AN ANALYSIS OF EMERGENCY RESPONSE TIMES IN THE GREENSBORO FIRE DEPARTMENT

STRATEGIC MANAGEMENT OF CHANGE

By: David L. Bullins
Battalion Chief
Greensboro Fire Department
Greensboro, North Carolina

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

January 2002

ABSTRACT

The problem was the Greensboro Fire Department was not meeting response time goals set by the Department. The purpose of this research project was to analyze response times and determine methods of improvement for the Greensboro Fire Department. The project used Historical and Action Research to answer the following questions:

(1) Are there nationally recognized standards for fire department response times?

(2) How are response times calculated?

(3) What are the influencing factors affecting response times?

(4) What methods are available to improve response times?

The procedures used to complete the research project consisted of a literature review beginning at the National Fire Academy and included research locally. Personal interviews were also conducted with City personnel and members of national fire organizations. Information was compiled and an outline was developed to establish key points that related to the four research questions.

The results of this research project identified significant research previously conducted by the fire service community. Three national organizations already had guidelines relating to response. Greensboro was recording response time information inconsistently with national data. Emergency response is affected by numerous influencing factors on any given day. Several ways were identified to improve the time it takes to get the companies on the scene and working. Unforeseen was the fact that there were opposing views to the need for improvement of response times. Some views indicated that response times and property loss or survival rates do not have a clear-cut relationship.

This researcher recommended a company relocation policy be written to establish methods of providing stand by coverage in stations where companies are involved in outside activities. Guidelines for calculating response times to include processing times, turn-out times, travel times and set up times will also need to be developed in order to improve the level of service to the community.

TABLE OF CONTENTS

INTRODUCTION

The sudden impulse of audible tones sounded throughout the station. Each firefighter immediately stopped what they were doing and headed for the fire engine. The driver holds a blank stare while he processes the address of the emergency. The company officer listens intently to the type of call the dispatcher is announcing. In seconds, the fire company is racing through the streets to get to a house fire. Each firefighter has a job to do once they arrive on the scene. The captain of the rig will plan the initial fire attack and the driver will operate the fire pump to get the water through the hose lines. The firefighters will stretch the hose across the yard and into the house to extinguish the blaze. This type of call happens across America on a daily basis.

The time it takes to determine a fire is taking place is critical. The time it takes for the dispatcher to process the call is critical. The time it takes the firefighters to get on the truck and respond to the incident is critical. The time is takes the fire company to set up their operation on the scene is also critical. Every part of the emergency call is important to the overall success of the operation (Assistant Chief, P.D. Brooks, personal communications, August 8, 2001).

Fire departments across the nation respond to fires everyday. Many fire departments respond to medical emergencies everyday as well. Over the past twenty years, more than 115,400 people have died from the effects of fire (Waters, 1999). The first five minutes of most fires are the determining factors as to whether that fire will remain a small fire or become a large fire (Peterson, 1998). In fact, there is as much as 50 percent reduction in effectiveness for each minute of increased response time (Drew, 1999). An event referred to as flashover that is generally associated with a rapid transition in fire behavior from localized burning of fuel to involvement of all the combustibles in the enclosure can occur in as little as two minutes and

twelve seconds (Waters, 1999) or as much as ten minutes (Elements, 1997; Drew, 1999). About 220,000 people a year die of coronary heart disease without being hospitalized (American Heart Association, 2001). On an average day in America, 1000 adults die from sudden cardiac arrest. Experts believe that at least a third of these people could be saved if the maximum time to defibrillation were in the range of five to seven minutes (Swayze, 1997). Brain death and permanent death start to occur in just four to six minutes after someone experiences cardiac arrest. A victims chance of survival is reduced by seven to 10 percent with every minute that passes. Few attempts at resuscitation succeed after ten minutes (American Heart Association, 2001).

The Greensboro Fire Department has previously published an average response time to medical related calls of around 4 minutes (Greensboro Fire Department, 1993, 1994, 1995, 1996, 1997, 1998). However, average response time data can create a false expectation for the public. A department is setting itself up for a fall by publishing an average response time and then having to explain an extended response time (Dawson, 1999). The Department recognized the problem and currently uses a fractile method of tracking the response time goal. The Department attempts to reach 80 percent of the emergency incidents in six minutes or less (Greensboro Fire Department, 2001). The problem turned out to be that the goal was not being attained for several reasons, from the firefighters becoming complacent to the dispatchers incorrectly entering dispatch information. The time it took to process a call from the dispatch center or the time firefighters took getting on their gear and on the apparatus were not being scrutinized. The Department determined awareness was a key issue.

This researcher saw a connection in response times and life safety in fires and survival rates in cardiac arrests. The purpose of this Applied Research Project is to analyze the

Greensboro Fire Department's response times and determine any methods of improvement. In order to do this, historical research was conducted from the previous two years response time records. Action research was then used to develop guidelines for calculating response times and a fire company relocation policy. The two types of research were applied to the chosen research questions:

(1) Are there nationally recognized standards for fire department response times?

(2) How are response times calculated?

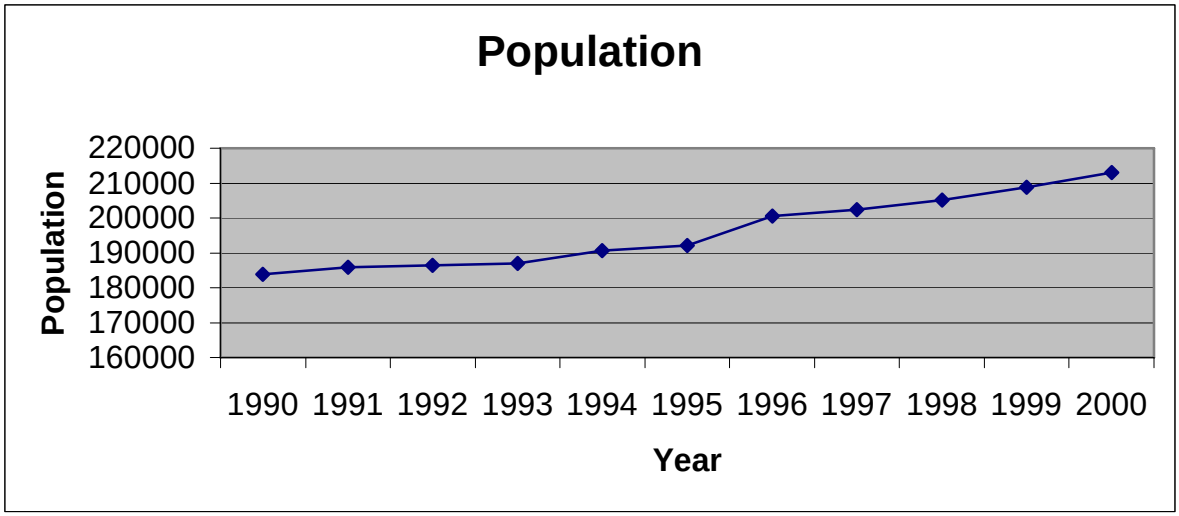
(3) What are the influencing factors affecting response times?

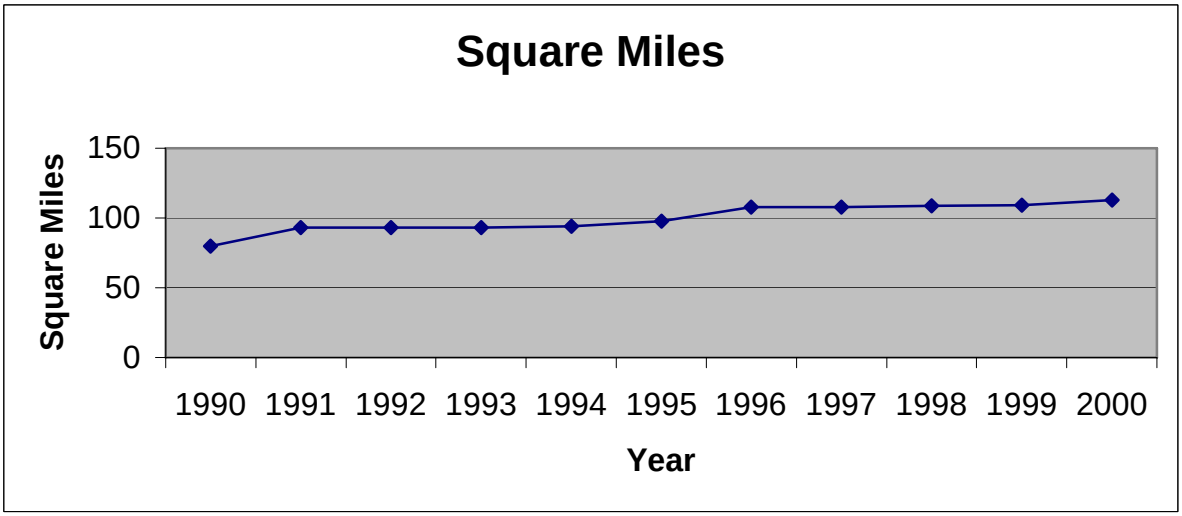
(4) What methods are available to improve response times?

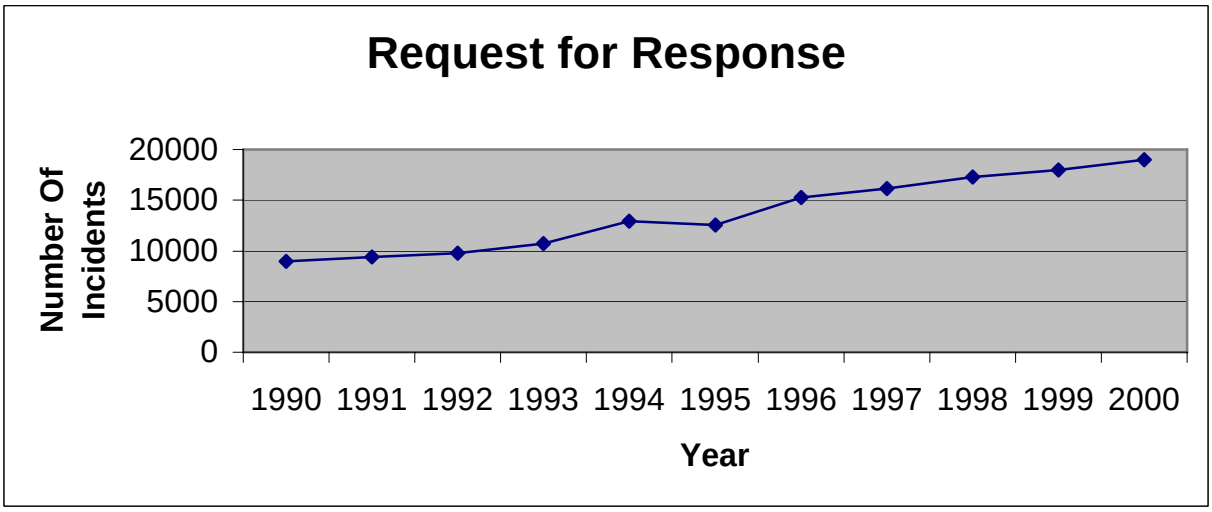
BACKGROUND AND SIGNIFICANCE

The City of Greensboro, North Carolina currently covers a land area of 113.06 square miles with a population of 213,003 (Planning and Research Officer, Alan Cagle, personal communication, August 18, 2001). In 1990, the Fire Department responded to 8929 incidents (Cagle, personal communications, 2001). The City has grown in land area and population over the past decade. The population has increased by almost 16 percent and the land area has increased in size by about 42 percent. Response incidents have increased over 112 percent.

Year	Sq. Miles	Population	Number of Incidents
1990	79.7	183894	8929
1991	93	185789	9395
1992	93	186392	9749
1993	93	187050	10720
1994	94	190640	12932
1995	97.7	192108	12544
1996	107.7	200485	15277
1997	107.7	202321	16136
1998	108.9	205132	17310
1999	109.4	208887	17969
2000	113.06	213003	18971


Population
Population
220000
210000
200000
190000
180000
170000
160000
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year


Square Miles
Square Miles
150
100
50
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year


Request for Response
Number Of Incidents
20000
15000
10000
5000
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000
Year

Response time issues were brought to the forefront due to the development of a new NFPA Standard. NFPA 1710 (*Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*) has a purpose of specifying minimum criteria addressing the effectiveness and efficiency of the nation's emergency fire and emergency medical services (National Fire Protection Association, 2001). The Fire Department's Leadership Team recognized a potential problem in meeting this standard. Continued growth is also expected according to the indicated trends (Cagle, personal communications, August 18, 2001). This fact concerned the Leadership Team.

Until 1998, the Department had a response time goal of an average response time of 4 minutes or less (Greensboro Fire Department, 1993, 1994, 1995, 1996, 1997, 1998). A new goal of responding to 80 percent of the emergency calls in five minutes or less was not being met. This method is referred to as fractile percentage. In response time performance reporting, performance based on a percentage of compliance to a goal is needed, not averages (Clet and Larson, 1998). The following charts indicate a breakdown of responses during 1999 and 2000 which include the time from when the emergency call was dispatched until the first unit arrived on the scene.

1999

Turnout Time+Travel Time = 1st Unit on Scene

Number of Incidents	1st Unit on Scene
473	*>1 minute*
783	*1-2 minutes*
2674	*2-3 minutes*
4682	*3-4 minutes*
4039	*4-5 minutes*
2332	5-6 minutes
1075	6-7 minutes
422	7-8 minutes
200	8-9 minutes
100	9-10 minutes
49	10-11 minutes
115	<11 minutes

2000

Turnout Time+Travel Time = 1st Unit on Scene

Number of Incidents	1st Unit on Scene
529	*>1 minute*
830	*1-2 minutes*
2802	*2-3 minutes*
4823	*3-4 minutes*
4205	*4-5 minutes*
2495	5-6 minutes
1141	6-7 minutes
485	7-8 minutes
233	8-9 minutes
116	9-10 minutes
70	10-11 minutes
160	<11 minutes

The charts indicate the Greensboro Fire Department is responding to incidents in less that 5 minutes 74.66% of the time in 1999 and 73.73% of the time in 2000.

NFPA 1710 recommends a response time goal of five minutes or less, 90 percent of the time. It should be noted that this time does not include the time it takes the dispatcher to process the call. An additional one minute is allowed to accomplish this task. This researcher asked the question, "if the Department is not meeting the current response time goals, what will the Department do when the call load increases due to the population and land area growth?" "The Department is determined to improve the service to the citizens (Brooks, personal communications, August 8, 2001)."

The Department also realized a problem in determining the actual response time (Brooks, personal communications, 2001). Total response time must be broken down into several components (Mason, 1996). The Greensboro Fire Department is not currently able to accurately track one of the components – turnout time, or the time it takes the firefighters to hear the dispatch and get to the apparatus and out the door (Brooks, personal communications, 2001). Currently the Department incorporates the turnout time into the overall driving time to the incident. Call processing is also a factor in the total response time. It is clear the response time must be a total elapsed time. The customer who makes the request is interested in total response time and not how long the call takes to process or the firefighters to get on the apparatus (Dawson, 1999). The Greensboro Fire Department is currently adding the turnout time, travel time and call processing time to get another goal of six minutes to arrive on the scene. The following chart indicates the time from when the dispatcher received the call to the time it takes the apparatus to arrive on the scene during 1999 and 2000 (Cagle, personal communications, 2001).

1999

Turnout Time + Travel Time + Call Processing = 1st Unit on Scene

Number of Incidents	1st Unit on Scene
268	*>1 minute*
139	*1-2 minutes*
828	*2-3 minutes*
2658	*3-4 minutes*
4153	*4-5 minutes*
3801	*5-6 minutes*
2389	6-7 minutes
1361	7-8 minutes
630	8-9 minutes
315	9-10 minutes
159	10-11 minutes
266	<11 minutes

2000

Turnout Time + Travel Time + Call Processing = 1st Unit on Scene

Number of Incidents	1st Unit on Scene
279	*>1 minute*
167	*1-2 minutes*
962	*2-3 minutes*
3013	*3-4 minutes*
4314	*4-5 minutes*
3864	*5-6 minutes*
2418	6-7 minutes
1312	7-8 minutes
638	8-9 minutes
336	9-10 minutes
188	10-11 minutes
414	<11 minutes

The charts indicate the Greensboro Fire Department is responding to incidents in less than 6 minutes (including the time it takes the dispatcher to process the call) 69.82% of the time in 1999 and 70.37% of the time in 2000.

The results indicated a need to further analyze the response time patterns in order to determine why the Department was not meeting the response time goals. The Department could then determine methods of improvement.

This researcher found that time of day and day of the week also affects response times in the Greensboro Fire Department. Training and departmental activities are routinely conducted during the daytime hours. However, the busiest times in relation to response are also during those hours. The following charts and graphs indicate the most active time during the day for emergency response is between the hours of noon and eight o'clock in the evening. The numbers indicate actual responses. The hours between four o'clock p.m. and eight o'clock p.m. are even higher in the years 1999 and 2000.

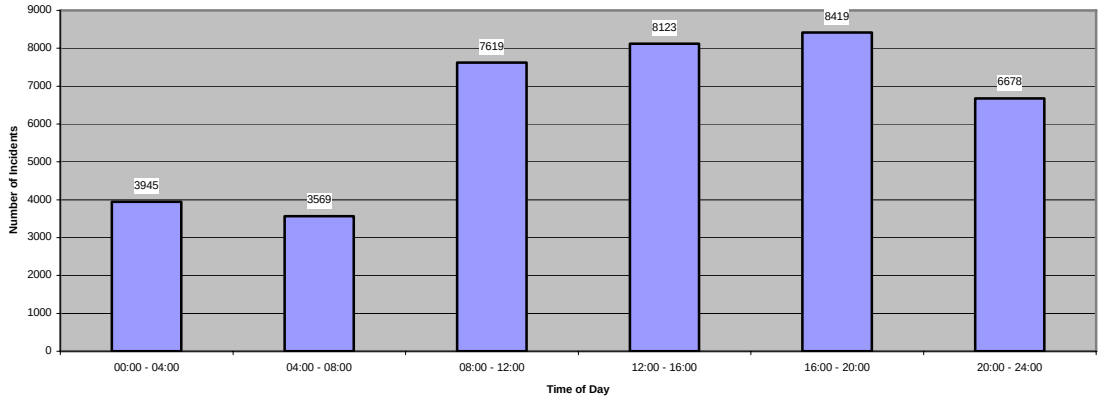
1999

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	Total
00:00 - 04:00	423	460	556	498	570	712	726	3945
04:00 - 08:00	567	530	487	529	461	514	481	3569
08:00 - 12:00	1127	1191	1205	1188	1097	964	847	7619
12:00 - 16:00	1204	1241	1181	1305	1160	1053	979	8123
16:00 - 20:00	1200	1298	1393	1191	1180	1139	1018	8419
20:00 - 24:00	815	825	907	999	1081	1111	940	6678
Total	5336	5545	5729	5710	5549	5493	4991	

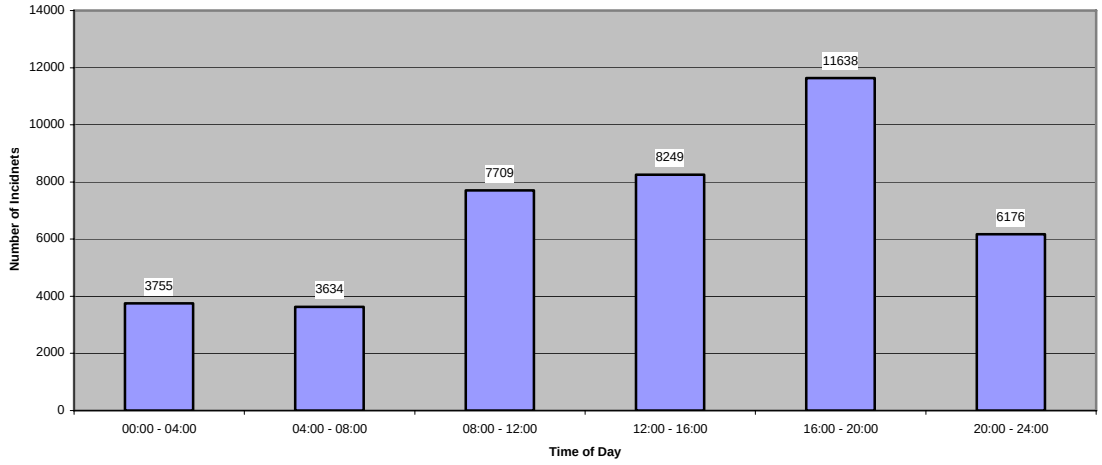
2000

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday	
00:00 - 04:00	495	462	373	434	591	705	695	3755
04:00 - 08:00	507	555	623	454	562	491	442	3634
08:00 - 12:00	1056	1243	1116	1405	1225	854	810	7709
12:00 - 16:00	1174	1160	1257	1372	1190	1092	1004	8249
16:00 - 20:00	1157	1202	1296	1302	1354	1286	4041	11638
20:00 - 24:00	855	857	933	827	887	905	912	6176
Total	5244	5479	5598	5794	5809	5333	4904	

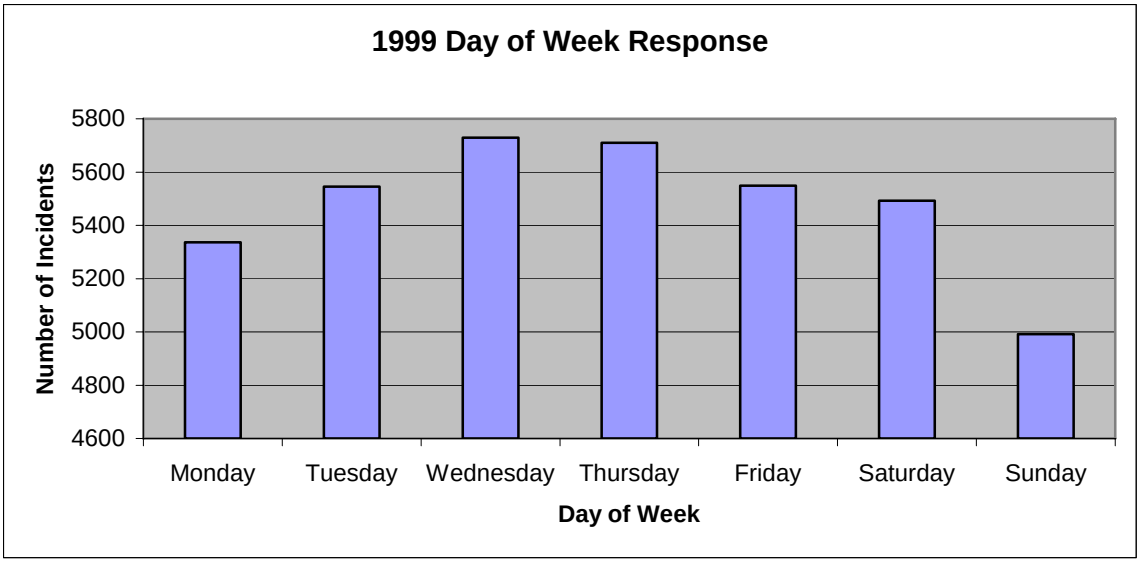
Response by Time of Day - 1999

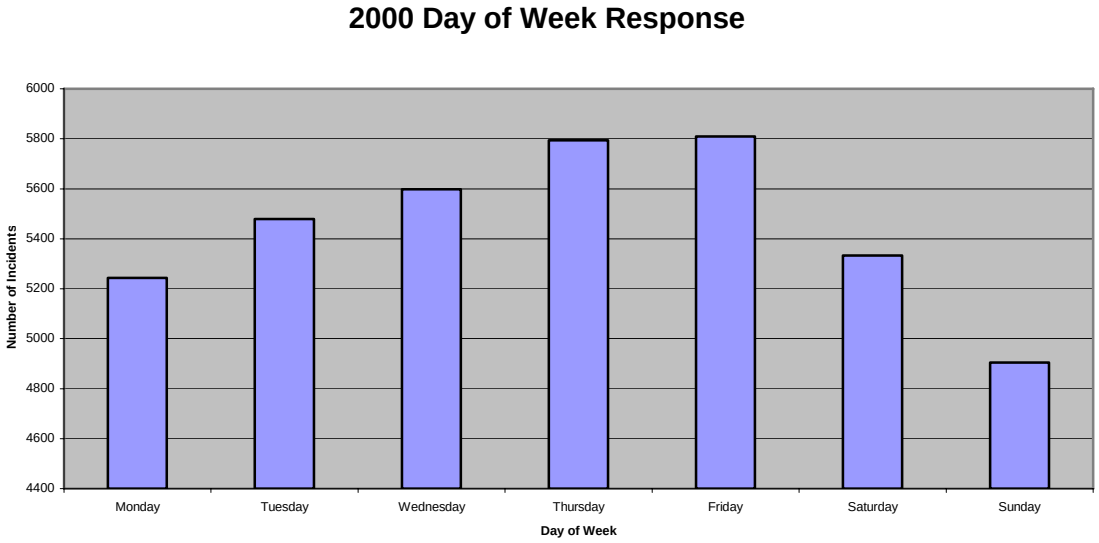


Response by Time of Day - 2000



Additionally, the evaluation of incidents over the previous two years indicated that Wednesday through Friday were the most active days in relation to response as indicated by the charts.





The second due unit is often times dispatched to incidents due to the first due being involved in other activities such as response, training, community activities, or maintenance (Planning and Research Section, D. Campbell, personal communications, September 19, 2001).

1999-2000

2nd Due Company Dispatched

12:00 AM - 4:00 AM	5.90%
4:00 AM - 8:00 AM	7.80%
8:00 AM - 12:00 PM	29.30%
12:00 PM - 4:00 PM	26.10%
4:00 PM - 8:00 PM	22.80%
8:00 PM - 12:00 AM	8.30%

The average time companies spend on emergency calls depends on the type. Medical emergencies require 18.81 minutes, and fire emergencies require 43.51 minutes. The average of all calls is 20.55 minutes per call. Equipment is out of service due to maintenance only 1% of the time due to the supply of reserve apparatus (Cagle, personal communications, August 18, 2001).

The Department operates a fully paid staff on a schedule of three-24 hour shifts. Apparatus are staffed by a Captain (Company Officer), a Fire Equipment Operator (Driver), and two firefighters. The Department is divided into four battalions and is managed on a daily basis by a battalion chief serving each. Each battalion has four engine companies. Seven ladder trucks are stationed throughout the City. Two rescue squads split two response districts.

This project relates primarily to the Analysis Phase of the Change Management Model introduced in the NFA Course: Strategic Management of Change. Past response times were analyzed. A needs assessment was made to determine if there was actually a need for a change. Two methods of change, a Relocation Policy and Guidelines for calculating response times, were conceived during the analysis that would lead into the Planning Phase of the model.

LITERATURE REVIEW

Recognized Standards

Response time is a critical element in providing quality emergency service to a community. Fire growth can expand exponentially with every additional minute. Research indicates a reduction of 50% in effectiveness for each minute of increased response time. Therefore, a three minute response time is only 25 percent as effective as a one minute response time (Taylor, 1998).

Fire Departments all across the United States believe that response times affect the quality of service delivered to their communities. Austin Fire Department has an average response time goal of three minutes and thirty seconds. The Witchita Fire Department has a goal of arriving in less than four minutes from the time the citizen calls for assistance. Edmonds, Washington has a set goal of arriving on scene in less than nine minutes, 80% of the time. The Phoenix Fire Department has a target response time of three minutes (Taylor, 1998).

Guidelines for determining a department's response time goals have been set by several national organizations. Life safety and fire loss have a direct relationship with response time (Taylor, 1998; Drew, 1999).

Flashover is the determining point at which a fire becomes deadly. A small, smoldering fire that is not controlled will eventually present visible flames. This stage of fire is typically referred to the incipient phase. The burning is limited to the immediate area of origin. Eventually nearby objects will reach ignition temperature and begin burning. Combustible gases will rise toward the ceiling. The gas layer will begin to bank down from the ceiling as the volume increases. This will in turn heat all combustible objects in the enclosure regardless of their proximity to the burning object. The gas layer can quickly reach temperatures of 1500

degrees Fahrenheit. The toxic gas consists mainly of carbon monoxide. Oxygen is limited which prevents heated objects from bursting into flames. At this point the room is untenable. Oxygen may be introduced when the high heat breaks out a window. The sudden surge of oxygen will cause everything in the room to instantaneously ignite since a temperature of ignition has already been established. The flames generate a tremendous amount of heat, smoke, and pressure to push the fire beyond the room of origin causing the rate of combustion to drastically increase (Elements, 1997).

The time a fire takes to reach the point of flashover depends on several items. Increased use of synthetic products have reduced the time necessary for a structure to reach flashover (Peterson, 1998). Fire fighter safety is jeopardized by the use of truss systems which have the potential to fail rapidly causing the floor or roof systems to collapse.

Stanley Crosley, fire chief in Sidney, Ohio explains:

> One of our objectives, as a fire department, is to arrive at the scene prior to flashover. Flashover is a critical stage of fire growth for two reasons. First, no living thing in the room will survive [and] the chances of saving lives drops dramatically. Second, flashover creates a quantum jump in the rate of combustion, and a significantly greater amount of water needed (Taylor, 1998).

The exact time of flashover depends on many unknown variables and depends on the reference source used. In 1980, the National Bureau of Standards [now the National Institute of Standards and Technology (NIST)] conducted fire tests of typical residential rooms. Francis L. Brannigan sited the results in his book *Building Construction for the Fire Service.* The typical single family dwelling living room fire only took three minutes and 41 seconds from first flame to the time of flashover. An article with no byline in the August 1986 edition of Fire Command

Magazine stated flashover occurs within a bedroom in as little as two minutes and 12 seconds from first ignition (Waters, 1999). The Phoenix Fire Department conducted flashover tests in 1993 and found that flashover can be expected at seven minutes after ignition (Taylor, 1998). The Commission of Fire Accreditation International states that flashover typically occurs within 8-10 minutes after flaming ignition (Elements, 1997; Nuttall, 1999). Other sources from Robert Taylor's Applied Research Project indicated: "Research indicates that a room fire can progress from ignition to flashover in six to nine minutes." "Fire experience and full scale experimental fires have shown certain materials capable of producing room flashovers in as little as five minutes from start to flaming (Taylor, 1998)."

The American Ambulance Association (AAA) and the American Heart Association suggest a response time goal of four minutes for urban responders. The Commission on the Accreditation of Ambulance Services (CAAS) and the (AAA) suggest a goal of not more than eight minutes and 59 seconds for the transport portion of the urban EMS system. In the 1997 survey conducted by the Journal of Emergency Medical Systems (JEMS) identified first responders most frequently set a performance goal of being on the scene in five minutes, 90 percent of the time (Mayfield, 1998).

The American Heart Association (AHA) says that brain death and permanent death start to occur in just four to six minutes after someone experiences cardiac arrest. Cardiac arrest is reversible if treated with early defibrillation to restore a normal heartbeat. A victims chances of survival are reduced by seven to ten percent with every minute that passes. Few attempts of resuscitation succeed after ten minutes (AHA, 2001; Elements, 1997).

Other research has also indicated drawbacks from early defibrillation. One study concluded that:

> Faster response by medics, or any individual Advanced Life Support (ALS) intervention other than first-responder defibrillation, demonstrated no benefit in the urban population with short intervals between responder arrivals. Aggressive ALS increased the number of survivors but also decreased their neurologic quality. The benefit of rapid ALS backup to first responder/defibrillators needs further study in other systems. System performance cannot be judged without knowledge of neurological outcome (Callaham and Madsen, 1996).

Response times have been correlated to outcome for many years. The NFPA presented criteria for both response distance and response time in 1972. The criteria was to have the first unit on the scene in three minutes and the entire alarm assignment on the scene in five minutes (Taylor, 1998). In 1980, the Insurance Services Office (ISO) introduced the Fire Suppression Rating Schedule, which specified distance standards. The ISO Schedule requires an engine company within 1 ½ mile of every area of the city and a ladder/service company within 2 ½ miles of every area of the city. 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), 2001 Edition has set new response time requirements. The first unit must respond in four minutes 90 percent of the time and/or the initial full alarm must respond in eight minutes 90 percent of the time on emergency calls (Taylor, 1998). The Commission on Fire Accreditation International developed a standard of coverage in relation to types of occupancies.

Standard of Response Cover Based on Fire Flow Requirements

Risk Type	Number of Companies	Company Due-In Time (Minutes)* 1st	2nd	3rd
Max/Worst Hazard >5,000 GPM	5	3	5	8
High/Key Hazard <5,000 GPM	4	4	6	10
Moderate Hazard <2,000 GPM	3	5	8	11
Low Hazard <1,000 GPM	2	6	10	-
Special/Remote Hazard	as needed			

*Example only - 50 seconds should be added for alarm processing time and one minute added for turnout time to establish a full response time requirement

Chart from CFAI.

In summary, many fire departments have recognized the relation of response times and the successful outcome to the emergency. An effective response time must be less than ten minutes. Any reduction in the response time significantly improves the end result. Fire fighters arriving on the scene before flashover are much more likely to rescue trapped victims and save property. Early intervention on emergency medical response has a dramatic effect on cardiac arrest patients. Each minute that passes drastically reduce the chances of survival for the patient (Drew, 1999).

Response Time Calculation

Traditionally fire departments report their performance based on travel time. Travel time is the time it takes the fire company to get into the apparatus and arrive on the scene (Clet and Larson, 1998). Contrary to casual thought of how quickly vehicles can reach an emergency, response time is a complex measurement of several identifiable time segments. The progress of a fire or medical emergency is defined differently by different authors. The Phoenix Fire

Department stops the response time when the first unit arrives on the scene while other departments stop the time after the first company is ready to operate. (Taylor, 1998). Assistant Chief Paul Brooks, with the Greensboro Fire Department and also a member of the review board for the CFAI, says the terminology also depends on the author. In some departments, travel time includes the time it takes a fire company to react to the dispatch and get on the apparatus (Brooks, personal communication, August, 8, 2001).

> The San Jose Fire Department has established three primary components of dispatch: Call Processing Time or Alarm Processing time – the interval between the answering of the 911 call and the dispatch of a unit to that incident; Turnout Time or Reflex Time – the interval between the time responders in the field are alerted to the call, stop whatever activities in which they are engaged, proceed to the apparatus, and leave the station or wherever they are when the call is dispatched; and Travel Time – the interval between the time responders begin to drive to an incident location and the time they arrive on the scene (Clet and Larson, 1998; Dawson, 1999).

The Phoenix Fire Department outlined response times to calls as follows: Fire detection and alarm initiated, Dispatch Center processing of the alarm, Target response time, and On Site Action before water is applied to the fire and rescue initiated. The total time allowed is seven minutes.

Another method of calculating response time breaks the total elapsed time of the fire or emergency scene into seven different segments:

> Discovery Time – the time from the occurrence until someone becomes aware of it; Notification Time – the time after discovery that elapses until a phone is located and a call for assistance is made; Comprehension Time – time expended by the dispatcher in

understanding the nature of the call and determining the proper course of action; Activation Time – the period it takes to notify responders of the emergency; Responder Preparation Time – measures the length of time it takes emergency responders to prepare themselves for the incident; Travel Time – the length of time for the emergency unit to travel to the scene; and Assessment and Action Time – the period between units arriving on scene and corrective action beginning (Dawson, 1999).

The National Fire Academy defines response time as "The time a company takes to get to a fire and begin fire operations, it includes dispatching time, turnout time, travel time, and setup time (Dawson, 1999).

The Commission on Fire Accreditation International has developed common terminology to assist departments in standardization of elements of response times. This will allow agencies to do a "comparative analysis" that is not based on subjective interjection but rather on true comparisons. CFAI defines the elements of response time as follows:

Event Initiation – The point at which factors occur that may ultimately result in an activation of the emergency response system. Precipitating factors can occur seconds, minutes, hours, or even days before a point of awareness is reached. A patient who ignores chest discomfort for days until it reaches a critical point, at which the patient makes a decision (Point of Awareness) to seek assistance. Rarely is it possible to quantify the point at which event initiation occurs.

Emergency Event – The point at which an awareness of conditions exists which require an activation of the emergency response system. Considered the Point of Awareness, it may be the recognition by an individual that assistance is needed, or it may consist of a

mechanical or electronic recognition of an event such as smoke or heat detector activation.

Alarm – The point at which an emergency response system activation is initiated. The transmittal of a local or central alarm to public safety answering point is an example of this time point. Again it is difficult to determine with any degree of reliability the time interval during which this process occurs.

Notification – The time at which an alarm is received by the agency. This transmittal may take the form of an electronic or mechanical notification to the point at which a call is received and answered in the public safety answering point.

Alarm Processing – The time interval from the point at which a request or alarm is received and transmitted to emergency responders. Additionally, the time period that is required for the communication center to identify the fact that an emergency is in progress, collect the information pertinent to make the appropriate dispatch, and assess the methodology used by the agency to deploy the agency.

Turnout Time – The time point at which responding units acknowledge receipt of the call from the dispatch center, total turnout time begins at this point and ends with the beginning of travel time.

Travel Time – The point at which units are en route to the call. When responding from a fixed facility, the point at which the apparatus exits the facility. Total travel time begins with this initial time point and ends with the on-scene time.

On-Scene Time – Time point at which the responding unit arrives on the scene.

Initiation of Action – Time pint at which operations to mitigate the event begins. May include size-up, resource deployment, etc. (Elements, 1997).

NFPA 1710 (2001) defines time elements or response as follows:

3.1.42.1 Alarm Time. The point of receipt of the emergency alarm at the public safety answering point to the point where sufficient information is known to the dispatcher to deploy applicable units to the emergency.

3.1.42.2 Call Processing Time. See definition 3.1.42.3, Dispatch Time.

3.1.42.3 Dispatch Time. The point of receipt of the emergency alarm at the public safety answering point to the point where sufficient information is known to the dispatcher and applicable units are notified of the emergency.

A.3.1.42.3 Dispatch Time. Dispatch times are addressed in NFPA 1221, Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems. These include call taking and call processing requirements.

3.1.42.4 Response Time. The time that begins when units are en route to the emergency incident and ends when units arrive at the scene.

3.1.42.5 Turnout Time. The time beginning when units acknowledge notification of the emergency to the beginning point of response time.

Departments throughout the nation rarely measure response time performance in the same manner across the board. For example, a fire department may say they have an average response time of five minutes. Statistically significant is that there are calls on the good side of five minutes and on the bad side of five minutes. One caller may get a response of three minutes, while another will get a response of seven minutes. It is crucial to understand the difference between an average and a fractal percentage (Clet and Larson, 1998). Fractile methods of calculation ignore averaging, rather fractiles require the counting of events within various time frequency ranges. The number of events is totaled within various time frequency

ranges to determining percentage performance at various thresholds and ceiling (Firefighting.com, 2001). In response time performance reporting, performance based on a percentage of compliance to a goal – not averages – is needed. Most high performance EMS systems try to meet the goal 90 percent of the time. This means that nine out of ten times responders will arrive at that particular time standard or sooner (Clet and Larson, 1998). Fire organizations across the country are attempting to do the same, according to the CFAI (Elements, 1997).

In summary, currently fire departments calculate total response times differently. Many departments still calculate average response times but many are changing to calculating a fractile percentage. Efforts are being made to standardize methods of calculation by the nation's fire service leaders.

Influencing Factors Affecting Response Times

Response times are affected negatively and positively by an array of issues. This researcher found many national concerns. However, the Greensboro Fire Department has identified several local problems affecting their response times.

False alarms plague fire departments across the nation daily. These alarms stress the unit availability capacity of the responding agencies. Fire alarms may be activated for many reasons: malicious alarms, system malfunctions, systems functioning properly but activated for the wrong reason, or honest mistakes (Mason, 1996). All of these alarms take fire companies out of service to respond to actual emergencies.

Neighborhoods across the country want a safe place to live. Cars speeding through the streets concern citizens. Community traffic management programs are used to identify problem areas are make the necessary corrections. Traffic control devices are used as one method in

controlling vehicle traffic. These devices include: speed bumps, traffic circles, cul-de-sacs, curb extensions, gates across roadways, medians, and street closures. The most common control device is the speed bump (McGinnis, 1997).

The Austin Fire Department conducted a study relating to response regarding speed bumps. They found that emergency medical response with patients in the ambulances increased by as much as 9.7 seconds per speed bump. Fire apparatus had delays per bump in the 3-5 second range. The significance seems small. The issue multiplies when you consider that most streets with speed bumps have more than one (McGinnis, 1997).

Some fire departments rely on police-operated dispatch centers. These departments may have little control over the call processing times. The fire department may not be able to set the goals for dispatching but it is certainly an operational obligation to the community to provide a timely response to all emergency calls. The police operated dispatch center may not be optimal but it is workable. Each agency must speak the same language when identifying the types of response time components they are measuring and reporting (Clet and Larson, 1998).

System Status Management is a concept used by some fire and EMS service areas. This concept uses past experience to adjust the number of units and their location on the theory that past demand alone determines the future demand for emergency response (Burnett, 1999). A more refined view of System Status Management is shown in the Applied Research Project by Terrence Lewis. He says,

> "The dynamic realities may include traffic patterns, weather conditions, road construction, railroad crossings, and the location of mutual aid responders. The concept of a moving response zone permits the manager to utilize the ambulance closest to the

location of the call. This is because the response zone surrounds the ambulance wherever it may be (Lewis, 1997)."

The Greensboro Fire Department identified other issues affecting response times. The time of day and the day of week present response problems. The Department responds to tens of thousands of calls each year. Data from the previous two years indicated concerns for the fire department. The hours between noon and eight o'clock in the evening account for 43.16% of the calls in 1999 and 48.3% of the calls in 2000. Wednesday through Friday tend to be the most active days in relation to response (Cagle, personal communication, August 18, 2001). Randall Larson, of the San Jose Fire Department, made an analogy printed in a national publication. "Suppose we find out that we're not meeting our response time performance during the weekdays from 9 to 11 a.m. and we discover that that's the time of the day we're having the firefighters do hose testing, then maybe we need to move hose testing to a different time of the day (Clet and Larson, 1998)."

Alan Cagle (August 18, 2001), of the Greensboro Fire Department Planning and Research Section also indicated that between the hours of noon and 8 p.m. the second due company was dispatched to the incidents 48.9% of the time during the years 1999 & 2000. The reasons are not only because companies are on emergency calls but also these are the hours that most training is occurs, maintenance such as hose testing and apparatus service are conducted, and companies are involved in community service/education programs.

The Greensboro Fire Department has identified specific drills relating to initial fire attack. These times are a piece of the puzzle regarding the overall response time from the time the citizen requests assistance to the time the company initiates action to mitigate the problem. Scenarios are derived from NFPA 1410, Standard on Training for Initial Fire Attacks. They

range from simply laying one supply line and making an attack with two handlines to supplying a standpipe system on the fifth floor of a high rise building. Time lines begin at three minutes for the simplest scenario to over five minutes for the most complex. At a minimum, the Department has identified a three minute time for a company to control the fire after they arrive on the scene of the emergency (Greensboro Fire Department, 1996). Many departments consider this activity as the set-up time.

All factors affecting response times are not negative. Past experience and technology have generated positive impacts to response times. Enhanced 911 systems allow dispatchers to know the location of the caller. Automatic vehicle locator systems track emergency response vehicles and make for easy dispatch of the closest vehicle. The list goes continues to grow (Gabliks, 1999).

Pre-alert dispatching systems notify responding companies that a call is coming in, so responders can stop what they are doing, pull their run card or map, get into the appropriate gear, and get into the rig and be ready to respond when the actual call comes in (Clet and Larson, 1998; D. Maddox, personal communication, August 29, 2001).

Signaling control systems allow fire units to control traffic lights in high volume intersections. A Strobe light atop the cab signals traffic signals to turn green, allowing for a faster, safer passage (Clet and Larson, 1998).

CAD to CAD (computer aided dispatch) links neighboring agencies in communities. Calls come into a dispatch agency and the dispatcher realizes the complainant needs another agency to respond. Ambulances are dispatched in this way in San Jose, California. Medical calls come into the Fire Department and are immediately transferred to the county ambulance service. No longer are dispatchers required to make a phone call and give the needed

information. Both systems receive the information at the same time, thus saving time (Clet and Larson, 1998).

Dispatchers in Greensboro have guidelines for asking questions to callers. Dispatchers are trained in the use of the *Classification and Prioritization Dispatch Manual*. David Maddox, a supervisor from the Greensboro Police Communications Center, said, "Asking the right questions is a key to getting the proper units to the scene in the fastest time possible (D. Maddox, personal communication, August 29, 2001)."

Computers are being placed in fire apparatus to assist in finding emergency locations. However, computers do go down from time to time for a variety of reasons. Map reading skills are being taught to dispatchers in the Oregon Department of Public Safety.

The use of warning lights and sirens during response has been previously researched and found to save time in overall response. One study conducted in a metropolitan area determined an average of 3.02 minutes are saved on each call when responding units use lights and sirens during their response (Ho and Cassey, 1998). Another study conducted in Syracuse, New York agreed with the savings of time but disagreed in the value of it. Conclusions indicated a savings in response time of 1 minute and 46 seconds. Although statistically significant, this time saving is likely to be clinically relevant to only a very few cases, according to the 1999 study (Jermyn, 1999).

In summary, there are many factors affecting response times. There are national trends as well as local issues. Technology has provided solutions to some of the response time problems. A key point though is, if you are not measuring the time completely, you will not be able to make informed decisions for the purpose of change. Fire departments need to determine the specific areas causing delays in response (Clet and Larson, 1998).

Methods to Improve Response Times

This researcher has identified several reasons that cause delay in the total response time to emergency incidents. Answers to the problems have already been identified in many cases. Today's firefighters spend hours away from their assigned stations. Fire service leaders realized this and found a way to dispatch the closest vehicle by using automated vehicle locating systems. Department leaders have become involved in planning in some cities (McGinnis, 1997). Fire departments and police departments with joint dispatch centers now communicate on a regular basis (Clet and Larson, 1998). System Status Management has been modified to work in other locals (Lewis, 1997). Previous research indicates progress in all of the previously mentioned areas. However, new standards have created new problems. These new problems need new solutions to resolve.

NFPA 1710 has identified ideal response times. Even if departments decided not to implement this new standard, it is a good idea to use it for long range planning (Firefighting.com, 2001). One area of NFPA 1710 addresses emergency response. Departments across the nation respond to calls in different manners. Some respond with lights and sirens to carbon monoxide alarms, others do not. An implementation guide was developed by the International Association of Fire Chiefs in 2001. The task force of chief officers have determined the Standard allows individual departments to determine what is an emergency and what is not. If fire departments do not develop a source document and define emergency service alarms and fire suppression incidents, all response events are then theoretically considered measurable calculations according to the Standard (Firefighting.com, 2001).

The CFAI has developed common terminology to assist departments in standardization of elements of response times (Elements, 1997). Other departments realize the need to break the

responses into measurable segments of times to allow for unilateral results (Clet and Larson, 1998; Dawson, 1999).

Response distance formulas are used to calculated travel time estimates from travel distances. Some departments measure the distances and translate into travel times by timing the trips (Taylor, 1998). Other departments simulate the response and calculated the travel time with computer software. The Greensboro Fire Department considers each 1/10 mile is equal to 12 seconds of response. These numbers reflect a response time of 300 seconds, or 5 minutes, for each 2.5 miles. Stations can be planned by calculating response distances (Cagle, personal communication, August 18, 2001). One can easily identify that putting stations closer together will reduce response times.

False fire alarms decrease unit availability and increase response times of other responding units. False alarm ordinances initiatives have been enacted to curtail the number of false activations. The Ithaca, New York Fire Department implemented such a plan in 1989 with moderate success (Mason, 1996). Battalion Chief Terri Wallace, Assistant Fire Marshal for the Greensboro Fire Department, does not believe ordinances are the answer. In the past, the City of Greensboro, used fines to enforce fire protection ordinances, according to Chief Wallace (personal communication, October 31, 2001). Chief Wallace said, “The Department found that occupants tend to disable their systems rather than making costly repairs or upgrades.”

This researcher found an opposing view to the belief that response time and property loss have a strong relationship. Nyle Zikmund, Moundsview Fire Chief agrees with a portion of the response time scenario. He does see the relationship between when the fire was detected and the fire department was notified. “The longer the fire goes undetected, the greater the fire loss.” NFPA data analysis research indicates that full time fire departments have only a 13 percent

chance of making a significant difference in the result of a fire. Chief Zikmund goes on the say, "the average dollar loss in the Moundsview Fire Department was less for response times of more than seven minutes versus response times of under seven minutes (Zikmund, 1997)." Another article suggest that fire apparatus are three times more likely to get into an accident running lights and sirens (Wilbur, 1995).

In summary, the Nation's fire service is taking the response issue head on. NFPA 1710 is providing tools to plan for response in the future. The CFAI has developed a standard list of terms to use in calculating response times. Ron Coleman summed the response issue:

> Considering that the time required for flashover in structural fires with standard fuels is typically about seven minutes, the apparatus and firefighters must arrive and get operating very quickly. If it takes a resident two or three minutes to discover and report a fire and three minutes for the apparatus to be dispatched are arrive, the sizing up and initial attack need to be done in a minutes or two or the typical fire will have grown significantly in size. An unconscious person with depleted oxygen will typically suffer permanent brain damage after approximately four minutes. All of this needs to be considered within the context of multiple alarm fires and simultaneous alarms. Delayed response and understaffed response appear inevitable under those circumstances, unless planning is complete (Coleman and Granito, 1988).

PROCEDURES

Definitions of Terms

Defibrillation. A process in which an electronic device gives an electric shock to the heart. This helps reestablish normal contraction rhythms in a heart that's not beating properly. In recent

years small portable defibrillators have become available. These are called automated external defibrillators (AHA, 2001).

Flashover. When the mixture of gases reach the flammable range or ignition point, at which time the whole area bursts into flames (Bugbee, 1985).

Fractile calculation. Fractile methods of calculation ignore averaging of response times, rather fractiles require the counting of events within various time frequency ranges. The number of events is totaled within various time frequency ranges to determine percentage performance at various thresholds and ceilings (Firefighting.com, 2001).

Hand line. A fire hose use to extinguish a fire by firefighting personnel. The hose is connected to the fire pump on the firefighting apparatus (Greensboro Fire Department, 2001).

NFPA. (National Fire Protection Association) a private, voluntary, non-profit association whose activities include the production of technical and professional standards using a consensus approach in the development of standards (NFPA, 2001).

Second due company. Fire company not normally assigned to an incident. Company is dispatched due to closest fire company is out of service. This company is the next closest to the incident (Assistant Chief, W. Ritter of Emergency Services, personal communication, October 12, 2001).

Standpipe system. A water pipe system running from the base of a building to the roof with hose outlets at each floor level used for firefighting. The system is supported by a fire apparatus on the exterior of the building (Greensboro Fire Department, 2001).

Supply line. A fire hose used to establish a water supply from a hydrant to a fire pump for the purpose of extinguishing a fire. These lines are usually 4 inches in diameter and may be

hundreds of feet in length in the Greensboro Fire Department (Greensboro Fire Department, 2001).

Research

The Problem that the Greensboro Fire Department was not meeting response time goals was reviewed and found to be an accurate statement. The goal of this historical and action research was to analyze the Fire Department's response times and determine methods of improvement. Historical research was conducted by reviewing the following documents from the Greensboro Fire Department: 1995-1999 Annual Reports, reports developed by internal Fire Records Management software, and the Greensboro Fire Department Vision and Strategic Plan. Action Research applied the historical data to the questions at hand:

(1) Are there nationally recognized standards for fire department response times?

(2) How are response times calculated?

(3) What are the influencing factors affecting response times?

(4) What methods are available to improve response times?

This researcher originally began the project while attending the Strategic Management of Change Class in the Executive Fire Officer Program (EFOP) in July of 2001. The National Fire Academy Learning Resource Center provided the initial information to determine the need for the study of the chosen topic. The idea was confirmed by the amount of previous research already conducted by EFOP students in the past.

After returning to Greensboro, a more thorough, in depth process took place. A list of pro/con issues was developed that included: related recognized standards, response times, life safety/fire loss affected by response time, verified statistics, response time definitions, and calculation of response times. An outline was developed for the overall project to include all of

the areas required in the *Applied Research Guidelines* manual provided by the National Fire Academy. Initial research began on the internet from numerous fire service related sites. From there, a review of personal reference material was conducted. The Greensboro Fire Training Section provided resources in the form of periodicals, national standards, and departmental documents. Six interviews were conducted with local fire service and police personnel to provide personalization of the project. The interviews confirmed this researchers view, the Department was not meeting the response time goals. The Department had just recently made the firefighting forces aware of the problems with response in the past six months. Progress was being made. However, there were factors still affecting response times and improvement was wanted by the Department leaders. Microsoft Word files were used to collect points of interest provided by the source/material. This portion of the overall process lasted until October of 2001.

Assistant Chief Paul D. Brooks provided insight into the response time issues. Chief Brooks played a key role in the Department's goal of becoming accredited by the Commission on Fire Accreditation International. He now serves on their review board to evaluate other fire departments progress toward accreditation. A meeting was scheduled and took place on August 8, 2001 at the Administration Offices of the Greensboro Fire Department. The interview lasted approximately 2 hours. Chief Brooks' position in the Department allows him to focus on special assignments designated by the Fire Chief. One of his current assignments is that of a study on implementation of NFPA 1710. Interview questions centered around the intent of NFPA 1710, response issues. He explained the various methods of calculation of response times. He also provided possible solutions to the problem.

The second interview with Dave Maddox, Supervisor of the Greensboro Police Communications Division took place via telephone. The interview took place on August 29,

2001 for a duration of approximately 30 minutes. Mr. Maddox supervises the Communication Division of the Police Department that also dispatches all fire calls in the City of Greensboro. He was able to explain what actually happens when 911 calls are received to the Communications Center. He also explained what he hoped for in the future. The Guilford County Communication Division and the City Communication Division are discussing methods of consolidation currently. He said, "we are trying to get the political bodies to agree." He feels if everyone could be on the same system, administrative procedures would be reduced.

Mr. Maddox transferred me to Wesley Reid who actually supervises the dispatchers in the Division for further discussion. We spoke for another 30 minutes. He sat in on the meetings in making the departments aware of response issues. The dispatching section has made changes already. The Fire Department and Police Department have developed a Communications Committee and plan to meet quarterly to discuss response times in relation to dispatching protocols. They have started using a pre-alert method of dispatching and now only give precise information on initial dispatch. The details of the call is given to the companies after all companies have confirmed they are en route to the call. Mr. Reid required all of the supervisors in the Section to sit with each dispatcher and watch the actions and suggest improvements. He also advised that they have a standard list of questions for each specific type of call in their *Classification and Prioritization Dispatch Manual*. He would like to see an interface between the County/City Communication Centers, but thinks it is too expensive. He closed with saying, "We've made the folks aware of the problem and are now holding them accountable."

The fourth interview took place with Alan Cagle on September 18, 2001 at the Greensboro Fire Department Administrative Offices. Mr. Cagle is assigned to the Planning and Research Section of the Department. He is responsible for managing data from the local Fire

Records Management System. He was able to provide tangible data in relation to response times. Firefighter Cagle provided information in the following areas: response time peaks, average time on scenes, and out of service time. He provided input on data and assisted with interpretation of the information throughout the research project.

The fifth interview was conducted with Battalion Chief Terri Wallace on October 31, 2001 for approximately one hour. Chief Wallace is the Assistant Fire Marshal for the City of Greensboro. Interview questions focused on methods to improve response times from a fire prevention stand point. We discussed issues with enforcement fees, codes in relation to smoke/heat detector installation, and fire alarm monitoring. Chief Wallace gave suggestions of improvement from her point of view.

The last interview was not formally conducted. Assistant Chief Warren Ritter is this researcher's direct supervisor in the Emergency Services Section of the Greensboro Fire Department. Several discussions have taken place throughout the research project. Discussions have focused primarily on methods of calculation of times, relocation of companies and improvement of response times.

End Product Developed

The Awareness of response times brought the issue to the forefront. The Greensboro Fire Department was not recording segments of the total response time consistently throughout the Department. Some company officers put the company en route as soon as they heard the dispatch and some waited until everyone was on the apparatus. Companies did not have an absolute guideline as to when they were to record being on the scene. According to Chief Brooks, the Greensboro CAD system is capable of tracking turnout time and travel time separately but companies need to be more consistent in when they report each time. A General

Operating Guideline was developed, as shown in Appendix A, to provide a clear outline to front line personnel the sequence of response events. Primarily, the Guideline identifies that companies will verify they are en route once the vehicle starts moving and the on scene time will be recorded when the wheels of the apparatus stop moving. This researcher found other methods of automatically collecting the data, such as infrared beams at the base of the station overhead doors. The Greensboro Fire Department is in the process of reviewing the entire Communication system with the Police Department and are looking at ways to better track overall response times (Brooks, personal communication, August 8, 2001).

Research has indicated that fire companies in the Greensboro Fire Department routinely respond into other companies response areas due to emergency response or daily duties. Response incidents were divided into four hour increments. Research parameters requested information on percent of time a fire company other than the closest company was dispatched. The researcher found that between the hours of 8:00 a.m. and noon, 29.3% of the time, the second due apparatus was dispatched. Between the hours of noon and 4:00 p.m., 26.1% of the time, the second due was dispatched. During the hours between 4:00 p.m. and 8:00 p.m., the second due was dispatched 22.8% of the time. A General Operating Guideline was written to provide battalion chief officers a guideline for providing a consistent standard of coverage throughout the City. Appendix B provides a sample copy of the plan.

Assumptions and Limitations

This researcher conducted a literary review by researching periodicals, reference books, and personal interviews. It was assumed the written information was valid and correct. Interviews were personal viewpoints of the individual only. It was also assumed that alarm records were correct and information entered by fire companies was valid. Research focused primarily around

fire departments with paid, full time staff. Research was limited to material written within the past 5 years, with only a few exceptions used to verify particular points. Local response time calculations did not include non emergency calls, mutual aid calls, hazardous materials team regional response calls. Travel time charts did not depict incidents that had response times on the exact minute. For example, the computer software was unable to distinguish a call with a response time of exactly 5 minutes. In the event of a call like the example, the computer report deleted the incident from the record and did not use it in the calculation. The Planning and Research Office of the Department did not feel this would make a quantifiable difference in the calculations.

RESULTS

Research Questions

Are there nationally recognized standards for fire department response times? This is the first question answered by this researcher. National standards are not always established as a requirement. However, many standards are have become what is know as consensus standards and are enforced on a routine basis. The NFPA first presented requirements for response time in 1972. Other national agencies followed suit in later years. Considerable data is recorded in two areas regarding response and have led to specific response time goals (Taylor, 1998; Drew, 1999). Flashover is a determining point in the life of a fire. This sudden ignition of flames throughout the fire area results in a deadly, untenable room (Elements, 1997). Test fires have indicated that flashover can occur in as little as two minutes and 12 seconds or as much as ten minutes (Waters, 1999; Elements, 1997; Nuttall, 1999). Medical response is impacted by research conducted by the American Ambulance Association and the American Heart

Association. Resuscitation efforts have little possibility of success after ten minutes (Mayfield, 1998; AHA, 2001; Elements, 1997).

The previous research resulted in the development of national standards. Emergency service agencies are not bound by these standards but the response times give fire departments guidelines on setting their own response time goals.

How are response times calculated? This was the second questions answered. Response time calculation is a complex measurement of several identifiable time segments. Terminology is not universal among fire departments. The actual times fire departments record are not consistent on a national basis. Some departments record average times while others record fractile times.

This researcher assimilated the different response time increments along with their associated definitions. Overall response times can be divided into six sub-categories: Discovery time, Notification time, Call Processing time, Turnout time, Travel time, and Set-up time. Each increment has a specific starting and stopping point. Three of the six time are controlled by the fire department and are identified in the General Operating Guideline as depicted in Appendix A.

Average response times misrepresent the goals of a fire department. Chief Brooks said, "Average response times indicate we reach a location half the time below the goal and half the time above the goal." The Greensboro Fire Department now records fractile times. This allows the department to report on performance of stated goals, rather than averages.

What influencing factors affect response times? This was the third research question explored. The overall literature review indicated the number of responses relate to the number of units to respond directly correlate to the amount of time it takes to arrive on the scene of an emergency. The number of false alarms take fire companies out of service to respond to actual

emergencies. Safety is a key concern to citizens of any community. Some locals have implemented speed bump programs to slow vehicle traffic. This in turn slows emergency response. Fire departments that lack control of the dispatch center have concern for response time goals. The Communications Division is operated by the Police Department in Greensboro. David Maddox (personal communications, August 29, 2001), with the Communications Division said, "We may not have the optimal method for the fire department, but we are talking with the Fire Department on a regular basis. Communication is the key."

This researcher identified other issues affecting response times in Greensboro. The time of day and the day of week present response time concerns locally. The hours between noon and eight o'clock in the evening accounted for 43.16% of the calls in 1999 and 48.3% in 2000. Wednesday through Friday tend to be the most active days in relation to response (A. Cagle, personal communications, September 18, 2001). Also, the Greensboro Fire Department conducts training drills derived from NFPA 1410. These drills directly relate to the set-up time in the response time goal. The results show that the simplest scenario has a goal of three minutes to complete and the most complex takes no more than five minutes. At a minimum, the Fire Department has identified a three minute set-up time for a company to control a fire after they arrive on the scene. A 1.5 minute set-up time is established for defibrillation activation during cardiac emergencies (City of Greensboro, 2001).

Several positive influencing factors were identified during the research. Enhanced 911 systems allow dispatchers to know the location of the caller. Automatic vehicle locator systems track emergency response vehicles and make for easy dispatch of the closest vehicle (Gabliks, 1999). Communication centers are using Pre-alert systems to notify companies an emergency call is coming in to the station (Clet and Larson, 1998). Signal control systems are in place in

Greensboro to turn traffic signals green at high traffic intersections throughout the City. Some dispatch centers in neighboring communities are linked together to allow both agencies to receive the information at the same time, which shortens call processing times.

The forth and last question: What methods are available to improve response times? Many fire department leaders have become involved in planning (McGinnis, 1997). Fire departments and police departments with joint dispatch centers communicate on a regular basis (Clet and Larson, 1998). System Status Management has been modified to work in some localities (Lewis, 1997).

NFPA 1710 addresses emergency response. Departments across the nation are deciding rather or not to implement the Standard (Brooks, personal communications, August 8, 2001). The Standard gives departments direction for long range planning in relation to response times (Firefighting.com, 2001). The CFAI has identified common terminology to be used in calculating response times (Elements, 1997).

Cities across the country are dealing with the issues associated with false alarms. Locally, the City of Greensboro is trying to present alternative methods of compliance to property owners (Assistant Fire Marshall, Greensboro Fire Department, Battalion Chief T. Wallace, personal communication, October 30, 2001).

Unexpected Findings

The past research completed indicates that flashover times range from just over two minutes to as much as ten minutes. This researcher wanted to identify methods to improve response time in an effort to save civilian lives as well as enhance firefighter safety. An overall response time is able to be determined once the methods of calculation are identified. The conclusion showed a response to a medical incident to be 8.5 minutes, which includes the

discovery time until medical intervention takes place (Appendix A). A fire incident has a minimal goal of ten minutes, which includes discovery time to the time the company begins to mitigate the incident (Appendix A). These times show there is only a slight change of successful results to medical emergencies involving cardiac arrest. A ten minute response to a fire puts the fire companies on the scene during or just after the flashover occurs. This is the most dangerous time for companies to be entering the building. The occupants of the structure have little change of being rescued at this point but the firefighters have a high chance for being injured or killed. (Waters, 1999).

Final Product

This researcher identified two methods to improve response times in the Greensboro Fire Department. First, the method of calculation must be recorded consistently to allow for correct and valid information. Second, a relocation policy was written to allow battalion chief officers a consistent method to keep fire protection forces evenly dispersed throughout the City.

A policy was written to show the breakdown of overall response times (Appendix A). The policy identifies the exact times of each stage of the response and gives a performance goal for the fire companies. The policy will be used on a trial basis in District 1 for 3 months. Battalion 1 chief officers will be briefed on the new methods of calculation. Response records will then be compared to the remainder of the city.

This researcher also identified a method of improvement to be relocation of companies during peak times of activity (Appendix B). The relocation plan will be presented to the Greensboro Fire Department Management Team at one of the weekly staff meetings in the coming year. Department schedule will determine the time of the actual presentation. Input will

be encouraged from all Department chief officers. The implementation goal is set for July 1, 2002.

DISCUSSION

Fast response times save lives. This researcher believes the previous statement. However, it is not that simple. It is not as easy as having the fire companies get to the truck faster. Overall response time includes educating the public to call for emergency assistance in a timely manner. It includes working with dispatchers to show the need for quick and precise information. It includes teaching the firefighters the reasons getting to the apparatus is so important. It includes training in routine hose drills to establish minimum standards. Recording response times must be viewed in a systematic approach.

National Standards are needed. The results showed the standards are already there. NFPA 1710 has identified response time goals. However, some appear to be too stringent for many fire departments, according to this researcher. Turn-out times of 60 seconds or less seems appropriate. A travel time of four minutes may be pushing the limits of safety. It is my experience that drivers of fire equipment will try to make up any delays while traveling on the road. Also, company officers will advise the unit is on the scene, and in fact they are still trying to find the exact location.

My interpretation of flashover times in relation to other fire departments seems to put the fire units on the scene at one of the most dangerous times of the fire. This researcher suggests training officers need to teach this in basic recruit firefighting. Firefighters need to be aware of the forces working against them.

This researcher also agrees with the other research in that we have little chance of success in dealing with a cardiac arrest response. Response times of over 8-10 minutes may not have had great success rates, but there have been successes. Is it worth it to try? This researcher thinks so.

The fire service needs one method of tracking response times. The findings indicated that the CFAI has developed a method to do so (Elements, 1997). The message must be presented to the nation's fire services. Locally, the Greensboro Fire Department needs to be able to track segments of time of the response better. The new guideline, shown in Appendix A, assist with the process but still has limitations. Fire departments should also track set-up times. These times can later be applied to training goals. The literature review provided little direction in methods of improvement. When the total response is viewed objectively, strengths and weaknesses can be identified.

Many fire departments are now using a fractile method of tracking response times. Departments who do not are misleading their community, according to the research. The fractile method gives the customer and the provider a clear understanding of what is acceptable. Response goals can then be set. Fire departments then strive to meet realistic response times on a consistent basis (Clet and Larson, 1998).

False alarms plague fire departments daily. Documentation shows only minimal fires are mitigated after an alarm activation (T. Wallace, personal communication, October, 30, 2001). A method of a tiered response was identified during the research and would assist in keeping companies in service until a fire was confirmed (W. Ritter, personal communication, October 28, 20001). A tiered response method would send fewer apparatus to a scene. Some would respond with lights and sirens, other would respond non emergency, and still others would only monitor the call from their location. The current standards require a minimum number of firefighters on

the scene of an emergency in a specified time. The problem is that we do not know if it is an emergency until the fire units arrive on the scene. The Relocation Plan shown in Appendix B gives the battalion chief officers in Greensboro the flexibility to do just that.

Statistics from the past two years in Greensboro identified the highest response rate during the hours between 4 o'clock in the afternoon and 8 o'clock in the evening. The Department currently requires each company to conduct 2 drills at night per year. These drills are allowed after 6 o'clock in the evening. The problem incurred is this is the busiest time of the day in relation to response activity. This researcher is proposing delaying night drills to after 8 p.m. The hours between 4 p.m. and 8 p.m. would be strictly dedicated to response. The companies would remain in service and in their districts during those hours. Company members would classify the time as operational readiness and include activities such as physical training, relaxing, or preparing meals. Emergency calls would take priority over all other activities. The trade off is the companies training at night would be working later in the evening with a break during the daytime hours if no calls are dispatched. During the same hours of the day, companies are often required to be out of service training or doing any other daily activity that requires the company not to be available for response. Fire Department Section chief officers should also attempt not to schedule these activities during the hours between 4 p.m. and 8 p.m. Saturday through Tuesday may be used if the activity can not be avoided, since these days tend to less response activity.

Battalion chief officers have the authority to operate their companies as they see fit and within limitations. Relocation of fire companies for daily activities is a new concept for many of the existing chief officers in Greensboro. The new policy will give written guidelines of what is expected during peak times of activity or during large scale emergencies.

The research findings did little to identify future problems. Call loads continue to increase even after some predictions disagreed. The Greensboro Fire Department will respond to approximately 20,000 incidents this year (A. Cagle, personal communication, September 18, 2001). This number has doubled in less than 10 years. What is to come? Will the department respond to 40,000 incidents in 10 more years? This researcher questions if fire departments will be able to keep up with the pace of responses unless changes are made.

Education is the key to success, education of the public as well as the firefighters. The public needs to know how to use extinguishers. They need to know the needs of having defibrillators in their shopping complexes or malls. They need to know how to be fire safe. Firefighters need to know their part of improving public safety. Fire service leaders need to get involved in outside agencies. The importance of automatic residential sprinkler systems should be stressed to city leaders. Smoke detector ordinances need to be enacted. If a company responds to an incident and finds a home without a smoke detector, one should be installed. There are sponsoring agencies willing to buy them (W. Ritter, personal communication, October 28, 2001). The fire department just needs to ask. Increasing the number of fire stations is not the answer but increasing the educational opportunities just might provide a solution.

The purpose of this research project was to analyze response times and determine methods of improvement. The research questions applied to the problem and the purpose. However, a unified concerned was identified throughout the project. If you are not measuring the time completely, you will not be able to make informed decisions for the purpose of change (Clet and Larson, 1998). The public is concerned for the overall time not how long it takes a firefighter to get on the truck.

RECCOMMENDATIONS

NFPA 1710 is the most current national standard in relation to response times. The CFAI has also written material in relation to response times. NFPA provides a phase in period. The Greensboro Fire Department needs to seriously consider the implications of adopting the Standard.

NFPA 1710 recognized that there will be times when a department can not meet the 4 minute travel time. An exception was made to allow for the overall responding units to be on the scene in 8 minutes. The Greensboro Fire Department tracks unit response times but does not have an easily accessible method of determining if all units were on the scene in 8 minutes or less. The Department needs to determine a method of identifying the overall response that can be viewed by battalion officers. The information could then be used to identify problem areas. Chief officers could identify slow responding companies or land areas needing additional support in the overall response time.

The CFAI has identified segments of response. The Greensboro Fire Department needs a clear method of determining each segment. The new guideline will assist in explaining the times of each portion of the response. The guideline will be presented to the leadership team to gain support for the necessary changes. An annual review will be conducted to identify further improvements.

There were factors identified during the research that affect response times. One particular one had a local impact. The total response of the fire department has risen dramatically over the past 10 years. Companies are constantly responding out of their assigned response zones to cover for out of service units. The new Relocation Plan will be implemented in the near future. The written document will support the battalion chief officers in making their

daily decisions. The policy will provide consistency throughout the department. Fire companies will understand the need for moving their units. Department leaders will understand the need to plan activities around more active times of the day. In the end, response times should decrease as companies are in their assigned response zones more often.

Other improvements are needed by the Greensboro Fire Department. The department needs to determine the types of incidents that are truly emergencies. This will allow for fewer units to be on the road at one given time. This will in turn provide possible solutions to decreasing responses in the city. Last, the Greensboro Fire Department should use NFPA 1710 as a tool in long range planning. Actual implementation of the response portion of the Standard will be determined as progress is monitored.

Additional research is needed in the area of analyzing response times. Departments should be able to calculate when other than first due units are actually on the scene first. Researchers may want to identify methods other departments are providing necessary statistics. Traffic calming devices appeared quite often during the research project. This area may need to be explored in further detail. Fire departments may be able to get ahead of the curve in regards to these devices.

It is clear that response times are of concern to the nation's fire service. It also appears that fire units will continue to struggle to get to the scene in time to make a difference. Further research is needed in prevention of flashover. The questions might be to determine if residential sprinklers make a difference in fire loss.

Barry Furey, Executive Director of the Know County, Tennessee Emergency Communications District explained the response time problem in a simple way:

As we head into the next century, there are few certainties. But, if the past is a worthy guide, there will be an ever growing number of calls and a finite number of units to send. Increasing pressure and emphasis will be placed on proper call management within the center. Sometimes I kinda wish I worked in Mayberry. Andy and Barney handled everything. And, somehow, they were able to do it with just one car, just one phone, and with both of them working the day shift (Furey, 1996).

REFERENCES

American Heart Association. (2001). Defibrillation. Retrieved November 8, 2001 from: http://216.185.112.5/presenter.jhtml?identifier=4540

American Heart Association. (2001). Sudden cardiac death. Retrieved August 21, 2001 from: http://www.americanheart.org/Heart_and_Stroke_A_Z_Guide/sudden.html

Bugbee, Percy. (1985). Fire hazards of Materials. *Principles of Fire Protection*, Quincy, MA: National Fire Protection Association.

Brown, L.H., Whitney, C.L., Hunt, R.C., Addario, M., & Hogue, T. (2000, January/March). Do warning lights and sirens reduce ambulance response times? *Pre Hospital Emergency Care*, 4, 70-73.

Burnett, Hal. (1999, March). Move to a fire based ems system would save both lives and money. *Fire*, 91, 17-18.

Callaham, Dr. M., Madsen, C.D. (1996, May). Relationship of timeliness of paramedic advanced life support interventions to outcome in out-of-hospital cardiac arrest treated by first responders with defibrillators. *Annals of Emergency Medicine*, 27, 638-647.

City of Greensboro. (1999, February). *International association of fire chiefs accreditation project report.* Greensboro, NC: Author.

City of Greensboro. (2001). General operating guidelines. Greensboro, NC: Author.

Clark, W.E. (1991). Firefighting Strategies. *Firefighting principles and practices*, (pp. 75-76). Saddle Brook, NJ: Pennwell Publishing Company.

Clet, Jeff, & Larson, Randall. (1998, July). Improving response time. *Fire Engineering*, 151, 88-96.

Coleman, R.J. & Granito, J.A. (Ed.). (1988). *Managing fire services*. Washington, D.C.: International City Managers Association, p. 120.

Dawson, K.K. (1999, January). Calculating the oregon city fire department's response times. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Delisio, David C. (1997, April). GPS receivers in emergency vehicles. *Firehouse*, 22, 111-112.

Drew, D.D. (1999, April). A review of response times for paid and volunteer units within the east fork fire and paramedic districts. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Elements of response time. (1997). Commission on Fire Accreditation International, Section 6, p. 1-42.

Finch, H., Gerard, & W., Harvey, A. (1999, January). Actual vs. perceived ems response time. *Pre Hospital Emergency Care*, 3, 11-14.

Firefighting.com. (2001, September 4). *NFPA 1710: an implementation decision*. Author: Oriole, Kim. Retrieved September 14, 2001 from the World Wide Web: http://www.firefighting.com/articles/namFullView.asp?namID=3951

Furey, Barry. (1996, September/October). Speed vs. detail – the calltaker in a changing world. *911 Magazine*, 9, 56-57.

Gabliks, Eriks J. (1999, March/April). Location…location…location… *911 Magazine*, 12, 48-49.

Greensboro Fire Department (1993). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1994). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1995). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1996). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1997). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1998). Annual report. Greensboro, NC: Author.

Greensboro Fire Department (1996). NFPA 1410 standards on training for initial fire attacks. Greensboro, NC: Greensboro Fire Training Section.

Greensboro Fire Department. (2001). Vision statement. *Greensboro Fire Department Vision and Strategic Plan*. Greensboro, NC: Author.

Greensboro Fire Department. (2001). *Training Manual*. Greensboro NC: Greensboro Fire Training Section.

Ho, Dr. Jeffery, & Cassey, B. (1998, November). Time saved with use of emergency warning lights and sirens during response to requests for emergency medical aid in an urban environment. *Annals of Emergency Medicine*, 32, 585-587.

IAFF wins approval of nfpa 1710 standard. (2001, May). *International Firefighter*, 84, 3.

Jermyn, Bruce D. (1999, January). Response interval comparison between urban fire departments and ambulance services. *Pre Hospital Emergency Care*, 3, 15-18.

Lewis, T.L. (1997, January). Resource management for effective service delivery. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Mason, R. (1996, December). Analysis of response times of the saint peters fire protection district. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Mayfield, Ty. (1998, February). EMS in the nation's most-populous cities. *JEMS*, 23,51-53.

McGinnis, Lindy. (1997, January/February). Things that go bump in the night. *NFPA Journal*, 91, 78-82.

Meislin, H., Conn, J., Conroy, C., & Tibbitts, M. (1999, October). Emergency medical service agency definitions of response intervals. *Annals Of Emergency Medicine*, 34, 453-457.

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

Nuttall, S.R. (1999, February). The impact of traffic calming devices on emergency fire response. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Page, David. (1996, February). Lost without a trace? *JEMS*, 21, 65-69.

Pegram, Steve N. (2001, July). Number crunch – how many firefighters does it take to knock out a structure fire? *Fire Rescue Magazine*, 19, 27.

Peterson, C.E. (1998, August). 1998 ames fire department response time study. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Ritter, W., & Spears, D. (2001). Emergency services summary [CD-ROM]. Greensboro NC: Emergency Services Section.

Swayze, A.P. (1997, February). Emergency medical response times for the city of Delafield, Wisconsin fire department. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Taylor, R.G. (1998, October). Impact of a second firehouse on response time. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

U.S. Fire Administration. (1992, January). Analytical approaches to public fire protection – course guide. Emmitsburg, MD: Author

Waters, John R. (1999, February). Fire department response time vs. flashover. *Fire Engineering*, 152, 107-114.

Wilbur, B.H. (1996, December). Managing fire department resources by reducing the response. Emmitsburg, MD: National Fire Academy, Executive Fire Officer Program.

Wilbur, Michael. (1995, March). Emergency vehicle operations – flawed response policies. *Firehouse*, 20-21, 96.

Withington, Dr. Deborah. (1997, June). How more effective sirens can cut journey times noticeably. *Fire*, 90, 27-28.

Zikmund, Nyle. (1997, July/August). Response time hogwash. *Minnesota Fire Chief*, 33, 13-15.

APPENDIX A

General Operating Guideline

Subject: Response Time Calculation Method

Section: Emergency Response

Page: 1 of 2

Date: 1/1/2002

Overview

It is important to recognize that the individual time elements are critical components of an organization's ability to positively impact the outcome of an emergency event. Fire growth is exponentially based upon concentration of fuels, elapsed time to intervention, atmospheric conditions etc. Similarly, medical emergencies, especially in terminal events such as cardiac arrest, the elapsed time to effective intervention has a direct relationship in determining survivability and ultimately, quality of life.

Response Times

The following times depict the typical response to an emergency event. It is understood that companies will routinely be responding from outside of the station and will cause some times to overlap.

The fire department only has control of a portion of the times that include: Turnout time, Travel time, and Set-up time. The Police Communications Center has control over the Call Processing time only. It is understood that the City of Greensboro has no control over the Discovery time or the Notification time. Therefore no data is kept regarding these times. However, these times do affect the overall outcome of the event and must be considered by responding personnel.

Definitions

Discovery time	Point of awareness by the citizen or mechanical recognition.
Notification time	The time between when the problem is identified by the citizen to the time it is reported to the Communications Center.
Call Processing Time	The time the dispatcher receives the call, takes the necessary steps to process the call, and dispatches the required companies. Time ends when dispatcher stops talking.

Subject: Response Time Calculation Method

Section: Emergency Response

Page: 2 of 2

Date: 1/1/2002

Turnout Time	The time beginning when the dispatcher has finished speaking and ends when the fire company acknowledges they are en route. The company officer shall not acknowledge the call until all personnel are on the apparatus and the wheels begin to move.
Travel Time .	The point at which the wheels on the apparatus Begin to move and ends when the wheels stop on the scene of the emergency.
Set up Time	The time from when the company arrives on the scene until the company begins to mitigate the event. (These times should coincide with 1410 drill times).

Total Response Time	The time beginning with the Point of awareness by the citizen or mechanical recognition and ends when the company begins to mitigate the event.

Goal

The goal of the Fire Department is to have a total response time meeting the following criteria

Discovery/Notification Time	1 minute
Call Processing Time	1 minute
Turnout Time	1 minute
Travel Time	4 minutes
Set up Time	3-5 minutes
Total Response Time	10-12 minutes

APPENDIX B

Relocation Plan

Departmental Activities

Schedule training and departmental activities between 0800 – 1200 Mon-Sun

Schedule training and departmental activities after 2000 Mon – Sun

Do not schedule training and other routine departmental activities Wed-Fri 1200-2000
Note: Hours between 1600 – 2000 tend to be most active in relation to response

Department Sections shall make every effort not to schedule training or non essential events during peak response times

Night drills conducted after 2000 hours (instead of after current (1800 hours)

1600 – 2000 – down time for companies

Relocation of companies

When companies are scheduled to be out of the response area for 2 hours – relocate from two company stations to provide 1 apparatus in every station possible

2nd alarm incidents – relocate from two company stations to provide 1 apparatus in every station possible

After all two company stations are depleted to one company, begin requesting mutual aid from county into outlying stations. Move City companies into more active zones.

Quints may be utilized into other quint stations, battalion chief determines best coverage

All stations shall provide a map or run book. Books shall be stored in station office and labeled on the front cover and binder with title "Station Run Book"

Altered Response

During peak times of activity, battalion chief officers may elect to alter response with tiered response

The following is an example but not the only method

1st eng – Emergency traffic
1st quint – Non-emergency traffic
2nd eng. – no response