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Emergency Response Time in Motor Vehicle Crashes: Literature and Resource Search

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Introduction:

In recent years, General Motors and the National Highway Traffic Safety Administration have explored potential standardized tests for fire propagation to vehicle interiors. Results of such tests could be available to vehicle designers, but would be more useful with accompanying information about target propagation times that would reduce occupant injury in vehicle collision fires. One possible propagation time criterion would be to design for fire resistance to the interior that is long enough to allow emergency personnel to either control the fire or remove occupants from the vehicle for a reasonable percentage of collision fires. In exploration of this criterion, the Motor Vehicle Fire Research Institute (MVFRI) sponsored Leland E. Shields, Inc. (LES) to research published information and available data that could be useful in defining and evaluating emergency response time as a means of developing propagation time design targets.

The emergency response time of interest for this purpose can be broken down into 3 practical intervals:

1) Time from crash event or fire to notification of emergency personnel.
2) Time from notification to arrival on the crash scene.
3) Time from arrival to occupant removal or extinguishment of fire.

These intervals are similar to those identified in fire service and emergency medicine literature (International Association of Fire Fighters, 2003; Champion, 3-4/1999; Champion, 5/1999). The time interval from crash to initiation of the fire is not listed separately due to the difficulty in finding reliable data.

The literature search included searches of bibliographic databases in the fields of government emergency services, transportation engineering, health and medicine. After limited information was found in published sources, Internet sites and interviews were conducted to reasonably assure that available resources to define response time were located.

Concurrent with the current research, MVFRI separately sponsored others to analyze the National Fire Incident Reporting System (NFIRS) database for response time data. In support of the NFIRS research, LES included in this study investigation of information related to the validity and precision of NFIRS emergency response values.

Within the literature collected to date, there are several examples of studies showing the time from notification to arrival of first responders. Most sources list aggregate values; some include distribution for urban and rural individually. Three sources included citations for the time from a crash event to notification; two related values that were for urban and rural fatal accidents; the third included a range of urban-only accidents.

After thoroughly searching for relevant data, it was determined that limited sources of information are currently available to fully define all components of emergency response time for motor vehicle collision fire events. Information found was supportive of NFIRS for reasonably valid reflection of the time from notification to emergency personnel arrival on scene. Sources of information consistently identified disaggregation of urban and rural data for response time analyses. To further evaluate response time and its potential as a target for vehicle design of resistance to fire propagation, follow-up studies are necessary.

Bibliographic Literature, Internet Searches, and Interviews

The literature search included commercial (fee-based) bibliographic database searching of publications in the fields of engineering safety, government and industry regulations, transportation research, government research, public health and safety (fire and EMS services), and emergency medicine. Limited information was found by searching published documents, so other sources of data were explored as well, including phone interviews with fire department contacts in varied organizations, contact with researchers in related topics that may have had exposure to useful data, and searches of Internet sites. In conducting interviews, some fire response data were offered to LES, received, and analyzed for initial utility in defining emergency response time.

Initially, search terms used were variations on appropriate combinations of words and phrases to retrieve material pertinent to emergency response time to vehicle fires. The limited number of resulting papers led to broadening concepts to include ambulance, police, and fire department response rates to emergencies in general. Searches included transportation, health, and fire related databases and websites, which often linked to other sources.

<u>Dialog Databases Searched</u>

Transportation Research Information Services (TRIS)
National Technical Information Service (NTIS)
PAIS International
Gale Group Health & Wellness Database
Medline
Biosis Previews
Scisearch (Science Citation Index)
Embase

Appendix A contains detailed descriptions of each of the Dialog databases accessed.

<u>Relevant Internet Sites Found in Internet Searches</u>:

National Highway Traffic Safety Administration (NHTSA)
U.S. Department of Health and Human Services (DHHS)
National Fire Protection Association (NFPA)
US Fire Administration (USFA)
International Fire Service Training Association (IFSTA)
National Association of State EMS Directors
International Association of Firefighters
Automatic Crash Notification service providers

Interviews:

Representatives of the organizations related to the Internet sites above were contacted, in addition to representatives of various fire service organizations, and authors of papers identified in the literature search. In each interview, contacts were asked about their knowledge of emergency response-time data, the accuracy of published statistics, and the procedures by which data were collected. As in any such process, those contacted often gave the names and numbers of others to contact; all credible leads were followed.

The results of all searches and interviews are described by topic below.

Standards, Regulations and Industry Guidelines

Standards were identified at Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services (ODPHP), The National Institutes of Health (NIH), NFPA and the state of California (Table 1).

The table entries frequently refer to EMS response, not fire services. The respondents to the Phoenix Fire Department survey, dominated by professional fire departments, indicated that 75% of EMS services were provided by fire services. The US Fire Administration has actively promoted the EMS activity within fire services in part to reduce EMS response times (Krohmer and Perina, 2000) Still, EMS response is separate from fire service response in many locations in the country, particularly in rural areas. When EMS and fire services are recorded separately, the fire service is likely to have a shorter response time than EMS. When EMS and fire services calls are taken by the same dispatch system (911 service), the notification time may be recorded as the time of the 911 call and be the same for all services, or be recorded individually for each service when each is specifically dispatched, depending on local procedures.

Table 1 contains a summary of the standards found. Excerpts from the relevant documents related to these standards are provided in Appendix B. Internet addresses are given when available.

Available Response Time Values

Time from Crash to Notification of Emergency Services

Three sources were found for values of the time from crash to notification (Table 2). The two most recent sources were likely related (Champion, et al., March/April 1999; Champion, et al., May 1999) and were taken from EMS notification times for fatal crashes. While useful, the values from fatal crashes have a higher representation of events on high speed, two-lane, undivided highways, and are more likely to occur late at night (Traffic Safety Facts, 2001). The values for EMS notification also may be longer than those for fire service notification. In addition, Champion (March/April 1999) noted that the rates of unknown values were 35% for rural and 49% for urban events respectively. It is quite possible that the events with unknown notification times do not occur randomly but are biased in a manner that could significantly alter the averages. Lastly, it is also possible that the notification times for fire events may vary from those of all fatal crashes. Thus, there are inherent biases in fatal crash and EMS data that must be understood before conclusions are drawn from these data.

Table 1 – Summary of Standards, Regulations and Industry Guidelines

Organization	Time Specified (Minutes)	Interval Description	Percentage of Calls	Emergency Service
Office of Disease Prevention and Health Promotion	5	Call to arrival	90	Urban first responder EMS
	10	Call to arrival	80	Rural first responder EMS
National Institute of Health	5	Dispatch to arrival	90	Life threatening calls
NFPA (1710)	4	Call to arrival	90	First engine company, career departments
NFPA (1720)	No specification	Call to arrival	None	First engine company, volunteer departments
NFPA (Proposed 450)	To be set locally	Call to arrival	To be set locally	EMS
California	10 20 30	High population density Medium density Low density		EMS response time

The third source of data regarding the time from crash to notification was taken from a 1970 study of collisions in the city of Detroit, Mayor's Committee for Urban Renewal, 1970) In the study, comparisons were made between incident time and notification time on police and fire reports. Detroit had separate dispatch centers for police and fire at the time; each was responsible for specified medical emergency response and transportation. The study was not specific to vehicle crashes.

Information was available on 253 of 317 dispatch tickets. Errors were evident in the data, as is clear from the number of records for which the time of the crash was estimated to be later than the time of notification (see original source Figure 9.1 in Appendix C). The study authors suggested that the negative values were indicative of the unreliability of the data that were derived from interviews of victims and witnesses. The original investigators adjusted the notification times based on a presumed exponential distribution of first and subsequent calls. They assumed a Poisson distribution for the time intervals between events with multiple calls, calculated the average interval between first and second calls, presumed the existence of a minimum notification time and used these parameters to calculate characteristics of the delay

(Detroit, Mayor's Committee for Urban Renewal, 1970, page 213-215). The study also warned against using the adjusted figure to estimate notification time because the model was not adequately tested. The adjusted value is shown in Table 2 as well

Five sources were found for the response time from emergency service notification to arrival on scene (Table 2). The values and the differences in their development are self-explanatory. Data from the Phoenix Fire Department Survey (2000), Traffic Safety Facts (NHTSA, 2001), Champion (3-4, 1999; 5, 1999) and Tessmer (1996) are published values. Values were not taken from "U.S. Fire Trends and Patterns" (NFPA, various years) as this appeared to be redundant with the efforts of other MVFRI researchers.

The data from the California National Fire Incident Reporting System (CA NFIRS) was sent as an electronic file to LES by the California Fire Marshal's Office. The file provided raw data for over 7,000 motor vehicle calls between 2000 and 2003 that have not yet been input to the NFIRS system. The Fire Marshal' Office later sent data to allow differential analysis for types of fire departments (paid, mostly paid, volunteer, mostly volunteer). The data received contained relatively few events from all volunteer fire departments. The limited representation of volunteer departments may be a confounding factor for all NFIRS data.

The emergency medical and public health literature does contain studies that address the time from heart attack to notification. Even from this source, little is available, and that which is available has uncertain correlation with motor vehicle crash notification times. Those studies that include quantification of the time from heart attack to emergency notification are based on interviews of witnesses to heart attacks.

Another study (Mayer, 1979) examined the relationship between EMS (fire service, non-paramedics) and paramedic response time and fatality rate in the Seattle area's Medic 1 system. The author defined response time as the interval from dispatch to arrival on the scene. Fatality rates were not significantly correlated with response time for all emergencies, but 99% of the responses occurred in less than 7 minutes. The author speculated that in rural settings, with a greater response-time distribution, a difference in outcome would likely emerge. Even more interesting was a refinement of the analysis, which looked at only those calls related to life-threatening emergencies. In this subset, fatalities were significantly less likely for first unit responses of one minute or less, and paramedic unit responses of either one minute or less and nine minutes or less. Response times of 1 minute or less were recorded for 127 events for EMT unit arrival (1.2% of the sample) and 80 events for Paramedic units (0.8% of the sample). The author did not comment on how response times of one minute or less are achieved, but it is possible that the wide distribution of teams in Seattle (44 EMT units, 4 Paramedic units throughout the city) made such response times possible for the relatively small percentage of the samples. Other possible contributions to the short times could be due to defining arrival time as the moment the scene is in view, and measurement error.

Response time analysis of motor vehicle crash fire events may also demonstrate a similar lack of significant correlation to injury or fatality with aggregate data. The EMS analysis provided an example of a means of identifying not only important factors, but various time intervals as well.

Table 2 Summary of Published Response Time Values

Interval	Time (Minutes)	Average or Percentage of Calls Included	Data Description	Source
Crash to Notification	3.87	Average	Urban, 1996 Fatal, EMS	Champion, 3-4/1999
	7.36		Rural, 1996 Fatal, EMS	
	4	Average	Urban, 1997 Fatal, EMS	Champion, 5/1999[1]
	7		Rural, 1997 Fatal, EMS	
	8.4 minutes	Average	Urban	Mayor's Committee for Urban Renewal, 1970
	3.9 minutes		Urban, Adjusted	
Notification to Arrival	4:19	Average, US cities	First Unit	Phoenix Survey, 2000[2]
	4:30	80%, US cities		
	0-10	81.7%	Rural Fatal, EMS	Traffic Safety Facts, 2001[3]
	0-20	94.3%	Rural Fatal, EMS	
	0-10	93.8%	Urban Fatal, EMS	
	0-20	97.7%	Urban Fatal, EMS	
	6	Average	Urban, 1997, Fatal, EMS	Champion, 5/1999[1]
	11		Rural, 1997 Fatal, EMS	
	0-10	88.3%	Urban, 1975-1993 Fatal, EMS	Tessmer, 1996[4]
	0-10	57.7%	Rural, 1975-1993 Fatal, EMS	
	0-20	97.8%	Urban, 1975-1993 Fatal, EMS	
	0-20	89%	Rural, 1975-1993 Fatal, EMS	
	5.1	Average	2000, Fire Service	CA NFIRS[5]
	5.3		2001, Fire Service	
	5.4		2002, Fire Service	
	5.3		2003, Fire Service	
	0-7	80%	2000, Fire Service	
		77%	2001, Fire Service	
		75%	2002, Fire Service	
		77%	2003, Fire Service	

[1] Excerpt in Appendices, page 19.
[2] Excerpt in Appendix C, page 22.
[3] Excerpt in Appendix C, page 20
[4] Excerpt in Appendix C, page 18, Appendix D pages 23-4.
[5] More information in Appendix C, page 21.

In collision fires, there may be a subset of crashes that are not severe enough to have likely entrapment or trauma preventing egress, and another subset of events with fires that are so rapid that serious injury occurs before there can be any practical emergency response (e.g., catastrophic fuel tank breaches). This suggests the necessity of differentiating a subset of accidents to the frontal 1/3 or 2/3 of the vehicle (with lower probability of fuel system breach) and of sufficient severity to entrap or prevent the ability to for egress.

Brodsky and Hakkert (1983) analyzed EMS data from rural Texas to identify the critical factors related to injury severity in highway traffic accidents. The intent of the study was to determine the influence of EMS accessibility on outcome with other factors controlled. The authors did not estimate response times; instead they classified counties that met criteria for ready access to EMS, remote access, and mixed, then looked for differences in probabilities for serious or fatal injuries between regions. Correlated variables included EMS accessibility, time of day, type of accident (single, multiple vehicle, overturn), number of persons involved, road alignment and interactions between variables (type of accident and road alignment). Speed limit was not available as a factor, though the authors thought other variables were surrogates to speed limit. The logits (natural log of odds ratios) related to EMS access were –0.362 for counties with relatively good access to health care and 0.248 for remote counties, indicating the remote region had a higher severity ratio (greater probability of fatal versus incapacitating injury).

Appendix D contains an excerpt from CODES analysis (Tessmer, 1996) demonstrating the difference in relative likelihood of injury for urban and rural vehicle crashes. The analysis does not control for critical factors but does show the aggregate increase in risk of rural crashes.

The information from the CA NFIRS system was further differentiated by fire department type in Table 3 (average response time by type) and Table 4 (count by type). The four types are designated by “VOL” (all volunteer), “M/VL” (mostly volunteer), “M/PD” (mostly paid professional staff) and “PAID” (all professional staff). The greatest variation in response time is evident in comparing the all-volunteer services to services with any paid staff. It is also evident that the sample size for volunteer services is quite limited. It is possible that the volunteer services that participate in the CA NFIRS data collection are those that are best organized and/or have the most active participation. If so, these volunteer participants would be likely to have a faster response time than the average volunteer fire department as well.

Table 3: Average Time from Notification to Arrival
By Incident Year and Fire Department Type

Incident Year	VOL	M/VL	M/PD	PAID	Weighted Average
2000	10.4	5.3	5.1	5.3	5.1
2001	5.7	4.9	5.3	5.4	5.3
2002	7.9	5.6	5.4	5.3	5.4
2003	6.2	6.2	5.8	5.0	5.3
Weighted Average	7.2	5.5	5.3	5.2	5.3

Table 4: Count of Incidents Included
By Incident Year and Fire Department Type

Incident Year	VOL	M/VL	M/PD	PAID	Grand Total
2000	7	75	1009	85	1176
2001	13	246	1686	343	2288
2002	27	476	1337	982	2822
2003	20	124	173	642	959
Grand Total	67	921	4205	2052	7245

Given the limitations in the available data, a preliminary exploration of fields available in state motor vehicle accident databases was initiated. The NHTSA supports an Internet site of current state police accident reporting forms and the author of this study has file copies of forms from the states from a range of previous years. Examination of a subset of forms indicated that the states (as of November 2003) with commonly used vehicle accident databases have not recently and do not currently record notification or arrival time (Texas, Washington, Michigan, California, New York). Oregon, Maryland, Delaware and Wyoming do record notification and arrival times (as of November 2003). As a random check, the Oregon Department of Transportation was contacted; although the Police Accident Report (PAR) records the desired times, the electronic database records only the crash time. In order to define notification time, or to study the correlation between response time intervals and injury, one or more states with notification and/or arrival time would have to be identified. If none code the necessary times, then the data may still be available, albeit with more work to isolate the information of interest. For any appropriate states with accommodating privacy regulations, PARs could be ordered for fire crashes with and without injuries. The time data could then be added to the electronic database(s).

Interviews Conducted

Fire service personnel were asked:

1) Their experience regarding the factors that influence the rate of their response to a scene. (Information to be used for reference to the necessity of finding response time information specific to vehicle fires versus data for all motor vehicle events).
2) Their experience in interpreting the notification, dispatch, arrival and control time from field data in their own departments or that of others.
3) The factors that influence response time
4) Availability of information related to time between event and notification

<u>Interpretation of Notification, Arrival and Control Times</u>

1) The U.S. Fire Administration, NFIRS Support Line representative said the alarm time is defined in different ways depending on how the individual fire departments define the elements. Some define the notification time as the time of call to 911; others use the time of the fire company alarm. The contact thought there could be a difference that ranged from seconds to minutes.

2) Comments from a board member of the NFPA Transportation Emergency Response Committee (TERC):

- Notification time is usually an automatically recorded value for career fire departments. When the call is initiated, a time stamp is automatically placed in the record.
- Arrival time is automatically recorded for a growing number of systems. In an automated system, the fire fighters push a button on the dash of the fire engine when they arrive and the computer record is updated. Many systems are not yet automated (Seattle will be automated at the end of 2003 or beginning of 2004), in which case arrival is announced over the radio. Dispatch types in the time when they can. Dispatch may be tracking several calls simultaneously, and therefore may be delayed in entering the time. Delay can be 2-5 minutes. The contact did not give a sense of the distribution (frequency of significant errors) from the TERC contact. Other times, such as control time, time fire is "tapped" (extinguished), would be manual for all systems.
- Control time is ambiguously used in the industry. It could be used to describe a fire that is still burning but will not spread further in the vehicle, or a fire that will not spread to adjacent structures.
- Fire out: The scene commander is responsible for declaring the fire out or "tapped." He or she will do so when there are no flames or smoke, though there may be some residual steam.
- Extraction time is not well documented in many systems and may not be as accurately recorded as it is of less focus than the primary tracking times.

3) Comments from the data collection division of the Phoenix Fire Department. This office conducts a yearly survey of fire departments for various parameters. The vast majority of respondents are career departments; rural events and procedures are not well represented in their data or experience.

- Notification time: Mostly automatic and thus reliable. He said there are differences in definition between jurisdictions. Some record alarm time in the fire house, others record time of the 911 call.
- Arrival time: The contact believed most career fire departments had automatic systems and multiple dispatchers. He believed the recorded values were likely within seconds of the times indicated by those in the field. He also said some fire fighters push the "arrival" button when in view of smoke and prior to actual arrival. This is done so that other priorities can be focused upon as the vehicle pulls up to a scene.

Procedures for Determining the Rate of Response

1. City of Seattle (all professional staff): The Seattle Fire Department uses a 3-tiered response system that is common throughout the industry. The highest-level response, "full code," is used for any event that includes smoke, fire, or injury. The contact said he thought all collision-fire events would receive the same level of response independent of other severity factors. No further information about the nature of the event will increase the rate of response or decrease the response time. While this was apparently true for the

fire service in general, it was not clear whether the dispatch of the Paramedic units followed different procedures.

2. Twisp Fire Department (all volunteer, in the foothills of the Cascade Mountains): An experienced volunteer reported that volunteers are notified of a fire by use of a text pager. The message includes a description of the event and location. All volunteers drive first to the station to get equipment and vehicles. They are instructed to wait 10 minutes for other fire fighters before leaving. If someone arrives late, he or she radios the scene before taking a department vehicle to join the response. The contact believed that all events receive equal response rates.

3. Burlington Fire Department (combination of professional and volunteer): One of the professional staff members said that the significant factors that influence response time are time to receive notification, time for volunteers to assemble, and time to transport to the scene.

Automatic Crash Notification Industry and Researchers

Contacts were made with representatives in the Automatic Crash Notification ACN industry, and with one of the industry's research organizations. Interviews were initiated in the hope that the ACN industry may have developed values for the time from crash event to notification for comparison to the service the ACN offers. No such information was located. ComCare Alliance expressed willingness to assist with research; ATX may be willing to as well, if their major clients are supportive.

Conclusions

The available sources of quantified response time data are limited. In particular, the data reflecting the time from crash event to notification of emergency services is particularly sparse. In addition, the first responder to a specific crash event may be a police officer, fire service company, EMS company or (in some jurisdictions) a paramedic company. Individual data sources, such as most listed in Table 2, record only the arrival time of the service for whom the form is being completed and do not track whether another service was actually on scene prior to the recorded time. It has been the author's experience that any service arriving will attempt to intervene.

It is clear that insufficient data are available at this time to provide vehicle designers parameters for ideal resistance to fire propagation. Further research is still required to define the critical period of time between collision occurrence and fire suppression or occupant removal. Some potential areas of additional research include:

1) Analysis of state accident databases for estimates of the time from crash event to notification and arrival.
2) Analysis of state accident databases to determine whether response time is correlated to injury in motor vehicle fires.

3) Analysis of accident databases (not just fatal events) to identify the proportion of injuries in motor vehicle fire crashes that occur in urban and rural areas.
4) Survey research unrelated to existing databases to determine expected time from crash fire events to emergency service notification, notification to arrival of all relevant services, and time from crash to fire control or occupant safety.

References

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NFPA 1720 (2001). "Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments 2001 Edition."

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National Highway Traffic Safety Administration, "Traffic Safety Facts." 2001.

National Institutes of Health, "Staffing and Equipping EMS Systems: Rapid Identification and Treatment of Acute Myocardial Infarction," NIH Publication No. 93-3304; September 1993. http://www.nhlbi.nih.gov/health/prof/heart/mi/staffing.pdf

Roche, K., "Phoenix Fire Department Survey." 2000.

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Appendix A: Dialog Database Files Searched

File 63: Transportation Research Information Services (TRIS)
Records contain bibliographic citations and abstracts of published articles and reports, or summaries of ongoing or recently completed research projects, state and federal government reports, conference proceedings, and monographs relevant to the planning, development, operation, and performance of transportation systems and their components. TRIS provides international coverage.

File 6: National Technical Information Service (NTIS)
Provides summaries of U.S. Government-sponsored research, development, and engineering, plus analyses prepared by federal agencies. Additionally, some state and local government agencies contribute summaries of their reports to the database.
NTIS also provides access to the results of government-sponsored research and development from countries outside the U.S.

File 49: PAIS International
Public Affairs Information Services covers the social sciences, with emphasis on contemporary public issues and the making and evaluating of public policy. International coverage is provided.

File 149: Gale Group Health & Wellness Database
A comprehensive periodical and reference database providing broad coverage in the areas of health, medicine, fitness, and nutrition. Includes both consumer health magazines and professional medical journals.

File 155: Medline
Produced by the U.S. National Library of Medicine (NLM). It is one of the major sources for biomedical literature, including emergency medical services.

File 5: Biosis Previews
Provides worldwide coverage of research in the biological and biomedical sciences.

File 434: Scisearch (Science Citation Index)
An international, multidisciplinary index to the literature of science, technology, biomedicine, and related disciplines.

File 73: Embase
More medical literature.

Appendix B: Excepted Standards, Regulations and Industry Guidelines

Healthy People, (managed by) Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services
http://www.healthypeople.gov/document/HTML/Volume1/01Access.htm#_Toc489432817

> 1-11. (Developmental) Increase the Proportion of Persons Who Have Access To Rapidly Responding Prehospital Emergency Medical Services.
>
> "The outcome of many medical emergencies depends on the prompt availability of appropriately trained and properly equipped prehospital emergency medical care providers. In urban areas, this capability is defined by an interval of less than 5 minutes from the time an emergency call is placed to arrival on the scene for at least 90 percent of first-responder emergency medical services and less than 8 minutes for at least 90 percent of transporting EMS. In rural areas, this capability is defined as an interval of less than 10 minutes from the time an emergency call is placed to arrival on the scene for at least 80 percent of EMS responses."

National Institutes of Health, "Staffing and Equipping EMS Systems: Rapid Identification and Treatment of Acute Myocardial Infarction," NIH Publication No. 93-3304; September 1993. http://www.nhlbi.nih.gov/health/prof/heart/mi/staffing.pdf

> There needs to be sufficient first-responder units deployed in the community at all times to ensure a rapid response to all life-threatening calls. As a rule of thumb, a first responder should arrive at the scene less than 5 minutes from the time of dispatch in 90 percent of all such calls. This will generally result in a median first-responder response time of 2 to 3 minutes.

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:

5.2.3 Deployment.

5.2.3.1.1 The fire department's fire suppression resources shall be deployed to provide for the arrival of an engine company within a 4-minute response time and/or the initial full alarm assignment within an 8-minute response time to 90 percent of the incidents as established in Chapter 4.

NFPA 1720 Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Volunteer Fire Departments 2001 Edition

Chapter 4 Organization, Operation and Deployment.

4.1.1 The authority having jurisdiction shall promulgate the fire department's organizational, operational, and deployment procedures by issuing written administrative regulations, standard operating procedures, and departmental orders.

4.2.2.1 Upon assembling the necessary resources at the emergency scene, the fire department shall have the capability to safely initiate an initial attack within two minutes 90 percent of the time.

NFPA 450 (Draft Proposal) Guide for Emergency Medical Services and Systems
http://www.nfpa.org/PDF/450_draft.pdf?src=nfpa

5.6.5.3 First Response. The community should establish response times for first responders that are appropriate for that community. Those standards should be suitable for the local demographics, resources, medical need, and geography. The times should be systematically monitored for compliance with that local standard.

California guidelines were taken from Brodsky and Hakkert, 1983.

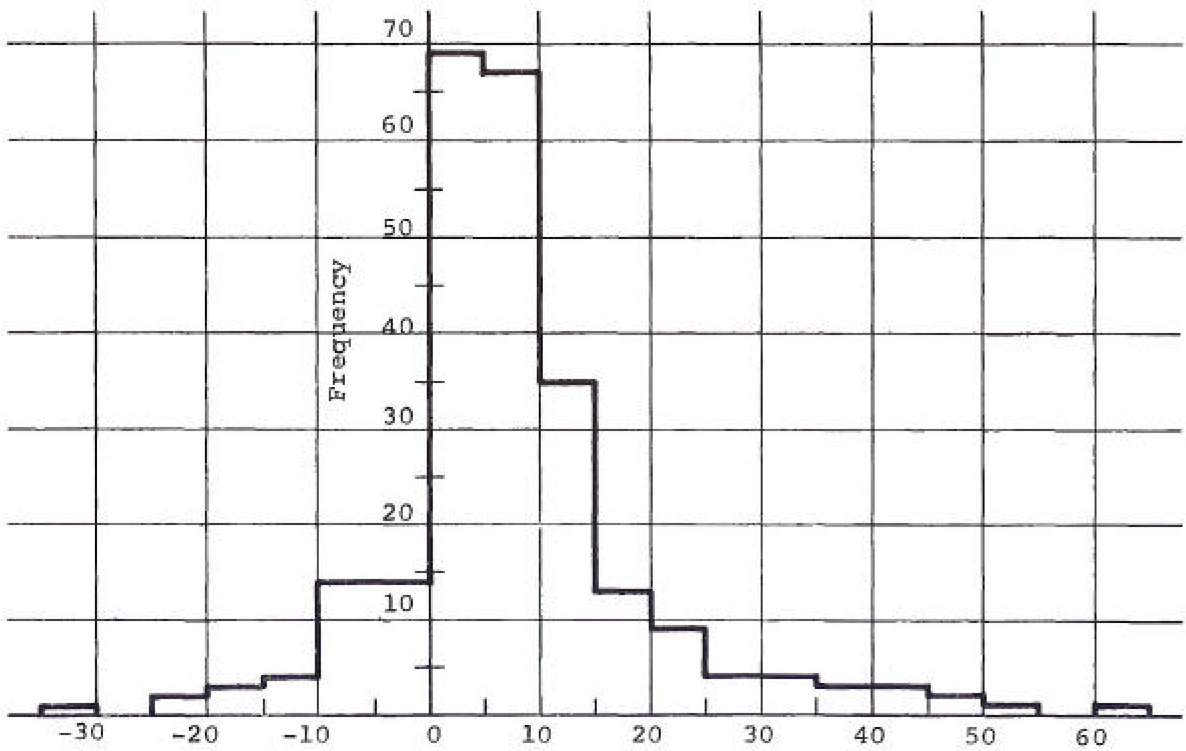
Appendix C: Available Response Time Values

Excerpt from The Mayor's Committee for Community Renewal, 1970. "Emergency Medical Services for an Urban Area," page 212.

<u>Notification Delay from Accident Reports</u>

FIGURE 9 - 1

DISTRIBUTION OF NOTIFICATION DELAY



Time from Accident to Call into IMPACT
Center in Minutes

Time from Notification to Arrival

Excerpt from Tessmer, J, 1996. "Rural and Urban Crashes – A Comparative Analysis."

Probability of EMS Arrival

The cumulative distributions, of the length of time from the notification of a fatal crash to the arrival of the emergency medical services (EMS), for both the rural and urban areas, appear in Exhibits 14 and 15. The data represent fatal crashes for the period 1975 to 1993. The time required for EMS services to respond to a rural fatal crash tend to be somewhat longer than for an urban fatal crash. In approximately 57 percent of the rural fatal crashes the time for the emergency medical services to arrive, once they have been notified, is not more than 10 minutes. Likewise, for approximately 88 percent of the urban fatal crashes, the time for the emergency medical services to arrive, once they have been notified, is not more than 10 minutes. The largest difference between rural and urban areas in the arrival of EMS occurs for times of 10 minutes and less.

Exhibit 14
Cumulative EMS Arrival Time Distribution, Maximum Minutes 1975 - 1993

		RURAL		
TIME	COUNT	LOWER	PERCENT	UPPER
MINUTES		LIMIT		LIMIT
10	122886	57.44%	57.65%	57.86%
20	189654	88.83%	88.97%	89.10%
30	205320	96.24%	96.32%	96.40%
40	209767	98.35%	98.40%	98.45%
50	211524	99.19%	99.23%	99.26%
60	212274	99.55%	99.58%	99.60%
61+	213175	100.00%	100.00%	100.00%
		URBAN		
TIME	COUNT	LOWER	PERCENT	UPPER
MINUTES		LIMIT		LIMIT
10	107159	88.14%	88.28%	88.42%
20	118689	97.71%	97.78%	97.84%
30	120339	99.10%	99.14%	99.18%
40	120846	99.53%	99.55%	99.58%
50	121048	99.70%	99.72%	99.74%
60	121173	99.81%	99.82%	99.84%
61+	121387	100.00%	100.00%	100.00%

Excerpt from "Reducing Highway Deaths and Disabilities with Automatic Wireless Transmission of Serious Injury Probability Ratings from Crash Recorders to Emergency Medical Services Providers," Champion, et al.

Table 1 lists the ***average*** time intervals experienced in fatal crashes in the U.S. in 1997 [13].

Table 1. Average Elapsed Times in Fatal Crashes in 1997 (Minutes)

Time Intervals	***Urban***	***% Unknown***	***Rural***	***% Unknown***
1. Crash to EMS Notification	4	48	7	35
2. EMS Notification to Scene	6	49	11	34
3. Scene Arrival to Hospital	26	72	36	67
4. Crash to Hospital Arrival	35	72	52	68

http://www.nhtsa.dot.gov/cars/problems/studies/acns/champion.htm

Excerpt from "Traffic Safety Facts," 2001

Table 26
Fatal Crashes by Emergency Medical Services (EMS) Response Times Within Designated Minutes and by Land Use

Response Time (Minutes)	Time of Crash to EMS Notification		EMS Notification to EMS Arrival		EMS Arrival at Scene to Hospital Arrival		Time of Crash to Hospital Arrival	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Rural Fatal Crashes								
0 to 10	10,460	81.7	7,039	53.6	156	2.7	27	0.5
11 to 20	1,599	12.5	4,611	35.1	1,136	19.8	188	3.4
21 to 30	352	2.7	1,004	7.7	1,375	23.9	650	11.7
31 to 40	131	1.0	300	2.3	1,132	19.7	1,118	20.1
41 to 50	84	0.7	100	0.8	788	13.7	1,187	21.4
51 to 60	57	0.4	26	0.2	448	7.8	878	15.8
61 to 120	123	1.0	43	0.3	709	12.3	1,509	27.2
Total*	**12,806**	**100.0**	**13,123**	**100.0**	**5,744**	**100.0**	**5,557**	**100.0**
Urban Fatal Crashes								
0 to 10	6,346	93.8	5,638	87.2	182	6.1	33	1.1
11 to 20	266	3.9	679	10.5	996	33.2	435	14.7
21 to 30	73	1.1	105	1.6	910	30.3	908	30.6
31 to 40	25	0.4	21	0.3	491	16.4	738	24.9
41 to 50	20	0.3	12	0.2	211	7.0	414	13.9
51 to 60	14	0.2	6	0.1	97	3.2	213	7.2
61 to 120	19	0.3	8	0.1	115	3.8	227	7.6
Total*	**6,763**	**100.0**	**6,469**	**100.0**	**3,002**	**100.0**	**2,968**	**100.0**

*Includes crashes for which both times were known.

Summary Statistics

CA NFIRS Data

Years	Counts	Average (min)	Stand Dev (min)	Max (min)	Median (min)	% < 7 min
2000	1176	5.1	3.83	43	5	80%
2001	2288	5.3	4.04	50	5	77%
2002	2822	5.4	4.10	57	5	75%
2003	959	5.3	4.17	49	5	77%

Analysis by LES, data received from the California Fire Marshal’s Office

2000 PHOENIX FIRE DEPARTMENT SURVEY RESULTS (Excerpt)

AVERAGE RESPONSE TIME:

This table contains the average response times (call receipt at the fire station until arrival on-scene) for; First Arriving Unit, Total Alarm Assignment, First Unit Objective (response time goal) and Percentage Met, Ladder Objective and Percentage Met, Ambulance Objective and Percentage Met, (Fire) Chief Objective and Percentage Met.

POPULATION	FIRST UNIT	TOTAL ALARM	FIRST UNIT OBJ.	FIRST UNIT % MET	LADDER OBJ.	LADDER % MET	AMBO OBJ.	AMBO % MET	CHIEF OBJ.	CHIEF % MET
0 - 99,999	4:05	5:41	4:09	85%	4:52	85%	6:06	82%	5:37	86%
100,000 -499,999	4:29	6:52	4:41	78%	6:57	91%	7:51	85%	6:13	84%
500,000 -999,999	4:42	6:40	5:36	73%	6:45	72%	6:31	63%	6:15	84%
1,000,000+	4:43	8:05	4:37	69%	7:00	81%	8:30	88%	7:20	78%
ALL US CITIES	4:19	6:18	4:30	80%	6:28	87%	6:24	83%	5:56	85%
CANADA	4:00	6:00	4:52	84%	6:52	91%	6:14	80%	8:00	93%

Appendix D: Urban – Rural Differences in Injury Outcomes

Excerpt from "Rural and Urban Crashes," August 1996, Joseph M. Tessmer (Continued on next page)

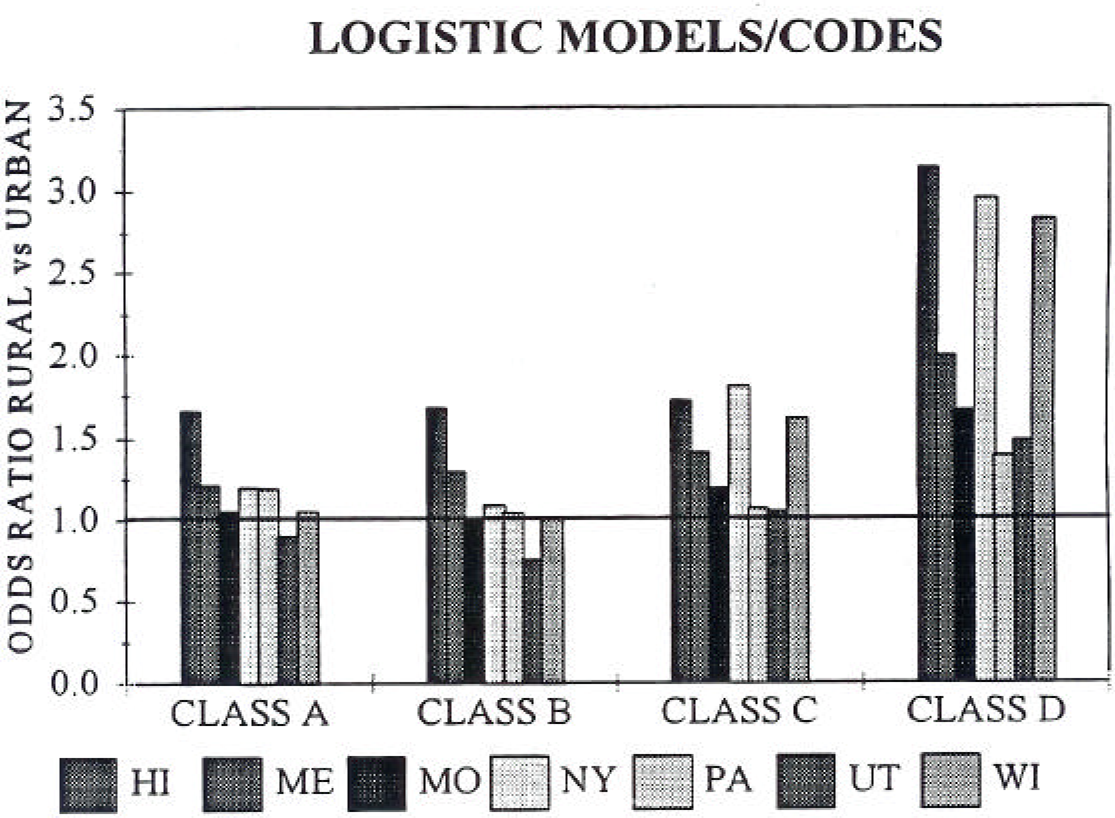
Estimating Statistical Models Using CODES Data

An empirical statistical model may prove useful in approximating a response, e.g., as an injury or death, over a limited range of available variables. Such a model, by separating the effects of the input variables, in particular the rural/urban location variable, and permits one to examine the net effect of location on injuries, while holding all other variables in the model constant. Four models were estimated to examine the effects of a rural location of the crash vs. an urban location of the crash, on injury levels.

The results of the modeling effort are expressed in terms of the odds ratio denoted by Ψ. The odds ratio, Ψ, is the quotient of the odds, i.e., the odds ratio of the odds 10 to 1 is 10/1 = 10.0. The odds ratio of 2 to 5 is 2/5 = 0.4. For these data, an odds ratio of 2, for example, would interpreted as a fatality is twice as likely to occur in a rural crash than in an urban crash. The percentage increase/decrease is defined by the equation (odds ratio - 1) * 100. If the odds ratio of an independent variable is 1, then the dependent variable is not sensitive to changes of the independent variable. The closer an odds ratio is to 1 (using a multiplicative scale; the logarithm of the scale is a conventional metric) the less sensitive the dependent variable is to changes in the independent variable. To obtain the odds ratio, one exponentiates the estimated model coefficient, denoted by beta, i.e., $\Psi = e^{\beta}$, (i.e., the estimated change in the log of the odds ratio).

Four classes of injuries were examined: Class A contrasts any injury with no injury, Class B contrasts transported injuries with no injuries or slight injuries, Class C contrasts hospitalized injuries or deaths with non transported individuals, Class D contrasts deaths with survivors. The results appear in Exhibit 137. The data for Class D show that an individual involved in a crash is up to 3 times as likely to die in a rural crash (using data from Hawaii, New York and Wisconsin) than in an urban crash.

Exhibit 137



(Note: Color copy not available. Legend believed to be in the same order as the bars on the graph)