Emergency Medical System Delivery

Analysis of System Performance and Recommendation to Improve Service

FINAL (10/23/2007)

1) Introduction

During the August 21, 2007 meeting among City and County staff and stakeholders, a motion was made to form a subcommittee to analyze the City's emergency medical system (EMS) performance relative to a recommended standard and develop options to address any deficiencies found. The committee is composed of Chief Charles Werner (CFD), Chief Dayton Haugh (CARS), and Chief Dan Eggleston (ACFR). The following report is the result of the committee's work.

2) Problem Definition

Over the past year, several responders have reported that during some emergency medical events, the ambulance dispatched to the scene often has a prolonged response. The delay in the ambulance response results in a delay in transporting the patient to the hospital. The concern is that the delay in transport could negatively affect patient outcome.

Staff and stakeholders have reviewed the response time data to help qualify the responders' concerns. However, a review of the data led to a significant debate about how to gauge the system's performance. The problem is that no uniform response time standards or key performance indicators exist to aide in evaluating system performance to further define gaps in service. Valid system enhancements cannot be determined without first identifying gaps in service.

This report will:

a) Recommend an EMS response time standard and key performance indicators.
b) Compare the system's performance against the recommended standard to define gaps in service.
c) Develop various recommendations to address gaps in service.

3) Problem Analysis

a) Current Delivery Model

Emergency medical services are provided to the City of Charlottesville in a tiered fashion through a combination of career and volunteer resources. The Charlottesville Fire Department deploys primarily basic life support first response resources out of three fire stations strategically located throughout the City. The goal of a first response resource is to quickly arrive on scene at high priority calls (usually dispatch priority 1 and 2) and provide life saving care until the transport unit arrives..

For lower priority calls (dispatch priority 3), basic life support, emergency medical transport and advanced life support services are provided by CARS. CARS is the primary provider of all three components within the City of Charlottesville. CARS operates out of a primary station on McIntire Road. On average, CARS strives to staff three ambulances on a daily basis with supplementary staffing assistance provided by Albemarle County. The goal of the transport agency (i.e. – CARS) is to respond to the scene and continue care started by the first response resources (if there was a first response) and continue to provide care while in route to the hospital. When required, CARS provides advanced life support care.

The tiered system model as described above is used throughout the country. The differences are that basic life support, advanced life support, and transport services are sometimes delivered by a single agency or separate agencies, volunteer, career, or a combination thereof.

b) EMS response time standards

There appears to be no “universally accepted” national standard for EMS responses. However, some historical general standards from the American Heart Association and NFPA 1710 have been adopted:

- A turnout time interval of 1 minute or less 90% of the time.
- A response time interval of 4 minutes or less for a BLS EMS unit 90% of the time.
- A response time interval of 8 minutes or less for an ALS EMS unit 90% of the time.

The American Heart Association Chain of Survival outlines actions that must be taken in order to successfully resuscitate victims in out-of-hospital cardiac arrest. The measure for EMS must be considered in two different ways.

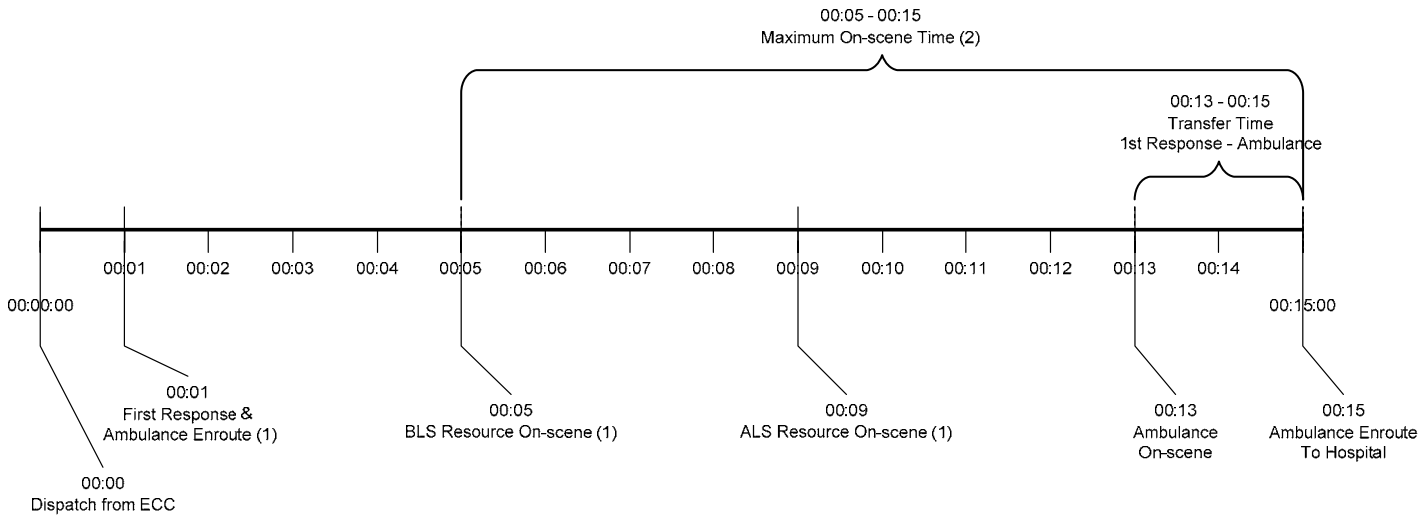
1. The first consideration is how fast basic life support can be provided to citizens who suffer from cardiac arrest. American Heart Association studies have shown that cardio-pulmonary resuscitation (CPR) must begin immediately, and in all cases no later than 4-6 minutes of a cardiac arrest. Early defibrillation (AED) must then follow early CPR. These actions must be followed up by advanced life support in order to provide advanced coronary care. The combination of late CPR (more than four minutes) and late advanced life support (more than 12 minutes) is particularly lethal. Several researchers have called these time dimensions the resuscitation “failure zone.”

2. The second consideration is early advanced life support intervention for patients that are not yet in cardiac arrest, but have a cardiac rhythm that will become lethal if not treated rapidly.

In addition, the Pre-Hospital Trauma Life Support (PHTLS) guidelines state that for life-threatening trauma type incidents, emergency medical providers should be en-route to the nearest trauma center within 10 minutes of arrival of the first responder. The PHTLS guideline is based on an analysis of trauma related incidents which are most critical when determining how quickly an ambulance should be en-route to the hospital.

When factoring in the guidelines for first response basic level care, advanced level care, and maximum time on scene, a standard for response to life-threatening incidents (dispatch priority 1 and 2) can be defined as illustrated below:

Recommended EMS Response Time Standard



(1) National Fire Protection Association. *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. Quincy, Massachusetts, United States of America; National Fire Protection Association; 2000.
(2) American College of Surgeons and Prehospital Trauma Life Support (PHTLS) International consensus standard for the optimal on-scene time for major trauma

c) Workload analysis - ambulance availability

A consulting team, Matrix Consulting Group, recently conducted a study of possible consolidation of City and County fire and rescue services. During their analysis of one year of data from the City and County system, Matrix calculated the daily ambulance staffing needs for the CARS service area that includes the City of Charlottesville and areas surrounding the City (Ivy, Stony Point, North Garden, and East Rivanna.) Matrix compared the call volume with the average time for an ambulance to process a call (dispatch to clear from hospital). The results determined that three ambulances are needed twenty-four hours a day and one ambulance is needed during peak times from 8:00 am to 8:00 pm.

Considerable review of the Matrix calculations revealed some assumptions that were not based upon historical experience, and subsequently left the fleet size recommendation in question. A review of another fire rescue study published by Tri-Data Corporation for Stafford County (VA) afforded an opportunity to apply different methods of unit hour utilization (UHU) calculation to our local historical data.

Unit-hour utilization (UHU) is often used as a primary measure of EMS unit workload. UHU is the total number of unit-minutes per hour that units are in service. There is some evidence to suggest that a UHU of approximately 0.42 represents the optimum utilization for responding to emergency calls, balancing availability, and productivity. Too far above 0.42 and personnel are arguably overworked, and the unit availability is low (i.e., often busy when a call arrives). Too far below 0.42 and the cost-effectiveness of the unit could be questioned.

Specific assumptions that were utilized in the recalculation of fleet demand included the call processing times, incidents by time of day and the mix of transport versus non-transport events that had been identified in the Matrix study. The Tri-Data study acknowledged industry consensus about the importance of fleet utilization analysis, but also recognized that interpretation of those rates as they apply to overall efficiency is “much debated.”

The result (see Appendix B for a detailed analysis), however, reaffirmed the Matrix recommendation for 3.5 staffed ambulances (per day) to meet call demand. In addition, the Tri-Data formula may be useful in projecting when future resources need to be added based upon changes in demand.

(3) City system performance relative to EMS response time standard and workload analysis

a. Response time analysis

When assessing response times, fractile time analysis is utilized because it recognizes that there will occasionally be outliers even in the best performing systems. Additionally, simple average time analysis can be distorted by a relatively small number of abnormal events (in data capture or actuality). The 90 percentile is most commonly used by fire rescue departments as a high-performance measure.

The following tables illustrate the system’s ability to meet the benchmarks defined in the standard described in the recommended EMS response time standard:

- 5 minute response time goal for a BLS first response resource on scene, 90% of the time
- 9 minute response time goal for an ALS response resource on scene, 90% of the time *
- 13 minute response time goal for an ambulance on-scene, 90% of the time

(The system does not currently capture the amount of time for an ALS resource to reach the scene. However, an assumption can be made that CARS often supplies the ALS resource on the ambulance.)*

City Responses from 5/1/2007-7/31/2007

First Response Data (City Fire)

Minutes	*Incidents*	*Cumulative %*
2	23	4.82%
3	72	19.92%
4	102	41.30%
5	112	64.78%
6	89	83.44%
7	38	91.40%
8	24	96.44%
9	6	97.69%
10	5	98.74%
More than	6	100.00%

Ambulance Response Data (CARS)

Minutes	*Incidents*	*Cumulative %*
2	10	2.10%
3	15	5.24%
4	37	13.00%
5	88	31.45%
6	103	53.04%
7	91	72.12%
8	62	85.12%
9	34	92.24%
10	18	96.02%
More than	19	100.00%

Results

(1) The recommended EMS response time standard should be considered for adoption. Performance measures should be carefully monitored on an on-going basis to determine system needs and steer improvements as required.

(2) The first response BLS resource time needs improvement. The 90 percentile was only achieved at 7 minutes for a recommended target of 5 minutes or less. Future deployment of BLS and/or ALS first responder services from the Fontaine Avenue area could result in improved EMS response times throughout the City, especially the southwest portion in particular.

(3) The system does not currently capture the amount of time for an ALS resource to reach the scene. However, if the assumption is made that CARS often supplies the ALS resource on the ambulance, ALS on scene times of 9 minutes or less was achieved 92 percent of the time. This exceeds the recommended target of 9 minutes or less 90 percent of the time.

(4) Ambulance on scene times of 9 minutes or less was achieved over 90 percent of the time. This exceeds the recommended target of 13 minutes or less 90 percent of the time.

b. Workload analysis

According to the Matrix report and analysis using TriData unit hour calculations, Charlottesville (and surrounding areas of the County currently served by CARS) needs three staffed ambulances -- twenty-four hours a day, and a peak activity unit from 8:00 am to 8:00 pm daily.

On average, CARS strives to staff three ambulances on a daily basis with some staffing assistance provided by Albemarle County. For the months of May, June, July, August and September of 2007 CARS has had a minimum of 3 ambulances staffed 24 hours a day. However, no data exist to confirm prior staffing levels.

Utilizing the methods described in the workload analysis, it is evident that fewer staffed ambulances would have a dramatic effect on availability and response time. However, review of ambulance response time data shows no current negative impact.

The addition of a staffed ambulance would lower the ambulance utilization rate for the Charlottesville area. The cost of the additional staffed ambulance should be evaluated in terms of

actual ambulance response performance (which currently meets the standard**) and the EMS system's ability to consistently maintain the necessary level of staffed ambulances.

**This assumption is based on the limited data of 5 months.

4) Option for increased transport services – (See appendix D for all options)

5) Potential Improvement to First Responder Capability

The greatest positive impact on the outcome of life-threatening EMS events resides with first responder arrival time within 5 minutes or less from the time of alarm. To accomplish this improvement, reduced response time could be achieved through use of specialized technology, greater saturation of resources and/or internal processes designed to reduce reaction times.

Technologies such as Smart Station Alerting, can reduce the interval between communication center receipt of an emergency call and the notification of on-duty station personnel. Other technologies such as Opticom Traffic Control systems, Geographic Information System(GIS)/Global Positioning System(GPS) can assist in reducing the actual response travel time. The addition of resources responding from the Fontaine Avenue area would have a positive effect on City first response time, since travel time would be reduced in certain areas and unit availability would improve. Addition and utilization of more first responder equipped vehicles for the delivery of initial emergency medical services will help improve response times. Dedicated ALS first responder coverage would provide the added benefits of a higher level of department EMS service, plus an increased ability to utilize CARS BLS staffed ambulances to meet ALS patient needs for on-scene patient treatment and continuation of care during transportation to the hospital.

An option exists for CFD first response to be increased to cover all levels of EMS calls (to include BLS dispatches). The advantages would include the potential to decrease the overall ambulance demand, since approximately 25% of all EMS calls do not require transport. This option would increase wear and tear on the fleet of fire apparatus, but may be less expensive than the personnel cost associated with adding ambulances. The effect of committing fire apparatus to first response calls more frequently would create a negative impact on fire response by reducing the available fire units needed to meet initial response apparatus and personnel to meet present National Fire Protection Association(NFPA) and Accreditation standards and need to be weighed against the level of fire suppression calls and availability of other system resources. Of the 24 structure fires recorded over the last year, fire units were tied up for 3 of the calls which exceeds the standard utilization factor. The addition of a staffed CFD ambulance helps to meet the EMS demand and reduce the burden on the fire response resources, increase medics on City engines and balance the wear and tear impact on the larger fire apparatus.

Lastly, preliminary data review suggests that turn-out time (alarm to unit responding) often exceeds two minutes. The data from the Fire Records Management System shows that City Fire's turnout time is within 1 minute 22.7% of the time and within 2.5 minutes 89.2% of the time. No turnout time data is available for CARS. There are some issues with the unit response times as times are not always captured accurately due to radio traffic. Mobile data computers would help to capture accurate response time data.

Advantages -
- Greatest patient impact on survival and patient outcome
- Better level of customer service (and potentially community perception)
- Utilizes existing resources

Disadvantages –
- Increased performance demand on existing units
- Expenses with additional equipment, training and operating costs
- May not be embraced by all personnel

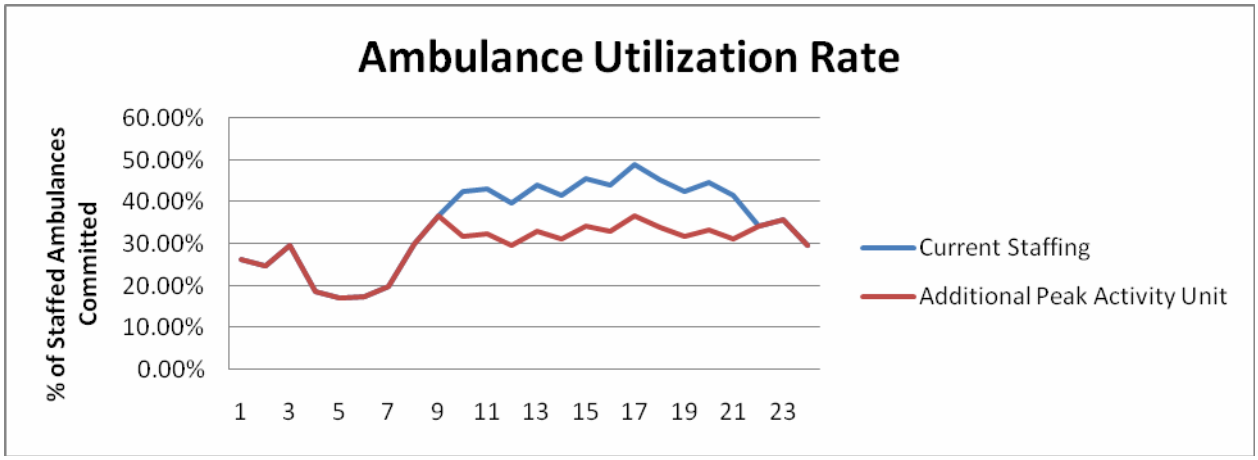
Cost –
- Variable

Appendix A - Definitions

a) ALS First Response unit – an Office of EMS ALS licensed non-transport EMS vehicle with at least one ALS provider (EMT-CT or higher), monitor/defibrillator, drug/IV box, and other required EMS supplies/equipment.
b) ALS Transport unit – an Office of EMS ALS licensed Ambulance with at least one ALS provider (EMT-CT or higher) and one BLS provider (EMT or higher), monitor/defibrillator, drug/IV box, and other required EMS supplies/equipment.
c) BLS First Response unit – an Office of EMS BLS licensed non-transport EMS vehicle with at least one BLS (First Responder or higher trained EMS provider), AED, and other required EMS supplies/equipment.
d) BLS Transport unit – an Office of EMS BLS licensed Ambulance with at least one BLS (First Responder or higher trained EMS provider) and a driver.
e) Dispatch time – the point in time at which the appropriate units/stations are notified of the emergency.
f) Turnout time interval - the interval between dispatch time and the time at which the appropriate emergency vehicle starts moving towards the emergency.
g) Unit on scene – the time at which the appropriate unit arrives on the scene of the emergency.
h) Priority 1 call – a high priority call involving a potential life threatening situation
i) Priority 2 call – a moderate priory call involving a event that could result in a life threatening situation.
j) Priority 3 call – a low priority call involving a non-life threatening event.

Appendix B – Ambulance Utilization Analysis

										Percent of Staffed Ambulances Committed		
Hour of the Day	Annual Calls Per Hour	Average Daily Calls Per Hour	# of Transports Per Hour	Average Handling Time for Transports in Minutes	# of Non-transports Per Hour	Avg Handling Time for Non-transports in Minutes	Availiable Time per Hour	Number of Staffed Amublances	Current Staffing	Number of Staffed Amublances	Additional Peak Activity Unit
0000	381	1.0	0.78287671	53.2	0.2609589	21.3	60	3	26.23%	3	26.23%
0100	359	1.0	0.73767123	53.2	0.24589041	21.3	60	3	24.71%	3	24.71%
0200	432	1.2	0.88767123	53.2	0.29589041	21.3	60	3	29.74%	3	29.74%
0300	271	0.7	0.55684932	53.2	0.18561644	21.3	60	3	18.65%	3	18.65%
0400	249	0.7	0.51164384	53.2	0.17054795	21.3	60	3	17.14%	3	17.14%
0500	255	0.7	0.5239726	53.2	0.17465753	21.3	60	3	17.55%	3	17.55%
0600	290	0.8	0.59589041	53.2	0.19863014	21.3	60	3	19.96%	3	19.96%
0700	435	1.2	0.89383562	53.2	0.29794521	21.3	60	3	29.94%	3	29.94%
0800	533	1.5	1.09520548	53.2	0.36506849	21.3	60	3	36.69%	3	36.69%
0900	618	1.7	1.26986301	53.2	0.42328767	21.3	60	3	42.54%	4	31.91%
1000	627	1.7	1.28835616	53.2	0.42945205	21.3	60	3	43.16%	4	32.37%
1100	577	1.6	1.18561644	53.2	0.39520548	21.3	60	3	39.72%	4	29.79%
1200	637	1.7	1.30890411	53.2	0.43630137	21.3	60	3	43.85%	4	32.89%
1300	605	1.7	1.24315068	53.2	0.41438356	21.3	60	3	41.65%	4	31.23%
1400	662	1.8	1.36027397	53.2	0.45342466	21.3	60	3	45.57%	4	34.18%
1500	640	1.8	1.31506849	53.2	0.43835616	21.3	60	3	44.05%	4	33.04%
1600	709	1.9	1.45684932	53.2	0.48561644	21.3	60	3	48.80%	4	36.60%
1700	656	1.8	1.34794521	53.2	0.44931507	21.3	60	3	45.16%	4	33.87%
1800	615	1.7	1.26369863	53.2	0.42123288	21.3	60	3	42.33%	4	31.75%
1900	646	1.8	1.32739726	53.2	0.44246575	21.3	60	3	44.47%	4	33.35%
2000	602	1.6	1.2369863	53.2	0.41232877	21.3	60	3	41.44%	4	31.08%
2100	498	1.4	1.02328767	53.2	0.34109589	21.3	60	3	34.28%	3	34.28%
2200	520	1.4	1.06849315	53.2	0.35616438	21.3	60	3	35.79%	3	35.79%
2300	429	1.2	0.88150685	53.2	0.29383562	21.3	60	3	29.53%	3	29.53%
									35.12%		29.68%



Annual Calls - CARS

	3 units	**3 units**	**2 units**	**4 units**	**4 units**
Total EMS Calls - CARS	12,247	14,000	12,247	12,247	19,000
Percent transport	0.75	0.75	0.75	0.75	0.75
Percent non-transport	0.25	0.25	0.25	0.25	0.25
Transport calls	9,185	10,500	9,185	9,185	14,250
Avg call handling time	53.20	53.20	53.20	53.20	53.20
	488,655	558,600	488,655	488,655	758,100
Number of non-transport	3,062	3,500	3,062	3,062	4,750
Total handling time, non transport	21.30	21.30	21.30	21.30	21.30
	65,215	74,550	65,215	65,215	101,175
Total handling time in minutes	553,871	633,150	553,871	553,871	859,275
Total handling time in hrs.	9,231	10,553	9,231	9,231	14,321
Amount of time unit was in service	8,760	8,760	8,760	8,760	8,760
time unit was in service x # of units	26,280	26,280	17,520	35,040	35,040
UHU	0.35	0.40	0.53	0.26	0.41

Appendix D –Options

- Addition of a CFD Ambulance for twenty-four hour Operations and ALS Engine Companies

  Advantages -
  - Added resource should ease ambulance utilization rate and may have a positive effect on both ALS and ambulance arrival times
  - Provides a consistent/predictable level of service
  - Increases twenty-four hour ALS medic capability on City fire engines.
  - Improves geographic placement of EMS/ALS resources in the City of Charlottesville
  - Provides reserve ambulance capacity twenty-four hour to cover unpredictable EMS surge
  - Provides the ability to strategically/dynamically position EMS unit to address peak demand
  - Provides additional EMS resources to the Charlottesville Fire Department limiting the impact on fire protection and other emergency response requirements
  - Could reduce the number a vehicles responding to ALS calls.

  Disadvantages -
  - Significant expense to improve an ambulance response time that currently meets an appropriate performance standard

  Cost -
  - $1,047,000 first year, with an annual operating cost of $579,727 as estimated by Matrix

9 FTEs

- Addition of a CFD staffed Ambulance for Peak Response Times

  Advantages -
  - Approximately 75% the cost of staffing a twenty-four hour ambulance.
  - Improved depth of ambulance service over existing level.
  - Addresses the minimum ambulance utilization needs
  - Accomplishes a geographic advantage to the southwest area of the City

  Disadvantages -
  - Logical issues associated with integration of an additional work schedule into department operations and personnel assignments.
  - Will not affect periodic surges in demands that occur outside of historic peak hours.
  - Does not build in a significant reserve ambulance capacity.
  - Does not increase the desired medic level (ALS) on City engines.

  Cost -
  - ¾ the operational cost of twenty-four hour Ambulance.
  - 6 FTEs

- Partnership with CARS

Charlottesville Albemarle Rescue Squad has a fleet of eight transport ambulances, several of which may not be staffed at any given moment. Additionally, there is a greater availability of basic EMTs than ALS providers on-duty at CARS. The most limiting factor in the deployment of medic units is ALS staffing.

If CFD entered into a partnership with CARS, the number of FTEs required to staff an additional medic unit would be reduced by 50%. This assumes one CARS volunteer EMT/Driver and one CFD ALS provider are utilized. This arrangement might also eliminate the need for the City to purchase ambulances and related equipment.

Advantages –
- Less expensive than full time CFD unit
- Could be used for peak hour coverage or continuous twenty-four hour
- This partnership model has worked successfully for Albemarle County

Disadvantages –
- Depending on location of deployment, geographic advantage (from another location within the City) may not be obtained and continues the practice of clustering of resources
- Decentralized operations and personnel identity
- Greater potential for inconsistency with assigned personnel
- Difficulting in achieving continuing education

Cost –
- 2 - 4.5 FTEs versus 4.5 – 9 FTEs
- Capital costs unlikely

- <u>Partnership with ACFR at Station 11</u>

Similar to the option with CARS, a partnership between Albemarle County Fire Rescue and CFD would result in less expenditure in both personnel and possibly equipment. Utilizing the Albemarle County Fire Rescue member assigned to Car 111 (for ALS first response), the addition of a City firefighter each shift would achieve an ALS ambulance crew. The ambulance would have to be provided by Albemarle County Fire Rescue or CFD, although initially, CARS may be willing to provide an ambulance for the first several months

Advantages –
- Less expensive than full time CFD unit
- Could be used for peak hour coverage or continuous twenty-four hour
- Greater consistency with assigned personnel likely
- Would provide better service coverage for the southern portion of the urban ring

Disadvantages –
- Decentralized operations
- Logistical issues of personnel assignments
- Difficulties in personnel management/supervision
- Resources located outside of the City of Charlottesville
- Will not improve response coverage issues on the southwest area of the City

Cost
- 2 – 4.5 FTEs versus 4.5 – 9 FTEs
- May incur capital expense associated with purchasing and equipping an ambulance

- <u>Contract with the County to Provide Peak Hour Staffing</u>

Advantages -
- Uses existing transport system provides and existing system.
- Could be staffed and operational relatively quickly.

Disadvantages -
- Will not cover southwest area of city any better than current system
- Places resources outside of the City of Charlottesville
- Creates some issues with logistical placement and decision process

Cost –

- 4 FTEs

- Take No Action

There does not appear to be an immediate deficiency with regard to length of time for an ambulance to reach the scene of a medical emergency in the City. This assumes a 90 percentile achievement of a 13 minute on scene response time is acceptable, as the recommended EMS response time standard suggests.

Advantages -
- No additional cost
- No redundancy of services

Disadvantages -
- May not meet future staffed ambulance needs
- Does not improve current first responder response time performance

Cost –
- None