CITY OF HANFORD
FIRE DEPARTMENT

GEORGE P. MORRIS, FIRE CHIEF

HEADQUARTER STATION

January 21, 1999

TO: City Manager/City Council

FROM: George P. Morris, Fire Chief

SUBJECT: **FIRE STANDARDS OF COVER ANALYSIS**

RECOMMENDATION

As directed by Council and in accordance with established objectives, staff has conducted an evaluation of our emergency response capabilities within our existing and future service areas. The methodology for this study includes an analysis of Hanford Fire Department data and the use of a Standards of Cover process model adopted and instructed at the California State Fire Academy. This report addresses the following issues: performance goals, risk assessment, service level objectives, distribution and concentration of resources, response reliability and past performance indicators. Staff is proposing the following for Council consideration:

- ✓ To adopt the proposed Standards of Cover as a component of our Master Plan.
- ✓ Enhance staffing to meet service level objectives.
- ✓ Add an additional station to meet distribution and concentration needs.

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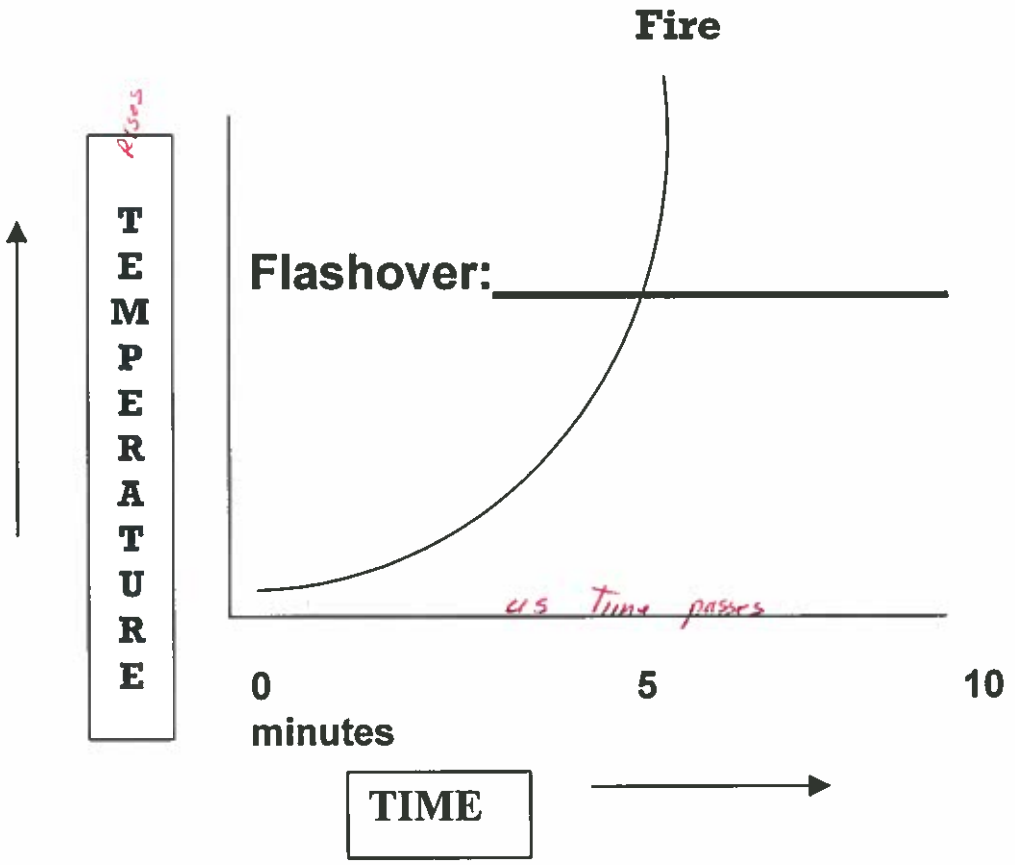
FIRE CONTROL DYNAMICS AND PERFORMANCE GOALS:

In order to determine a time frame of effectiveness, it's beneficial to have some understanding of fire control dynamics. The key for controlling the variation in fire dynamics lies in finding a common reference point; something that is common to all fires regardless of the type of building, fire load or time the fire has burned. Fortunately, such a reference point exists. Regardless of the speed of growth or length of burn time, all fires go through the same stages of growth. One particular stage emerges as a very significant one because it marks a critical change in conditions in terms of strategy tactics and necessary resources. This stage is referred to as *flashover*. Realistically, fire companies must arrive prior to this in order to engage in rescue operations or effectively limit property damage. When flashover occurs, everything in the room breaks into open flame at once. This instantaneous eruption into flame generates a tremendous amount of heat, smoke and pressure with enough force to extend beyond the room of origin through doors and windows. The combustion process then speeds up because it has an even greater amount of heat to move to unburned objects.

Measuring the time to flashover is a function of time and temperature. Fire growth occurs exponentially, that is, fire doubles itself every second of free burn that is allowed. We can illustrate this on what is known as the time and temperature curve.



Flashover is a critical stage of fire growth for two reasons. First, it's highly unlikely that any living thing in the room of origin will survive, so the chance of saving lives drops dramatically. Secondly, flashover creates a quantum jump in the rate of combustion requiring a significantly greater amount of water to reduce the burning material below its ignition temperature. In other words, a fire that has reached the stage of flashover means it's too late to save anyone in the room of origin and substantially more staffing is required to handle the larger hose streams needed to extinguish the fire. A post- flashover fire burns hotter and moves faster, making search and rescue almost impossible in the remainder of the structure. Flashover can occur from four to ten minutes after free burning starts.

EMERGENCY MEDICAL SERVICES PERFORMANCE GOALS:

Similar to fire flashover, EMS uses a critical point in time around which to deploy resources. This point in time is that of brain death. When breathing and/or circulation stops, the brain starts to die in four to six minutes without oxygen. Brain damage is usually irreversible after ten-minutes. The American Heart Association and American Medical Association have established a guideline of eight-minutes or less for advanced life support to arrive and commence emergency care following cardiac arrest. Unless advanced life support care arrives within that time, the chances of a patient surviving are minimal.

Restate the Performance Goals - Fire / EMS

TOTAL REFLEX TIME MEASURES:

If we are to design and plan effective response around the bench mark times of flashover and brain death, the measure of time needs to be defined and fully understood. In an emergency there are many components of time to consider. Ignition point, heart cessation, reporting the emergency – 911, dispatch, turnout time, travel time and set up time. The cumulative totals of all these steps are referred to a total reflex time. We must plan a system that places effective resources on scene within the timeframes set forth in our performance goals while taking into account all the steps necessary. These times or steps can be graphically portrayed in a time line format. While we continue to attempt to shorten each of these steps, some are difficult to impact and others are impossible to control.

Total Reflex Time in Minutes (cumulative)

1	2	3	4	5	6	7
Fire Incident or Medical Emergency	**Detection**	**Report & Dispatch**	**Turnout**	**Travel**	**Set-up**	**Take Action**
Time Per Step	**:30**	**1:00**	**1:00**	**4:00**	**1:00**	**2:00**
Time Cumulative	**:30**	**1:30**	**2:30**	**6:30**	**7:30**	**9:30**
Fire *Incident Progression*	**Smoke Smell**	**Free Burn**	**Fire Intensifies**	**Flashover**	**Fire Extends Beyond Room**	**Contain**
EMS	**Injury/Symptom**	**Condition Degrades**	**Cardiac Arrest**	**Brain Death Begins**	**Chances of Survival Reduce**	**Resuscitate & Transport**

the point here is that because Time passes that we can't control. We need distribute our resources in a way that reduces over all response time so we can still achieve our Performance Goals

RISK ASSESSMENT:

The Hanford Fire Department responded to 2,486 calls for service in FY98 compared to 2,182 calls in FY97, an increase of 13.9%. This increase in responses is a result of continued growth throughout the city but predominately to the north and west. Based on assumptions extracted from the General Plan, it's estimated that the population will increase by an average of 1,065 people per year over the next five years. Seventy per cent of this population will live in single family dwellings and 30% in multi-family dwellings. This will result in the annual average construction of 262 single-family units and 127 multi-family units per year. Also, the industrial and commercial areas are expected to expand accordingly, resulting in increased business and visitor traffic. This anticipated increase in population, additional structures and increased traffic will add to an already heavy emergency workload for the existing stations and staff.

RISK PLANNING:

Risk planning takes into account fire potential, life hazards and economic impact to the community. Staff has separated Hanford's fire risk into the following categories:

High Hazards

- Large warehouses, industrial facilities, hospitals, schools, assembly buildings, downtown, The Mall and government offices. The majority of these facilities are located in the Industrial Park, central Hanford area and the West Lacey corridor connecting to The Mall and Wal-Mart complexes.

Impact on Community

Fires occurring in facilities categorized as *high hazards* can result in a variety of adverse impacts on the community, particularly the risk of multiple life losses. Fires in industrial and large commercial facilities often result in serious economic impact to the community – loss of tax revenues, loss of business and loss of jobs. Fires in government buildings present substantial life loss risk, the potential loss of essential records and the loss or delay of governmental services to the community. Churches, schools and public buildings are a frequent target for arsonists.

Typical Hazards

- Residential – single-family and multi-family occupancies, strip malls and small businesses. This category is widely distributed throughout the city and makes up the majority of the risk for the Hanford area.

Impact on Community

Single family and multi-family dwellings present primarily a life loss risk. In the United States, approximately 80% of the fire fatalities and 65% of fire injuries occur in residential occupancies. Although most residential occupancies are covered by fire insurance, losses often far exceed fire insurance coverage. example Leland fire

Fires in small commercial occupancies present a risk of economic loss to the community, the proprietor and the tenant. Losses can impact other inter-dependent commercial occupancies as a result of being temporarily or permanently closed. The United States Small Business Administration has identified a high rate of business failures as a result of moderate to severe fire damage. Again, fire insurance does not always prevent serious financial losses when fires occur. Janitor Service Hong kong example

Next Category

Low Hazards

- Isolated single-family dwellings and out buildings. These hazards are interspersed throughout the city but are more common to the east of 10th Avenue and in the south central portion of the city.

Impact on Community

These structures present primarily a life loss risk. Fire losses associated with these properties often exceed the amount of insurance coverage.

List

Special Hazards

- Include the airport, freeways, highways and railways.

Impact on Community

The primary risk related to airport operations is aviation crashes on and off the airport facility. Since scheduled air carrier service is not operated in Hanford, certain FAA fire protection requirements do not apply. We will not have to staff a station at the airport

Highways 198 and 43 present the risk of potential incidents involving substantial volumes of flammable liquids, pesticides, explosives and other hazardous materials. Emergency services are provided by the Hanford Fire Department to incidents that occur on highways within the city limits.

Railroads transport the widest variety of hazardous materials of any ground transport system. These materials are frequently transported in large quantities in individual freight or tank cars. 26 Trains per day

Incidents involving rail vehicles can be caused by a variety of reasons and can pose a significant threat to life and environment.

Trains travelling through or switching cars within the city can block emergency response routes and cause significant delays for responding units.

Distribution Concentration

Snap shot of our battlegrou and what the potential impac can be if were unable to achieve our performance goal

SERVICE LEVEL OBJECTIVES:

With the various risk categories defined, our next step is to identify service level objectives for each category.

our definition

An effective response force is one that can respond within the established response time standards with sufficient staffing and equipment to combat emergencies in all identified risk categories. Considering that no fire department can hold risk to zero, this study's objective is to find a balance between distribution, concentration and reliability that will keep risk at a reasonable level and at the same time yield the maximum savings of life and property at the least cost.

An assessment of crew capabilities, deployed in a manner to become an effective response force was conducted. Staff concluded the following critical tasks, response times and fire flow capabilities are necessary to provide adequate protection for each risk type identified. Fire flow, (gallons of water per minute from fire fighting streams, calculated for buildings based on fire load) is a standard method used to determine the number of hose lines, apparatus and personnel necessary to mitigate a fire in a particular building. example single family dwelling

Based on our this analysis, the minimum levels of resources needed to stop the escalation of an emergency in each risk type were established. If fewer firefighters and/or apparatus are available, or if their response is delayed, then the critical tasks cannot be effected simultaneously and the community may suffer greater losses.

the Charts on pages 8-9 & 10

The following charts illustrate the service level objectives for three of the four risk categories. Staff believes that it is not, at this point, practical to develop service level objectives for special hazards.

Critical Tasks Necessary at a Low-Risk Structure Fire (i.e. Isolated Residential Occupancy)

Tasks	Number of Firefighters
Fire Attack/Search & Rescue (1 hose line)	2
2 In 2 Out Rapid Intervention Team (1 hose line)	2
Pump Operation/Water Supply	1
Ventilation/Salvage	2
Utilities/Safety/Initial Command	1
Command/Accountability	1
Total	**9**

Paid staff supplemented with volunteer staff

identifies the

Critical Tasks Necessary at a Typical-Risk Structure Fire (i.e. Residential Occupancy) Small Business, Single & Multi-Family

Tasks	Number of Firefighters
Fire Attack/Search & Rescue (1 hose line)	2
2 In 2 Out Rapid Intervention Team (1 hose line)	2
Pump Operation/Water Supply	1
Ventilation — more difficult if commercial or multi family	2
Utilities/Safety/Initial Command	1
Exposure Protection — The house next door	2
Salvage	2
Command/Accountability/Staging/Rehab	2
Total	**14**

Paid staff supplemented with volunteer staff

More Command Staff

Critical Tasks Necessary at a High-Risk Structure Fire Industrial Facility, Hospitals, Mall & Downtown Business Area

Tasks	Number of Firefighters
Support Standpipe and/or Sprinkler System	1
Initial Fire Attack (1st hose line)	2
Pump Operation/Water Supply	1
Rapid Intervention Team	2
Initial Command-Utilities	1
Assist with Fire Attack (2nd hose line) 1 RIT ok if same entrance used	2
Search/Rescue/Evacuation due to multiple floors	3
Ventilation	2
Salvage	2
Command/Accountability First arriving chief officer	1
Exposure Protection	2
Division Commanders / operations / Span of control example. hospital operations on each floor	2
Safety	1
Logistics	1
Staging/Rehab	3
Total	**26**

Paid staff supplemented with volunteer staff and mutual-aid from nearby agencies

Any questions about Hazard Categories and Critical ?

Along with assessing critical tasks, staff evaluated time and performance expectations for each risk type based on fire flow and travel time requirements. The following guidelines are recommended as a **Standard of Cover for the city of Hanford**. This includes placing a first due unit on scene within 4 minutes total travel time for 90% of fire and medical emergencies. The first due unit shall be capable of advancing the first attack line for fire control, starting rescue or providing life support for medical incidents. The following chart illustrates the time and performance expectations proposed by staff for the city of Hanford.

Proposed Time and Performance Standards in the City of Hanford

Travel Time
Engine Company Due in Minutes

Explain

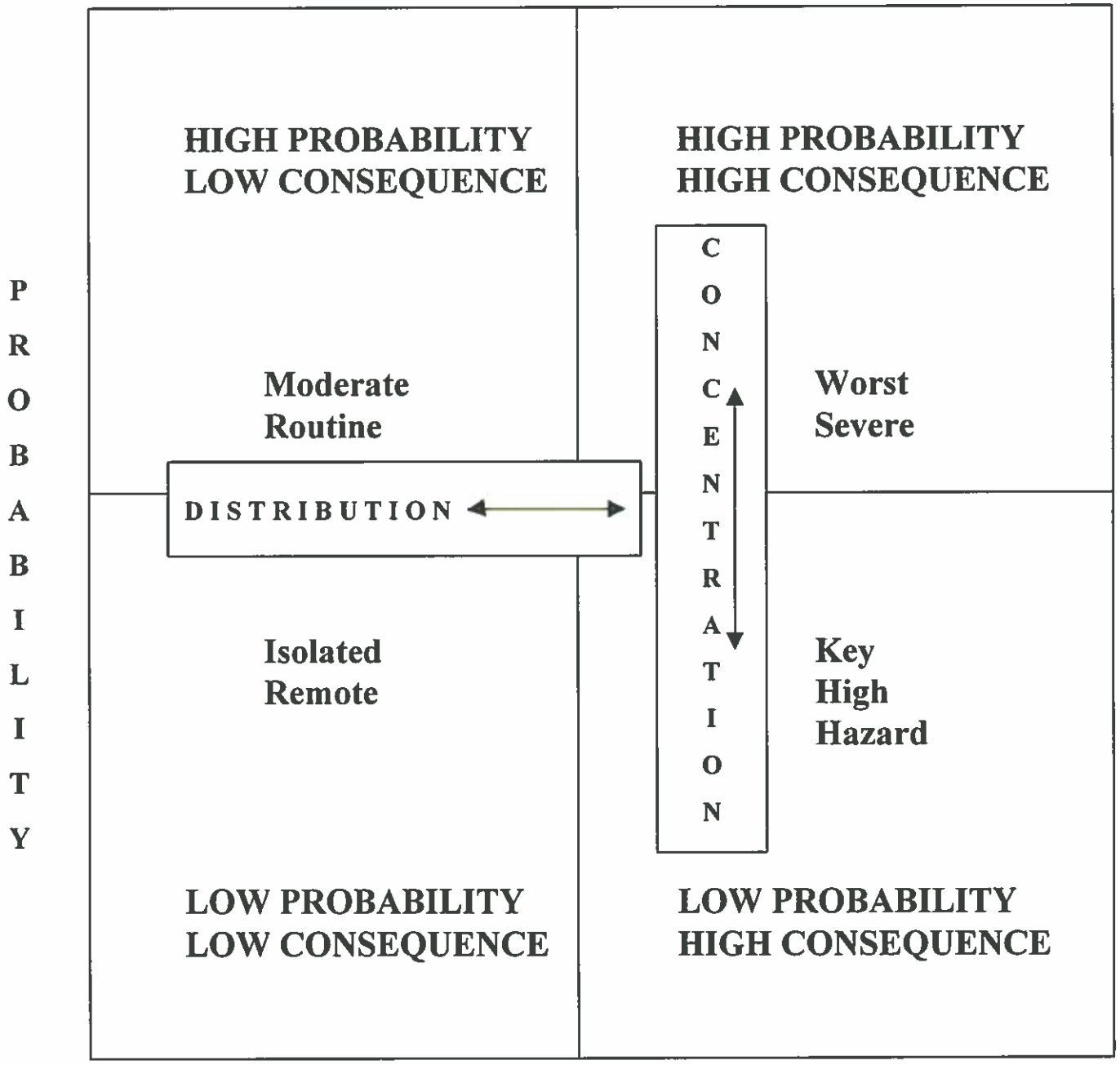
Risk Type	Fire Flow GPM	# of Companies	1st	2nd	3rd
High Hazard	1500-4500	4 - 10 (3 person company)	4	6	10
Typical Hazard	500-1500	2 – 4	4	6	10
Low Hazard	<500	1 – 3	4	6	10
Special Hazard	As Needed				

all the issues were covered to this point ~~support~~ (Performance goals) (Risk Assessi (Impact on Community) (Service Level Objectives all support the concept of

ANALYSIS:

Distribution and *Concentration* of Resources

The following matrix shows how we can deploy resources based on the probability and consequences of risk. We tend to *distribute* stations fairly evenly throughout communities for every day routine events. It is also important to *concentrate* stations close enough together so those major emergencies can receive sufficient resources within accepted benchmark timeframes.



CONSEQUENCES

- **Distribution is an equity issue between neighborhoods**
- **Concentration is a risk/cost issue *and* both are variables**
- **Increased risk = Increased concentration**

- Want to provide the same level of service throughout the community

the closer you get to the outside perimeter more calls exceed 5 min

Staff reviewed response data on selected areas within each station's district and also conducted actual response simulations, to determine geographical response capability for existing and future station locations. Staff has concluded that with our existing station locations and staffing, we can place the first due engine on scene within the established benchmark timeframes for the vast majority of the existing dwellings and structures providing a unit is available and in position at time of request. This capability will surely diminish as the city builds out. However, with our existing response force there are two glaring weaknesses. (1) The ability to place a second due engine at scene within the established performance expectations. This is critical particularly in light of the recently enacted OSHA Two In Two Out rule. The delay of adequate resources can certainly result in increased property damage and potentially the loss of lives. (2) Our existing station distribution does not provide for adequate coverage when the first due unit is committed. As an example, if Station #1 is committed to an incident and a second incident occurs in that district, Station #2 will in most cases have a travel time exceeding six minutes.

show map #4

Explain committed call At shop Training

Example reload time E-15 & E-21 left station same E-21 on scene 5 min after E-15

RESPONSE RELIABILITY

135 calls

Reliability is a measure of how often multiple incidents occur within a fire district. This is referred to as "*call stacking*". Our study revealed that during calendar year 1998 our first due unit was not available for response 4.8% of the time. As our population increases and incidents escalate, it is staff's opinion that this percentage will increase accordingly and diminish our ability to meet our response objectives for first due units. This measure of call stacking shows the importance of second and third due station distribution. If stations are too far apart, the second available unit cannot effectively cover when the first due unit is committed.

PERFORMANCE INDICATORS

The Hanford Fire Department's response objective in the 1991 Master Plan Up-date recommends we maintain the capability to respond to 90% of all emergencies within 5 minutes. This 5-minute objective includes turnout time and travel time. In other words from the time we are notified until we arrive at scene. The following chart illustrates the gradual decline in our ability to meet this objective.

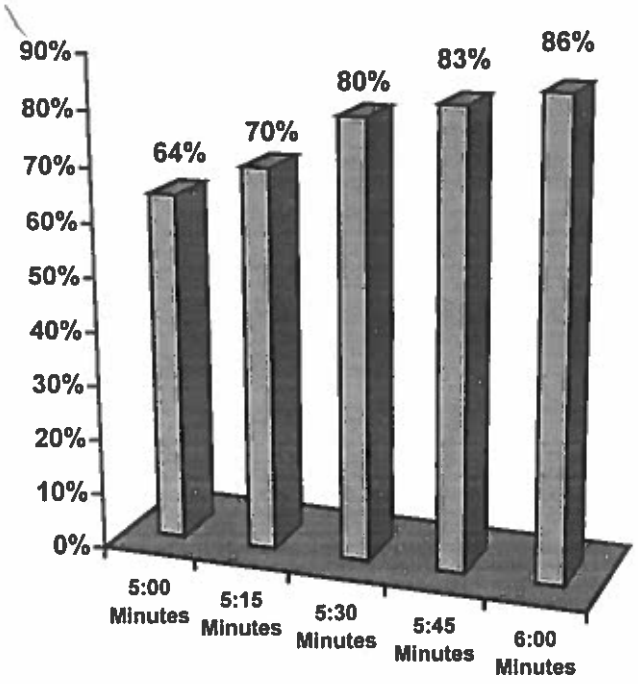
RESPONSE TIME
Including Turnout Time

Calendar Year	Percent of Responses < 5 minutes*	Total Number of Responses
1990	84%	1,258
1991	84%	934 explain
1992	86%	1,332
1993	82%	1,462
1994	78%	1,721
1995	76%	2,149
1996	71%	2,051
1997	**76%**	**2,324**

***In whole minutes**

It's important to note that these response percentages are categorized in whole minutes and can be somewhat misleading. Staff attempted to clarify this raw data in order to determine more accurately what our actual response performance indicates. Because calls have been separated into whole minute categories, a 5-minute response could be anywhere from 5 minutes to 5 minutes and 59 seconds. If you only consider calls of less than 5-minutes, our percentage drops from 76% to 64%. The following graph illustrates our response performance in minutes and seconds with corresponding percentages.

1997 RESPONSE PERFORMANCE



we arrive at 86% of calls within 6 min

the point is that our ability to meet our response time objective is diminishing

Our incident distribution maps indicate that an increasing number of incidents are occurring outside our geographic response capability area. The percentage of incidents occurring outside our estimated 5-minute response perimeters has increased from 7.8% in 1995 to 9% in 1997. Approximately 65% of these calls occur in the areas west of our existing response diamonds. Also because of Traffic congestion many of the calls at the outer edge of the perimeter are taking + 5 min

RECOMMENDATION

Considering the previously discussed benchmark points of flashover and brain death along with the unavoidable reflex time involved in emergency responses, it is staff's recommendation that we endeavor to maintain a response capability that places the first due unit at scene within 5-minutes 90% of the time consistent with our Master Plan objective. Additionally, staff recommends that we modify our existing Master Plan to include the proposed Standards of Cover identified in the service levels objective portion of this report. That is, to maintain or achieve the capability to place first, second and third due units at the scene within the established travel time service level objectives of four, six and ten minutes respectively. In order to accomplish this objective, we need to increase our minimum staffing levels and improve our existing distribution and concentration of resources by adding an additional station. Staff proposes that we increase staffing by nine personnel phased in over the next four years and add a third station. This will service the western portion of the city and provide second due support for the existing stations.

Cost Estimate –Staffing	FY99/00	FY00/01	FY02/03	Total On-going
Three Personnel	152,700			152,700
Three Personnel		157,275		157,275
Three Personnel			166,710	166,710
Promote Three Engineers			18,765	18,765
Promote Three Captains			35,010	35,010
Grand Total				530,460

Cost Estimate Fire Station #3,

Description	*Capitol Cost*	*On-Going Cost*
Land	50,000	
Engineer/Design	50,000	
Construction	395,000	
Services & Supplies		61,000
Total	475,000	61,000

Cost Estimate Apparatus & Equipment

Description	*Capitol Cost*	*On-Going Cost*
Front Line Apparatus	270,000	
Front Line Apparatus Equip.	55,200	
Reserve Apparatus	110,000	
Reserve Apparatus Equip.	21,200	
Apparatus Maintenance		11,000
Fleet Reserve		30,000
Total	456,000	41,000

Cost Summary

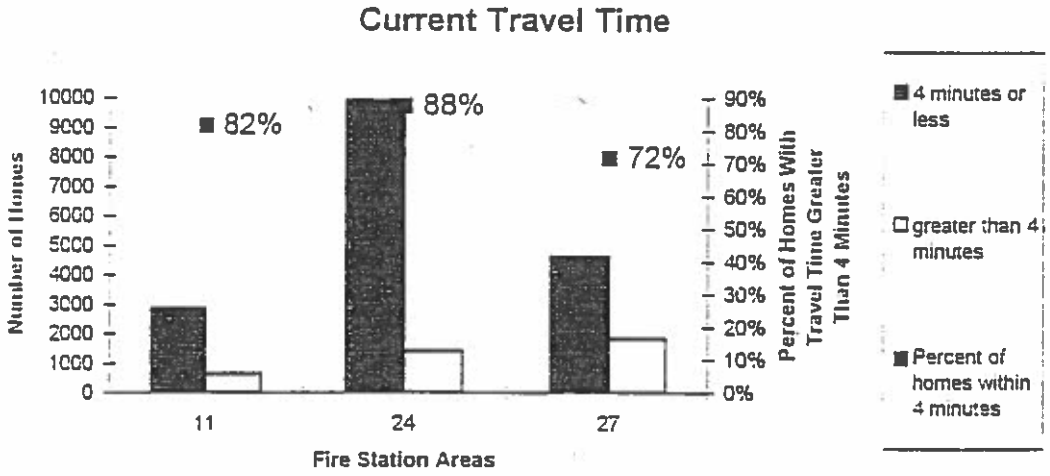
Description	*Capitol Cost*	*On-Going Cost*
Staffing	-0-	530,460
Third Station	475,000	
Service & Supplies	-0-	61,000
Apparatus	380,000	
Equipment	76,400	
Apparatus Maintenance		11,000
Fleet Reserve		30,000
Total	931,400	632,460

Performance Study

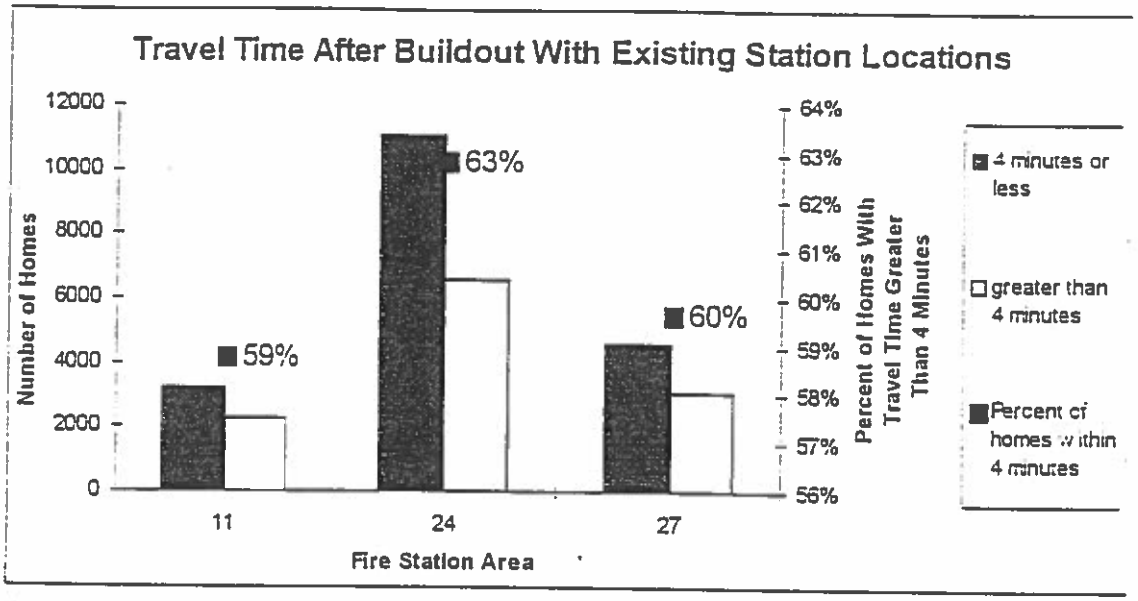
The San Jose Fire Department standard of cover for the Souteast Study area is:

> Place a first due unit on scene within 4 minutes total travel time, for 80% of fire and medical emergency incidents. The first-due unit shall be capable of advancing the first line for fire control or starting rescue or providing advanced life support for medical incidents.

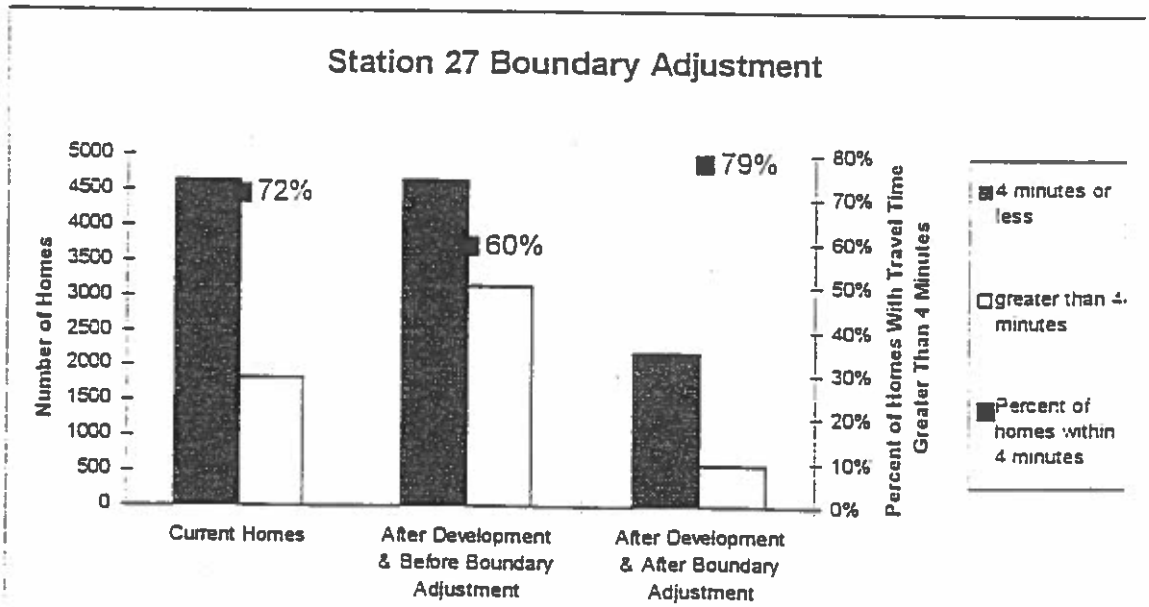
The chart below indicates the number of homes currently within the desired 4 minute travel time for fire stations 11, 24, & 27. The Fire Department's goal is currently being accomplished at 72 to 88 percent.



The chart below indicates the number of homes that will be within the desired 4 minute travel time for each fire station after proposed development. Without relocating fire stations 24 & 27, the percentage of homes within the desired 4 minute travel time will decrease to a range of 59% to 63%.



Movement of fire stations 24 & 27 and the addition of two new stations located within the study area will increase the Fire Department's ability to reach the 4 minute travel time in fire stations 11, 24, & 27's area. As an example, the following chart shows the significant improvement in travel time within fire station 27's area.



RECOMMENDATIONS/COST ESTIMATES:

The continued trend in increased travel time of units to emergencies in the Southeast Study Area was the leading focus of this study. The study also reviewed in detail the Fire Department's goal in providing timely emergency response to fire and emergency medical calls. Staff recommends the City of San Jose build and move fire stations in the Southeast Study Area such that a 4 minute travel time gets the first-due fire apparatus on-scene prior to or at flashover, and before brain death becomes irreversible in EMS emergencies. Cost estimates for the recommendations have been provided based upon input from the San Jose Fire Department Staff. In order to accomplish this objective:

4. Build a new multi-company Station 31 at Aborn & Ruby:

   a) Equip with a new engine and an existing brush patrol from Station 24 (requires new staffing of 1 captain, 2 engineers, and 1 firefighter/paramedic);

   b) Relocate Station 24 to Silver Creek Road & Yerba Buena (single engine company with existing staffing of 1 captain, 1 engineer, 1 firefighter/paramedic, and 1 firefighter);

   c) Relocate USAR 16 to Station 24.

Cost Estimate - Recommendation 1		
	Capital Cost	On Going Funding Needed
New Station 31	$1, 500,00 (station)	$1,000.000 (personnel)
	$325,000 (apparatus)	
Relocation Station 24	$1,500,00 (station)	$0
	$(300,000) (sale of old station)	
TOTAL	$3,025,000	$1,000.000

2. Build a new multi-company Station 32 at Poughkeepsie Road & Cottle Road:

   a) Equip with a new engine (requires new staffing of 1 captain, 1 fire engineer, 1 firefighter/paramedic, and 1 firefighter);

   b) Move Truck 18 to Station 32;

   c) Add a 6th battalion headquartered at Station 32.

   d) Relocate Station 12 to Chesbro & Calero

   e) Relocate Station 27 to Bernal & San Ignacio.

Cost Estimate - Recommendation 2		
	Capital Cost	On Going Funding Needed
New Station 32	$2, 500,00 (station)	$1,450,000 (personnel)
	$325,000 (apparatus)	
Relocation Station 12	$1,500,00 (station)	$0
	$(300,000) (sale of old station)	
Relocation Station 27	$1,500,00 (station)	$0
	$(300,000) (sale of old station)	
TOTAL	$5,225,000	$1,450,000

3. Add a medic squad to Station 18 (multi purpose vehicle with ALS capabilities, staffed with two firefighter/paramedics, assigned with Engine 18).

Cost Estimate- Recommendation 3		
	Capital Cost	On Going Funding Needed
Add Medic	$300,000 (training)	$540,000 (personnel)
	$120,000 (apparatus)	
TOTAL	$420,000	$540,000

4. Adopt a residential sprinkler ordinance for all new construction outside the 4 minute travel time areas.

5. Review feasibility of street design/construction to increase areas within 4 minute travel time. For example, a collector between Silver Creek and Yerba Buena Road.

6. Adopt a Wildland Urban fuel management plan.

7. Continue installation of opticom traffic control devices.

Attachments:

1. Standards of Coverage Process Diagram
2. Maps 1-6

Attachment 1

Standards of Coverage Process