STANDARDS OF EMERGENCY SERVICES COVERAGE

WFCA

Washington Fire Commissioners

A brief overview and history of the "Standards of Coverage" doctrine as it applies to emergency services in the State of Washington.

RESPONSE PERFORMANCE and STANDARDS OF COVERAGE

Standards of Cover History/Overview

Much of the following materials have been adapted or directly quoted from the publication, *Creating And Evaluating Standards Of Response Coverage For Fire Departments*©, 4th Edition, Commission On Fire Accreditation International, Inc., Chantilly, VA. Additional materials have been added by Ron Coleman and Gene Begnell, two of the co-authors of the above publication.

History

In the early days of the fire service, there was not much reason to talk about response time. In the days of hose carts and bucket brigades, fire stations were based more on the limitations of the fire truck and the means used of hauling the heavy equipment over distances. With hand-operated equipment, the distance was obviously limited. When the steam engine came into service, horses were used to pull the equipment from the station to the scene. In areas where full-time departments were created, generally in the large communities, the placement of fire stations became a public policy decision process. This was the first instance where time and distance were really given consideration in selecting the locations for stations. This required that fire stations be placed using some type of criteria.

Beginning around 1850, with the creation of full-time fire departments, fire stations were originally staffed according to the existence of the earlier stations, which were essentially based upon neighborhoods and the location of volunteers. When new stations were required, one of the very first criterion to be applied was the idea that multiple fire stations needed to be spaced sufficiently far apart so that the overall community was covered, and yet close enough together to be able to support one another. Because this criterion was based upon the use of horses to haul the equipment, it was natural to look to the capacity of these horse teams to arrive at an emergency in a relatively short time.

Whether it was by intent or by accident the numbers that were arrived at were fairly easy to understand: how far could a good team of fire horses haul a steamer in five minutes? At a gallop, horses pulled steamers about 1.5 miles in five minutes. This practice was discussed in the fire literature at the time and was a widely accepted practice. For more than 40 years, the method

of choice for responding was to continue to use horses. The fire service adopted automotive fire apparatus to replace the horses once the technology had been proven to be reliable. However, the transition was not short, nor was it universal. There were many fire departments that operated horse-drawn apparatus for 25 years after the introduction of internal combustion engines. Therefore, the existing prevailing practice of site planning for fire stations was based upon the common practice of the 1.5-mile radius as a rule of thumb. In fact, the practice was also institutionalized by fire agencies that continued to use the criterion in spite of upgrades of roadways and traffic circulation systems.

Influence of National Organizations on the Process

With the creation of the fire grading system by the National Board of Fire Underwriters, the fire service was almost immediately affected by that group's establishment of an evaluation system that was somewhat based upon science and somewhat based on past practices. For example, the work that was done to create fire stream hydraulics was based upon very specific studies and considerable data. The fire flow figures that were developed for the various construction types were based upon studying actual fire losses. The data was not as scientifically verifiable, but it was systematic. The grading schedule was designed to prevent urban conflagration, not to serve the day-to-day activities of a fire agency. Among the concepts incorporated into this system was the assumption that the 1.5-mile fire station radius was appropriate for use in that context.

There is very little literature describing fire station citing studies from the early 1920s until the 1960s. At that time there was an interest in the question of how to site and staff fire stations in heavily urbanized and highly impacted fire service agencies. Beginning in 1968, the Rand Institute developed a research project that began to study all of the variables of fire station response. This included a review of the factors of both time and distance. The Rand studies were complex and difficult for local government or fire service personnel to fully understand.

One group that did pay attention to this research was the International City/County Management Association (ICMA). As a result of a series of exchanges between the organization and the insurance industry, there was a concern expressed that the insurance industry's criteria were antiquated and not consistent with contemporary issues facing the fire service. Several documents were produced challenging the assumptions of the insurance industry relative to fire station locations and methodologies.

Role of International Association of Fire Chiefs and International City/County Management Association

In 1986, the International Association of Fire Chiefs (IAFC) began the development of the concept of fire department self-assessment after adopting a proposal established by Chief Ron Coleman, IAFC second vice president. The IAFC Executive Board adopted the creation of a task force to explore the concept. The intent of this project was to develop a more uniform method of evaluating fire defenses. The program was intended to result in the development of a system of accreditation for organizations that had met all of the categories, criterion and performance indicators established within the system. The first meeting was held in Washington D.C. at the annual conference of the IAFC. The committee eventually grew to more than 50 persons and was in the developmental process until 1997, when the Commission on Fire Accreditation International Inc. (CFAI) was formed. The Accreditation Task Force instituted a study of the methodology, which was introduced in the first edition of its Fire and Emergency Service Self-Assessment Manual.

ICMA entered into a memorandum of agreement with the IAFC to advocate the concept of self-assessment. The CFAI Board of Trustees was established in 1997. The commission was created after nominations were received from agencies that were eligible to have a seat on the commission. The Fire and Emergency Service Self-Assessment Manual was published and copyrighted. The commission reviewed and granted accreditation to the first five agencies that had successfully completed the entire process.

European Practices

When the Commission on Fire Accreditation International Inc. began its research into the concept of having a standardized model for reviewing fire department deployment, it discovered that this concept has been in practice in many European fire departments since the end of World War II.

Fire station location in other parts of the industrial world developed under slightly different conditions. In Europe, as a result of more national involvement of the provision of fire services, especially in the aftermath of World War II, there was a desire to set some standards. Right after World War II, the British fire service adopted a concept called *Standards of Response Coverage*. Between 1950 and the early 1980s, the British fire service adopted a series of standards that dealt with a wide variety of conditions ranging from rural to urban settings.

Systems Approach

The historical Standards of Cover systems approach consists of the following eight components:

1. Existing deployment
2. Risk identification
3. Risk expectations
4. Service level objectives
5. Distribution
6. Concentration
7. Performance and reliability
8. Overall evaluation

Together, these eight components provide the groundwork for the adoption of system performance measurements. The process is changing slightly in current practice, in that some of the more subtle components are receiving additional attention. Current thinking includes following process:

1. Overview of Existing Deployment

All agencies have an existing policy, even if it is undocumented or adopted by the locally responsible elected officials. Originally, stations and equipment were situated to achieve certain expectations. How and why they were sited needs to be historically understood, described, and contrasted to proposed changes. A review of the facilities, equipment, and personnel in the existing system needs to be provided. One of the key issues in this phase is to determine and document the services that are provided by the organization. Traditionally, fire departments have provided fire and rescue service, but today also provide emergency medical services (EMS), hazardous materials response (HazMat), and specialized services such as RAFF (aircraft), marine, or wildland services.

2. Risk Identification and Assessment

Risk Assessment consists of two key elements:

- Probability: The likelihood that a particular event will occur within a given period of time. An event that occurs daily is highly probable. An event that occurs only once in a century is very unlikely. Probability is an estimate that an event will occur and a prediction that it will be very close by in time, or sometime off in the future.
- Consequence: Consequence can be subdivided into two components.
    - Life safety: the amount of emergency personnel and equipment to rescue or protect lives from life-threatening situations.
    - Economic impact: the losses of property, income or irreplaceable assets.

Risk Factors

In order for a fire agency to make specific observations about the scope and complexity of its risk areas, it must have conducted a risk assessment. The key risk factors to be evaluated include:

- Population/demographic factors such as density or aged populations
- Building/occupancy factors, such as the relative risk to life and property resulting in a fire inherent in a specific occupancy or in a generic occupancy class
- Environmental factors such as floods zone, wildland fires, topographic issues, weather, and climatic conditions
- Infrastructure including transportations systems (road, rail, water, and air), water systems, communications, and support systems (traffic control, flood control, storm drains, level systems, etc.)
- Demand/service zones which are areas used to define or limit the management of a risk situation
- Community, which is defined as the overall profile of the community based on the unique mixture of individual occupancy risks, demand zone risk levels, and the level of service provided to mitigate those risk levels

Risk must be assessed for each service provided.

3. Risk Expectations

Before performance measures can be developed for a community, it is necessary to determine the expectations of the citizens within the community. For example, fire protection for a community could range from a single fire extinguisher placed at the center of town for everyone's use, to having firefighters stationed at every corner. While neither of these extremes is likely, the answer for each community lies somewhere in between the two extremes. The point at which it lies is a community decision, and will likely be different in every community. The level of consequence that is *acceptable* to a community will dictate the level of resources the community is willing to provide to see that the acceptable threshold is not exceeded.

After understanding the risks present in the community, what control measures do the citizens and elected officials expect? For example, does the agency confine the fire to the compartment of origin, area of origin, floor of origin, or building of origin? Some agencies in sparsely populated areas with long response times of 30 minutes or more might have to accept (but not like), an exposure level of service where the building fire does not spread to the adjoining forest and start a conflagration. In EMS, we might expect to get a trauma patient to the designated trauma center within the first hour.

4. Service Level

Typically, the level of service areas would be: urban, suburban, rural, or undeveloped. This does not stop a community from combining areas or

developing new ones. Each risk category found in a community should have an outcome expectation developed for it. Risks, other than structure fires, are typically EMS and special rescue such as confined space, hazardous materials, airports, and airplanes, etc. Deployment is measured and typified from two concepts, distribution and concentration, which are influenced by response time and create an effective response force for each risk category for each service provided in each level of service defined.

5. Statistical Measures

Throughout this document, certain descriptive statistical measures are utilized which may not be familiar to all readers. In an effort to reduce confusion or the drawing of inaccurate conclusions, this section seeks to provide a brief explanation of these measures. The measures most often used which require clarification are average and percentile measures.

Average

The average measure is a commonly used descriptive statistic also called the mean of a data set. It is a measure which is a way to describe the central tendency, or the center of a data set. The average is the sum of all the points of data in a set divided by the total number of data points. In this measurement, each data point is counted and the value of each data point has an impact on the overall performance. Averages should be viewed with a certain amount of caution because the average measure can be skewed if an unusual data point, known as an outlier, is present within the data set. Depending on the sample size of the data set, the skewing can be either very large or very small.

For example, assume that a particular fire station with a response time objective of six minutes or less had five calls on a particular day. If four of the calls had a response time of eight minutes while the other call was across the street and only a few seconds away, the average would indicate the station was achieving its performance goal. However, four of the five calls, or 80 percent, were beyond the stated response time performance objective.

The opposite can also be true where one call with an unusually long response time can make otherwise satisfactory performance appear unacceptable. These calls with unusually short or long response time have a direct impact on the total performance measurements and the farther they are from the desired performance, the greater the impact.

The reason we compute the average is because of its common use and ease of understanding that is associated with it. The most important reason for not using averages for performance standards is that it does not accurately reflect the performance for the entire data set. As illustrated above, one

extremely good or bad call skewed the entire average. While it does reflect all values, it does not really speak to the level of accomplishment in a strong manner.

Percentile

With the average measure, it is recognized that some data points are below the average and some are above the average. The same is true for a median measure which simply arranges the data set in order and finds the value in which 50 percent of the data points are below the median and the other half are above the median value. This is also called the 50th percentile.

When dealing with fractals or percentages, the actual value of the individual data does not have the same impact as it did in the average. The reason is that the fractal is nothing more than the ranking of the data set. The 90th percentile means that 10 percent of the data is greater than the value stated and all other data is at or below this level.

Higher fractal measurements are normally used for performance objectives and performance measurement because they show that the large majority of the data set has achieved a particular level of performance. This can be compared to the desired performance objective to determine the degree of success in achieving the goal.

Before discussing the department's current performance, it is important to understand the dynamics of fire and medical emergencies. ESCi has provided additional information in the Appendix regarding these dynamics and how they affect incident outcomes. An understanding of the dynamics of emergencies is essential to the proper selection of performance objectives and analysis of performance.

Emergency service agencies should have clearly defined response performance objectives established to allow evaluation of capability and service delivery. An organization's performance objectives should clearly state both the current and desired emergency service capabilities in very measurable terms. For emergency response, performance objectives should define response performance using both time and resource criteria. For example:

- Provide for the arrival of adequate resources to initiate basic emergency medical services at the scene of any medical emergency within "X" minutes following dispatch, 90 percent of the time.
- Provide for the arrival of adequate resources to initiate interior fire suppression operations at the scene of any fire within "X" minutes following dispatch, 90 percent of the time.

With specific performance criteria a fire department can develop deployment methodologies to achieve desired levels of performance, and can quickly identify when conditions in the environment degrade performance.

6. Measurements of System Performance

Distribution: The locating of geographically distributed, first-due resources, for all-risk initial intervention. These station location(s) are needed to assure rapid deployment to minimize and terminate average, routine emergencies. Distribution is measured by the percentage of the jurisdiction covered by the first-due units, within adopted, public policy response times. Policies shall include benchmarks for intervention, such as: arrival prior to or at flashover; or arrival on EMS incidents prior to brain death in cardiac arrest. From risk assessment and benchmark comparisons, the jurisdiction will use critical task analysis to identify needed resource distribution and staffing patterns.

A sample distribution policy statement could be:

> *"For 90 percent of all incidents, the first-due unit shall arrive within five minutes total reflex time. The first-due unit shall be capable of advancing the first line for fire control or starting rescue or providing basic life support for medical incidents."*

Distribution statements have some very specific grammar and structure. They must have a fractal performance measure and a time measure - either total reflex or travel.

Concentration: Concentration involves the spacing of multiple resources arranged (close enough together) so that an initial *effective response force* can be assembled on scene within adopted, public policy time frames. An *initial* effective response force is that which will most likely stop the escalation of the emergency for each risk type.

For example, in urban/suburban areas, an initial effective response force is typically three to four units, all arriving within 10 minutes or less travel time. Such a response can stop the escalation of the emergency, even in a high-risk area. An initial effective response force is not necessarily the total number of units or personnel needed if the emergency escalated to the maximum potential.

For example, if a building pre-planned for a worst case scenario has a fire flow of 4,000 gpm, it is possible for the jurisdiction to plan an initial effective response force to provide the gpm necessary (say 1,500 gpm) to contain the

fire to a reasonably sized compartment of origin for initial attack, but have further planned for multiple alarms to fill in the remainder of the fire flow demands if initial attack is unsuccessful. Additional alarms or units could be planned on from farther away, including automatic and mutual aid. If risk is well defined within areas smaller than a fire company first-due area (demand zone, run box, CAD response grid, etc.), the initial effective response force should be planned for the predominant risk type found. Historical fire data is used to match predicated response staffing to prior incident history and department standard operating procedures. This method is commonly called critical tasking.

Concentration is measured by risk category type - high-risk areas need second and third-due units in shorter time frames than in typical or low-risk areas.

Sample standards of cover policy statement on concentration could be:

> "*That in a maximum risk area, an initial effective response force shall arrive within 10 minutes total reflex time, 90 percent of the time and be able to provide 1,500 gpm for fire fighting, or be able to handle a five-patient emergency medical incident.*"

Concentration statements, like distribution statements, have very specific grammar and structure. They must have a fractal performance measure and a time measure - either total reflex or travel. The performance measure is for the initial effective response force that may not finish the job without additional help, but is designed to stop the escalation of the emergency. For example, the force (first alarm) is designed to stop fires historically found in each risk category, not the worst fire flow expected. The force may call for additional help to finish the tasks of overhaul and crew rest rotations.

Concentration pushes and pulls distribution, and there is no one perfect mathematical solution. Each agency, after risk assessment and critical task analysis, must be able to quantify and articulate why its resource allocation methodology meets the governing body's adopted policies for initial effective intervention on both a first-due and multiple-unit basis.

Performance Reliability: This looks at actual incident history data to measure historical performance. If your agency states it does something within X-minutes, Z percent of the time, does it? The reliability of the response system is evaluated. Does the agency frequently see multiple calls for service (stacked or queued calls), and do these degrade performance? Are there predictable times of the day, week, or year when queued calls occur? Can these occurrences be controlled or can peak hour staffing be used? For

example, in some areas in the summer during extreme fire weather conditions, additional crews are placed into service for the worst part of the day. In a similar manner, EMS peak hour incident needs can be handled by additional, part-time units. In essence this section of the methodology looks at outcomes and determines if the standard of coverage is achieving the community's expectations.

7. Critical Task Analysis

The scene of an emergency is by definition, organized chaos. It is extremely important to study the sequence and nature of the primary or critical tasks that much be performed in order to bring the emergency to a positive conclusion. This is referred to as Critical Task Analysis. Use of this analysis will determine the number, type, and timing of needed resources to accomplish the tasks at hand. Because the equipment, training, procedures, and knowledge differ from one organization to another, this process should be accomplished by each organization as it moves through the SOC process. While most are similar, difference will occur.

8. Overall Evaluation

Once all the individual standards of coverage factors are understood and measured, an overall, comprehensive evaluation must be conducted. This is where the professional fire officer's experience in his/her community is needed. We have all heard the term "garbage-in, garbage-out". Well, all the statistics may say one thing, but they may totally disagree with real world experience. If so, find out why and keep studying until the numbers come close to reality. Then based on good data, compare and contrast the study findings to community needs, expectations, and the ability to afford. All elected officials should be presented with a cost-benefit analysis, not just a demand for a change! The decision-making body should also adopt the performance measures identified in the process.

9. Compliance Methodology

Finally, it is extremely important that a methodology is established for the continued measurement of performance and adjustment of the delivery system as needed to attain desired performance. This is accomplished by detailing the methodology that will be used in the evaluation of the organization's performance in the future. Good compliance systems will have monthly, quarterly, and annual components to them, as well as long term plans to revisit the entire SOC process. It is important to remember that, "What gets measured; gets done".

Summary
Fire departments have been building fire stations and staffing them in this country for more than 250 years. Benjamin Franklin probably did not have much discussion about where to place his first fire company in Philadelphia. Today, there are a wide variety of reasons to place emphasis on this methodology. Among the top contenders for the prime reason is *fire department performance* in a contemporary fire service. Placement and staffing of fire companies is not as simple as it once was, but it is not as complicated as some would have it be. Standards of response coverage are merely a rational and systematic way of looking at the basic service provided by a fire agency: emergency services.

RESPONSE PERFORMANCE

As stated earlier, the ultimate goal of any emergency service delivery system is to provide sufficient resources (personnel, apparatus, and equipment) to the scene of an emergency *in time to take effective action to minimize the impacts of the emergency*. This need applies to fires, medical emergencies, and any other emergency situation to which the fire department responds.

As noted earlier, any discussion of response time performance centers on these four key time sequences:

- *Call processing and dispatch*
- *Turnout time of firefighters*
- *Initial resource arrival (travel time)*
- *Effective response force arrival*

Though the following standards discussed in this section are not mandatory, they provide at least some generally accepted *targets* against which to benchmark response time performance in the absence of formally adopted response time standards.

NFPA 1710

The National Fire Protection Association (NFPA) has issued a response performance standard for all or mostly career staffed fire departments. This standard, among other things, identifies a target response time performance objective for fire departments and a target staffing standard for structure fires. *Though not a legal mandate*, *NFPA 1710* does provide a useful benchmark against which to measure the fire department's performance.

NFPA 1710 contains time performance standards for structure fire response as well as emergency medical response. Each will be discussed individually.

NFPA 1710 recommends that the first company arrive at the scene of a structure fire within five minutes of dispatch, 90 percent of the time. NFPA uses the 90th percentile rather than average. This allows an evaluation of a department's performance on the vast majority of its incidents.

The standard establishes that a response company consists of four personnel. The standard does not require that all four be on the same vehicle, but does expect that the four will operate as a single functioning unit once on scene. The *NFPA 1710* response time standard also requires that all four personnel be on scene within the recommended five minutes, 90 percent of the time.

There is another reason the arrival of four personnel is critical for structure fires. OSHA regulations require that before personnel can enter a building to extinguish a fire at least two personnel must be on scene and assigned to conduct search and rescue in case the fire attack crew becomes trapped.[1] This is referred to as the *two-in-two-out* rule. The only exception to this regulation is if it is known that victims trapped are inside the building.

Given typical staffing of engines, the time it takes for the second unit to arrive becomes very important to achievement of the NFPA standard. If additional help is a considerable amount of time away, the fire will continue to grow rapidly contributing to damage to the property.

Finally, the NFPA standard calls for the arrival of the entire initial assignment within nine minutes of dispatch, 90 percent of the time. This is to ensure that enough people and equipment arrive soon enough to be effective in controlling a fire before substantial damage occurs.[2]

NFPA 1710 describes the following performance as meeting the structure fire response criteria of the standard:

- Turnout time within one minute, 90 percent of the time
- Arrival of the first company within five minutes of dispatch, 90 percent of the time, or
- Arrival of the entire initial response assignment (all units assigned to the incident) within nine minutes of dispatch, 90 percent of the time

[1] 29 CFR 1910.134(g)(4).

[2] See Appendix for discussion about the time/temperature curve and the effects of flashover.

There are three time standards within *NFPA 1710* for emergency medical responses. They are:

- Turnout time within one minute, 90 percent of the time
- Arrival of a unit with first responder or higher level of capability (basic life support) within five minutes of dispatch, 90 percent of the time
- Arrival of an advanced life support unit, where this service is provided by the fire department, within nine minutes of dispatch, 90 percent of the time

NFPA 1710 describes the following performance as meeting the *structure fire* response criteria of the standard:

• *Turnout time within one minute, 90 percent of the time*
• *Arrival of the first company within five minutes of dispatch, 90 percent of the time,* ***or***
• *Arrival of the entire initial response assignment (all units assigned to the call) within nine minutes of dispatch, 90 percent of the time*

There are three time standards within *NFPA 1710* for *emergency medical* responses. They are:

• *Turnout time within one minute*
• *Arrival of a unit with first responder or higher level of capability (basic life support) within five minutes of dispatch,*
• *Arrival of an advanced life support unit, where this service is provided by the fire department, within nine minutes of dispatch.*

Again, it is noted that the standard 'measuring device' for these requirements is on a *ninetieth* percentile – meaning that the performance must be met ninety percent of the time. Often, when fire departments analyze their response performance, they use an *average percentile* when measuring their performance against an established standard.

Call Processing and Dispatch

When it comes to call processing and dispatch time, *NFPA 1221: Installation, Maintenance, and Use of Emergency Services Communications Systems* provided a benchmark for call processing time (call pick-up to completion of unit notification) of *60 seconds or less*. The standard calls for this performance to be met at least 90 percent of the time.

Turnout Time of Firefighters

For firefighter turnout times, *NFPA 1710* provides a benchmark for firefighter turnout time (from notification to apparatus response) of 60 seconds or less. The standard calls for this performance to be met at least 90 percent of the time. As most fire personnel will attest to, this is a difficult standard to meet due to designs and barriers beyond their control.

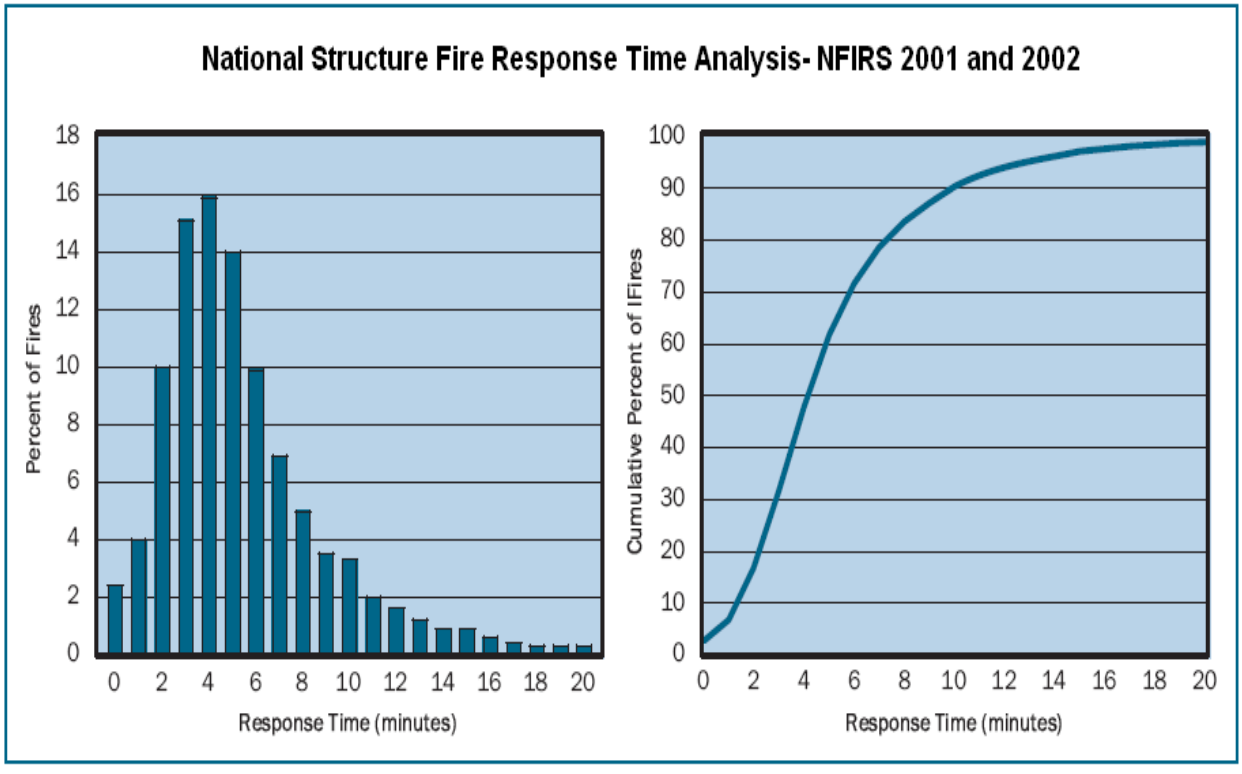
STANDARDS OF COVERAGE

Initial Resource Arrival (Travel Time)

For initial unit response times, *NFPA 1710* provides several benchmarks for career fire departments.

- For fire incidents, the standard provides a benchmark for initial engine company arrival (from apparatus response to arrival on scene) of 4 minutes or less. The standard calls for this performance to be met at least 90 percent of the time.
- For emergency medical incidents, the standard provides a benchmark for initial arrival of trained medical responders with an automatic external defibrillator (from apparatus response to arrival on scene) of 240 seconds or less. The standard calls for this performance to be met at least 90 percent of the time.

Nationally, the highest percentage (16%) of structure fires had a response time in the 4-minute range. The percent of structure fires with response times of 3 and 5 minutes were not far behind at 15% and 14%, respectively. Overall, 61% of structure fires in 2001 and 2002 had a response time of less than 6 minutes.[3]



"Structure Fire Response Times"- U.S. Fire Administration/ National Data Center, January 2006

[3] FEMA/NFPA, "*A Needs Assessment of the U.S. fire Service*", FA-240/December.

NFPA 1720

The National Fire Protection Association (NFPA) has issued a response performance standard for all or mostly volunteer staffed fire services. In recognizing that volunteer fire departments across the United States cover a variety of communities, the **recommended standards** are classified according to population densities.

- **Population greater than 1000 persons per square mile**: *Urban*
    - *Within these types of communities, NFPA 1720 recommends that the first company arrive at the scene of a structure fire within nine minutes of dispatch, 90% of the time.*
- **500-1000 persons per square mile in population**: *Suburban* time objective of
    - *10 minutes from time of dispatch, 80% of the time.*
- **Less than 500 persons per square mile**: *Rural*
    - 14 minute response time, 80% of the time
- ***Greater than eight miles from a fire station**: Remote*
    - No response time requirement

The standard establishes that a response "company" consists of four personnel. The standard does not require that all four be on the same vehicle, but does expect that the four will operate as a single functioning unit once on scene. The NFPA 1720 response time standard also requires that all four personnel be on scene within the recommended time frame.

As discussed, the NFPA Standards set response time performance for arriving apparatus at the scene of an incident. These standards do not include call processing time, which is covered in other related NFPA standards that call for a performance of one minute or less for this activity.