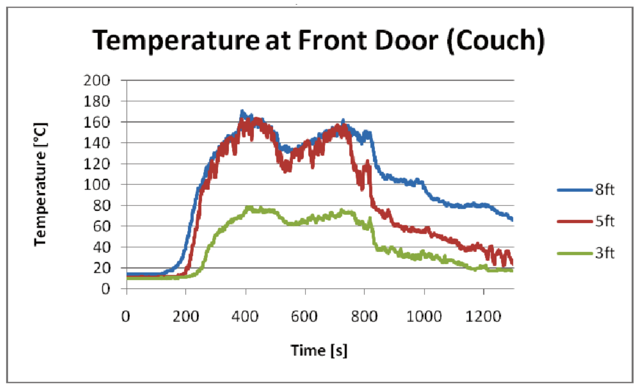
2-Person, Early Arrival



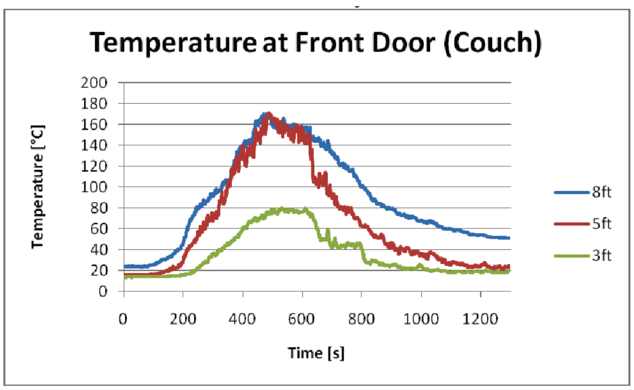
2-Person, Late Arrival



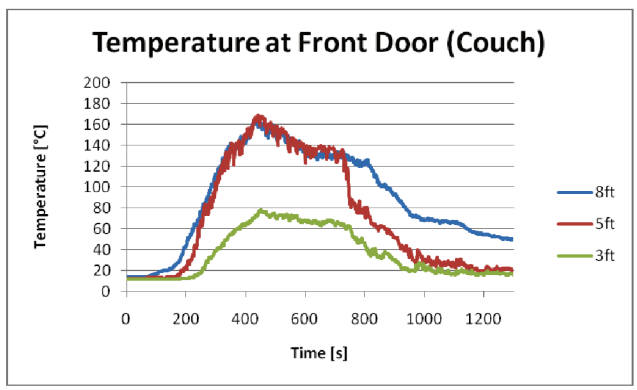
3-Person, Early Arrival



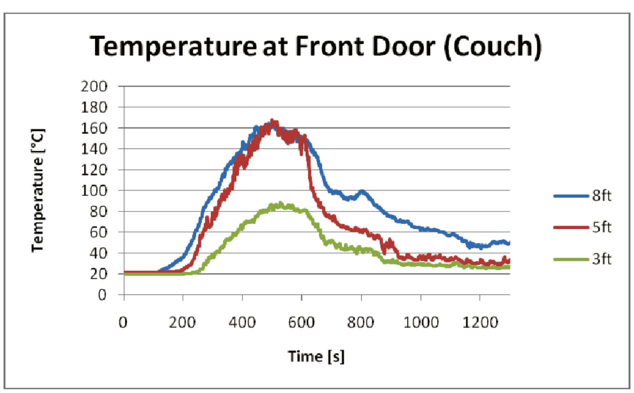
3-Person, Late Arrival



4-Person, Early Arrival



4-Person, Late Arrival



5-Person, Early Arrival

NOTES:

APPENDIX C

Municipal
Resources

Survey: Dracut Fire - Employee Survey

Report: Default Report

Survey Status		Respondent Statistics		Points Summary		
Status:	Closed	Total Responses:	37	Max Attainable:	0	100%
Deploy Date:		Completes:	37	Highest:	0	0%
Closed Date:		Partials:	0	Lowest:	0	0%
				Average:	0	0%
				Median:	0	0%

1. My position with the Department is:

	Responses	Percent
Firefighter:	20	54.05%
Fire Lieutenant:	9	24.32%
Fire Captain:	4	10.81%
Chief Fire Officer:	3	8.11%
Civilian Employee:	1	2.7%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

2. The facility where I work provides a clean and safe environment in which to deliver a professional level of service.

	Responses	Percent
Strongly Agree:	5	13.51%
Agree:	8	21.62%
Neutral:	6	16.22%
Disagree:	13	35.14%
Strongly Disagree:	5	13.51%
Additional Comments:	20	54.05%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

2. The facility where I work provides a clean and safe environment in which to deliver a professional level of service.

Response	Comments
1	Station #3, no vent for exhaust
2	Depends on the building
3	No exhaust elimination system at 3- mold issues sta. 1 + 2
4	All stations: doors are open until 10:00pm on warm days. Lends itself to theft and safety risks. Station 3: Diesel fumes from truck lingers in the bay as a result of no plymo vents or exhaust filters;
5	Sta 3 the oldest station should be closed due to having no exhaust eliminating system. Members are breathing toxic fumes. when problems happen they should be addressed.
6	NO exhaust removal, no seperation of gear; lockers between apparatus (illegible)
7	The buildings are cleanfor what you can see but the dept still has not answered or fixed problems that were discovered by Mass Health and safety 8yrs ago. IE cleaning of air ducts, exhaust elimination
8	Clean but not safe. When our front line engine 3 went out of service we were told to drive engine 4 with significant tire wear. Tire was so bald that in the rain and sitting in the officers seat, I fe
9	Sta 3, the oldest manned station is nothing more than garage w/ a 280 sq ft room w/ 3 guy on some days. The bldg is not equipped for proper ventilation, drafty in the winter and the spare truck used y
10	stat #3
11	Mold on ceiling tiles, bay doors always open so anyone can walk in until 10pm in good weather
12	Sta 1 and 2 are good. Sta 3 living quarters are not up to par, requires more space for a 3 man apparatus and may need larger facilities for future expansion due to heavier call volume in that district
13	Spare trucks only work with Plymo at Sta 1, No Plymo at Sta 3. Truck maintenance is a joke to say the least, Sta 3 has heating issue to include CO in locker room
14	We the firefighters clean the facility
15	Station 3 doe snot have adequate exhaust removal system and 3 people are working in an area hardly big enough for 2.
16	Need for Plymo vent exhaust in all station
17	Diesel fumes get into the bunkroom.
18	Sta 1 has a bay w/o exhaust recovery. Sta 2 has no exhaust recovery in the lower level. Sta 3 has no exhaust recovery at all. The exhaust recovery systems that do exist are not compatible at the conne
19	Sta 3 is small and outdated, very tough to work with 3 people, pretty much on top of eachother, truck fumes are an issue.
20	Sta 3 is not clean and safe; Sta 2 is

3. My department is a well managed organization.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	5	13.51%
Neutral:	8	21.62%
Disagree:	11	29.73%
Strongly Disagree:	11	29.73%
Additional Comments:	15	40.54%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

3. My department is a well managed organization.

Response	Comments
1	Intimidation
2	Not on same page, input not well taken/at all, micro-managing breeds incompetence
3	Chief subject to mood swings, uses bully tactics + threats of firing
4	Chief mismanages funds, I.e. winter 2015 we ran 2 members at each station. Then at the end of the fiscal year the chief had extra money that he needed to spend. It was expected that FF's worked the OT
5	Ineffective management. Chiefs, past + present have had no administrative leadership, management and most of all no people skills
6	Inconsistent, unlcear who has answers
7	The dept is managed poorly, financially, communications wise and micor managed by deputies and chief
8	Upper management micro-manages officers, captains should be able to run their shift however they deem necessary
9	Some individuals like to keep information to themselves or just looking out for themselves for promotions (Dep. R. Patterson, J. Kohanski)
10	The Chief doesn't know how to budget. We run short 1/2 year then Chief try to fill everything in the month of June putting guys on 4 to 6 shift in a row
11	SOP's/SOG's were just reviewed or put in place for assessment. But there was no formal training on new protocols or open discussions with people that have to perform these duties. Management puts new
12	Chief doesn't have management skills, financial or personel wise
13	Could be stronger
14	To much micro - managing
15	Examples- the budget as it goes to staffing/OT. In FY15 staffing levels were dropped to "minimum" staffing of 6 in suppression for several months. Even with heavy snow most shifts were left short. The

4. There is a high level of mutual respect across all ranks within the department.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	3	8.11%
Neutral:	6	16.22%
Disagree:	14	37.84%
Strongly Disagree:	12	32.43%
Additional Comments:	17	45.95%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

4. There is a high level of mutual respect across all ranks within the department.

Response	Comments
1	Input not received, insubordination/lack of respect for rank
2	Officers promoted under civil service think they are better than officers promoted before civil service
3	2 Acting Captains with little respect from any rank
4	Chief and senior Deputy are condescending, territorial and inflexible. They do not foster learning, team building or education. They do not welcome ideas or input from staff. Chief has had heated argu
5	There is no respect, none w/i the ranks due to the attitude of certain officers, continuously belittling, intimidating personnel. You lead by example, helping each other, not by beating people up
6	From top down no
7	There is disrespect among some as you know who are the special chosen ones are by the brass.
8	There is little respect going up and hardly any coming down from the top. Respect is a two way street and I think all employees need to work on it.
9	This place is a joke when it comes to seniority unless you are a deputy chief or higher. Bad mouthing of others is a constant occurance
10	Chief, Senior Deputy talk down to personnel. Rank doesn't matter.
11	Lieutenants and captains get micromanaged from chiefs.
12	They belittle you
13	Chief does not respect many, possibly any employees, other officers have respect issues and some firefighters don't respect officers, possible trickle down effect.
14	Condescending attitude from ranking officers does nothing for morale.
15	officers and chief officers pull rank too often
16	little respect in the ranks
17	While the chief demands respect going up the chain, it is non-existent going down. Frequently members are met with "are you the chief/deputy/capt" when trying to hold discussion or give input. "are yo

5. I receive the support and encouragement from my department that I need to be successful.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	6	16.22%
Neutral:	10	27.03%
Disagree:	12	32.43%
Strongly Disagree:	6	16.22%
Additional Comments:	13	35.14%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

5. I receive the support and encouragement from my department that I need to be successful.

Response	Comments
1	No mentor program, no officer development
2	Upper management (Chief, Sr. Dep) will berate personnel when they ask questions or ask for clarification. Some staff do not readily or openly share info that fosters learning. There is no grooming pro
3	Very poor morale! Personnel do not want to work OT, call back etc. due to continous arrogance of certain officers
4	Not without negative inflections when asking your support
5	As FF's I believe we do not receive support or encouragement from the Dept. As a probationary FF you are constantly made fun of, threatened to be fired, and questioned if you can pass the Fire Academy
6	The dept does not support personnel but rather brow bash younger personnel who try to do things right. And the dept does not recognize the small things personnel do.
7	After taking and passing the LT promotional civil service test, I was told I must have had a "lucky saturday". Implying that all the studying I had done didn't mean a thing. Just recently took the Ca
8	Having a degree in fire related or EMS means nothing. You ask questions cause of being unfamiliar with a location or building, you get "you should know that!" by Kohanski
9	Senior Deputy always make comment about personnel doing it wrong with no support on fixing problem saying they should think but some cannot think on their own
10	Capt on my crew "doesn't give a fuck" in his words. No officer training at all. When I make suggestions for bettering Dept it is looked down upon, some upper level officers including the Chief view ag
11	Some support from some others not so much
12	Support and encouragement are all but non-existent.
13	in a lot of ways your expected to be successful on your own but at the same time looked down upon if you don't work together. Depends on the managements "mood" or goal for that

6. All department employees share in a common understanding of current goals and a vision of the future.

	Responses	Percent
Strongly Agree:	1	2.7%
Agree:	8	21.62%
Neutral:	7	18.92%
Disagree:	18	48.65%
Strongly Disagree:	3	8.11%
Additional Comments:	14	37.84%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

6. All department employees share in a common understanding of current goals and a vision of the future.

Response	Comments
1	old school vs. new school
2	Chiefs wants to look into an ambulance. Deputies don't.
3	Goals are not discussed. The Chief is not receptive to others' ideas.
4	There is an enormous amount of talented individuals in this dept dedicated, hard working members who are just disgusted w/ the day to day operations of this dept.
5	Moral is to blame. Small group is in the know
6	FF's and officers share a common understanding of current goals and vision of the future, most are proactive. Upper level management voices their vision, but I feel they don't have a plan to put anyth
7	I do not think there is one common goal of this dept other than a new sta 3.
8	Yes we have a mission and vision statement for the dept but we are definitely not all on the same page.
9	Chief try to do more with less man power and some of us don't even know the plans for the future
10	Goals change all the time due to chief. No clear understanding of direction, chief sometimes tries to take on to many fights at one time.
11	Some do, Chief changes his mind on "goals and vision" too often for anyone to follow.
12	Communication is an issue in this dept.
13	The chief has implemented radical changes to our operations and run order. While he has talked about re-assigning personnel to create 3 person apparatus response in the month of Jan. he reassigned 1 m
14	everyone has their own "visions", a lot of conflict comes from this in different ways.

7. Expectations for the performance of department members are made clear to all employees.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	14	37.84%
Neutral:	9	24.32%
Disagree:	9	24.32%
Strongly Disagree:	3	8.11%
Additional Comments:	10	27.03%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

7. Expectations for the performance of department members are made clear to all employees.

Response	Comments
1	Not all senior officers on same page
2	The members are dedicated but are just not happy with the current atmosphere
3	This is based more of our commitment than clear expectations
4	No the dept lacks SOG's.
5	Negative. Only when you do something wrong, is it made clear.
6	Expectations change all the time. Different commanders require different ways.
7	See above. No officer training, rules and regs as well as SOP's and SOG's out of date adn there is only copies at sta 1
8	Communications is an issue in this dept.
9	The CHief states frequently, as he had when he was a Capt, that we need a better chain of command as well as allow line officers to run the shift and let people do their jobs. Yet he continues to micr
10	your expected to do more with less, for example running 2 man engines, which is extremely dangerous, we feel like the town doesn't care or doesn't understand the danger

8. The utilization of internal discipline for policy and rule violations are administered in a fair and consistent manner.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	6	16.22%
Neutral:	5	13.51%
Disagree:	13	35.14%
Strongly Disagree:	10	27.03%
Additional Comments:	15	40.54%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

8. The utilization of internal discipline for policy and rule violations are administered in a fair and consistent manner.

Response	Comments
1	They have favorites
2	There are favorites and fall-guys
3	1 member forced to move back into Town, one not
4	Disgruntled employees are sent to outying stations rather than being dealt with at station 1 with the capt, deputies and chief
5	Discipline has always been unfair and selective. If a person complaints and goes against the brass they are reprimanded. Favorites can do as they please.
6	No one set process. We have had everything from counseling statements to a hearing/investigation by Dep. Police Chief
7	Internal discipline is not administered fairly. Current members on sick and disability leave are often criticized. A previous employee was put on house arrest while out sick, having to call the dept e
8	No they are not; depends on the person involved.
9	There is no consistency with discipline whatsoever. Employees have been banished to perform dispatch duties for years for discipline. Others were put on "house arrest" or paid leave pending a court ca
10	Definitely not the case, certain folks can live out of town, others get forced into town. A huge investigation was put into play with the deputy police chief, who has his own issues, when a FF was fou
11	Depends on personalities, deputy's treat similar events regarding failures or violations of policies differently. One person will not get in trouble and another will.
12	Depends on who you are!
13	Depends on the individual
14	Different roles for different people
15	Discipline is administer inconsistently. Chief has been known to go on a tantrum on unrelated subjects when a member of the union challenges him on an issue. While the rules and regs are currently und

9. I receive adequate training to perform my duties as an employee of the department.

	Responses	Percent
Strongly Agree:	6	16.22%
Agree:	15	40.54%
Neutral:	7	18.92%
Disagree:	8	21.62%
Strongly Disagree:	1	2.7%
Additional Comments:	11	29.73%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

9. I receive adequate training to perform my duties as an employee of the department.

Response	Comments
1	out-dated training, excessive non-pertinent training, difficult to conduct own training
2	Basic daily drills
3	Training is improving but a lot including RIT training is repetitive. there are many new members that need to know streets, hydrants, panels, utility shut offs, access to buildings etc.
4	Same repetative annual training and not enough updated skills
5	As a dept we do receive a lot of training; I believe a lot of the drills and training exercises are outdated, use old equipment or do not pertain to our dept. There is also no uniformity in training.
6	No training lacks funding IE: foam is too expensive to drill with
7	I do receive training on a daily basis, however year after year it's all the same training and videos. Also, depending on the Officer performing the training, evolution's may be done differently leadi
8	Dept. does train on a consistent basis but can be problematic with consent change as far as sog's. Dept does not train as we actually run and can be unrealistic. Drills during summertime can be to muc
9	EMS training is adequate, firefighting training is ok, rescue training is sub par, officer training program non existent.
10	Frequently training is by "u-tube" videos. Some training is repeated annually, namely RIT, has been a hot topic. While this is important and valuable skill, it takes weeks and weeks of the training sc
11	Sometimes inconsistent, not enough basics, too much hig end rescue etc.

10. Internal training opportunities are distributed on a fair and equitable basis.

	Responses	Percent
Strongly Agree:	4	10.81%
Agree:	17	45.95%
Neutral:	8	21.62%
Disagree:	7	18.92%
Strongly Disagree:	1	2.7%
Additional Comments:	8	21.62%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

10. Internal training opportunities are distributed on a fair and equitable basis.

Response	Comments
1	not sure I understand
2	Due to limited staffing, EMD training is inadequate. The dept is not doing it correctly (e.g. Q & A)
3	A designated training officer should be in place and all units should follow the same standards. when officers disagree they should be dealt with accordingly
4	New training Deputy is doing a better job of this.
5	Emd class alway fall short. Not trained properly
6	Deputy Chief's got trained on equipt and don't teach lower ranks leaves gaps in how certain eqpt operates. Dept does not conduct any mentoring of employees.
7	Internal training is scheduled on every crew, but mandatory training for things like EMD is only offered as a bare minimum and if you have a scheduled vacation during that class you are out of luck.
8	Internal training as it goes to the "daily drill" is fair and equitable. Very little financial backing is given to the area. Thus training by U-tube. The contract with the local EMS provider is part o

11. External training opportunities are distributed on a fair and equitable basis.

	Responses	Percent
Strongly Agree:	5	13.51%
Agree:	9	24.32%
Neutral:	11	29.73%
Disagree:	8	21.62%
Strongly Disagree:	4	10.81%
Additional Comments:	13	35.14%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

11. External training opportunities are distributed on a fair and equitable basis.

Response	Comments
1	For those that seek such training, many do not
2	Hand picked, not even offered to all
3	Favoritism
4	The opportunities are not available to the entire staff. Chief selects who will go. There is no protocol in place.
5	Again, training is important, but should be beneficial + not punishing. Doing RIT training in 900 degree weather for a month in the summer is abusive.
6	Not many given. These are more self obtained.
7	External training opportunities are available, but not posted or brought to the dept's attention as it should.
8	No again lack of funding and chosen personnel by chief
9	If we had a consistent training officer, academy classes could be posted and guys would be aware of upcoming classes. There have been individuals that were offered specific courses (fire inspector, CP
10	These are generally not distributed it's up to individuals to seek knowledge
11	Certain individuals are provided the opportunity to take classes on the Dept dime or on duty. Mostly Deputies and Chief.
12	External training is not financially backed. Thus few seek it out. No time off, no OT and any fees are out of pocket. Chief is known to seek out the same members for special academy training thus givi
13	None

12. I believe that the department should provide additional non fire related training in areas such as technology, personnel management, health and employee wellness.

	Responses	Percent
Strongly Agree:	16	44.44%
Agree:	15	41.67%
Neutral:	3	8.33%
Disagree:	2	5.56%
Strongly Disagree:	0	0%
Total Responded to this question:	36	97.3%
Total who skipped this question:	1	2.7%
Total:	37	100%

13. I receive personal and professional satisfaction from my job with the department.

	Responses	Percent
Strongly Agree:	15	40.54%
Agree:	12	32.43%
Neutral:	6	16.22%
Disagree:	4	10.81%
Strongly Disagree:	0	0%
Additional Comments:	12	32.43%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

13. I receive personal and professional satisfaction from my job with the department.

Response	Comments
1	I love helping people
2	On my own doing, self- motivated
3	Did not apply for promotion- officers treated poorly
4	I am satisfied when working with the community and helping others. I receive little professional satisfaction when working with upper management.
5	I love my job, it is by far the best job in the world, most of the members are great it just that handful that have a superiority complex that destroy the morale every single day with their actions.
6	Love of the job.
7	I did but the uphill battle to stay positive here makes you feel less professional
8	I love my job as a FF, just disappointed in the Towns support.
9	I love helping people but working in Dracut has proved disillusional
10	I receive personal satisfaction performing my duties. I think professionally the Dept is far behind due to leadership.
11	As most all FF's I love my job. People don't take this job for the money or the benefits as we know. The satisfaction of helping people in their time of need is rewarding and satisfying. I can't say t
12	I'm always proud to tell people what I do for a living!

14. I receive timely feedback from my supervisors.

	Responses	Percent
Strongly Agree:	4	10.81%
Agree:	10	27.03%
Neutral:	6	16.22%
Disagree:	13	35.14%
Strongly Disagree:	4	10.81%
Additional Comments:	14	37.84%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

14. I receive timely feedback from my supervisors.

Response	Comments
1	Only negative feedback
2	Depends if it is something they want to talk about
3	If an officer doesn't seem to think it's a issue/problem it's not addressed.
4	Not without repeated request
5	No not unless it concerns them directly
6	I hardly receive any feedback from my supervisors. On multiple occasions I have saved a civilian adn it went unnoticed or acknowledged. A "good job" goes a long way.
7	With the Lt or Capts ask a question like, what was fixed on the truck you get "I don't know". Why!
8	Issues when the trucks. It may take a few weeks then Senior Deputy says are you a mechanic
9	Depends on situtations and events
10	I don't receive feedback unless I push for it then I get attitude.
11	From some not others
12	Feedback is usually only negative
13	Feedback, when offered, is 95% negative and offered in a hostile, cambative manor. As I have been told, and I quote from the chief; "This is an ass chewing, not a discussion, you may think we live in
14	But even if you do something perfect some supervisors always find negative or not up to par comments to say, not all do though

15. Do you receive an annual personnel evaluation? If yes, is this process timely, useful and meaningful.

	Responses	Percent
Yes:	0	0%
No:	36	100%
Additional Comments:	5	13.89%
Total Responded to this question:	36	97.3%
Total who skipped this question:	1	2.7%
Total:	37	100%

15. Do you receive an annual personnel evaluation? If yes, is this process timely, useful and meaningful.

Response	Comments
1	Union Employee
2	prohibited by CBA
3	Wish we did, informal
4	I do my job with pride and integrity and should not have to be evaluated. The certain officers who bash people should be evaluated.
5	We have been told of them but have not had one

16. Does the department provide incident command (ICS) training to all members on an annual basis?

	Responses	Percent
Yes:	16	43.24%
No:	21	56.76%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

17. The National Incident Management System (ICS) is utilized at every incident?

	Responses	Percent
Strongly Agree:	5	13.51%
Agree:	11	29.73%
Neutral:	8	21.62%
Disagree:	13	35.14%
Strongly Disagree:	0	0%
Additional Comments:	9	24.32%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

17. The National Incident Management System (ICS) is utilized at every incident?

Response	Comments
1	Every incident is different. The Chief freelances
2	Free for all, not on same page
3	ICS is utlilized during the day but it's modified at night. No deputy on duty at night.
4	Most of the time?
5	Depends on OIC
6	There is a command presence but the passing of command from first arriving officer to the Deputy is not done correctly. First arriving officer maintains command until some sort of update is relayed. D
7	Chief officers attempt to impliment ICS but don't follow it themselves. They don't seem to understand passing of command.
8	No Deputy Chief at night shifts
9	Under staffing makes that very difficult if not impossible

18. The leadership team (Chief and Deputies) are strong advocates for the needs of the Department.

	Responses	Percent
Strongly Agree:	4	10.81%
Agree:	7	18.92%
Neutral:	10	27.03%
Disagree:	10	27.03%
Strongly Disagree:	6	16.22%
Additional Comments:	8	21.62%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

18. The leadership team (Chief and Deputies) are strong advocates for the needs of the Department.

Response	Comments
1	Leadership will not listen to members/dept. of what needs are actually are. Snowblowers over compressor repair, buy paint for doors but H.U.D. doesn't work
2	New car 1 for chief, no exhaust system at 3, living conditions substandard at station 3
3	Manpower vs funding! They advocate for needs with no results.
4	Agenda's seem to dictate perceived needs.
5	Absolutely not! The health of FF's: random physical test, exhaust in Sta 3, cramming 3 guys in one station. Mold in ceiling. Tires reported unsafe or bald, they say their fine or they get moved to
6	Chief has idea but has awful people skills. Not good for Dep Patterson is too political and seems to only advocate for the Dept when he will gain. Patterson and Chief don't respect Dep. Mackey.
7	One deputy seems to have his own agenda. The Chief has done some great things for the dept but lacks helping needs for individuals
8	Inconsistent not always unified

19. Department employees are treated fairly and equitably when it comes to shift assignments and specialty positions.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	6	16.22%
Neutral:	6	16.22%
Disagree:	14	37.84%
Strongly Disagree:	9	24.32%
Additional Comments:	12	32.43%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

19. Department employees are treated fairly and equitably when it comes to shift assignments and specialty positions.

Response	Comments
1	Chief is always moving us to different stations when he wants.
2	Chief re-assigns people as he sees fit. move stations yearly
3	Confrontational employees are shipped out to outlying stations. Acting positions are filled with the Chief's friends.
4	Chief has the power of assignments, but people with less than 3 -5 years on the job should not be in outlying stations. You need to learn the job first.
5	Assignments are used negatively in many cases if individuals are not liked by OIC
6	The Chief has threatened to demote new officers with in their probationary period if they do not "straighten out the crew". Also threatens to shift new members around on different crews because he can
7	No the chief likes it when units don't get along
8	Shift assignments just most recently got re-assigned by the Chief despite what the Captains wanted to do with their own crew. Captains know the strength and weaknesses among their members and would be
9	Seniority should get more benefits
10	Specialty positions go to certain individuals. Shifts are set fine, station assignments have no regard for seniority.
11	There is no seniority
12	While the Chief was a strong advocate of seniorityas well as allowing capt's to run the shift, he has consistently goen against this, making assignments and re-assignments w/o consultation. Chief also

20. I have witnessed acts of discrimination based upon race, sex, age, ethnic origins, or sexual orientation from department employees toward members of the public.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	4	10.81%
Neutral:	6	16.22%
Disagree:	9	24.32%
Strongly Disagree:	15	40.54%
Additional Comments:	7	18.92%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

20. I have witnessed acts of discrimination based upon race, sex, age, ethnic origins, or sexual orientation from department employees toward members of the public.

Response	Comments
1	Seen Chief do this, not other members
2	Members of the dept. treat the public fairly and with respect.
3	I personally am not happy with the way I, or my or my fellow members have been respected over the years and this should be addressed sooner of later.
4	Chief of Dept. is one of the biggest offenders making racial references constantly and ethic related negative comments
5	Chief has been known to call the President of the US a "nigger".
6	Both the Chief and one of the Deputy's will make adverse comments about members of the public. The Chief is not shy about sharing political views, often with vulgar, discriminatory and offensive langu
7	once, but the individual has retired

21. The vehicle fleet of the department is well maintained and provides safety for personnel and a strong operational platform.

	Responses	Percent
Strongly Agree:	6	16.22%
Agree:	7	18.92%
Neutral:	8	21.62%
Disagree:	7	18.92%
Strongly Disagree:	9	24.32%
Additional Comments:	18	48.65%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

21. The vehicle fleet of the department is well maintained and provides safety for personnel and a strong operational platform.

Response	Comments
1	Some items are overlooked at times. Ex. tires
2	Mismanagement of budget. Brand new vehicles for leadership team, while driving on bald tires, no compressor, faulty brakes
3	Safety repairs based on availability of mechanic time, not degree of danger
4	Maintenance does not always happen in a timely manner.
5	When trucks/engines have ssafety issues they should be taken out of service until repaired. Bald tires, air leaks etc. Vehicles should be inspected by State Police.
6	We have ran with bald tires, non working pump on previous eng's for a year even after failure at a fire on 7/10/14
7	Repairs such as tires, drivers seats, front end work have been ignored. Officers were told to have the drivers drive slower in bad road conditions because of bald tires. Most equipment that is taken o
8	No the fleet repairs are only done when the DPW has time or the personnel strongly complains. The use cheap fix's as recap tires on emergency vehicles and aging tools instead of replacing them
9	Engines that go out of service for maintenance or repairs come back from maintenance adn we are never told what was fixed. The front tires on Eng 4 were extremely worn down adn noticeable loss of trac
10	Absolutely bullshit. The "new" Eng 3 is in for repairs more than it's been on the road. Tires, exhaust, optican light being unservicable. On other vehicles are an issue.
11	Tires are always an issue
12	We have difficulty getting front tires for emergency apparatus. Command will ignore serious requests from junior members regarding equipt failure or needing repairs. Deputy's do not communicate all fl
13	We have been verbally ordered to drive trucks with bald tires. When problems get fixed it is often done in a half assed manner.
14	The runnin gof bald tires on frontline apparatus isn't addressed in a timely manner. Back up air compressor in trucks out of service for months.
15	Backup fleet needs to be updated for health reasons
16	Tires are a huge and ongoing issue on aparatus. A side wall rear time "cut" was notice on Eng 1 while a private vendor was in doing a driver training class. Vendor stated the tire was unacceptable and
17	Some are, some aren't, but I don't think it's the dept's fault, again we "the fire dept" are expected to do more with less.
18	with the money the dept has

22. The Policies and Procedures as well as the Rules and Regulations of the department provide clear guidance for performance to all employees.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	5	13.51%
Neutral:	7	18.92%
Disagree:	16	43.24%
Strongly Disagree:	6	16.22%
Additional Comments:	16	43.24%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

22. The Policies and Procedures as well as the Rules and Regulations of the department provide clear guidance for performance to all employees.

Response	Comments
1	W're working on them due to assessment coming
2	CBA, rules + regs, SOP's all open now due to assessment. Run card changed as well
3	Rules, regulations and certain SOG's need to be updated. This has not happened w/i the past 3 years. Since the Dracut Police audit the Chief has begun to implement new SOG's and update rules and regs
4	And should be follow by all personnel. This is Union Dept with a CBA, ratified by the Town and Union and should be complied by all members in good standing
5	They are extremely out dated adn hav ebeen put under review as of Jan 2016 for the first time since 1999.
6	The rules and regulations are outdated, not having been revised since the 1980's.
7	No the chief rules under the gray areas and has personnel doing repairs to endanger or fatigue us. IE: shoveling snow off station roofs, repairing slop sink drains, snow raking the elderly housing bui
8	Until last 3 months policies and procedures and rules/regs haven't been touched since 80's
9	Considering they are only being updated and revamped because of this survey.
10	Rules and reg are old need to be updated
11	They are out dated and Chief picks and chooses wha to enforce.
12	very unclear
13	They are being reviewed. Outdated
14	SOG's and SOP's are weak, disorganized, out dated, and much that exists allows for too much interpretation. They also freely allow for the 4 capts to make adjustments as they see fit. Thus between the
15	SOG's are outdated and only now being looked at because of this assessment.
16	SOG's and SOP's are sometimes outdated. I believe new SOG's are currently being developed.

23. I believe that the department's internal communications (orders, directives, memos, emails and newsletters) are adequate.

	Responses	Percent
Strongly Agree:	1	2.7%
Agree:	5	13.51%
Neutral:	7	18.92%
Disagree:	17	45.95%
Strongly Disagree:	7	18.92%
Additional Comments:	14	37.84%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

23. I believe that the department's internal communications (orders, directives, memos, emails and newsletters) are adequate.

Response	Comments
1	Everyone not on same page
2	Memo's left on tanle with no explanation
3	Info is not forthcoming. Since the Dracut police audit, email was implemented. However I have not received any info or memos via email.
4	Favorites, some people know what's going on, some don't. No unity! When officers and management fail to communicate it's a domino effect.
5	Many times communications are verbal or followed by memos after the fact with no normal review
6	Our internal communications are not adequate. It's 2016 and members just received dept email.
7	No they very seldom come out signed or posted unless it something to do with of importants. They like controversy.
8	No standards are set, memos are pieced mailed togther.
9	We just got an email for all of us, but before to find anything out you had to be in the inner circle
10	Chief puts out memo's for everything. Instead of saying changes have been made to ops-001 of sop/sog he just makes up new rules.
11	Most are delivered as punitive measures or knee jerk reactions from the chief.
12	Communications are unclear sometimes
13	Lack communication
14	Take a look at the bulletin boards and tables around the 3 stations. Email although we are told has been in place for years has just been given to us with passwords and instructions. I have yet to rec

24. Promotions within the department are made fairly.

	Responses	Percent
Strongly Agree:	7	19.44%
Agree:	12	33.33%
Neutral:	10	27.78%
Disagree:	6	16.67%
Strongly Disagree:	1	2.78%
Additional Comments:	15	41.67%
Total Responded to this question:	36	97.3%
Total who skipped this question:	1	2.7%
Total:	37	100%

24. Promotions within the department are made fairly.

Response	Comments
1	Assessment Center for all promotions
2	People who pass the tests are generally promoted to those positions. However, if no one passes the test and a rank needs to be filled the chief hires a friend from the dept who didn't necesarily take
3	All promotions prior to civil service status were at the will of the chief. some officers have no academy training, no exams, personality promotions. Civil service exams are now in place and certain i
4	Civil service prevents many attempts by Chief to bend rules if no civil service the process would be very polluted
5	Promotions using civil service tests are done fairly. The chief wants to use assessment centers and other ways so he can manipulate who he wants to be promoted.
6	Yes so far with this chief
7	Promotions are made fairly under the current civil service practices. Chief has tried to circumvent that and find a loophole to promote who he wants by performing an assessment (which has never been d
8	Let's put guys in charge that "don't even want it" or bother taking a promotional exam but have no problem receiving the pay or getting their 3 highest years in a position of greater responsibility. T
9	Acting position are given to Chief Buddys not the personnel that takes the test are offered the position
10	Civil Service exam promotions have been good. Chief wants to move to evaluation centers because people he wants to promote can't pass them.
11	Chief promotes topscore down everytime
12	Thus far permanent promotions are made from civil service lists and have followed procedures in same. Provisional and temporary promotions are not as tightly regulated and the chief has tended to use
13	as long as civil service is still used for promotions
14	Civil Service= no good ole boy network
15	Department abides by civil service.

25. I have felt threatened or intimidated by co-workers or supervisors:

	Responses	Percent
Never (0 Points):	14	37.84%
Occasionally (0 Points):	16	43.24%
Often (0 Points):	7	18.92%
Additional Comments:	15	40.54%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

Points Summary:

Highest: 0 Lowest: 0 Average: 0 Median: 0

25. I have felt threatened or intimidated by co-workers or supervisors:

Response	Comments
1	Some of the Chief's comments could be intimidating
2	Chief
3	Chief
4	Feared the chief upon his return from deployment based on comments made
5	Often times employees feel like they are "walking on egg shells" depending on what kind of mood the chief is in on any paticular day.
6	People need to work together, this is for certain officers who belittle, cut down and abuse brother FF's over differences. should grow up.
7	Current CHief, when he was a Capt. he was a tyrant and main objective was to "break" new guys. As Chief he constantly reminds new hires they can be fired.
8	I have often felt threatened by the chief. He threatened to fire me while I was at the academy because of my body size. Chief stated his plan to take down the fire dept, starting in dispatch to take o
9	Yes, the chief rules by threats and bullying
10	By the Chief- feel like we are always walking on eggshells arounf the Chief. On more than one occasion the chief has explained in detail how he would "take us all out". One selectmen was made aware
11	Chief of Dept
12	Chief has threatened to make us miserable based on outcome of this evaluation for starters.
13	Particular by the Chief.
14	The Chief has made comments at times that were down right insulting, so much so that i have kept records of them.
15	Chief has issues with anger

26. I have witnessed or been the victim of harassment from members of my department based upon gender, race, age, ethnic origins, or sexual orientation.

	Responses	Percent
Strongly Agree:	8	22.22%
Agree:	4	11.11%
Neutral:	5	13.89%
Disagree:	10	27.78%
Strongly Disagree:	9	25%
Additional Comments:	7	19.44%
Total Responded to this question:	36	97.3%
Total who skipped this question:	1	2.7%
Total:	37	100%

26. I have witnessed or been the victim of harassment from members of my department based upon gender, race, age, ethnic origins, or sexual orientation.

Response	Comments
1	Again, the chief has made comments to a portuguese decent employee as a spanish thief (repeatedly) as well as a gay member orientation is always a joke to him.
2	Chief has stated his "plan" to take out the FD starting with dispatch and elimintaing communications. Then he would proceed to bunk room while members are sleeping. Have also heard intimidating commen
3	Addressing individuals that are hispanic when they are Portuguese being afraid addressing a female of her actions because your nervous of repercussions or something will be said.
4	Chief has made comments about our female member "filling his quotas" and she has also been able to slide by with inadequate training. She has also been allowed liberies that others did not receive due
5	Chief frequently will talk politics and current affairs in inappropriate and offensive terms. Of President Obama during the 1st campaign "If that Super Spook gets elected I will resign from the milita
6	witnessed: orientation and age
7	Never

27. The radio communications system of the department is reliable.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	7	18.92%
Neutral:	8	21.62%
Disagree:	14	37.84%
Strongly Disagree:	6	16.22%
Additional Comments:	15	40.54%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

27. The radio communications system of the department is reliable.

Response	Comments
1	in process of system upgrade
2	Too many dead spots to list, can't hear across town other apparatus
3	The communication system needs to be updated
4	Radio/dispatching is one of the most important parts of this job. Reception is poor in some sections of town and should be address. Moving dispatching to a town 10 miles away is a step backwards.
5	Anything outside district #1 is questionable especially portal TX & RX
6	The radio communications system is unreliable. Many parts of town have problems with sending and receiving radio transmissions. During any type of weather condition communications suffer.
7	No there are still dead spots in town. But much better than the past
8	Radio communications in certain areas and buildings within the town are completely unreadable. Repeaters in the vehicles could take care of most if not all of these problem areas.
9	My kids walkie-talkies work better than this. Radios (handhelds) are hand me downs from other depts. Cell phones are affecting our base radio's traffic. Trucks in town, driving by, come over our house
10	They are getting better.
11	Recent upgrades seem to have made radio communications worse. A new manufacture has been selected for portable radios. This decision was made in a void by Dep Patterson w/ the Chief. It was stated to
12	Look at Police's radio room and then look at ours then you tell me how "reliable" ours is.
13	much improved over the years
14	Some of the technology is outdated but I have few problems with reliability
15	Could be better

28. The salary and benefit package enjoyed by employees of the department is fair and adequate.

	Responses	Percent
Strongly Agree:	1	2.78%
Agree:	8	22.22%
Neutral:	9	25%
Disagree:	15	41.67%
Strongly Disagree:	3	8.33%
Additional Comments:	15	41.67%
Total Responded to this question:	36	97.3%
Total who skipped this question:	1	2.7%
Total:	37	100%

28. The salary and benefit package enjoyed by employees of the department is fair and adequate.

Response	Comments
1	Depends what I'm baseing it on.
2	Package is below neighboring departments
3	Not equal to nearby communities of similar size.
4	Town has never given the FF's a decent salary/benefit package. Always a revenue problem, sad thing is the guys have always been there to answer the call. raise or no raise.
5	Town mismanagement of former ins. funds pushed us to GIC
6	Compared to town departments and other municipalities we are severly under paid. The healthcare benefits are unacceptable with being forced to be in the GIC.
7	No with rising cost of insurance and inflation our raises do not keep up
8	The salary, in comparison to other municipalities of same size and population, is significantly lower. Most guys need to have multiple jobs to survive. Also the GIC insurance we carry now is costing m
9	The salary for a full time FF at the highest step only makes around 55k with little to no OT. Makes having a PT job necessary.
10	Our pay is not equal to the city and towns around us
11	We got hit on health care benefits when we got pushed into GIC. Our health care and retirement is under attack by public. GIC health care goes into same pot of money used for people on mass health but
12	underfunded
13	Our salary compared to our neighbors and other like communities in MA is low.
14	I'm required to live in town but struggle to do so on the pay. I have to have a 2nd/3rd job to provide for my family, we were also forced to change health care.
15	improvements in recent years but we lag behind other FD's and industry

29. The department is keeping up with the technological advances necessary to provide a modern professional level of service to the public.

	Responses	Percent
Strongly Agree:	0	0%
Agree:	2	5.41%
Neutral:	10	27.03%
Disagree:	15	40.54%
Strongly Disagree:	10	27.03%
Additional Comments:	18	48.65%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

29. The department is keeping up with the technological advances necessary to provide a modern professional level of service to the public.

Response	Comments
1	We locate residents address via word document, relayed over unreliable radio
2	Trying to when they have the money
3	I have GPS in my phone, not the engine
4	There are no ipads, computers on trucks. A cell phone was implemented 2/2016 on engine 1. However engine 2 + 3 have no technology. Inservice inspections are completed throughout the town. However, inf
5	Advances in public safety cost money, this dept is operated by dedicated members who do there best, with what they have to work with. The chief can't do his job without funding!
6	Slowly
7	The dept is always having computer problems; radios are not up to date as well as notification equipment. Most equipment we use are hand me downs from other town depts. Dispatch phones do not have cal
8	No they are way behind in the times
9	The dept does very little tech advances. Computers freeze up all the time and unable to do reports on numerous occasions. Computer systems are usually hand me downs from other depts getting upgrades.
10	Radio's, GPS, computer (tablets) of homes or businesses in town would greatly enhance our professional level
11	Outdated computer, programs
12	We need tablets, gps for mutual aid, digital files for hydrants, municipal water systems and building lay outs. Buildings need to identify exits, alarm panels and specific info relevant to Fire Dept
13	We are far behind on technology.
14	Some radios and tech are out of date.
15	Totally outdated
16	We have no technology for GPS or computers on the apparatus. Vital info is in a LARGE 3 ring binder in each truck. No 2 are actually the same. No master exists. Organization is at our best attempt and
17	We use scrap paper and donated equipment in dispatch, its dangerous to only have one dispatcher and they are forced to be in that room for 24 hours, only recently they were allowed to take a short nap
18	Needs more money

30. The administration of the department provides fair and equal treatment to all employees.

	Responses	Percent
Strongly Agree:	5	13.51%
Agree:	5	13.51%
Neutral:	8	21.62%
Disagree:	12	32.43%
Strongly Disagree:	7	18.92%
Additional Comments:	16	43.24%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

30. The administration of the department provides fair and equal treatment to all employees.

Response	Comments
1	Favorites and fall guys
2	Chief only other management is very fair and equal treatment given
3	Favorites, also chief punichses any who question his authority
4	Those who are confrontational are sent to outlying stations. Elected union officials are often ostracized by upper management
5	Pick and choose primadonna's. some people walk on water! Some people have targets on there back. Discrimination at it's best. Simple! Play by the rules. Play fair!
6	Admin aka secretary is excellent
7	Employees are not treated fairly. Every employee is treated differently based on who you are and who you know.
8	No they have favorites
9	The administration does not provide fair and equal treatment to employees. Dpending on who you are, who you know or who your family is or was with the FD has a big impact on how you're treated.
10	Refer to question 8
11	The personnel that are confrontational are placed in a sub station and the personnel that are not are place at main station 1
12	Depends who the person is
13	Chief has favorites.
14	Admin does very well
15	if you stand up for yourself yes, if not no
16	What one may do and go "unnoticed" another could be called on the carpet for at any time and for any cause.

31. Considering that leaders often make difficult decisions, rate the level of trust that you have in the command staff.

	Responses	Percent
High:	1	2.86%
Above Average:	5	14.29%
Average:	21	60%
Below Average:	5	14.29%
Poor:	3	8.57%
Total Responded to this question:	35	94.59%
Total who skipped this question:	2	5.41%
Total:	37	100%

32. The department has adequate equipment to complete its duties.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	13	35.14%
Neutral:	12	32.43%
Disagree:	8	21.62%
Strongly Disagree:	1	2.7%
Additional Comments:	15	40.54%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

32. The department has adequate equipment to complete its duties.

Response	Comments
1	Could use newer equipment
2	Disagree, but can be fixed with budget management, spending
3	Broken jaws, back-up engines in bad shape, boats not for rescue, only saws on ladder 1 which doesn't respond
4	in need of technology
5	Newest engine 7 yrs old, 48k miles adn engines 17 yrs old 130k miles + ladder 18 yrs old 36k miles. Should order one new engine every 5 yrs. Again it's a funding issue. No money?
6	Aging
7	We do have adequate equipment but some could be updated such as a new jaws of life. Outfitting the back up apparatus would be helpful. A lot of the members PPE is outdated.
8	Not in all aspects; a lot of old and aging equipment, no plan on replacing aging things like gear and CGI meters unless they get grants or are forced to by equipment failure
9	Back up apparatus should be outfitted with all necessary equipment so moving equipment from one piece to another doesn't have to happen. Tools get misplaced in the shuffling of equipment.
10	Need more and new jaws of life. A lot of equipt is outdated and not useful. Some things take up space in front line apparatuses and limit equipt for emergency situations. Other items that are out date
11	Some equipment is dated, man power is the big issue.
12	Some outdated tools/no technology
13	Apparatus replacement is funded through a capital account. Frequently this account is underfunded. Apparatus have not been replaecd in the year scheduled. Usually 2 -3 years later. The replacement sch
14	We are starting to improve equipment, not sure how much of that is because of the town though.
15	money thing again

33.
The Town is a good employer.

		Responses	Percent
Strongly Agree:		2	5.41%
Agree:		18	48.65%
Neutral:		9	24.32%
Disagree:		6	16.22%
Strongly Disagree:		2	5.41%
Additional Comments:		7	18.92%
	Total Responded to this question:	37	100%
	Total who skipped this question:	0	0%
	Total:	37	100%

33.
The Town is a good employer.

Response	Comments
1	Still waiting on contract
2	Always stating no money
3	Life long residence, great town, good people, poor planning, no revenue, always running on a shoe string. I'm not leaving!
4	Improving, new offerings are refreshing and more (illegible)
5	I believe the Town offices are not aware of the struggles and problems with the FD.
6	Yes but the town could be better with more over site of depts adn their operations. The dept heads don't always be held accountable
7	Town has historically cut the fire dept.

34. The administration of the department welcomes suggestions and input.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	7	18.92%
Neutral:	14	37.84%
Disagree:	10	27.03%
Strongly Disagree:	4	10.81%
Additional Comments:	13	35.14%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

34. The administration of the department welcomes suggestions and input.

Response	Comments
1	They feel as if it's challenging their authority or pretends to never hearing input after the fact
2	Threatened by suggested change
3	The Chief is not receptive to ideas that differ from his. He often belittles those who voice their ideas in front of others.
4	They listen to some people and ignore others, I am not a negative person, it's just not a positive atmosphere.
5	Chief and FP Deputy often push back & not initially receptive to change
6	Anytime an employee makes a suggestion to supervisors (chief, DC's) we are criticized for our ideas. The dept needs change.
7	Yes if it makes them look good
8	The administration has a hard time with suggestions and input.A lot of guys don't speak up because of the anticipated reaction and others are yelled at or rdiculed for their suggestions.
9	Admin states they welcome suggestions but only for certain individuals.
10	When giving suggestions or input you are treated as if you are questioning their authority.
11	Depends on who you are
12	While the Chief likes to state that he welcomes suggestions and input this is not always or completely true. It depends on who is making the suggestion. It depends on the mood of the chief at the time
13	depends on who suggests them (at times)

35. The administration of the department recognizes my service to the agency.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	16	43.24%
Neutral:	10	27.03%
Disagree:	5	13.51%
Strongly Disagree:	4	10.81%
Additional Comments:	7	18.92%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

35. The administration of the department recognizes my service to the agency.

Response	Comments
1	I consider myself a dedicated FF and it's a honor and privledge to serve this town. I would hope they appreciate my service.
2	Not reviewed or feedback offered
3	No matter how much work you do its never enough. You either work too much or not enough. There is no happy medium. Morale is low. What is a sufficient amount of OT?
4	They say they do, but that's only if you have a good call or save. They forget about the everyday things you do for the dept
5	Only recognizes my service when they want to. I feel like we are always under a microscope. If you work too much OT your labeled a scab, if you don't work enough your questioned about it (why didn't y
6	I have yet to be sworn in as Lt. and it has been over a year, that's just one example.
7	Again, seniority means nothing

36. Obviously any change in working conditions would need to be bargained, what new services should the Department consider or seek out to better meet the needs of the community?

	Responses	Percent
Responses:	27	100%
Total Responded to this question:	27	72.97%
Total who skipped this question:	10	27.03%
Total:	37	100%

36. Obviously any change in working conditions would need to be bargained, what new services should the Department consider or seek out to better meet the needs of the community?

Response	Response Text
1	New equipment, more staff
2	The Department should provide ambulance service to the Town.
3	man power. We run with 7 guys. In April 1962 Dracut hired 6 full time guys because of the over grown population of 13,500. 2016 we gained 1 xtra man. 30,000+ population? Dangerous.
4	EMS Transport Community Outreach Education
5	Ambulance More public out reach; a lot more
6	Ambulance
7	Ambulances, fire education and assistance to elderly
8	Take the Chief out of civil service. Make the Chief a contract Chief so the Chief is held accountable for his/her actions and decisions. Centralize dispatch.
9	Ambulance service by the fire dept. 8 men/women and ambulances start up cost at least $500,000? Again I would also keep dispatching local.
10	Ambulance, better public education and full time staffed rescue
11	The dept could benefit from having its own ambulance. It would be a great way to supplement the Town's budget if it was disbursed equally to the public service depts. and beneficial to the FD in hiring more members.
12	I think getting rid of fire dispatch would be the best thing for the community, as it is not being done to state standards now.
13	I believe our own ambulance would raise revenue for the town. I would like to see a % allocated to the fire dept and remaining % be split with PD and DPW.
14	Lap tops in the trucks
15	Centralize Dispatch
16	Provide ambulance with dedicated members that will be life long employees of the town of Dracut. But ambulance personnel should not reduce personnel for fire suppression duties. So language would need to be bargained regarding minimum manning.
17	Computers
18	An ambulance
19	Additional personal, FD ambulance
20	have incentive for paramedic level; Deputy Chief for night hours for incident command 24/7
21	Manpower
22	More manpower
23	Community outreach programs; bring the ambulance service in house; re-alignment of the department and some duties.
24	Minimum 3 guys to a truck!!! a dispatch center that is up to date, new station 3, full staffing of the department!!! 2 sets of approved gear for every firefighter
25	Maintaining and fixing problems with equipment so they are safe and adequate for the job
26	More man power
27	I would like to consider the DFD running town operated EMS services

37. If the department expanded the level and scope of emergency medical services offered to the community, I would support that effort.

	Responses	Percent
Strongly Agree:	17	45.95%
Agree:	17	45.95%
Neutral:	2	5.41%
Disagree:	1	2.7%
Strongly Disagree:	0	0%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

38. I am proud to be a member of the department.

		Responses	Percent
Strongly Agree:		18	48.65%
Agree:		12	32.43%
Neutral:		7	18.92%
Disagree:		0	0%
Strongly Disagree:		0	0%
Additional Comments:		8	21.62%
	Total Responded to this question:	37	100%
	Total who skipped this question:	0	0%
	Total:	37	100%

38. I am proud to be a member of the department.

Response	Comments
1	Proud to be a firefighter, not as proud of Dracut Fire as I once was
2	I am proud of being a fire fighter but I am not proud to be working under the current administration
3	A proud member of a proud dept. The best job a man could ever have. I thank God everyday.
4	I pride myself adn fellow fire fighters in our image to public
5	I am for the personnel I work with, but not for the leadership representing me
6	Sometimes its embarassing when people ask what is wrong with the Chief or Dep Chief. Or people state they are "assholes".
7	For the most part yes. Best job in the world
8	I am. I ahve spent my entire adult life serving the town of Dracut in some capacity. That said, I find myself wanting to leave DFD. With less than 7 years till I hit my numbers to retire at a full 80%

39.
The Town Manager and Board of Selectmen of the Town support the Department.

	Responses	Percent
Strongly Agree:	2	5.41%
Agree:	13	35.14%
Neutral:	14	37.84%
Disagree:	3	8.11%
Strongly Disagree:	5	13.51%
Additional Comments:	12	32.43%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

39.
The Town Manager and Board of Selectmen of the Town support the Department.

Response	Comments
1	Budget weak
2	They have thier own agenda
3	The Town Manager adn BOS have never taken public safety seriously in this town. No additional manpower in 35 years. That is a disgrace to the citizens of Dracut.
4	I believe the BOS support the dept. I'm not sure about the TM. He is new to the Town and I am not sure if he is aware of the FD's needs.
5	The selectmen pick when they want to help and the TM is new to early to have an informed opinion.
6	Selectmen have always been supportive with issues that arise. TM is new to town and haven't built a relationship yet, however haven't had any issues that I'm aware of.
7	how's our contract going? Still haven't settled and no current contract sicne July 2015. Let's give the SoSchools an 8% pay raise. Nothing for FF's that live in this town.
8	They both want the best for Dracut and FD but TM can control us unlike school dept. School dept has level funding so thet always cut FD first. We are financially micro managed
9	New Town Manager says he supports us but we are still without a contract. Selectmen are better than they used to be.
10	While the jury is still mostly out with the new(er) TM, the previous manager left a foundation so weak that trust and relationship with management is difficult. Everything is done on a "dime". The con
11	Board and Town do, TM does not
12	New employee, I have no strong opinion at this time

40.
I believe the residents of the Town value the services provided by the department.

	Responses	Percent
Strongly Agree:	11	29.73%
Agree:	18	48.65%
Neutral:	7	18.92%
Disagree:	1	2.7%
Strongly Disagree:	0	0%
Additional Comments:	8	21.62%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

40.
I believe the residents of the Town value the services provided by the department.

Response	Comments
1	I believe they value the service but are reluctant to pay for service enhancements and proper staffing levels
2	I believe the residents value the services but are not aware of the manning issues. 2 men in each station, it's not adequate. 9 men baseball, 11 men football, 2 men firefighting
3	Yes but they don't know the behind the doors scene.
4	They only value the service when they need it and of course complain if we take to long responding due to whatever, definitely not because of us taking our time.
5	Some do, some think we sleep all day.
6	Some do
7	It's always hard to gage the general public's opinion. As is life, people don't really know what we do, how adequate or inadequate our funding, staffing or equipment is. Probably goes to question abov
8	But if they know how things really work and what we have to work with I think they would be shocked.

41. I believe that the department reaches out to residents and businesses to work together on issues of common interest.

	Responses	Percent
Strongly Agree:	4	10.81%
Agree:	9	24.32%
Neutral:	13	35.14%
Disagree:	8	21.62%
Strongly Disagree:	3	8.11%
Additional Comments:	5	13.51%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

41. I believe that the department reaches out to residents and businesses to work together on issues of common interest.

Response	Comments
1	I'm not sure I understand
2	The town has a limited tax base, bedroom town, limited business. 200 homes being built, we have to service these residents with no added help. More homes, more calls!
3	Union membership does this more than dept. Our involvement adn interaction is constant.
4	The Union does!
5	There is little or no PR.

42. The supervisors of the department provide quality guidance and support to employees.

	Responses	Percent
Strongly Agree:	3	8.11%
Agree:	6	16.22%
Neutral:	13	35.14%
Disagree:	11	29.73%
Strongly Disagree:	4	10.81%
Additional Comments:	13	35.14%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

42. The supervisors of the department provide quality guidance and support to employees.

Response	Comments
1	Officer communication with different units could be better
2	Depends on the day/mood of person
3	Negativity, condescension, belittling normal
4	Upper management (Chief, Sr. Dep) belittle personnel when they ask questions or voice opinions. There's no grooming process to help members advance between ranks. There are no formal mentors. Upper ma
5	There are good officers willing to help and work together and other officers who are arrogant adn only care about themselves. It shows everday!
6	A few good leaders. Many do not support.
7	Some supervisors provide guidance and support while some let you fail. Supervisors that support you, guide you through the task and assess the situation to better you as a FF.
8	The guidance only comes from the few officers that still have hope for better days to come.
9	Some supervisors provide guidance while others will not. Some will let you literally sink while others will ensire accuracy in job performance. There have been times an officer allowed a driver to go
10	Constructive critisim is non-existant.
11	Some do, some don't
12	Rank is pulled and info is not shared
13	Very seldom is positive guidance given. It's always what you did wrong and why you didn't know that.

43. If I had an opportunity to take a similar job with a different employer with comparable pay and benefits, I would leave the department.

	Responses	Percent
Strongly Agree:	10	27.03%
Agree:	8	21.62%
Neutral:	7	18.92%
Disagree:	7	18.92%
Strongly Disagree:	5	13.51%
Additional Comments:	8	21.62%
Total Responded to this question:	37	100%
Total who skipped this question:	0	0%
Total:	37	100%

43. If I had an opportunity to take a similar job with a different employer with comparable pay and benefits, I would leave the department.

Response	Comments
1	This is my hometown, I want to improve this Dept.
2	They will have to carry me to my grave before I ever leave here. I will leave on my terms.
3	I love the community. The leadership makes it hard to enjoy the environment. Pay is one fo the lowest in the area.
4	Enen though I love this town I would give it serious consideration becasue of management here.
5	No other dept in the area pays as low as Dracut does!
6	Most departments make more
7	I tried to transfer but was denied, this happened a few months after the Chief accepted a transfer from another town.
8	It's been 20+ years, my family is established

44. Please list the three things you like best about working for the department.

	Responses	Percent
1.:	35	100%
2.:	34	97.14%
3.:	27	77.14%
Total Responded to this question:	35	94.59%
Total who skipped this question:	2	5.41%
Total:	37	100%

44. Please list the three things you like best about working for the department.

Response	1.
1	Staff
2	Brother hood
3	The sense of teamwork
4	Brotherhood
5	Grew up in Town - like taking care of my community
6	The people
7	My community, responsibility
8	Being able to help the community
9	People
10	Enjoy helping people when they need it
11	Helping the community
12	Best job in the world
13	Great workers around here
14	Coworkers
15	The towns people and helping them in time of need
16	Self gratitude - nothing better than helping people in need and saving lives.
17	Definitely a need for us
18	24 hr shifts
19	helping people
20	schedule (flexible)
21	Having a Chief who plans ahead and is proactive
22	Work schedule
23	People
24	Serving my community
25	Serving the residents of the town
26	I like the work hours
27	helping people
28	Schedule
29	Helping people
30	Operating the trucks, equipment, tools etc.
31	Good job
32	The guys I work with
33	Station #1,2 updates (buildings)
34	Supportive leaders
35	Helping people

Response	2.
1	Type Job
2	Helping in community
3	Contributing to the community
4	Sense of duty

5	I'm proud to be a fire fighter
6	Being able to work on moving the Dept forward with equip and technology
7	Mentor, learn from others
8	Trying to make a change in community
9	24 hour shift
10	Camaraderie
11	My crew
12	Most people are great to work with
13	Community is great
14	Flexible schedule, more time for family
15	The hours and work schedule
16	Most co-workers
17	The comraderie on most of the crews
18	my crew
19	helping people/citizens
20	Having Civil Service promotional exams as the basis for promotions
21	Actually helping people
22	The job
23	Making a difference in people's lives
24	Driving fire trucks
25	Friendliness among co-workers
26	most coworkers
27	helping the public
28	Should be the best job in the world, and in general when we are doing THE JOB, helping people and on calls, it is.
29	The rush from the action
30	The service we provide to public
31	Working in the community I live in
32	Equipment
33	Comfortable work environment considering the nature of the job
34	Helping the new firefighters
Response	3.
1	Hours
2	Schedule
3	Having a job that makes a difference in people's lives.
4	Public service
5	The people I've met over the years
6	Teaching new and younger members the job - mentoring
7	Trying to promote positive environment
8	Working with Deputies, Capt's, Lt's and other firefighters
9	retirement system
10	Schedule
11	Schedule
12	Helping people all the time in town
13	Love of the job
14	Pension and benefits
15	The satisfaction from mentoring a member that appreciates you and thanks you for your assistance.
16	Retirement pension
17	Best job in the world (the 24 hours are not bad either)
18	working in diverse environments
19	Having a well-maintained, modern day fleet and equipment
20	Nothing else, Chief has ensured that people are miserable at work.

21	The size of Department
22	Making a difference
23	Short commute to work
24	job itself
25	The schedule
26	The way people look at you, being a firefighter. the pride you feel after helping someone
27	Great relationship with everyone in my unit

45. Please list the three things you dislike about working for the department.

	Responses	Percent
1.:	34	100%
2.:	32	94.12%
3.:	26	76.47%
Total Responded to this question:	34	91.89%
Total who skipped this question:	3	8.11%
Total:	37	100%

45. Please list the three things you dislike about working for the department.

Response	1.
1	Healthcare
2	Always having to do more with less money from the town
3	Chief is unpredictable (PTSD) intimidation
4	Small # of employees that are completely negative about everything
5	Sever disconnect with leadership on many topics
6	Chief
7	Salary's low
8	Hostile work environment
9	General mismanagement of the dept
10	Animosity
11	Leadership lacking
12	Equipment and apparatus maintenance, information pertaining to repairs
13	The way the leadership runs the dept by intimidation and bullying. IE: threaten to mix up units and personnel for no reason. Lack of personal respect for members.
14	Micor-management by Chief Officers
15	The head games of the Deputy's and higher
16	working holidays
17	disrepect to the rank and file by the chief and sr. deputy
18	Constant change of protocols without proper notifications
19	The management
20	The Chief's heavy-handedness, "Iron Fist" attitude at times
21	Lack of fire prevention education
22	Inconsistency in leadership
23	People being set up to fail
24	Angry people
25	Chief and Deputies don't take hazmat seriously
26	manpower
27	Micromanagement
28	Lack of partnership
29	Staffing, lack of full staffing
30	Demeaning management
31	Lack of integrity among some officers
32	Station #3 out dated building
33	Outdated technology
34	24 hours are long

Response	2.
1	Benefits
2	Having to put off purchases or training due to lack of funds from the town
3	Under staffed
4	Lack of funding to staff sufficiently

5	Safety is thrown out the window
6	lack of funding
7	Excessive training/busywork
8	Disrespect to staff by Chief and Sr. Deputy
9	Anger
10	No clear procedures or guidance
11	Upper management shows no support
12	The lack of funding for the dept to run properly and the way leadership appropriates the funds it does have. IE: Running short on personnel all winter when needed and then spending the rest of the budget in June because of poor planning
13	Lack of manpower
14	Disregarding our safety concerns
15	the general mismanagement of the dept
16	Every unit runs differently and sometimes can be difficult to determine what you are suppose to be doing
17	Intimidation
18	Operating with two-man engine companies, should be three
19	Lack of officer program or mentoring
20	probe (sp?) training (?) plans are not made
21	Lack of communication
22	Sarcasm
23	Running short staff
24	communication
25	negative attitude from upper management
26	Lack of respect and dignity
27	Comments made from the Chief and certain supervisors
28	Non supportive TM
29	Micromanaging
30	Dep. Patterson
31	2 man engine companies
32	not enough fire fighters
Response	3.
1	Pay
2	Unions
3	Allways changing rules
4	No mentor program 4. Hostile work environment, "busy-work" is insane
5	staffing levels
6	Changing stations + units undermines stability
7	Lack of technology and mentoring
8	Attitude
9	Pay is lacking compared to like communities
10	Micromanaging
11	The lack of care for the health and safety of the members. IE: No exhaust elimination at sta 3 or training in the extreme heat just because or not calling back help because of the cost
12	Equipment maintenance and repair info
13	Two guys on a piece
14	low morale of the entire dept.
15	Poor supervision of all ranks and positions in regards to counseling and mentoring stronger employees
16	Getting involved in your personal life
17	No financial compensation for members to attend outside training, such as the Mass Fire Academy
18	Lack of concern for members safety.
19	Timelines aren't kept
20	Commercial air compressor next to bunk room
21	I don't like the working conditions at sta 3

22	under scrutiny; no seniority/respect
23	busy work
24	Fear, intimidation, retribution
25	Dispatch being outdated and dangerous for the public
26	Chief

46. What is one idea that you have that could improve the department?

	Responses	Percent
Responses:	33	100%
Total Responded to this question:	33	89.19%
Total who skipped this question:	4	10.81%
Total:	37	100%

46. What is one idea that you have that could improve the department?

Response	Response Text
1	Overlap officers to help communicate within department
2	Better guidance
3	Hire 8 firefighters and own a department ambulance
4	Education
5	Get rid of Deputy's position. Why do we need them during the day but not at night when that is the most dangerous times to have a incident.
6	Technology upgrades to integrate a CAD, report writing, and pre plans and make these accessible in the field to all personnel.
7	-40% of dept is officer rank, eliminate deputy position, 4 captains as 24 hr. command - Chief develop confidence in staff to not micromanage everything, control
8	Ambulance Cut out the captains use all Lieutenants
9	Minimize the involvement of the chief in day to day operations. Keep chief on his medication. Allow captains to build cohesive teams.
10	Take the Chief out of Civil Service and make him a contract chief so he is accountable for his actions.
11	This dept has been mismanaged for years. In 1980 8 FF's were hired and station 3 was manned with 2 FF's, 24/7. There was 1 chief, 1 Deputy, 4 Lt's and 28 dedicated FF's. This operation was in place for 15 years with less personnel issues. In 1995, 4 Lt's were made and dispatchers were hired and this is when all the problems were created. In 2000 4 more Lt's were made when a new station 2 opened and the 4 Lt's at station 1 were promoted to Capts. To many officers, not enough help.
12	Leadership training is a must. The treatment of employees is the cornerstone to a successful organization. An environment where employee empowerment and trust will yield positive moral. Moral will then carry over into employee commitment and productive work force. The moral is lowest I have seen in years. Also, staffing is lacking. Understaffed and not looking to change other than another FF at Sta 3.
13	New personnel in upper management positions that want to move the dept forward. They should be able to balance the budget and make cuts in other places besides manpower.
14	In all I think the dept has the right bones and personnel that still want to make the dept better. But that starts at the top and will not get better unless the leadership has a serious change in his attitude and approachability to solve problems rather than creating them. The town also needs to find a way to fund the dept better maybe like a capital plan fund to replace turnout gear and expensive tools that wear out like they do with the apparatus pieces. They also should do these surveys on th
15	Laptops of Ipads on vehicles. Could be beneficial for hydrant locations, prior history at a particular address and location of calls (house locations) that are currently relayed by dispatch.
16	Removing the personnel that bitch or think they are a leader.
17	Laptops in trucks
18	take the chief out of civil service and make him a contract chief-makes him accountable for his management skills.
19	Minimum manning language in order to run more consistent. If we always run at same number of people on apparatus we can create standardized SOP/SOG to provide more consistent responses that are more efficient and timely.
20	Start by firing the Chief
21	Creating two more Deputy positions in addition to the current two, and assigning one to each shift so that 24/7 Incident Command can be implemented.
22	Allow captains to run their shifts and keep Deputy Chiefs out of everyday calls unless requested to respond by the capt on duty.
23	Getting the dept's own ambulance would make a great addition
24	Command (Dep Chief) around the clock.
25	A new Station 3
26	being able to have a give and take dialogue with administration and officers.
27	Having a clear definition of roles in the dept.
28	A town resource/personnel officer that was properly trained and inpowered to do something to make things better, safer, more sane.
29	Moving dispatch to the PD who has the equipment and technology to support a safer service. Then hire "dispatchers" not fire fighters to run our side of the dispatching service. PD can run their calls and FD dispatchers not firefighters can run fire and ems calls. our dispatching service is walking a fine line of being against state protocol/requirement.
30	Leadership listening to the ideas and advice of the guys that actually operate on the equipment everyday
31	Yearly mental evaluations of all officers
32	I believe the Dept should consider running its own BLS Ambulances
33	New Union President he thinks he runs the place

APPENDIX D

Municipal Resources

DRACUT FIRE ALARM RUN CARD

Dracut Fire Alarm Run Card

	TO BE CALLED TO SCENE					STATION COVERAGE		
Alarm	Engine	Engine	Ladder	Chief	Other	Engine	Engine	Ladder
1st Alarm	All on duty Apparatus							
Working Fire					Ambulance	Last Unit Off for Coverage		
2nd Alarm	All Off Out Personnel		Lowell (RIT)		Red Cross	Lowell	Pelham	
3rd Alarm	Lowell	Pelham				Tyngsboro	Methuen	
4th Alarm	Tyngsboro	Methuen		Lowell	Field Comm 60	Lowell	Nashua	Nashua
5th Alarm	Lowell	Nashua	Nashua			Hudson, NH	Lawrence	
6th Alarm	Hudson, NH	Lawrence		Nashua		Salem NH	Tewksbury	Andover
7th Alarm	Salem NH	Tewksbury	Andover			Chelmsford	Windham	
8th Alarm	Chelmsford	Windham				Billerica	Westford	Bedford MA
9th Alarm	Billerica	Westford	Bedford MA			Londonderry	Pepperell	
10th Alarm	Londonderry	Pepperell				No. Andover	Wilmington	
2nd Alarm	Methuen	Salem, NH			Pelham Tanker			

""'OUT OF Kenwood H20 DISTRICT ONLY** Add to second alarm response

Special Calls			
Ladders	Tankers	Rescues	Tower Ladders
Tyngsboro	Pelham, NH 603-635-2703	Lowell	Lowell
Methuen	Tyngsboro 978-649-4521	Methuen	Nashua 603-594-3641
Salem NH 503-890-2200	Hudson. NH 603-886-6021	Pelham	Methuen
Hudson NH	Windham NH 603-434-4907	Lawrence	Lawrence
Chelmsford		Tyngsboro	Andover
Tewksbury			
Staging Area, I	Fire Headquarters 488 Pleasant St. Dracut, MA		

District 6 Control to be notified to fill all resources from the 4th Alarm and greater