CONSOLIDATION LEGISLATION

There have been several legislative efforts to mandate consolidation of special taxing districts in Illinois. These efforts have been at the County level as well as the State level. In spring of 2012, DuPage County government launched an Accountability, Consolidation and Transparency Initiative, with county officials vowing to focus on reducing waste while finding efficiencies and ways for local agencies to collaborate. Included in this initiative was the concept of exploring the feasibility of a county-wide fire district.

In August 2013, PA 98-0126 (SB 0494) was signed into law granting authority to counties with a population of more than 900,000 and less than 3 million which are contiguous to a county with a population of over 3 million (DuPage County) to undertake the mandated dissolution of units of local government, including fire protection jurisdictions, by ordinance after having enacted an audit of the unit of government made.

In August, 2014, Senate Bill 1681 was signed by the Governor and became Public Act 98-1095. This Act is titled "The Regional Fire Protection Agency Act". The purpose and creation is written as follows:

> *Sec. 5. Purpose and creation.*
>
> *(a) Purpose. The General Assembly finds the consolidation of fire protection services on a regional basis provided by fire departments throughout the State of Illinois to be an economic benefit. Therefore, this Act establishes procedures for the creation of Regional Fire Protection Agencies that encompass wider service areas by combining existing fire departments and extending service areas of these departments into under-served geographic areas. It is the expressed intent of the General Assembly that Regional Fire Protection Agencies shall achieve a net savings in the cost of providing fire protection services, emergency medical services, and related services in the expanded service area by reducing and eliminating costs including, but not limited to, duplicative or excessive administrative and operational services, equipment, facilities, and capital expenditures, without a reduction in the quality or level of these services.*
>
> *(b) Creation. A Regional Fire Protection Agency may be formed by filing voter-initiated petitions for the purposes of integrating existing service areas of contiguous units of local government providing fire protection services to achieve the purposes of this Act.*
>
> *(Source: P.A. 98-1095, eff. 8-26-14.)*

In 2015, House Bill 229 was introduced to again amend the Counties Code. This time the amendment was to be statewide. However, in its final version, it was only subject to McHenry and Lake Counties. This bill would give the McHenry and Lake County Boards the power to consolidate government taxing entities where the county appoints more than 50 percent of the membership of that board. This would directly affect appointed fire district boards in both counties. This legislation is based almost exactly on a bill successfully implemented in DuPage County in 2013, and is part of a larger effort they initiated and call the Accountability Consolidation Transparency (ACT) Initiative. This bill has passed both the House and Senate and is undergoing final revision prior to sending it for Governor Rauner's signature.

Current legislative efforts have been bi-partisan and have the support of the general public. Illinois has between 7,000 and 8,500 units of local government, many of which are special districts including fire protection districts. It is generally believed that reducing the number of special districts will streamline operations and reduce duplicity of services. It is also believed that consolidation will save taxpayers' money and possibly reduce property taxes.

From these actions it is clear that the movement toward consolidation is gaining momentum politically. It is likely that mandated consolidation will take place in the future. It would be in the best interests of the fire service to implement consolidation strategies in a proactive manner where it is feasible rather than having changes made from outside sources.

Evaluation

Over the past 100 years various methods have been used to evaluate fire protection agencies. The majority of these originated with the insurance industry to protect property due to the devastating fires of the late 1880s. Insurance ratings started with the National Board of Fire Underwriters and with the American Insurance Association, both of which merged in 1971 into the Insurance Services Offices, Inc. (ISO).

In evaluating a fire protection agency, the IFCA Consulting Team looks at applicable federal, state and local regulations and nationally recognized standards. The purpose of this is to follow guidelines that meet the latest protocols on fire protection to have legally defensible positions. National standards are "minimum" standards and should be defined as the least needed to be done. It is certainly responsible and practical to consider the actual community needs and go beyond the minimum recommendations when necessary.

The IFCA Consulting Team uses three nationally recognized models as a basis for evaluation of a fire department. These are the Insurance Services Office (ISO), the National Fire Protection Association (NFPA), and the Center for Public Safety Excellence (CPSE). Each has a specific point of view and each brings a set of evaluation tools to the process. They each offer a unique but complementary prism to view effective fire department operations.

CURRENT FIRE AND EMS STAFFING RESEARCH MODELS

Insurance Services Office (ISO)

ISO is mainly concerned with property risk. The Insurance Services Office's purpose is to review and categorize a community's ability to fight fires. ISO measures major elements of a community's fire suppression system, such as personnel training; staffing levels of engine and ladder companies; water supply and distribution systems; receiving and dispatching fire alarms; firefighting equipment; needed fire flow; and fire company locations.

The ISO grade is broken down into three sections:

1. Fire department – 50%
2. Water Supply – 40%
3. Communications: receiving and handling alarms – 10%

By analyzing the data and using criteria outlined in a rating schedule, ISO produces a final classification number for a community. Each of the 43,000 plus communities evaluated by ISO across the U.S. is graded from 1 to 10, with 1 being the best. The ratings determine insurance rates for property owners. Generally, lower scores yield lower rates.

However, using only the insurance company criteria may produce unrealistic expectations about how effectively the fire department can reduce loss of life. ISO states that their regulations are not intended to design fire departments. Yet, in a practical way, they do for two reasons:

- Fire departments have been intensely influenced by ISO criteria in the past; therefore, the rating process is ingrained into a city's beliefs about fire safety. For instance, ISO stated that a 20-year-old fire truck had to be replaced due to its age regardless of the unit's frontline ability.
- Insurance grading remains a strong political influence because the general public and/or elected officials do not understand the limitations of fire protection operations. If the public perceives it pays lower insurance rates because of the ISO rating (current fire department design), then they will not pressure the fire protection agency to become more cost effective, regardless of its limitations.

Tragically, some recent fires resulting in loss of life have shown that cities with low ISO ratings did not meet legal requirements and current standards for fire agencies.

National Fire Protection Association (NFPA)

The National Fire Protection Association (NFPA) uses consensus standard rule making. The NFPA was formed in 1896 by a group of insurance firm representatives with the stated purpose of standardizing the new and burgeoning market of fire sprinkler systems. The scope of the NFPA's influence grew from sprinklers to include building electrical systems (another new and fast-growing technology), and then all aspects of building design and construction.

Its original membership consisted of, and was limited to, insurance underwriting firms. NFPA did not allow representation from the industries it sought to regulate. This changed in 1904 to allow other industries and individuals to participate actively in the development of the standards promulgated by the NFPA. The first fire department to be represented in the NFPA was the New York City Fire Department in 1905. Today, the NFPA includes representatives from many fire departments, insurance companies, manufacturing associations, unions, trade organizations, and average people.

NFPA consensus standards establish widely accepted standards of care and requirements for certain practices. *Standards* are an attempt by an industry or profession to self-regulate by establishing minimal operating, performance, and/or safety standards, which establish a recognized "standard of care." Committees composed of industry representatives, fire service representatives, and other affected parties, who seek consensus in their final rule, write these standards. The outcome is a "minimum" that everyone can agree on, rather than an "optimum" that is the best case.

The NFPA has many standards that affect fire departments. These standards should be followed by fire departments to protect fire and rescue personnel from unnecessary workplace hazards. The NFPA standards establish the standard of care that may be used to evaluate fire department performance in civil lawsuits against fire and rescue departments (NFPA, 1995). In most cases, compliance with NFPA standards is voluntary. However in some cases, federal or state OSHA agencies have incorporated wording from NFPA standards into regulations. In these cases, compliance with the standards is mandatory.

Regardless of whether compliance with an NFPA standard is voluntary or mandatory, fire and rescue departments must consider the impact of "voluntary" standards on private litigation. In some states, a department may be liable for the negligent performance of its duties. Even in states that protect rescue workers under an immunity statute, most state laws do not protect fire or rescue departments for grossly negligent or willful and wanton acts. Essentially, negligence involves the violation of a standard of care that results in injury or loss to some other individual or organization.

In establishing the standard of care for fire and rescue operations, the courts will frequently look to the "voluntary" standards issued by NFPA and other organizations. Although "voluntary" in name, these standards can be utilized as evidence of the existence of a standard of care that fire or rescue departments may be responsible to comply with. Accordingly, fire and rescue departments should pay close attention to applicable standards.

The mission of the NFPA, established in 1896, is to reduce the worldwide burden of fire and other hazards on the quality of life by providing and advocating consensus codes and standards, research, training, and education.

The world's leading advocate of fire prevention and an authoritative source on public safety, NFPA develops, publishes, and disseminates more than 300 consensus codes and standards intended to minimize the possibility and effects of fire and other risks.

These codes and standards are developed by technical committees staffed by over 6,000 volunteers, and are adopted and enforced throughout the world (NFPA, 2012). Therefore, applicable NFPA standards and codes will be applied within this study.

Center for Public Safety Excellence (CPSE)

The Center for Public Safety Excellence, or the “Accreditation” model, is outcome-based performance supported by best practices.

Over the last decade, there has been an increased concern by fire professionals that the insurance industry criterion by itself is unrealistic (CPSE, 1997). Although ISO and NFPA standards are extremely valuable for the purposes for which they were created, the fire service needed to elevate its level of performance and professionalism in another way.

A process was created where citizens, elected and appointed officials, and fire and emergency service personnel would assess all the activities and programs related to a modern Fire/EMS service. On October 27, 1988, the International City/County Management Association (ICMA) and the International Association of Fire Chiefs (IAFC) Executive Boards signed a Memorandum of Understanding that committed both organizations to the development of a voluntary national fire service accreditation system titled, Commission on Fire Accreditation International (CFAI). On December 13, 1996, a trust was executed creating the Commission on Fire Accreditation International to award accreditation to fire and emergency service agencies and to pursue scientific research and educational purposes in the public interest.

In November 2001, the original trust was dissolved and the Commission on Fire Accreditation International was incorporated as a nonprofit 501(c) (3) corporation. Then in March 2006, to reflect the organization’s larger focus and its importance to all-hazard response, the corporation’s name was changed to the Center for Public Safety Excellence (CPSE). The Commission on Fire Accreditation International (CFAI) became an entity under CPSE; however, it continues to assist organizations in making the transition from tactical deployment to strategic response.

The cornerstone of the CPSE is the role of self-assessment. This self-conducted performance evaluation results in increasing the efficiency and effectiveness of fire service agencies if the findings from performing the self-assessment are applied to planning and implementation activities. There are four major reasons why an in-depth evaluation of fire service agencies is critical today (CPSE Assessment Manual, 9th ed.):

- To assist organizations trying to cope with change;
- To provide for periodic organizational evaluations which ensure effectiveness (outcomes) and efficiency (cost);
- To raise the level of performance and professionalism within the organization and ultimately within the profession; and
- To provide an organizational benchmark when there is a change in leadership.

One of the major issues that the fire service has struggled with in the past decade is defining the Standards of Cover. This concept has evolved in concert with the other components of the accreditation model because it is essential to determine whether a fire agency is prepared to provide a level of service commensurate with its responsibilities and risks.

Standards of Cover

Two critical concepts to understand before we move on are the Standards of Cover and level of service. These standards form the basis of service to the community and response to emergencies. It is an often-overlooked detail in the process of evaluation. **It must start with the community looking at itself.**

The Commission on Fire Accreditation International (CFAI) defines Level of Service (LOS) as “the resources needed to meet the stated service level objectives”. LOS is defined only in terms of what is provided and not in terms of effectiveness or of quality.” Level of service is the community’s plan to deploy resources to deliver a range of solutions or services. For example, a community/fire department may choose to deliver Advanced Life Support over Basic Life Support; they may choose to have four firefighters per engine rather than three; they may send one engine to a car fire. However, LOS does not measure effectiveness; that is the concept of Standards of Cover (SOC).

The CFAI defines the Standards of Cover (SOC) as being those” **adopted written policies and procedures** that determine the distribution, concentration and reliability of fixed and mobile response forces for fire, emergency medical services, hazardous materials and other forces of technical response.” In other words, Standards of Cover is the delivery of resources within a timeframe a majority of time that is useful, or “effective,” to its citizens. This makes it measurable.

So that is the ultimate outcome of this process: to have measurable standards of effective response to predictable emergencies.

National Institute of Standards and Technology (NIST) has recently conducted research on service expectations placed on the fire service, including emergency medical service, response to natural disaster, hazardous materials incidents, and acts of terrorism. It becomes a greater challenge for local policymakers to balance service expectations, finite resources and fiscal responsibility (NIST Technical Note 1661, Report on Residential Fireground Field Experiments, 2010). Therefore, it is prudent to evaluate all available information in regard to making decisions on the staffing and deployment of resources while maintaining the highest level of safety for firefighters and the public alike.

In addition to the standards and guidelines developed by ISO, NFPA and CPSE, the IFCA Consulting Team analyzed two recent studies (September 2010) published by the United States Department of Commerce National Institute of Standards and Technology (NIST) to provide the policymakers of BFPD, IFPD and the WFPD with quantitative scientific data for response force deployment when developing and finalizing fire and emergency medical response policies and operating guidelines for their organizations. The information presented in the following two sections provides an overview of the research.

Overview of NIST Fireground Field Experiments Report

This report is the first of its kind to quantify the effects of crew sizes and arrival times on the fire service's lifesaving and firefighting operations for residential fires. It is imperative that decision-makers understand that fire risks grow exponentially. Each minute of delay is critical to the safety of the occupants and firefighters, and is directly related to property damage (NIST Technical Note 1661, Report on Residential Fireground Field Experiments, 2010). These experiments directly addressed 22 fireground activities that routinely occur on the scene of a typical residential fire (Figure 1).

22 Fireground Activities	
Stop @ hydrant, Wrap Hose	Advance Back-up Line Stairwell
Position Engine 1	Conduct Primary Search
Conduct Size-up	Ground Ladders Placed
Engage Pump	Horizontal Ventilation
Position Attack Line	Horizontal Ventilation (2nd Story)
Establish 2 In/2 Out	Control Utilities (Int.)
Supply Attack Engine	Control Utilities (Ext.)
Establish RIT	Conduct Secondary Search
Gain/Force Entry	Check For Fire Extension (Walls)
Advance Attack Line	Check For Fire Extension (Ceiling)
Advance Backup Line Front Door	Mechanical Ventilation

Figure 1: Fireground Activities, NIST 2010

Scope of NIST Fireground Study

The scope of the study was limited to understanding specific variables of response and staffing configuration to "low hazard" residential structure fires as defined by National Fire Protection Association Standard 1710. The experiments utilized a residential structure of 2,000 square feet, two story, single family dwelling with no basement and no exposures.

The purpose of analysis and evaluation of the study, the data reflected the following apparatus response and staffing distribution: three engines, one truck and a battalion chief with an aide. To create "real time" response, staggering times of arrival companies at one- and two-minute intervals, close and far, respectively, were incorporated into each segment of the experiments

Some limitations to consider include that the study did not expand to include "medium" and "high" hazard occupancies, commercial or multifamily structures. Additionally, special responses such as hazardous materials, technical rescue, natural disasters or response to emergency medical requests were not addressed. A separate emergency medical experiment/study was conducted and its overview is included following this section.

Primary Findings

Of the 22 firefighting tasks measured, results indicated that the following phases of all fireground activities had the most impact on overall firefighting operation success.

Overall Scene Time

Four- and five-person crews were able to complete the 22 essential firefighting and rescue tasks in a residential setting 30 percent faster than two-person crews and 25 percent faster than three-person crews. Overall scene time is the time that it takes the firefighters to complete all 22 tasks (Figure 2).

The overall scene time measure is critical to the fire crew's ability to complete their work safely and return to the station in order to be available for the next fire call. Furthermore, firefighter crews that complete several of the tasks simultaneously, rather than consecutively, are able to complete all tasks and are less fatigued. It is important to note that previous studies have documented significant benefits for five-person crews for medium- and high-hazard structures, particularly in urban settings, unlike the low-hazard residential fire scenario examined in this study.

In addition to varying crew sizes, the NIST experiments assessed the effects of time stagger between the arriving companies. Close stagger was defined as a 1-minute 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 conducted by the International Fire Chiefs Association and the International Association of Firefighters.

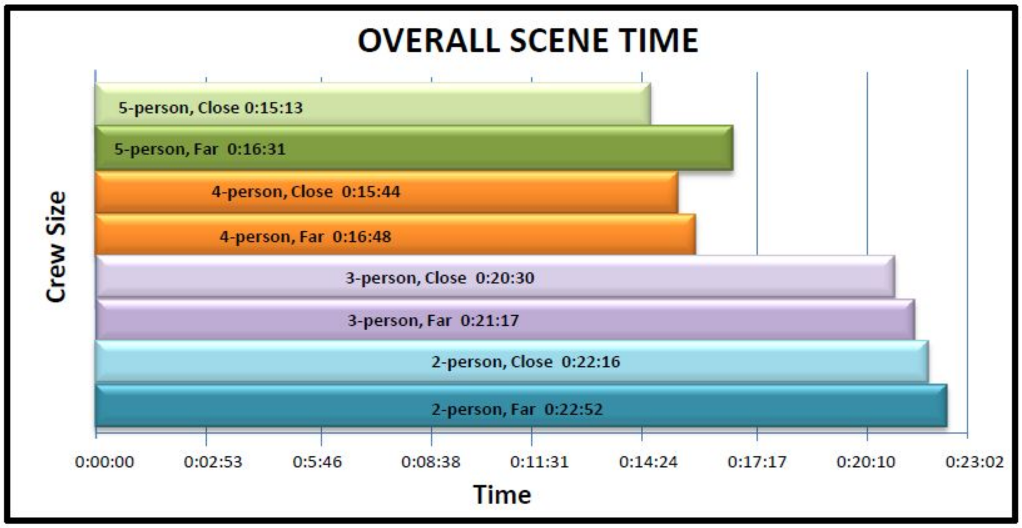


Figure 2: Overall Scene Time; NIST, 2010

Time to Water Application

In this study the term megawatt (MW) is used to measure the amount of energy that is released by fire. This unit of measurement is a key predictor of the hazard of a fire, directly related to the rate at which heat and toxic gases build up in a compartment or the rate at which they are driven into more remote spaces. Heat release rates on the order of 1 MW to 3 MW are typical in a room that has flashed over or from a single large object such as a bed or sofa. Fire risks grow exponentially. Each minute of delay is critical to the safety of occupants and firefighters and is directly related to property damage.

Results show that five-person crews were able to apply water to the fire 22 percent faster than two person crews. Four-person crews were able to apply water to the fire 16 percent faster than two-person crews, and 6 percent faster than three-person crews. What this means for firefighter safety is that two-person crews arriving later to the scene faced a fire about 2.1 megawatts in size.

On the other end of the spectrum, five-person crews arriving earlier to the scene faced a fire about half as big at 1.1 megawatts. For context, a 1-megawatt fire would be a fully-involved upholstered chair burning at its peak. A 2-megawatt fire, however, would be sufficient to produce near-flashover conditions in the 12 by 16 foot room of fire origin used in the experiments. Facing a fire of twice the intensity greatly increases the danger to both firefighters and civilians and increases the likelihood that the fire will spread beyond the room of origin.

Rescue Effectiveness

To estimate how various crew sizes would affect the exposure of occupants to toxic gases, slow -, medium-, and fast-growth rate fires were simulated using NIST's Fire Dynamic Simulator software (Figure 3). The simulation assumed an occupant unable to escape on his own from an upstairs bedroom with the bedroom door open. Occupant exposures were calculated both when firefighters arrive earlier to the scene, representing crews from fire stations nearby the burning structure, and those arriving later, representing crews arriving from more distant locations.

The simulations showed that for a medium-growth fire, two-person crews would not be expected to complete essential tasks in time to rescue occupants from exposures to toxic gases that would incapacitate sensitive populations such as children and the elderly. Two-person crews arriving later would also likely find a significant portion of the general public incapacitated by the time of rescue. The simulations for early arriving five-, four- and three- person crews show that they would likely be able to locate and rescue an occupant before sensitive populations would be incapacitated.

Summary

The NIST study specifically applied to firefighting crew sizes in a low-hazard residential setting and not to larger, more hazardous structures, outdoor or transportation fires. These studies also held apparatus response to a constant complement of firefighting vehicles. Decisions about crew size and how many apparatus to deploy in a specific community depend on a number of variables, including population density, the distribution of structures, age and type of construction, the size of the fire station's first due response coverage area, and the resources available to that jurisdiction.

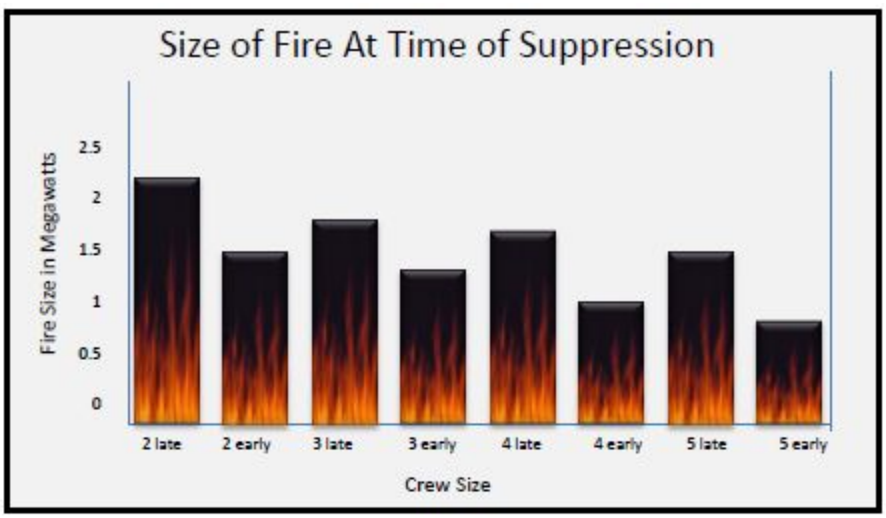


Figure 3: Size of Fire at Time of Suppression NIST, 2010

Overview of NIST EMS Field Experiments Reports

The fire service has become the first line medical responder for all types of medical emergencies in the majority of the United States. Increased demands for service, including the rising number of emergency medical responses, point to the significance of broadening the focus from suppression activities to include personnel configurations, crew size, and apparatus response for emergency medical intervention (Report on EMS Field Experiments, 2010).

Scope of NIST EMS Field Study

The EMS portion of the Firefighter Safety and Deployment of Resources Study was designed solely to assess the personnel number and configuration aspect of an EMS incident for responder safety, effectiveness, and efficiency. This study does not address the efficacy of any patient care intervention. This study does, however, quantify first responder crew size, i.e., the number and placement of ALS trained personnel resources on the time-to-task measures for EMS interventions. Upon recommendation of technical experts, the investigators selected trauma and cardiac scenarios to be used in the experiments as these events are resource intensive and will likely reveal relevant differences in regard to the research questions. The applicability of the conclusions from this report to a large-scale hazardous or multiple-casualty event has not been assessed and should not be extrapolated from this report.

Primary Findings

The objective of the experiments was to determine how first responder crew size, ALS provider placement, and the number of ALS providers is associated with the effectiveness of patient care. EMS crew effectiveness was measured by task intervention times in three scenarios, including patient access and removal, trauma, and cardiac arrest. The results were evaluated from the perspective of firefighter and paramedic safety and scene efficiency rather than as a series of distinct tasks. More than 100 full-scale EMS experiments were conducted for this study.

Hundreds of firefighters and paramedics are injured annually on EMS responses. Most injuries occur during tasks that require lifting or abnormal movement by rescuers. Such tasks include lifting heavy objects (including human bodies – both conscious and unconscious), manipulating injured body parts, and carrying heavy equipment. Several tasks included in the experiments fall into this category, including splinting extremities, spinal immobilization (back boarding) and patient packaging. Similar to the lifting of heavy workload tasks, larger crews were able to complete the labor intensive tasks using multiple crew members on a single task to assure safe procedures were used reducing the likelihood of injury or exposure.

A number of tasks are also labor intensive. These tasks can be completed more efficiently when handled by multiple responders. Several tasks in the experiments are in this category. These include checking vital signs, splinting extremities, intubation with spinal restriction, establishing I.V. access, spinal immobilization, and patient packaging. **During the experiments, larger crews completed these tasks more efficiently by distributing the workload among more people thereby reducing the likelihood of injury**.

Finally, there are opportunities on an EMS scene to reduce scene time by completing tasks simultaneously rather than sequentially, thus increasing operational efficiency. For the experiments, crews were required to complete all tasks in each scenario regardless of their crew size or configuration. Therefore, patterns in task start times and overall scene times reveal operational efficiencies. When enough hands are available at the scene to complete tasks simultaneously, this leads to overall time reductions relative to smaller crews that are forced to complete tasks sequentially.

Patient Access and Removal

Patient access is an important component of the time sequence. It is defined as the time segment between apparatus/vehicle arrival on the scene and the responder's first contact with the patient. With regard to accessing the patient, crews with three or four first responders reached the patient around half a minute faster than smaller crews with two first responders. With regard to completing patient removal, larger first responder crews in conjunction with a two-person ambulance were more time efficient. The removal tasks require heavy lifting and are labor intensive. The tasks also involve descending stairs while carrying a patient, carrying all equipment down stairs, and getting patient and equipment out multiple doors, onto a stretcher and into an ambulance. The patient removal results show substantial differences associated with crew size. **Crews with three- or four-person first responders completed removal 1.2 – 1.5 minutes faster than smaller crews with two first responders.** All crews with first responders complete removal substantially faster (by 2.6 - 4.1 minutes) than the ambulance-only crew (Figure 4).

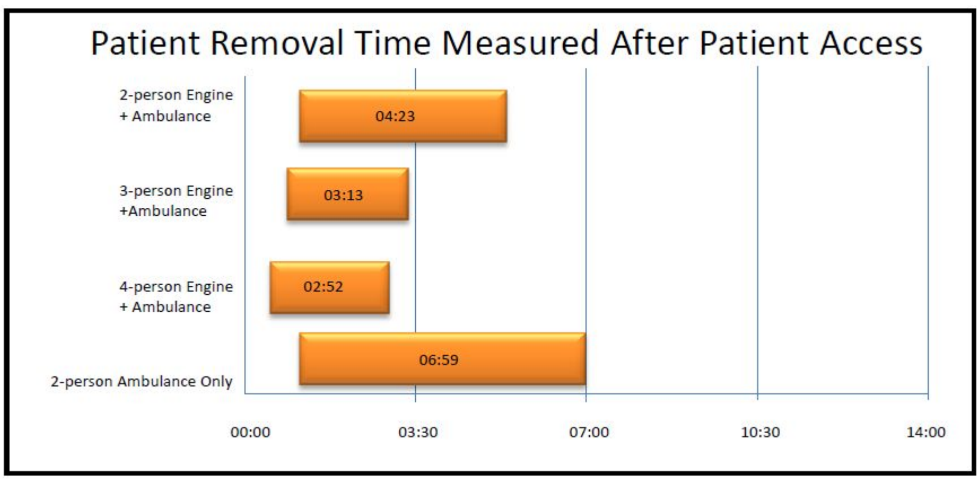


Figure 4: Patient Removal Time Measured After Patient Access, EMS Field Experiments, NIST, 2010

These results suggest that time efficiency in access and removal can be achieved by deploying three- or four-person crews on the first responding engine (relative to a first responder crew of two). To the extent that each second counts in an EMS response, these staffing features deserve consideration. Though these results establish a technical basis for the effectiveness of first responder crews and specific ALS crew configurations, other factors contributing to policy decisions are not addressed.

Trauma

Overall, field experiments reveal that four-person first responder crews completed a trauma response faster than smaller crews. Towards the latter part of the task response sequence, four-person crews start tasks significantly sooner than smaller crews of two or three persons. Additionally, crews with one ALS provider on the engine and one on the ambulance completed all tasks faster and started later tasks sooner than crews with two ALS providers on the ambulance. This suggests that getting ALS personnel to the site sooner matters. A review of the patterns of significant results for task start times reinforced these findings and suggests that (in general) small non-significant reductions in task timings accrue through the task sequence to produce significantly shorter start times for the last third of the trauma tasks.

Finally, when assessing crews for their ability to increase on-scene operational efficiency by completing tasks simultaneously, crews with an ALS provider on the engine and one ALS provider on the ambulance completed all required tasks 2.3 minutes (2 minutes 15 seconds) faster than crews with a BLS engine and two ALS providers on the ambulance. Additionally, first responders with four-person first responder crews completed all required tasks 1.7 minutes (1 minute 45 seconds) faster than three-person crews and 3.4 minutes (3 minutes and 25 seconds) faster than two-person crews (Figure 5).

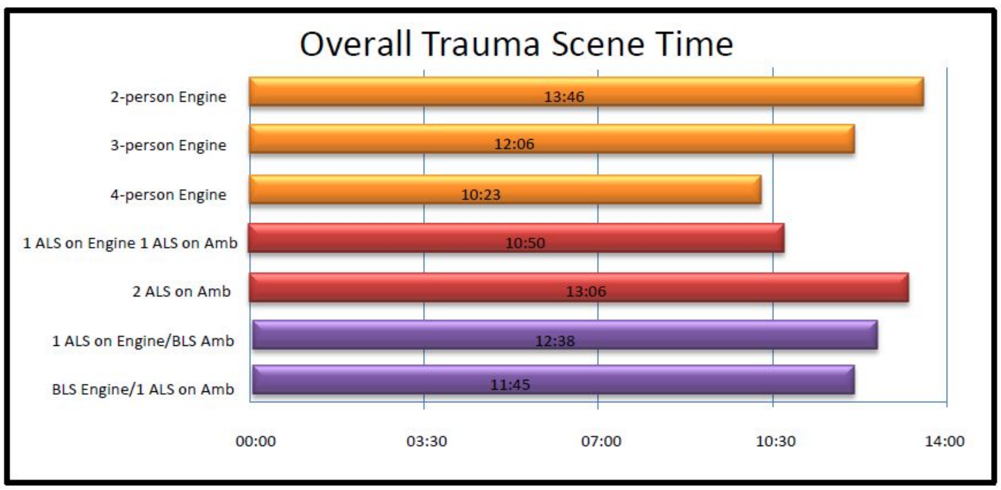


Figure 5: Overall Trauma Scene Time, EMS Field Experiments, NIST, 2010

Cardiac

The overall results for cardiac echo those of trauma. Regardless of ALS configuration, crews responding with four first responders completed all cardiac tasks (from at-patient to packaging) more quickly than smaller first responder crew sizes. Moreover, in the critical period following cardiac arrest, crews responding with four first responders also completed all tasks more quickly than smaller crew sizes. As noted in the trauma scenario, crew size matters in the cardiac response. Considering ALS placement, crews responding with one ALS provider on both the engine and ambulance completed all scene tasks (from at-patient to packaging) more quickly than a crew with a BLS engine and two ALS providers on the ambulance. This suggests that ALS placement can make a difference in response efficiency. One curious finding was that crews responding with a BLS engine and an ambulance with two ALS providers completed the tasks that follow cardiac arrest 50 seconds sooner than crews with an ALS provider on both the engine and ambulance. As noted, this counter-intuitive difference in the results may be attributable to the delay of the patient arrest time based on the arrival of the 12-lead ECG monitor with the two-person ALS ambulance crew.

The 12-lead ECG task end time was the arrest start time. In this scenario, there were instantaneously two ALS providers present at the arrest rather than the one ALS provider placing the 12-lead ECG device in the ALS engine /ALS ambulance crew. A review of the patterns of significant findings across task start times showed mixed results. An ALS on an engine showed an advantage (sooner task starting times) over an ALS on an ambulance for a few tasks located earlier in the cardiac response sequence (specifically, ALS Vitals 12-lead through IV access). A first responder with four-person crew also showed shorter start times for a few early tasks in the cardiac response sequence (initial airway, breathing and circulation (ABCs), and the ALS Vitals 12-lead and expose chest sequence).

More importantly, a sequential time advantage appears for the last three tasks of the sequence (analyze shock #2 through package patient). Finally, when assessing crews for their ability to increase on-scene operational efficiency by completing tasks simultaneously, crews with an ALS provider on the engine and one ALS provider on the ambulance completed all required tasks 45 seconds faster than crews with a BLS engine and two ALS providers on the ambulance. Regardless of ALS configuration, crews responding with four first responders completed all cardiac tasks from the 'at patient time' to completion of packaging 70 seconds faster than first responder crews with three persons, and 2 minutes and 40 seconds faster than first responder crews with two persons.

Additionally, after the patient arrested, an assessment of time to complete remaining tasks revealed that first responders with four-person crews completed all required tasks 50 seconds faster than three-person crews and 1.4 minutes (1 minute 25 seconds) faster than two-person crews (Figure 6).

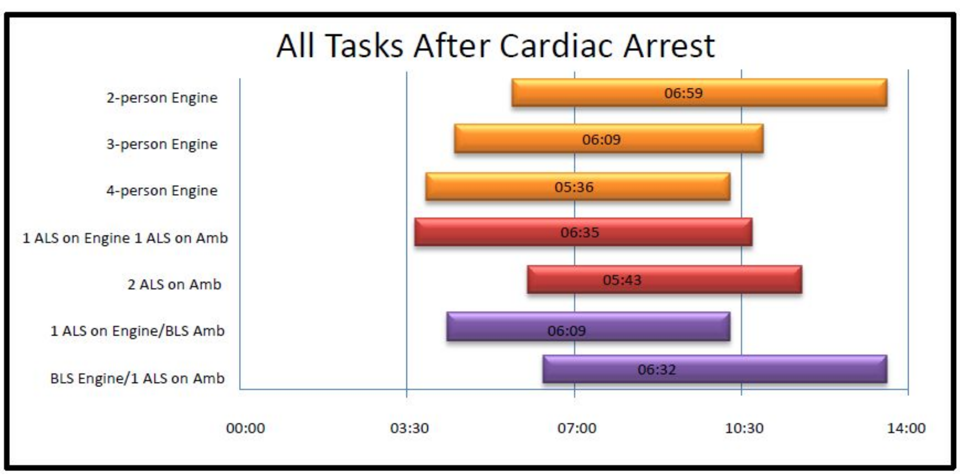


FIgure 6: All Tasks after Cardiac Arrest, EMS Field Experiments, NIST, 2010

Summary

While resource deployment is addressed in the context of three basic scenarios, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many factors including geography, resource availability, and community expectations, as well as population demographics that drive EMS call volume. While this report contributes significant knowledge to community and fire service leaders in regard to effective resource deployment for local EMS systems, other factors contributing to policy decisions are not addressed. The results, however, do establish a technical basis for the effectiveness of first responder crews and ALS configuration with at least one ALS level provider on first responder crews. The results also provide valid measures of total crew size efficiency in completing on-scene tasks some of which involve heavy lifting and tasks that require multiple responders to complete. These experimental findings suggest that ALS provider placement and crew size can have an impact on some task start times in trauma and cardiac scenarios, especially in the latter tasks leading to patient packaging. To the extent that creating time efficiency is important for patient outcomes, including an ALS trained provider on an engine and using engine crew sizes of four are worth considering. The same holds for responder safety – for access and removal and other tasks in the response sequence, the availability of additional hands can serve to reduce the risks of lifting injuries or injuries that result from fatigue (e.g., avoid having small crews repeatedly having to ascend and descend stairs) (Report on EMS Field Experiments, 2010).

Risk Assessment & Community Profiles

Introduction

A risk assessment includes determining and defining the distinct threats in the community based on occupancy such as single-family, multifamily, and industrial structures. Each scenario presents unique problems and requires an appropriate fire protection response. Fire stations, staffing, and apparatus need to be distributed within the community to provide an initial response force capable of dealing with each unique problem (CPSE Assessment Manual, 2009).

When determining the location of a fire station, apparatus placement, and staffing levels, a particular point in a fire's growth that marks a significant shift in its threat to life and property must be considered. This shift, or "flashover point," makes conditions non-survivable. The Standards of Cover are intended to put enough firefighters on the scene in time to prevent flashover as a means to protect both the occupants and the firefighters.

Therefore, response time becomes a critical component in measuring the level of service in the mitigation of significant life safety events. In order to analyze response time and shorten the time of the essential activities that make it up, we can deconstruct response time into key time intervals. Using standard terms and descriptions to describe the time segments will clearly establish the set of events upon which policy and procedural questions are based. Based on the concept of the Utstein Criteria (Time/Temperature Curve) the CPSE produced a similar response baseline for fire and emergency medical services agencies when defining their policies relative to the concentration and distribution of fire companies, emergency medical service units, hazardous materials response, and other resources that are routinely dispatched to the scene of emergency events (CPSE Assessment Manual, 9th ed.).

Similarly, from an emergency medical perspective, the use of a four to six-minute time frame as the Standards of Cover measurement is critical. Brain damage is very likely to occur with cardiac/respiratory arrest patients after six minutes without oxygen flow to the brain.

The mission of the fire service is to protect life, property, and natural resources from fire and other emergencies. With increasing demands, the fire service must utilize the best tools, techniques, and training methods to meet public expectations. Risk management, preparedness, and mitigation have taken on new importance with challenges facing fire departments today. One emerging tool that is helping the fire service optimize emergency services delivery is geographic information system (GIS) technology.

GIS supports planning, preparedness, mitigation, response, and incident management. GIS extends the capability of maps—intelligent, interactive maps—with access to all types of information, analysis, and data. When a fire occurs, any delay of responding fire companies can make the difference between the rescue of occupants versus serious injury or death. The critical time between fire containment and flashover can be measured in seconds. From the moment an emergency call is received through the deployment of tactical resources, GIS helps reduce critical time and increases efficiency. GIS technology brings additional power to the fire personnel whereby hazards are evaluated, service demands are analyzed, and resources deployed. The IFCA Consulting Team has applied GIS technology in this study to identify the needs of both agencies as exhibited throughout the report.

Figure 7 identifies the measurable events that constitute the individual time segments of an emergency response and the importance of time with respect to intervention and the initiation of corrective action.

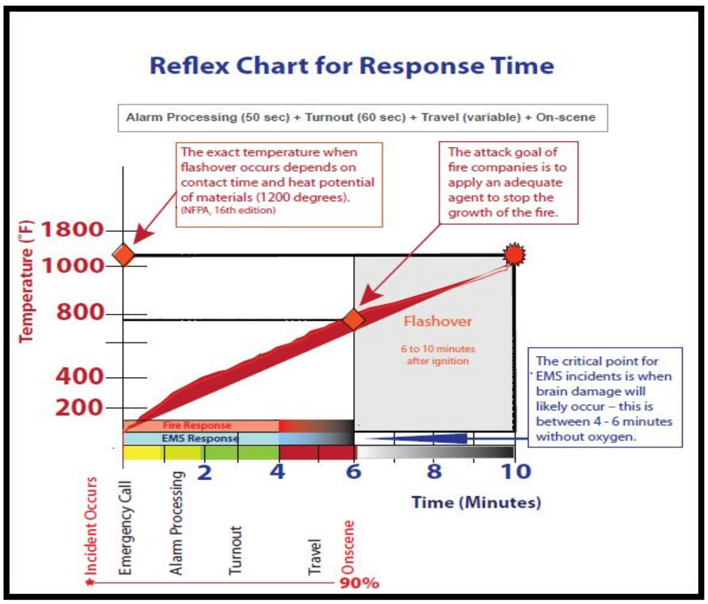
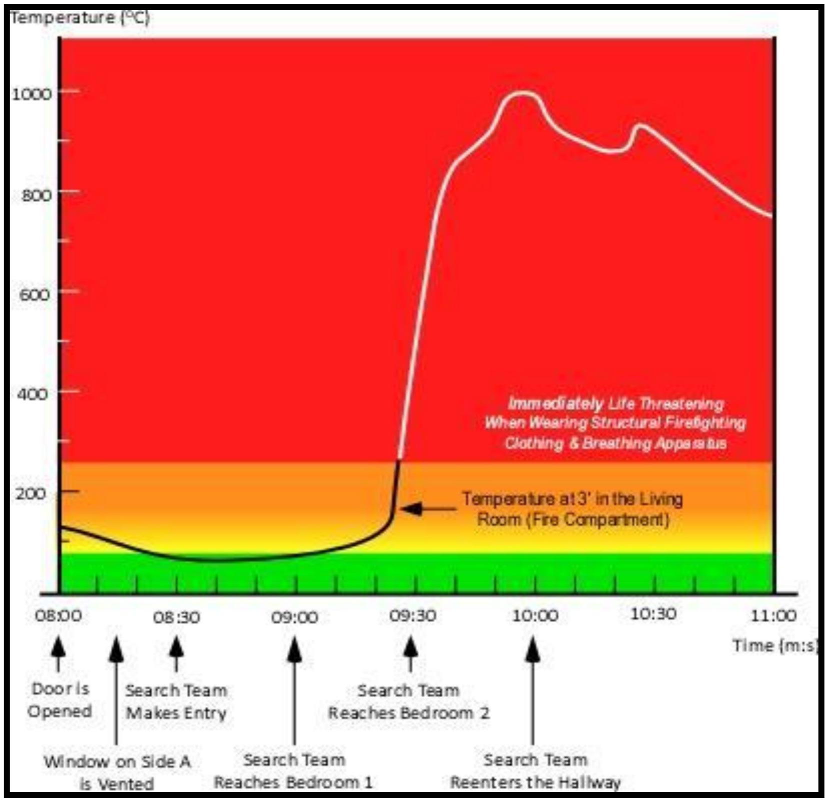


Figure 7: Reflex Chart for Response Time

The Reflex Chart provides emergency responders with a general rule of time over events and highlights significant benchmarks where there are variations of fire growth that must be also taken into consideration when developing a response strategy. As discussed in Underwriter's Laboratory Studies Tactical Implications, fires in the contemporary environment (as opposed to traditionally constructed buildings) progress from ignition and incipient stage to growth, but often become ventilation controlled and begin to decay, rather than continuing to grow into a fully developed fire. This ventilation induced decay continues until the ventilation profile changes (e.g., window failure due to fire effects, opening a door for entry or egress, or intentional creation of ventilation openings by firefighters. When ventilation is increased, heat release rate again rises and temperature climbs with the fire potentially transitioning through flashover to the fully developed stage. The purpose of this study is not to discuss the strategy and tactics involved in firefighting in structure fires. However, it is important to create an awareness of recent data in the correlation of fire growth, building construction and its relationship between response times and firefighter intervention.



Note: *Figure 8 illustrates temperature conditions starting eight minutes after ignition. The fire previously progressed through incipient and growth stages before beginning to decay due to lack of ventilation.*

While there are many other components to the CPSE self-assessment program, the previously mentioned components of the assessment review will be applied in this study.

In discussions where the UL, ISO, NFPA, CPSE and NIST standards and/or research are not appropriate or do not exist, the Team will use its experience, knowledge, research, judgment and reasoning to present a best-case recommendation.

Identifying and Categorizing Community Risks

Community risk level is typically established through an overall profile of the community, based on the unique mixture of demographics, socioeconomic factors, occupancy risk, fire management zones, and the level of services currently provided. Community hazards and associated risks may be divided into 3 categories.

- Property
- Life
- Critical infrastructure

The property category is of particular interest to the fire service. Each property or structure in a community can be considered a hazard that carries inherent risks based on occupancy type and fire load. Occupancy risk is a sublevel of property risk and is established through an assessment of the relative risk to life resulting from a fire inherent in a specific building/structure or in generic occupancy classes (e.g. high rise residential).

The *Fire Protection Handbook* is a resource guide for the fire service. The handbook identifies initial attack response capabilities for low, medium, and high hazard occupancies.

➢ **High-Hazard Occupancies**— Areas zoned for schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings and other high life hazard or large fire potential occupancies.

  ✓ Operations response capability — at least 4 engines, 2 ladder trucks (or combination apparatus with equivalent capabilities), 2 chief officers and other specialized apparatus as may be needed to cope with the combustibles involved; not less than 24 firefighters and 2 chief officers plus a safety officer and a rapid intervention team. Extra staffing for high hazard occupancies is advised.

➢ **Medium-Hazard Occupancies**— Areas zoned for apartments, offices, mercantile and industrial occupancies not requiring extensive rescue by firefighting forces.

  ✓ Operations response capability — at least 3 engines, 1 ladder truck (or combination apparatus with equivalent capabilities) 1 chief officer and other specialized apparatus as may be needed or available; not less than 16 firefighters and 1 chief officer plus a safety officer and a rapid intervention team.

➢ **Low-Hazard Occupancies**— Areas zoned for one-, two- or three-family dwellings and scattered small business and industrial occupancies.

  ✓ Operations response capability — at least 2 engines, 1 ladder truck (or combination apparatus with equivalent capabilities), 1 chief officer and other specialized apparatus as may be needed or available; not less than 12 firefighters and 1 chief officer plus a safety officer and a rapid intervention team.

Risk assessment includes determining and defining the distinct threats in the community, based on occupancy such as single-family, multifamily and industrial structures. Each scenario presents unique problems and requires an appropriate fire protection response. Fire stations, staffing and apparatus need to be distributed within the community to provide an initial response force capable of dealing with each unique problem (CPSE Assessment Manual, 2006).

Linking Community Risk Assessment to Response Force and Deployment

The IFCA Consulting Team reviewed each community's fire department personnel deployment practices (where applicable) since they are integral to the overall capability of the departments to respond to and manage a fire or EMS incident. Typically, a fire department's personnel resources assigned to various stations are dependent not only on population protected, but also on population demographics, geography, climate, environment and types of commercial development. The first step of the deployment plan, called Risk Analysis, involves categorizing the hazards for each fire hazard category in terms of potential for presenting hazardous situations or conditions (e.g., *low*, *medium*, *and high-hazard*) and determining the *optimal* level of response. If a comprehensive Risk Analysis were done, a fire protection survey would be completed to determine the *level of risk* that is a direct consequence of any *hazards* identified.

In this review, we analyzed the street layout, physical features, topography, industries, commercial areas, residential neighborhoods, built-up areas and other characteristics. The objective is to identify buildings where large numbers of people are found and where hazardous industries operate. These target hazards typically present significant risk because they offer the potential for large loss of life and/or catastrophic fire.

The second step is to assess the fire protection response system (deployment resources) to meet the worst-case scenario, which may be more costly than the community can afford. The deployment of these resources should be based on the worst-case scenario (i.e., target hazards) in the designated response area and may be adjusted as appropriate to the risks. An *optimal level* is preferred as it is the more cost-effective approach because it seeks the middle ground between *minimal* (least cost, highest risk) and *maximal* (highest cost, least risk).

The level of service is the product of the deployment of resources and provides a Standards of Cover for the respective community or service area. Figure 9 is a sample risk matrix table that can be used in determining the community's risk assessment.

COMMUNITY RISK MATRIX		
Risk Type	**Definition**	**Risk Profile**
Maximum Risk -1.0% (>5,000 GPM fire flow required)	Heavy concentration of property presenting a high risk of life loss, loss of economic values, such as: unsprinklered shopping centers, industrial complexes, and commercial properties.	**NIL**
High Risk – 4.0% (<5,000 GPM fire flow required)	High concentration of property presenting a substantial risk of life loss, a severe financial impact on the community, such as: high-rise structures, high-risk industrial plants, hazardous materials facilities, commercial, mercantile properties.	**NIL**
Moderate Risk – 95.0% (<2,000 GPM fire flow required)	Built-up area of average size, where the risk of life loss or damage to property in the event of a fire in a single occupancy is limited, such as: single family homes, apartment complexes, multifamily, industrial complexes.	**NIL**
Low Risk - <.01% (<1,000 GPM fire flow required)	Small commercial structures that are remote from other buildings, such as: detached residential garages, and outbuildings.	**NIL**

Figure 9: Community Risk Matrix (CPSE, 2000)

Each fire emergency category requires a different amount of firefighting staff and water or fire stream application rates to match the given risk. Fire suppression staffing is determined by the critical tasks that must be performed on the fireground and by the amount of water needed to suppress the fire, which is commonly called the “required fire flow.”

Fire flow is the amount of water needed to be directed at specific targets if desired offensive or defensive fire control objectives are to be achieved. Needed fire flow is the amount of water that should be available for providing fire protection at selected locations throughout a community. ISO has prepared a guide for estimating needed fire flow. The publication is only a guide and requires knowledge and experience in fire protection engineering for its effective application. However, there are software programs available that can easily determine fire flow rates for all properties.

In regard to staffing, NFPA guidance on company response time and minimum staffing provides minimum goals based on fractal measures. NFPA 1710 defines a “company” as:

> A group of members: (1) Under the direct supervision of an officer; (2) Trained and equipped to perform assigned tasks; (3) Usually organized and identified as engine companies, ladder companies, rescue companies, squad companies, or multi-functional companies; (4) Operating with one piece of fire apparatus (engine, ladder truck, elevating platform, quint, rescue, squad, ambulance) except where multiple apparatus are assigned that are dispatched and arrive together, continuously operate together, and are managed by a single company officer; (5) Arriving at the incident scene on fire apparatus.

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A measure of response effectiveness is the time from call received to apparatus arrival. We will go into more detail later. However the basics of time study are summarized here. For the purpose of this study, the IFCA Consulting Team utilized the standards as presented in NFPA 1710 (for departments that are 80-percent career) which identifies benchmarks at 90 percent of the time as illustrated below in Figure 10**.**

NFPA 1710 RESPONSE BENCHMARKS	
Task	**Time**
Turnout Time (EMS)	1 minute
Turnout Time (non-EMS)	1 minute 20 seconds
Arrival of First Engine Company (Travel Time)	4 minutes or less
Arrival of Full Alarm Assignment (Travel Time)	8 minutes or less
Arrival of First Responder Unit (Travel Time)	4 minutes of less
Arrival of ALS Unit (Travel Time)	8 minutes or less

Figure 10: NFPA 1710 Response Benchmarks

Effective Response Force (ERF)

The IFCA Consulting Team conducted 4 minute and an 8 minute travel time analysis from each station as the benchmark for determining an effective fire unit response. The 4 minute travel time standard defines the benchmark for initial company response to an emergency and is the standard used by the National Fire Protection Association (NFPA 1710) and the Center for Public Safety Excellence (CPSE). The NFPA and CPSE utilize an 8 minute response time standard as the benchmark for an effective response force (initial full alarm assignment) to arrive on the emergency scene for a residential structure fire.

These times are based on a time temperature curve that illustrates that flashover can occur as early as 8 minutes after its initiation. This benchmark ideally would be achieved 90 % of the time.

According to NFPA 1710, the full alarm assignment for a residential structure (2 story 2000 square feet) fire would include the following minimum staffing for each function (Figure 11):

NFPA 1710 Full Alarm Assignment-Residential Structure Fire		
Task	**Firefighters Required**	**Company Assigned**
Incident Command	1	Chief Officer
Water Supply	1	Engine
Attack Lines x 2	2/2	Engine
Back-Up-Line	2	Engine
Support Line-Attack Line	1/1/1	Engine or Truck
Search & Rescue	2	Engine or Truck
Ventilation	2	Truck
Truck/Aerial Operator	1	Truck
RIT	2	Engine or Truck
Total Personnel	**17**	

Figure 11: Assignment-Residential Structure Fire

The typical response to fill this minimum staffing and perform the necessary fireground tasks would include a Command Vehicle, two Pumpers, a Truck and an additional support vehicle with a total of 18 personnel.For EMS responses, the NFPA 1710 benchmark is to have an EMS response with a minimum of an Automated External Defibrillator (AED) within a 240 seconds (4-minute) travel time to 90 % of incidents. This response should be followed by an ALS emergency response with a minimum of 2 paramedics that arrives on the scene within a 480 second (8 minute) travel time to 90% of the incidents. This benchmark time is established using the probability of survival for a non-breathing patient. It is also based on the survivability of a severely injured trauma patient.