Council Study Session

November 14, 2021

Agenda Item	Ambulance Service Financial Review	
From	Ralph Sartain	Fire Chief
Contact	Ralph.sartain@ashland.or.us	541-552-2229
Item Type	Requested by Council ☐ Update ☐ Request for Direction ☐ Presentation ☒	

SUMMARY

City Manager Pro Tem Gary Milliman advised me; Council requested an update for Ashland Fire & Rescue (AF&R). AFR has undergone significant changes an increasing call volume, beginning a reorganization, completed an ambulance study, receipt of wildfire grants, a staffing crisis with mandatory overtime every day, staffing models, cost saving ideas, revenue producing ideas and interest in regionalization of firefighting efforts. Council asked that these items be placed on the October 4, 2021 Business Meeting for formal discussion.

POLICIES, PLANS & GOALS SUPPORTED

Council Goal 1 -Develop current and long-term budgetary resilience
Council Goal 2 - Analyze City departments/programs to gain efficiencies, reduce costs and improve services
Cost Review Ad-Hoc Committee Recommendation #5 (approved by Council May 19, 2020)-Direct staff to advise definitive ways where they could streamline operations with the goal of creating a meaningful cost/benefit review of services offered and that also creates efficiencies and reduces costs.
Cost Review Ad-Hoc Committee Recommendation #6 - Consider outsourcing services with the goal of reducing costs.

PREVIOUS COUNCIL ACTION

Multiple from 1995 thru June 2021

BACKGROUND AND ADDITIONAL INFORMATION

The Attached power point will address fire department restructuring, CERT, History of the Ambulance Service and Ashland Fire & Rescue, Staffing Guidelines, Call Typing, Fire Inspections, Ambulance Cost, Ambulance Revenue, Areas for increased revenue potential, areas of reduced costs, alternative staffing ideas and Community Risk Reduction.

- In the NIST Fireground Field Experiments (Attached please read page 10 and 11) to understand significant time to staffing differences on a fire scene.

FISCAL IMPACTS

An increase in the operational budget is needed to support necessary staff positions, both in Operations, Wildfire and Administration.

STAFF RECOMMENDATION

Staff recommends Council Direct staff to provide cost analysis for addition of staffing at an upcoming council meeting.

ACTIONS, OPTIONS & POTENTIAL MOTIONS

I move to request the Fire Department to submit proposals for staffing costs, reorganization costs and alternative staffing models to support increased call volume, fire inspection mandates, and community risk reduction.

I move to…..

REFERENCES & ATTACHMENTS

Attachment #1 – City Manager Pro -Tem Memo
Attachment #2 October 4 Presentation AF&R
Attachment #3 – Assignment of Service Area 3
Attachment #4 – City of Ashland Final Report 06.17.2021 Ambulance RFP
Attachment #5 – ISO Rating – AF&R
Attachment #6 - Mercy Flights Additional Questions
Attachment #7- NIST Fireground Study

CITY OF ASHLAND

GARY MILLIMAN, CITY MANAGER PRO TEM

MEMORANDUM

TO: Mayor and City Council

DATE: September 27, 2021

SUBJECT: Ambulance Service

Chief Sartain will be discussing ambulance service as currently provided by AFR at the financial study session of October 4 as a part of a larger discussion of AFR services.

I have spoken with Mercy Flights Board Chair Mark DiRienzo and Chief Operating Officer Sheila Clough concerning this matter, and invited their attendance at the October 4 meeting as an information resource. However, Clough is not available on that date, and we both agree that this matter should be the subject of a separate discussion if the City Council feels a change in ambulance service should be considered after the October 4 meeting. Clough does not want it to appear that Mercy Flights is "going after" the Ashland contract, and she said Mercy Flights has worked hard in partnership with AFR and others to improve working relationship after the last time this matter was discussed at an Ashland City Council meeting.

Mercy Flights is also concerned that if they engaged in a detailed public discussion of their strategy for providing ambulance service to Ashland, this somewhat proprietary information would be used by their private sector competitors in crafting proposals that would be submitted to the Jackson County Board of Commissioners in response to the upcoming ambulance service RFP process.

Chief Sartain, Sheila Cough and I all recommend that the City Council identify questions they would like answered as a part of the ambulance service consideration, and that City staff and Mercy Flights return to the Council with considered responses to those questions.

To reiterate, it is the Board of Commissioners that selects the ambulance service provider for the Ashland area, not the City of Ashland. If the City elects to maintain its ambulance service, the City would be among those competing for the ambulance service contract.

There are other aspects of the current fire service discussion that could impact the ambulance service discussion. For example, if there is interest in pursuing some form of AFR/Fire District 5 consolidation, ambulance service would need to be addressed as District 5 does not provide ambulance service.

Cc: Chief Ralph Sartain

Greetings. For our viewing and listening audience. My name is Ralph Sartain, Fire Chief of Ashland Fire & Rescue. I have been with Ashland Fire & Rescue for 4-years. I was hired in 2017 as the Division Chief of Fire and Life Safety. With the departure of Chief D'Orazi, it left a vacancy in the Administrative structure of Ashland Fire, leaving Chief Shepherd and me to run the department. I worked with Chief Shepherd in this position until his retirement on Oct 30 of 2020, leaving just me as the only Administrative Chief in the department. Since Oct 31, I have been the Interim Fire Chief until my appointment as the Fire Chief in June 2021.

As you are all aware, one of the primary concerns for this community and therefore the City Council is centered around the protection of the community, whether or not Ashland Fire & Rescue should continue to run the local ambulance service, emergency preparedness, proper staffing, smoke control and management of public funds in an ever-shrinking budget.

It is important for me to state that I am not here to "sell" you on fire department. I am here to give you the information you need so that you can make an educated decision about the future of Ashland Fire & Rescue.

As I begin my presentation tonight, I think it is also important to reiterate that the ambulance service here at Ashland Fire & Rescue is not its own entity. The services we provide as the holders of Ambulance Service Area #3 are very much integrated with our department's other services. Like all other fire departments in Southern Oregon, we respond to medical emergencies, we treat patients with medically qualified firefighting personnel, but then, instead of having someone else take the patient to the hospital, we take them ourselves. We are simply "finishing the job we started".

This is primarily a Qualitative review of AF&R and with some Quantitative information. A Qualitative review typically consists of words, while a quantitative review deals with data and numbers. A Quantitative review would require many more months and specific deep dives into individual topics, not a global request for information as was directed for tonight. I hold pride and integrity in the information I provide, and I could not gather the necessary data in such a short time to provide you with in-depth Quantitative data on so many topics.

What We Will Be Covering

Primary Focus

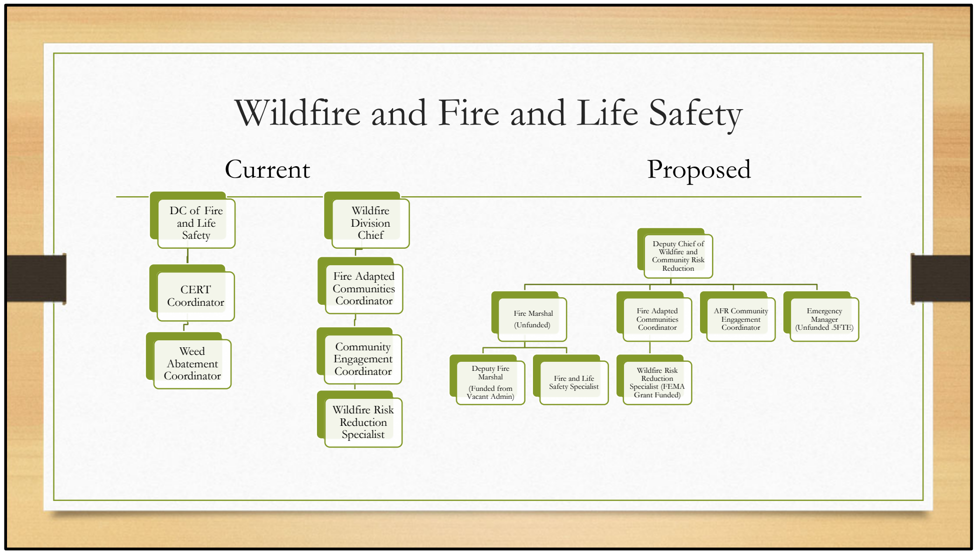
- Fire Department Reorganization
- CERT
- Fire Inspection (Council Mandated)
- 8/10 vs 9/11 fire staffing
- Ambulance service and impact on overall staffing
- ISO rating
- Volunteers vs. Student Firefighters
- Fire Adapted Ashland
- Ashland Forest Resiliency Program
- Fire District/IGA

Fire Department Reorganization

Executive/Fire and Life Safety/CERT/Wildfire

On the left, you see our current organizational chart with the Deputy Chief of Operations listed as Vacant (being filled) In a current hiring process. The Division Chief of Fire and Life Safety is currently unfunded and vacant; this is the actual Fire Marshal position and then the Division Chief of Wildfire currently staffed by Chris Chambers.

The reorganizational proposal would cause the elimination of the DC of Fire and Life Safety and reallocation into the Wildfire division; this will be explained in more detail in the next slide. It will change the title of the Wildfire Division Chief to the Deputy Chief of Wildfire and Community Risk Reduction. This position will oversee all items related to Wildfire and Community Risk Reduction. With the change in responsibility comes the change in title and a small pay raise to match the Deputy Chief of Operations. Chris will be required to attend specific training before the pay increase is to occur, which will allow his position and needed certifications to match.



This slide shows the existing organizational chart on the left and the proposed one on the right. This will remove the two executive-level positions in the organization chart for the two divisions and bring them under the direction of one executive level administrator. This creates the Deputy Chief of Wildfire and Community Risk Reduction. With this new organizational structure, the Fire Adapted Communities Coordinator remains funded, as does Chris through the water fee already being collected. The Community Engagement Coordinator and The Wildfire Risk Reduction Specialist are LDA position funded by Grants. The larger change comes into play under the restructured Fire and Life Safety Division.

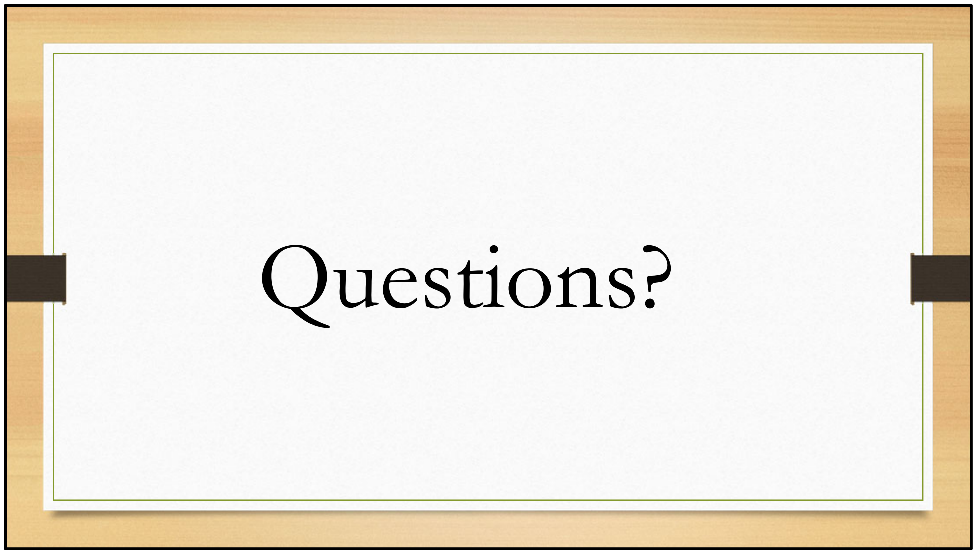
The Division Chief of Fire and Life Safety title is changed to Fire Marshal and a lower pay scale and placed under the Deputy Chief of Wildfire and Community Risk Reduction. For the time being, the Fire Marshal will remain unfunded as I can maintain the executive portions of the position as the Fire Chief as long as there is a Deputy Fire Marshal to assist with the day-to-day inspections, plan reviews, and complaints, etc. The Fire Marshal position will be funded once the community comes out of the financial burdens, or more dedicated funding is available for the fire department's staffing issues. The current benefited .5 FTE of the CERT Coordinator and the benefited .4 FTE of the Weed Abatement Coordinator, which are both currently vacant, will be combined to create a Fire and Life Safety Specialist position. This position will also be required to be a firefighter as well as a basic fire inspector. The primary function for the position is

CERT coordination and Weed abatement, with the availability to respond to structure fires as a firefighter to add as an additional structural responder. The basic fire inspector portion of the job will be very basic inspections, complaints, and community risk reduction programs. Combining the two benefited positions will create a wash in the increase of the .10 FTE and pay raise. This position, along with the CERT leadership team, will refocus the mission and bring the CERT leadership more in line with a traditional volunteer organization and the FLSS as the liaison for the City. The Deputy Chief of Wildfire and Community Risk Reduction will be tasked with working with the FLSS and the CERT members to advance their training, community, and mission-ready needs.

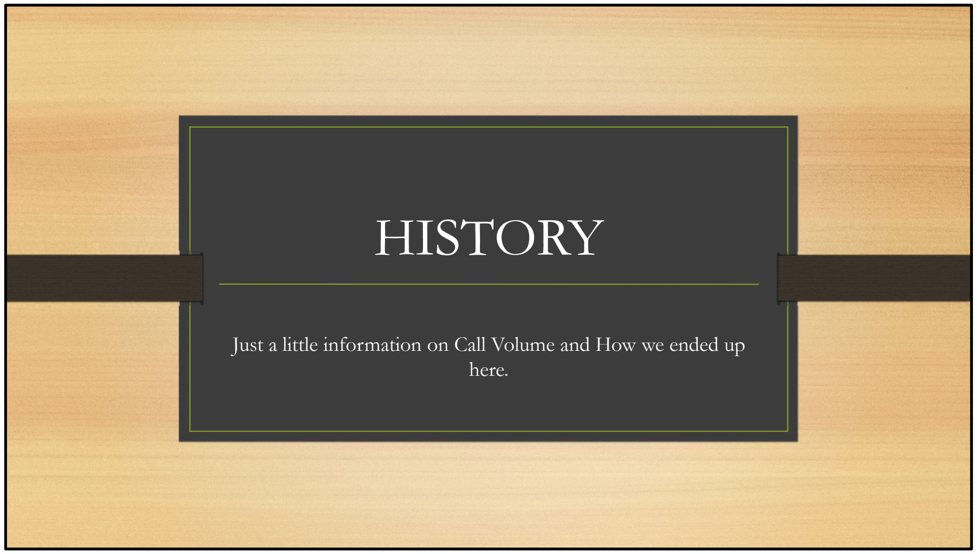
The final piece to this is the Deputy Fire Marshal. As you know, the City Council mandated in 2006 that all commercial structures in Ashland be inspected every two years. An inspection fee schedule was created, authorizing the fire department to collect inspection fees associated with the inspections. When the downturn in the economy occurred, the fire inspector position was eliminated to save firefighter positions, and the council authorized an additional overtime budget to complete inspections. Three firefighters were trained to become fire inspectors at the basic level. The fire inspector world is a completely different track than a firefighter, and unfortunately, our call volume and mandatory overtime and departure of employees have removed this availability. When I was hired, I was told it was in the works to reinstate a Deputy Fire Marshal, but immediately this was sidelined because of budget issues as well as working with temporary Finance Directors, City Administrators now City Manager Pro-Tems. We kept having to start the discussions repeatedly; the work had to be re-organized to meet the demands of the increased staffing issues. While COVID may have shut down society, construction, land development, DHS inspections, and the need for fire inspections continued.

I implemented a third-party inspection program for real-time tracking of fire systems in the City at no cost to the City. This does not give us a fire inspection of the building; however, it lets me know if a fire system is functional or deficient and keeps real-time records. With this, I moved the crews from inspecting businesses to inspecting multi-family residences, care facilities, apartments, and dormitories. This was done to match the national data that shows this is the highest risk for life loss in our community and an increase in firefighter injuries during a fire. Currently, I am able to use the retirement of the Fire Marshal from Medford to assist me in plan reviews, land development, and inspections. However, once his certification period ends, I cannot use him, as, under Oregon Law, you must carry DPSST credentials to conduct fire inspections, plan reviews, and comment on land development. The only way to carry DPSST credentials is through a fire department or upon retirement or separation from the fire department until the end of your credentialed time.

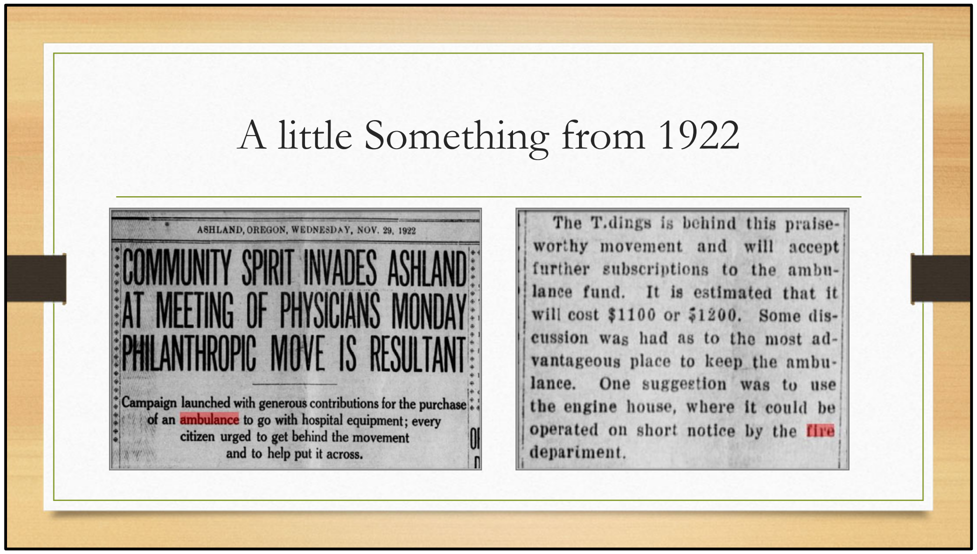
The Deputy Fire Marshal is needed to complete all of the inspections to continue to move the construction and development aspects of this community forward, complete higher-level commercial inspections, and handle the day-to-day operational needs of fire and life safety for the community. I am requesting the DC Fire and Life Safety funding to be reallocated from a Division Chief to a Captain Level wage through the Labor agreement. Because the position will be doing a fire commercial plan review, a portion of the FTE income will be covered by developmental income for all new construction and plan reviews. This will not cover the entire FTE; however, this is a necessary position for the continued advancement of development in the community and fire protection at a much more reasonable cost to the community. The Deputy Fire Marshal position with the limited availability of the FLSS to conduct basic inspections should allow for the Council directive of community inspections to be completed every two years. I will continue to update you on this progress.



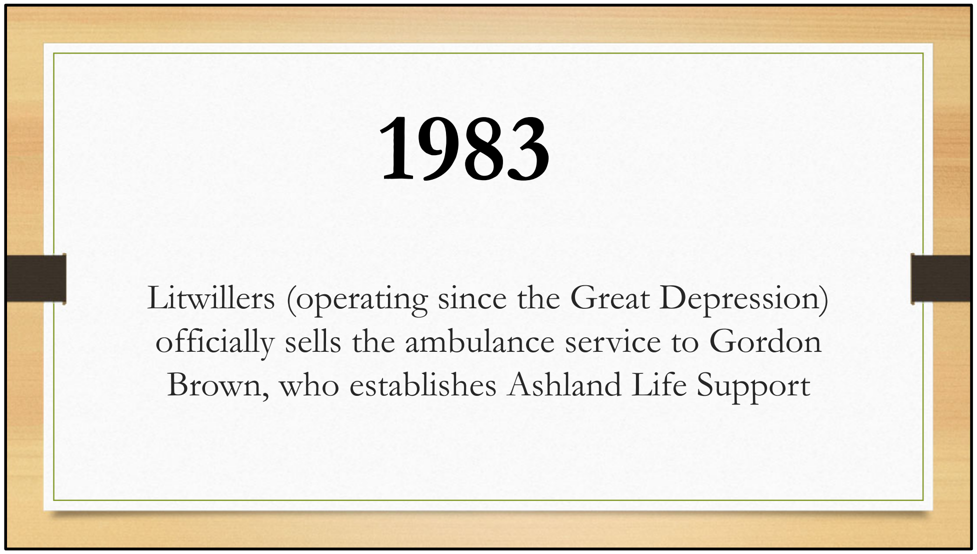
Any Questions?



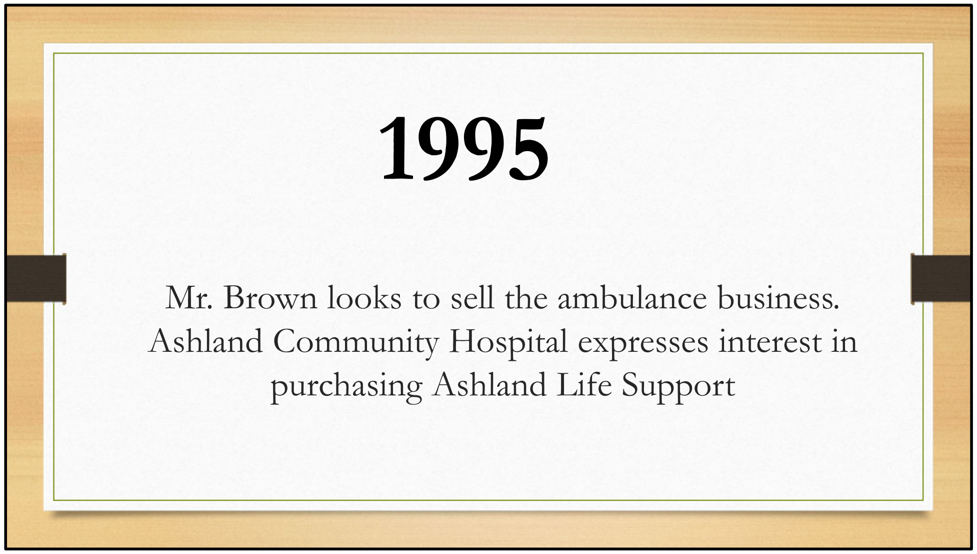
Now for Staffing and how AF&R came to be a transporting ambulance service and how our staffing model has become so intertwined with the operation of the ambulance and that there is no difference from one to the other.



Having an ambulance and transporting patients is not a new idea to the citizens of Ashland. This article from 1922 is talking about a city owned ambulance service giving this community nearly 100 years of interest in an ambulance service. This headline comes from the Ashland "Weekly" Tidings from November of 1922.



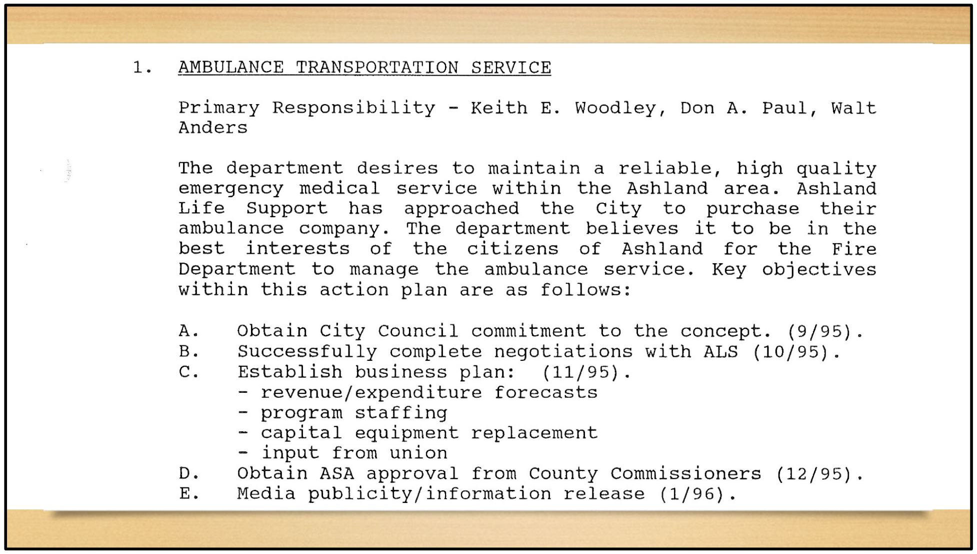
It’s a little unclear how it turned out in 1922, but sometime around the Great Depression, the local funeral home, Litwillers, began operating the ambulance service. This continued until 1983 when the owners sold the ambulance side of the business to a family member, Gordon Brown. The private ambulance service became Ashland Life Support.



Due to significant call volume increases in the City and surrounding area, Ashland Life Support could not keep up with responses (they only staffed one ambulance). Both AF&R and the Fire District 5 had licensed ambulances in their fleet and a contract with ALS to provide transports when ALS was not available. In 1995 this was occurring if not every day, at least every other day.

Sometime during 1995, Mr. Brown decided that he wanted to get out of the ambulance business. With Ashland Life Support directly across the street from Ashland Community Hospital, it made logistical sense for the hospital to buy the business and associated property. ACH began discussions with Mr. Brown.

During this time period, the hospital was still part of the City. Instead of creating an entirely new division at ACH to handle the ambulance, City Administrator Almquist directed Fire Chief Woodley to start gearing up the fire department to take on this responsibility.



1. AMBULANCE TRANSPORTATION SERVICE

Primary Responsibility - Keith E. Woodley, Don A. Paul, Walt Anders

The department desires to maintain a reliable, high quality emergency medical service within the Ashland area. Ashland Life Support has approached the City to purchase their ambulance company. The department believes it to be in the best interests of the citizens of Ashland for the Fire Department to manage the ambulance service. Key objectives within this action plan are as follows:

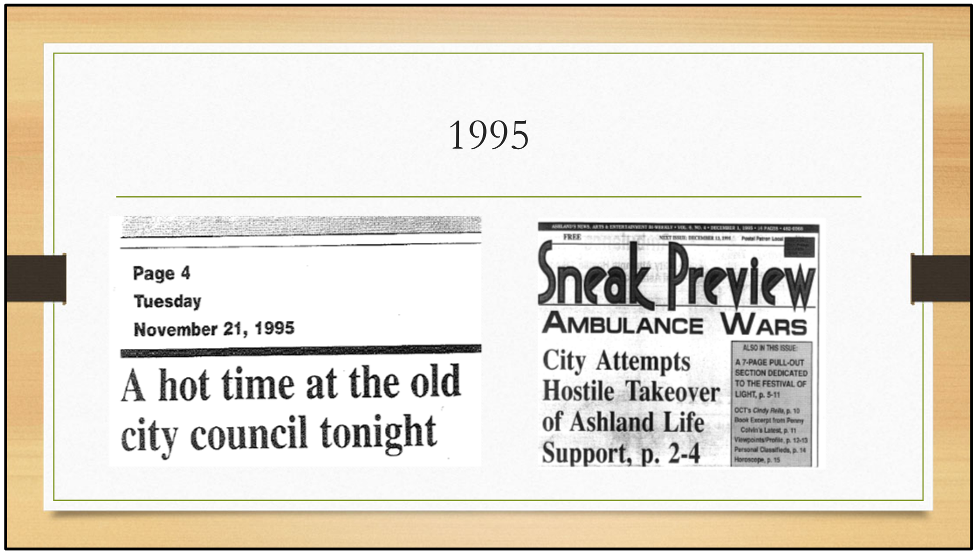
A. Obtain City Council commitment to the concept. (9/95).
B. Successfully complete negotiations with ALS (10/95).
C. Establish business plan: (11/95).
   - revenue/expenditure forecasts
   - program staffing
   - capital equipment replacement
   - input from union
D. Obtain ASA approval from County Commissioners (12/95).
E. Media publicity/information release (1/96).

As the fire department was in the process of creating a new strategic plan that year, the acquisition of the ambulance service became the #1 action item in the plan.

1995

An offer is made and not accepted. Tensions rise between the City and Mr. Brown. And Mr. Brown decides to sell to Mercy

News articles suggest that the City offered close to $300k to Mr. Brown who refused this amount and opened his discussions with Mercy Flights.



The City decided that they were going to have an ambulance service. Or, at the very least, they were going to make sure that anyone who operated an ambulance in the City of Ashland would have to meet very stringent response, facility, and personnel requirements. This was done by passing a new City ordinance that addressed these issues.

Consequently, there was a fair amount of backlash from some of our community members who thought the City had overstepped its bounds.

The ordinance even attracted attention at the state level.

Citing financial concerns related to the ordinance, and not wanting to be operating in a city that they did not feel welcome, Mercy Flights backs out of the deal to purchase Ashland Life Support.

Without Mercy Flights, Mr. Brown is forced to begin talks with the City again.

Ashland takes over ambulance service

By Wendy Siporen
Ashland Daily Tidings

Today obviously isn't New Year's Day, but it does mark the beginning of a new chapter in city services for Ashland. This afternoon, Ashland Fire and Rescue will assume the ambulance transport responsibilities of Ashland Life Support in the greater Ashland area.

Mayor Cathy Golden called the acquisition of the ambulance service the biggest decision in Ashland since 1981

1995

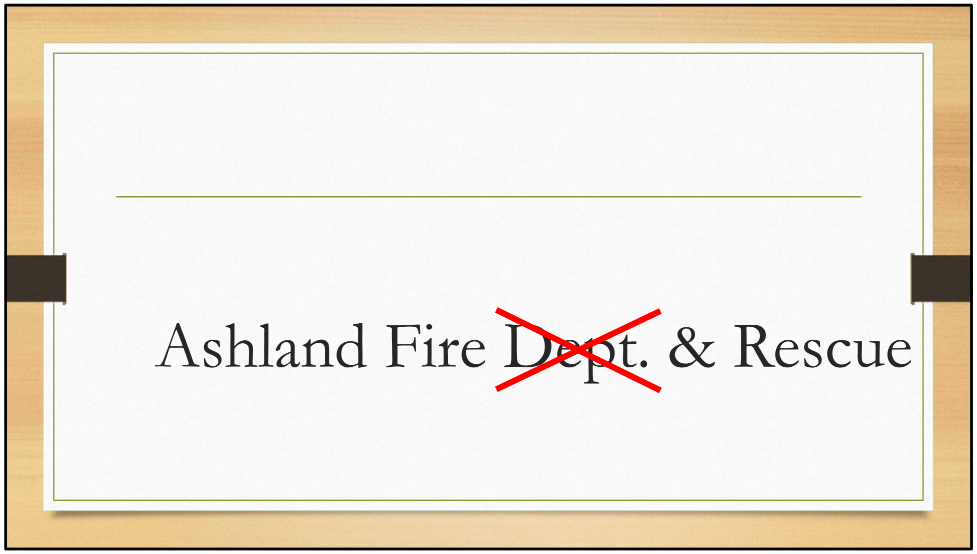
ness, and Medford-based Mercy Flights stepped in instead. Earlier last year, Mercy Flights had said it did not want to compete with Ashland for ALS.

During a strategic planning meeting for the fire department in late October, Golden had harsh criticism for the company's tactics. "... Mercy Flights is definitely in the business of getting what they can and I think in terms of capitalizing on human suffering and loss they have moved in there in an un-

The City agrees to pay Mr. Brown the $500k which Mercy Flights was going to. The City also gets approval from Jackson County for the ASA assignment.

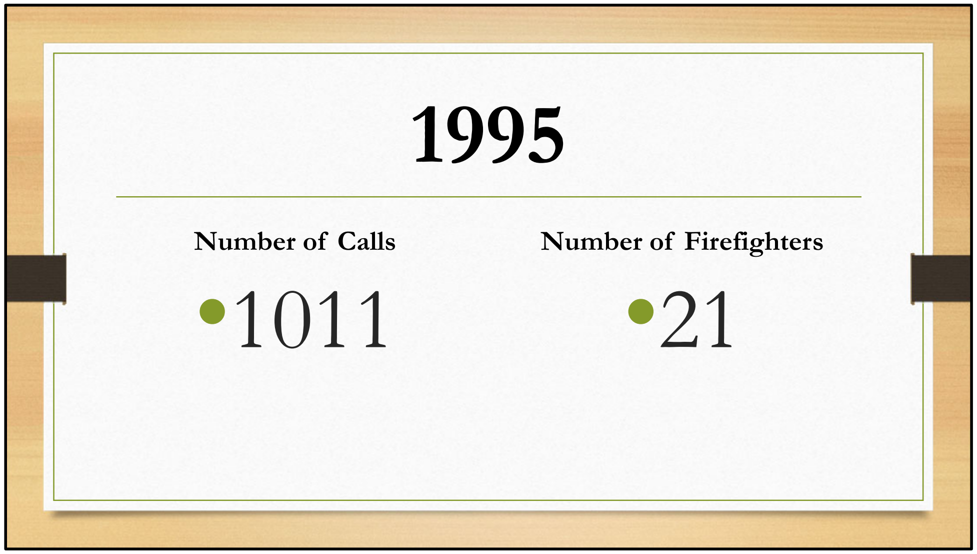
Most City Admin agreed that the ambulance service would provide needed General Fund revenues and thus was a good financial decision.

We now enter 1996 as the owners of an ambulance service.

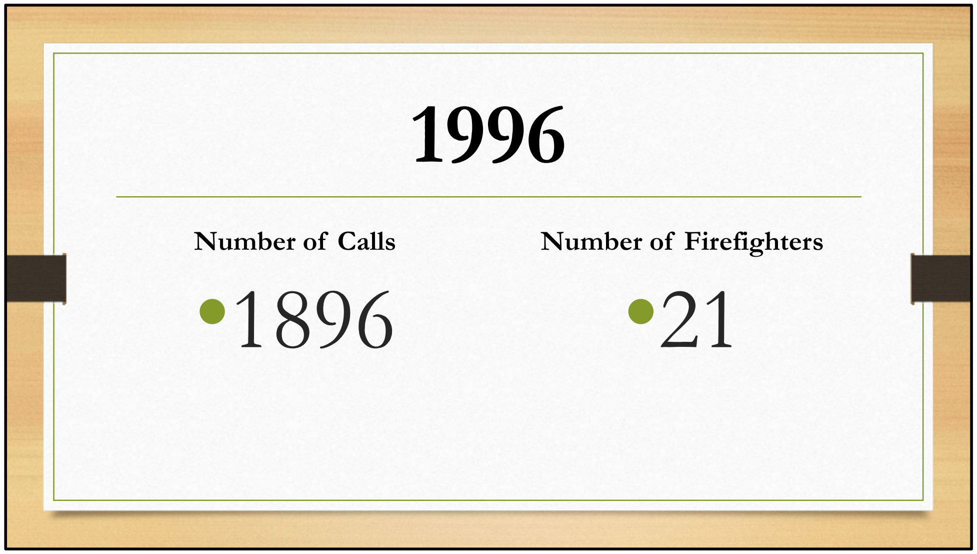


No longer just a fire department, we change our name to Ashland Fire & Rescue.

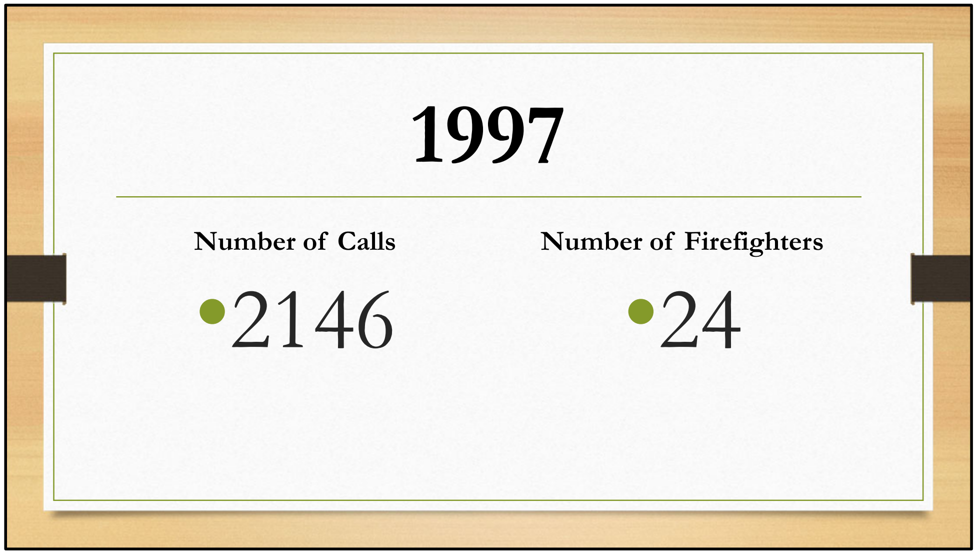
Let's now take a look at what has occurred with the department regarding call volume and staffing since taking over the ambulance service.



Prior to taking over the ambulance service, Ashland Fire Department responded to 1011 emergency calls in 1995. We were staffed with 21 full time firefighters.



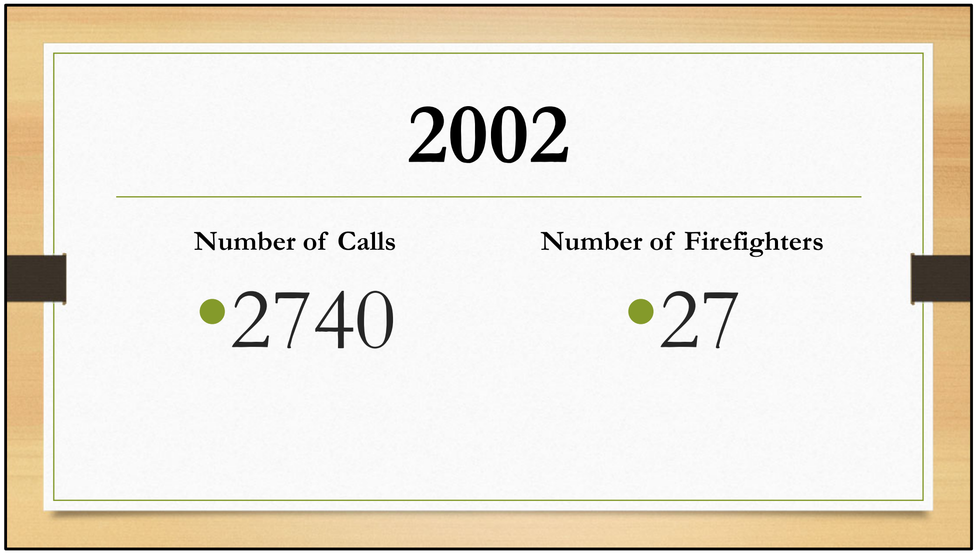
The following year, with one year of ambulance service under our care, Ashland Fire & Rescue responded to 1896 calls or an 84.87% increase in the calls for service with the same number of staff. This increase in calls for service was not planned for and placed a tremendous burden on department personnel.



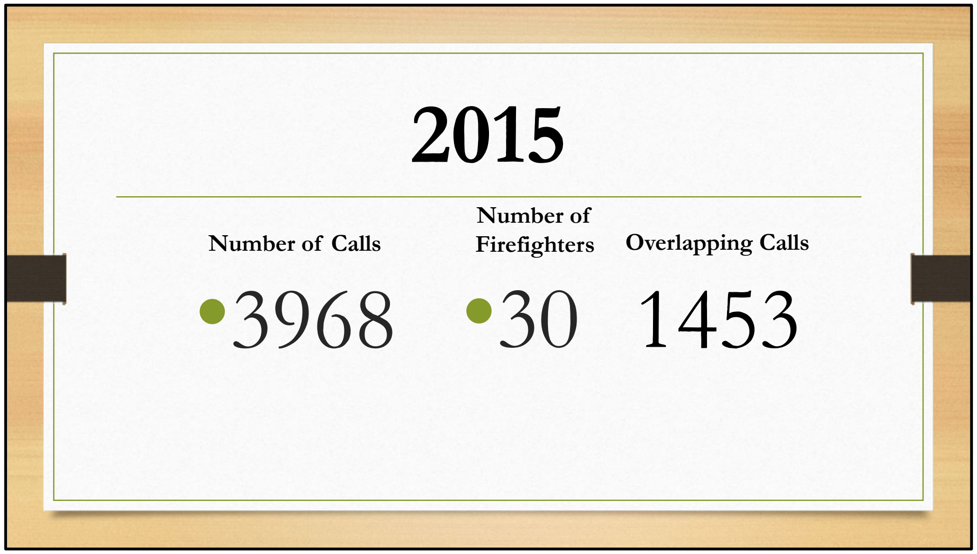
As we talk about the ambulance service, fire department staffing, and the budget, this is probably one of the more important slides I will show you. In 1997, Ashland Fire & Rescue finished the year with 2146 calls for service or an increase of 112.27% in call volume. Not only does AF&R have this increase in call volume, but we also have extra duties associated with ambulance transports, such as patient care reports, billing procedures, ambulance restocking, normal training, fire inspections, etc.

At this point, firefighters have to work 5-6 days in a row; if they aren't willing to volunteer to work, they were force hired. It is getting so bad that spouses are calling the fire chief, voicing their frustration about not allowing their loved ones to come home. Understanding that this is a huge issue, that we desperately need more people, the fire chief asks for more firefighters, and Council gives permission to hire…………..3.

In 1997, having taken over the ambulance service and increased our call volume by 112.27%, we should have gone from 21 to 30 firefighters. For the last 24 years, we have always been behind the curve, and while we have managed to do more with less, we have never had the proper number of responders, and it all began here.



In 2002 still behind the curve and responding to now 2740 calls for service or an additional increase of 27.68%, Ashland Fire was given permission to hire 3 more firefighters bringing our total to 27 firefighters.



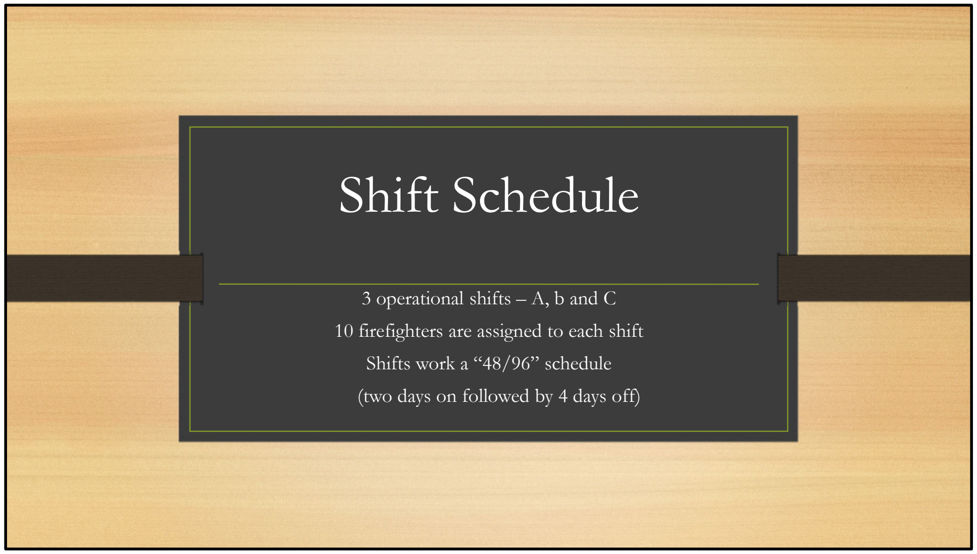
From 2002 until mid-2015, no firefighting staff was added; however, the call volume went from 2740 calls for service in 2002 to 3968 in 2015 or an increase of an additional 44.82%. Our ISO assessment was conducted shortly after the addition of the three firefighters in 2015.

In 2018 Fire Chief Mike D’Orazi was hired with a promise of taking the staffing level from an 8/10 to a 9/10 staffing model. Chief D'Orazi rolled out the implementation of the plan, and AFR for one year was able to see the benefits of one additional FTE per shift. However, because the labor agreement allows for two people off per shift, FMLA vacancies, retirements, injuries, and so on, the fire department budget became unsustainable. Every day, there was one or more OT positions to meet the 9/10 staffing model. The argument at the time should have been to take the staffing model to 9/11, to avoid the daily OT assignment.

During budget discussions in 2019, Chief D’Orazi chose to resign and vacate an Administrative role causing Deputy Chief Shepherd to Become Fire Chief and me to assume more administrative duties. In early 2020 Chief Shepherd reduced the fire department from the 9/10 staffing back to 8/10 staffing, where we currently remain.

Remember, in 1995, we had 21 firefighters, and we were responding to 1011 calls for service; last year, we responded to 4510 calls for service with 30 firefighters. Our call volume has increased by 345.7%, and staffing has only increased by 42.86%.

The additional problem with this exponential increase in calls is the increase in multiple calls for service occurring simultaneously. I cannot obtain records for repeat calls for service prior to 2015; however, I was able to pull our 2015 numbers when the ISO rating was completed. At that time, we had 3968 calls for service with 8/10 staffing, availability of three executive officers, and an overlapping call volume of 1453 calls. In 2020 we had 4510 calls for service with 1687 overlapping calls for service (37.41% of the time) or an increase of 16.10% over 2015 with three fewer firefighters from the 9/10 staffing and one fewer executive officer to respond or a net decrease in the staff of 11.11%.

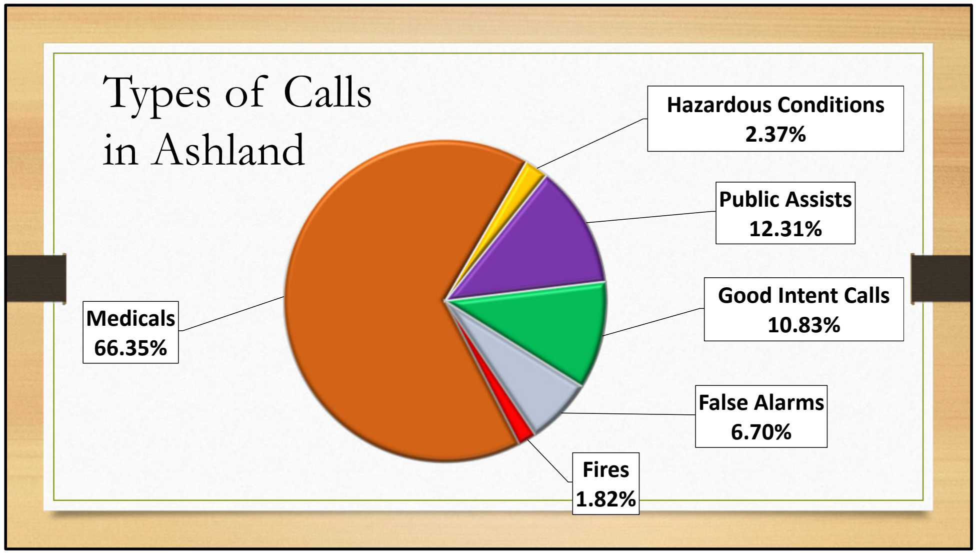


The department is divided into three operational shifts, A, B, and C Shift. There is 10 personnel assigned to each shift, for a total of 30 firefighters. Each shift works a 48-hour cycle, then gets 96 hours off. We refer to this common fire department schedule as a "48/96".

It has been suggested that we change the firefighter schedule by some to a 12-hour workday. While this seems like a great idea to combat fatigue, stress, and burnout and I appreciate the sentiment. The cost to the City would be impossible to overcome. What do I mean? Currently, the fire service has created its own monster in staffing while trying to save the communities money.

Let's look at one day 24 hours, and let's look at an individual FTE for a second, not what's needed for staffing but a singular person covering the 24-hour day. The current fire staffing has one firefighter covering the entire 24-hour period. If we move that one firefighter to 12 hours, it will now take two firefighters to cover the same 24-hour period.

In a workweek based on one firefighter covering the shift, you need three firefighters on a 48/96 to cover the entire week in a rotation; you will need four firefighters to cover the week rotation on a 12-hour schedule. This is to say, if we wanted to keep the same coverage we have right now, with no increase in service level, we would need an additional ten firefighters. We have no option but to maintain the 24-hour work periods.



In case you are wondering. Hazardous Conditions are things like natural gas leaks. Public Assists include lifting uninjured fall victims off the floor. Good Intent Calls occur when someone calls 911, we respond, and enroute we are told we are no longer needed (pt. gets a ride to the hospital). False Alarms can be something like a smoke detector activation from dust or steam.

Before we get deeper into staffing levels, I need to re-address a question that keeps coming up. Does the fire engine respond to every medical call with the ambulance, and the answer is **NO.** Well, as long as we keep the ASA, the answer is NO.

If we were dispatched on an Alpha level call or a low acuity call (such as lift assists, welfare checks, non-injury falls, agency assists), we would only send one ambulance Code 1. Code-1 means without lights and sirens. Only the ambulance generally responds on Bravo level calls (such as medical alarm activation, unknown medical problem, suicide, injury from fall); however, this is where the fire engine may begin to start responding to calls.

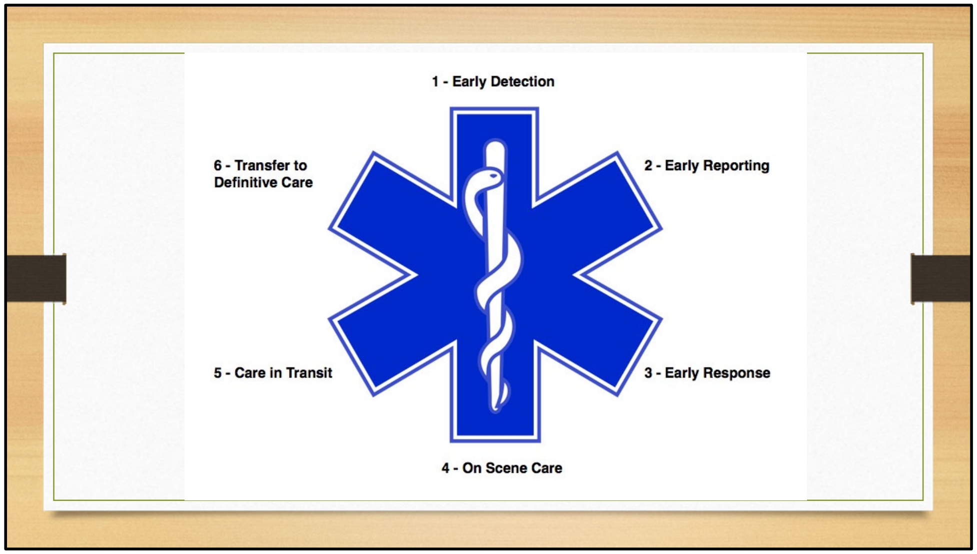
In some calls, such as a motor vehicle collision, the fire engine, and the ambulance are both dispatched to the call so they both would respond. In other Bravo calls, the ambulance will be dispatched by itself, and then the medic on the call can read the information from dispatch, and if they believe they need more help, they can request additional assistance from the fire engine.

We can dispatch in this manner as we hold the ASA, and our dispatch criteria are based on us responding to the call. If we do not hold the ASA and a private ambulance service holds the ASA, we will be sending the fire engine to more calls for service, causing the fire engines to be used more often and thus having to replace them more often, keeping them out of service for longer periods while waiting for the private ambulance service to arrive.

A Charlie call (such as diabetic problems, seizures, Covid cases) or David level response (such as overdose, stabbing, gunshot wounds, breathing problems, or unconscious people), would send both an ambulance and a fire engine Code 3. Code 3 being with lights and sirens on. This assures us that we get to the scene quickly and have the necessary personnel on the scene to treat an immediate life-threatening emergency.

As we talk about how and why we respond, I think this is a good time to point out that all fire departments respond to most medical emergencies. Their crew members are EMTs and/or Paramedics. They carry all of the necessary equipment to handle the most difficult medical and trauma situations. Their goal is to stabilize the patient and make them ready for transport by ambulance. At Ashland Fire & Rescue, we just took the next step and added ambulances into our fleet. We are allowing our Firefighter EMT's/Paramedics who were already on scene, to load the patient into an ambulance and take them to the hospital.

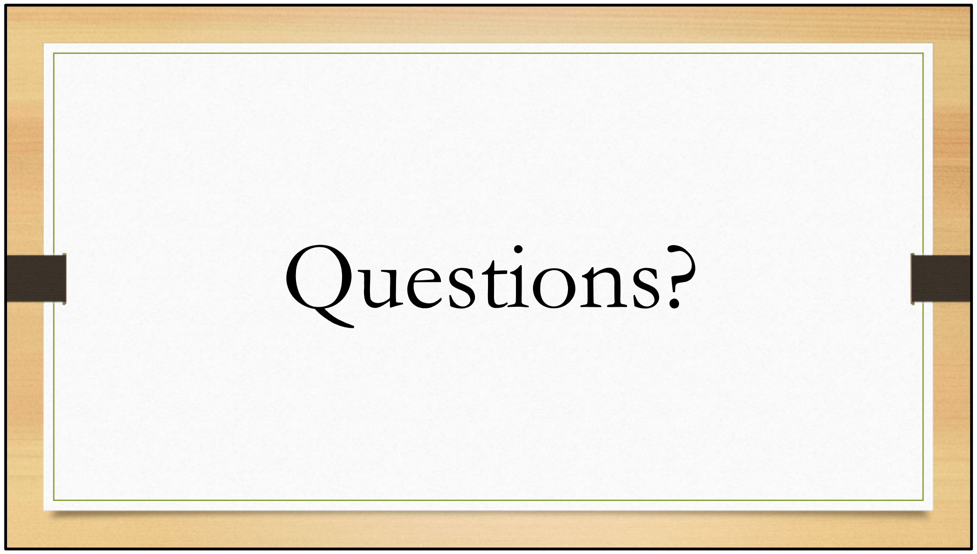
A statement was made that if the ASA were to go away, the fire department could stop training in EMS and focus on fire training only. This is an unbelievably false statement; the only way we could ever stop training on EMS was if council via the citizens of Ashland said that's it, we only want the fire department to respond to fires and nothing else, stay in your fire stations when a citizen has a heart attack, stroke, fall in the watershed or whatever type of medical emergency you can think of the fire department does not respond. This is the only way we could not support EMS training for firefighters.



As you noticed from the earlier slide, almost 2/3 of our 911 calls are for medical emergencies. There are a couple of graphics floating around that try to capture the essence of emergency medicals services. The graphic on the screen takes the six points of the Star of Life and relates them to the process that should occur when a citizen is suffering from a medical or traumatic event. The six steps are Early Detection, Early Reporting, Early Response, On Scene Care, Care in Transit, and Transfer to Definitive Care.

Whether we have the ambulance service or not, our crews will always be part of #3, Early Response, and #4, On Scene Care.

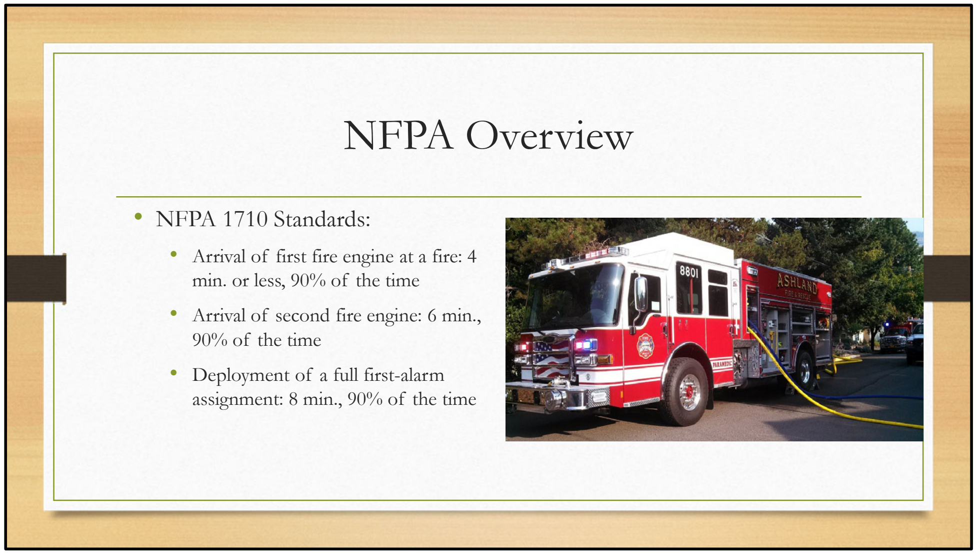
While it is not written into law, I believe that fire departments have a moral obligation to the taxpayers of their communities to initiate an Early Response and provide On Scene Care until the arrival of the ambulance service. Again, this is not something that is regulated by law; it has simply become a national fire service best practice.



Any Questions

We are currently staffed with what we call an 8/10 staffing level. What this means is we have determined that we need to have at least 8 firefighters on duty each and every day. We start each day with 10 firefighters assigned to the shift; however, we can have up to two people off without having to hire someone back on overtime. The union contract allows for two firefighters to be off duty on any given day due to vacation or comp time requests. Additionally, we have vacancies due to sick calls, family leave, injuries, and employee vacancies. Occasionally, we grant employees time off to attend mandated training or meetings. If we end up with more than two personnel off shift for any reason, we must fill any openings using overtime. We fill open slots until our minimum staffing is back to 8 personnel.

This is probably a good time to discuss overtime and the difference in the meaning of overtime from the non-ems understanding. We really need to change the word overtime in the fire service to mandatory staffing hours. Overtime to most, is something controllable. This controllable overtime would be limited to extra training hours, meetings on our days off, etc. Mandatory staffing is not something we can control; we do not have the availability to run short like the private side of the world; we cannot say, hey, I know you are having an emergency, but we didn't hire someone back to respond to your emergency.



Before we show the staffing level response, how do we determine how many firefighters we need, is there a national standard, or an unwritten rule?

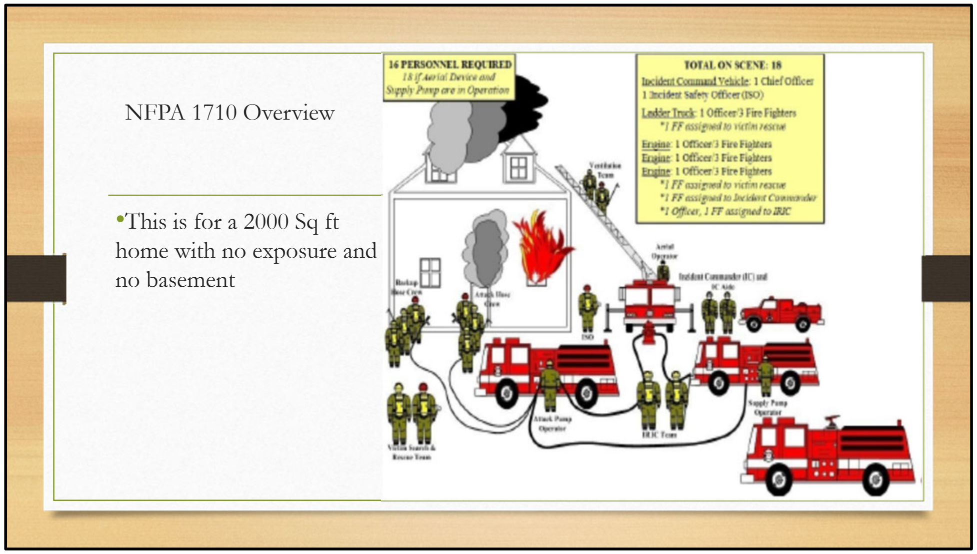
The answer is yes to both NFPA 1710 Organization and Deployment of Fire Suppression Operations, EMS, and Special Operations in Career Departments.

The 2020 release of NFPA 1710 with research from NIST now sets the standard at 16/18 firefighters to the scene of a single-family home 2000sg ft or less with no exposures and no basement. 28 firefighters for garden apartments and strip malls, and 43 firefighters for high-rise fires during the first alarm assignment.

NFPA 1710 applies to AFR currently compared to NFPA 1720 (the standard for volunteer fire departments), a definition of a career fire department was added that identifies a career department as one that utilizes full-time or full-time equivalent (FTE) personnel to comprise at least 50% of an initial full alarm assignment. In other words, if 50% or more of the personnel dispatched on the first alarm to a reported structure fire are career/FTE personnel, the department falls under NFPA 1710. The new definition will have no impact on fire departments that only employ career personnel. The biggest impact will be on fire departments that have a career and part-time and/or volunteer personnel.

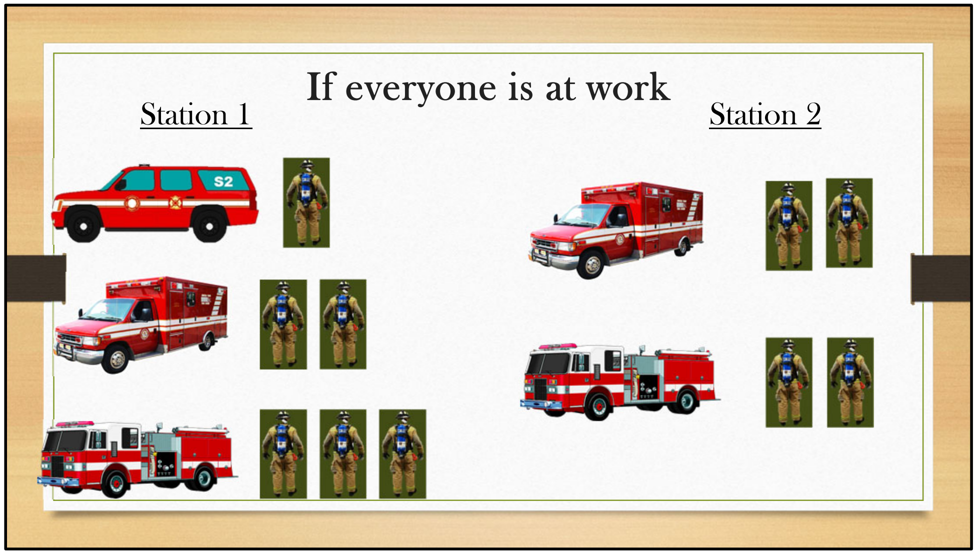
The unwritten rule is you should have five firefighters on duty for every 10000 persons being protected; this includes primary residents, college students, and tourists. Ashland's current population is approximately a little over 21000, with nearly 350,000 visitors a year. Just on our population alone, not taking into account any visitors, we should be at a minimum staffing of 10/12 staffing.

What does NFPA 1710 staffing look like at a fire?



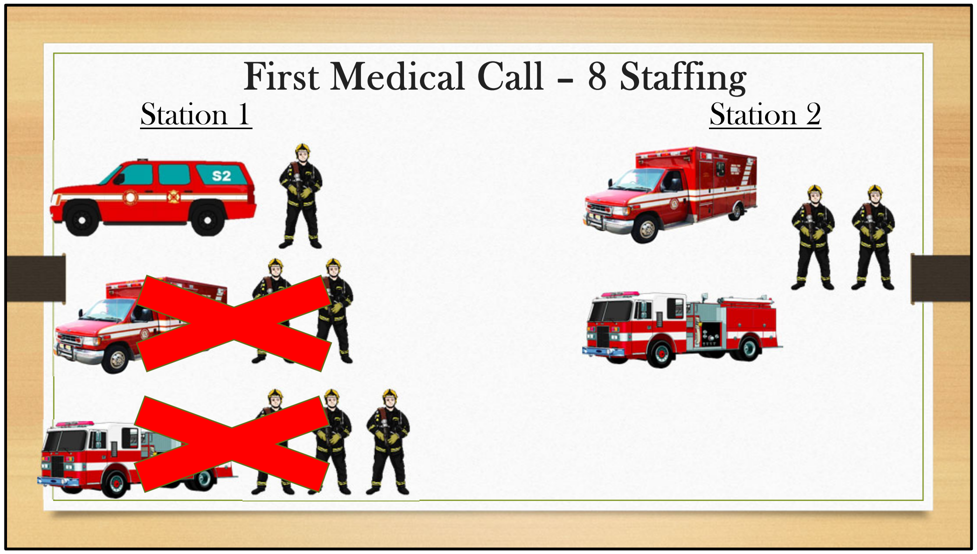
As you can see this is 1 Chief Officer, 1 Safety Officer (we do not have a ladder company yet, but when it does arrive form District 5 it will be staffed with 2 personnel). 4 Engine companies with 4 firefighters each.

AF&R does not meet the staffing provisions of NFPA 1710 even with the assistance of automatic aid from District 5. This includes counting the current minimum staffing of both fire departments. If we use the current minimum staffing of Fire District 5 and Ashland Fire & Rescue, we will put 14 firefighters at the scene or 4 less than the standard for safe operation utilizing an aerial apparatus.



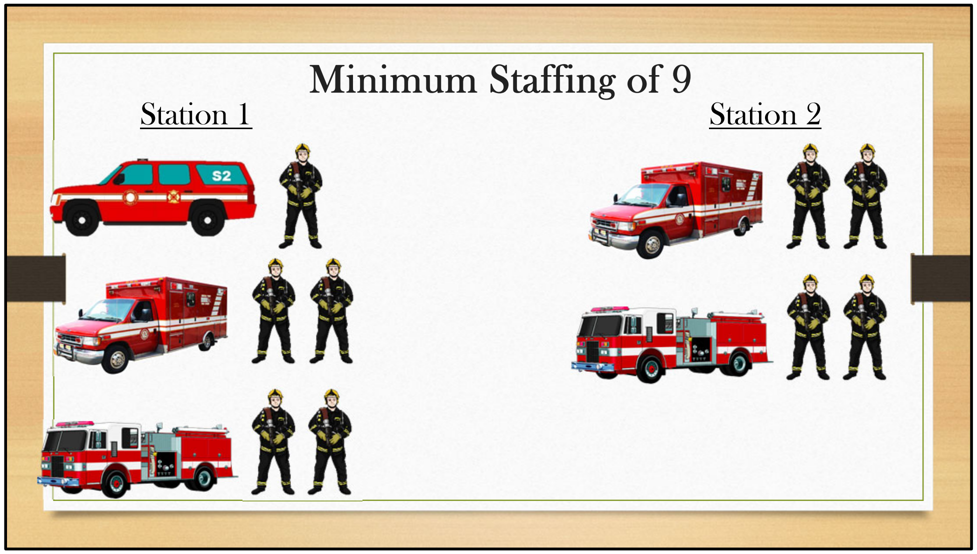
- The following slides give a graphic representation of how we deploy those 8, 9, or 10 firefighters that are on duty each day.
- This slide shows our maximum staffing or staffing at 10. As in, there is no one that is off duty because of vacation, sick leave, vacancies, FMLA, or injury.
- At Station 1, we have a shift commander (Battalion Chief), a fire engine with three, and an ambulance with two. Station 2 has a fire engine with two and an ambulance with two. This has only occurred a few times in the past 12 months.

- As you can see from the previous slide our minimum staffing causes the loss of two staff members from station two leaving the station available to respond to just one call.



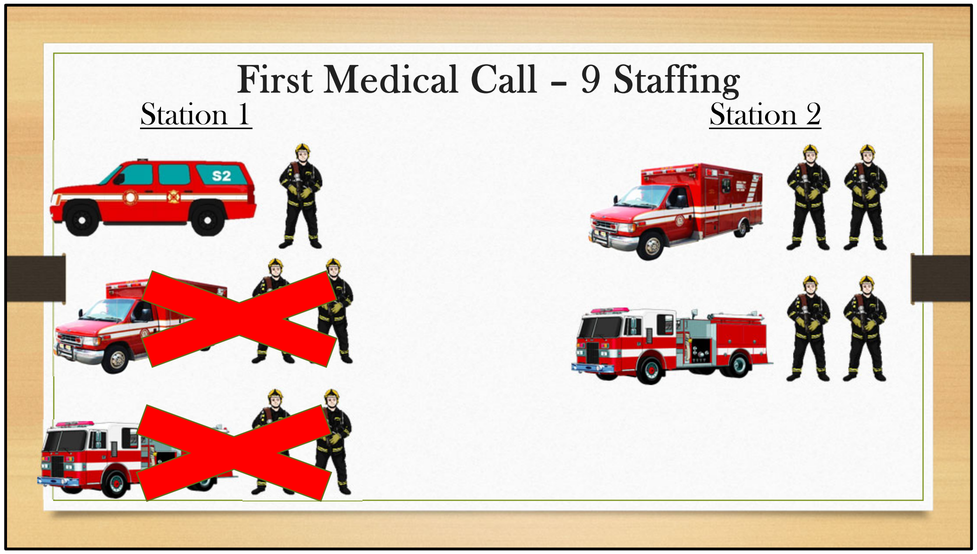
- One EMS call reduces available resources
- Can be for minutes or hours

- Due to our volume of calls we find ourselves at zero resources available on a daily basis as 37.41% of our calls occur simultaneously.



- What does Staffing of 9 look like:
- Having 9 firefighters on duty often allows us the flexibility to have 1 additional unit available to respond when we have overlapping emergencies
- It is important to note that over the last few years the fire department has been asking for an increase in staffing to get to a minimum 9-11 staffing model knowing that this is still not enough staff but absolutely needs to be done.
- A 9-11 staffing model means an additional three firefighter positions would need to be added to AFR staffing.

- I have included in your packet the NIST Fireground Field Experiments, if you turn to page 10 and 11, I have highlighted significant time findings based on staffing models to help you understand the significance of adding 1 additional person to a fire engine, or the ability to operate as 4 firefighters on an engine as Medford does.



- One EMS call reduces available resources
- Can be for minutes or hours

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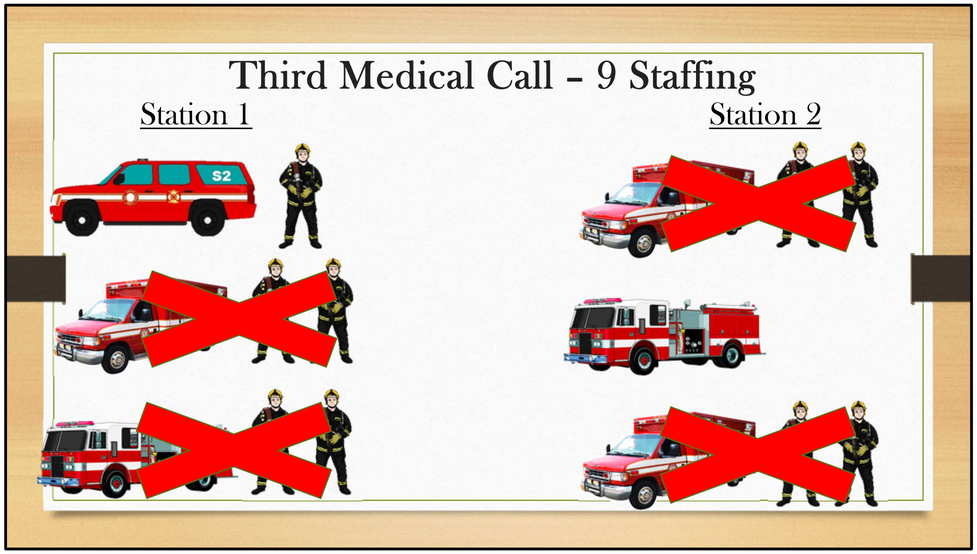
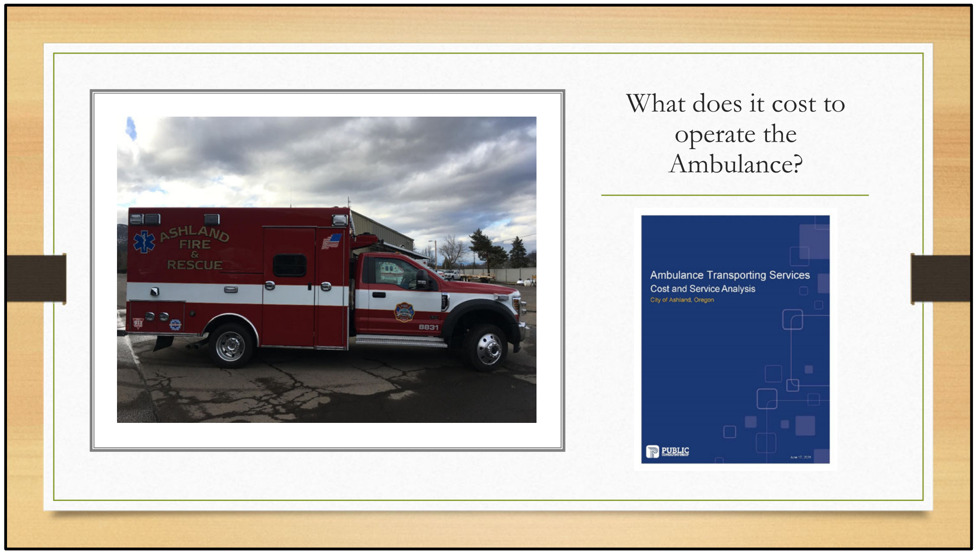
- Can be for minutes or hours



- As you can see form this slide at a minimum staffing of 9/11, we could handle 1 critical EMS call and two additional EMS calls for service simultaneously.

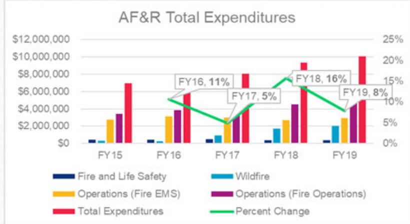
Questions?



The following information was provided by the Ambulance Transporting Services Cost and Services Analysis conducted by Public Consulting Group which presented its final copy of the report to the City on June 17, 2021.

Overall Budget Expenditures

	Fire and Life Safety	Wildfire	Operations (Fire EMS)	Operations (Fire Operations)	Total Expenditures
FY15	$410,554	$311,440	$2,768,370	$3,441,963	$6,932,327
FY16	$414,222	$274,693	$3,142,446	$3,835,605	$7,666,966
FY17	$527,106	$938,589	$2,968,292	$3,612,630	$8,046,617
FY18	$382,011	$1,717,786	$2,693,808	$4,516,694	$9,310,299
FY19	$385,320	$1,998,197	$2,912,383	$4,744,108	$10,040,008



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One of the large problems we keep addressing and it keeps coming back up is the addition of grant funds in the Wildfire Division as expenditures. When the community looks at our budget it is consistently fluctuating and then gets a huge net increase such as in FY18 and 19 when a 1.7 million and 1.99 million Grant for fuels management were added. This is not an increase in the FD budget from the general fund and is not used for an increase in FD Operations. This coming 21 and 23 Wildfire Division added an additional 2 million in Grants that will not be an increase in Fire Department Operational Budget but will be recorded as such.

Personnel & Shared Costs

	Total Operations Personnel Costs	Ambulance Personnel Costs
FY15	$4,706,082	$1,418,403
FY16	$4,845,552	$1,498,209
FY17	$4,919,705	$1,604,004
FY18	$5,399,631	$1,742,770
FY19	$5,894,849	$1,876,224

	Total Other Shared Costs	Ambulance Shared Costs
FY15	$129,294	$38,969
FY16	$163,613	$50,588
FY17	$133,224	$43,436
FY18	$183,600	$59,258
FY19	$151,366	$48,177

If we continue to staff the ambulance service with FF/s and not augment with single role EMT’s and Medics, this will continue to climb and not stabilize or decrease.

Ambulance Revenue

	911 Transports		Interfacility-Transfers		AF&R Ambulance Membership Program		Total Ambulance Revenue
FY15	$1,017,293	93.6%	$836	0.1%	$69,117	6.4%	$1,087,246
FY16	$1,089,835	93.8%	$3,250	0.3%	$68,267	5.9%	$1,161,352
FY17	$1,187,678	94.2%	$4,646	0.4%	$68,558	5.4%	$1,260,883
FY18	$1,061,335	93.9%	$4,124	0.4%	$65,132	5.8%	$1,130,591
FY19	$1,119,974	94.0%	$5,468	0.5%	$66,050	5.5%	$1,191,492

This slide is showing that our interfacility transports are not being realized as a true asset to the ambulance service and that we are continually sending transfers out of our department as we do not have staffing available to handle non-emergent transfers. This is an area additional staffing can realize an increase in income to the general fund.

Charges & Payments

	Trips	Gross Charges	Contract Allow	Net Charges	Payments
FY16	2,068	$2,329,765	$1,158,313	$1,171,451	$992,886
FY17	2,205	$2,501,085	$1,277,595	$1,223,490	$1,039,694
FY18	2,120	$2,394,233	$1,267,111	$1,127,122	$954,093
FY19	2,085	$2,423,855	$1,223,857	$1,199,998	$1,007,568

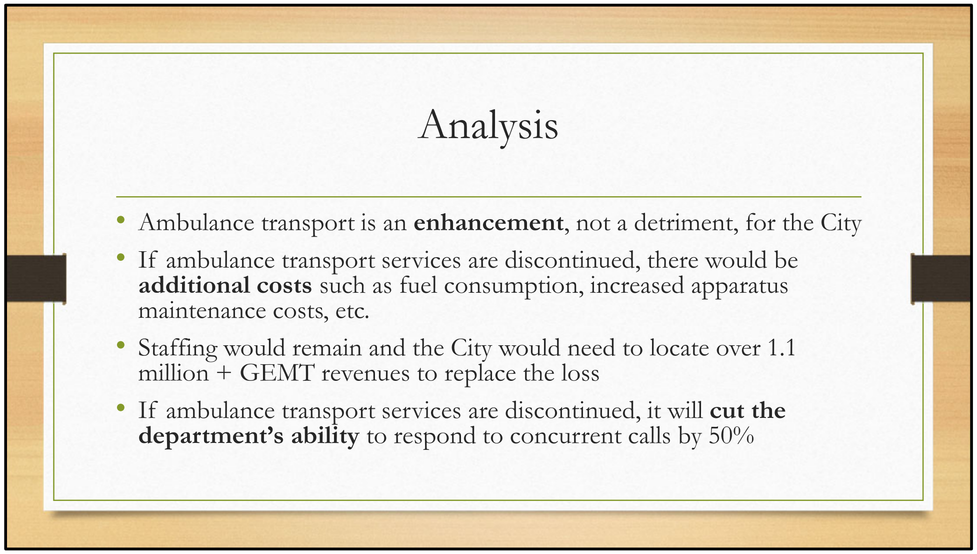
Payor Type	Average Annual Trips	Payor Mix by Trips	Average Annual Payment	Payor Mix by Billing Payments
Medicare	1,299	61%	$523,114	52%
Medicaid	385	18%	$134,091	13%
Insurance	301	14%	$301,744	30%
Facility Contract	32	2%	$24,364	2%
Bill Patient	104	5%	$15,246	2%

In this slide there appears to be about $200,00 from net charges to payments received this appears to be in membership write offs. This will be addressed later in ways to increase funding.

Net Cost

	Ambulance Expenditures	Ambulance Revenue	Net Cost
FY15	-$1,760,231	$1,087,246	-$672,985
FY16	-$1,881,099	$1,161,352	-$719,747
FY17	-$1,994,551	$1,260,883	-$733,668
FY18	-$2,133,123	$1,130,591	-$1,002,532
FY19	-$2,267,063	$1,191,492	-$1,075,571

5-year average Net Cost to operate ambulance services: **$840,900**



Many questions are surrounding the ambulance service, such as subsides, additional charges, cost, etc.

Can the City charge a higher fee for ambulance service outside the City Limits? The answer to this question is no; the billing is set during the ASA contract bid. We have to live with the rate set at the time of the contract with "cost of service built-in increases" on an annual basis. This is a small percentage, but it does occur.

The general fund heavily subsidizes the ambulance. I realize this is not a question but a repeated statement. The definition of subsidy is a sum of money granted by the government or a public body to assist an industry or business so the price of a commodity or service may remain low or competitive such as a farming subsidy. As you can see from the previous slides and the PCG review, the ambulance service and our staffing model have completely been intertwined since the inception of the ambulance service in 1996 and are funded out of the general fund.

The fire department staffing would not change if the ambulance service went away, as we would still be required to respond to medical calls and fires. We would simply move the two firefighters from the ambulance and put them on the fire engine with the other two employees to meet NFPA 1710 engine staffing requirements. However, we would decrease our availability to respond to simultaneous calls for service. The units would remain on scene for longer periods of time as we wait for a private ambulance to arrive at the scene to transport the patient.

If the question is, does it cost money to operate the ambulance, then the answer from PCG would be yes, it costs about $840,900 a year on average to operate the ambulance. In the same manner, like the statement the general fund subsidizes the ambulance, it could be argued the fire department subsidizes the general fund in excess of 1.1 million a year, which would need to be located from the general fund if the ambulance service went away.

What would it look like if the ambulance service went away, and the Council did not provide the replacement of the 1.1 million plus GEMT revenues?

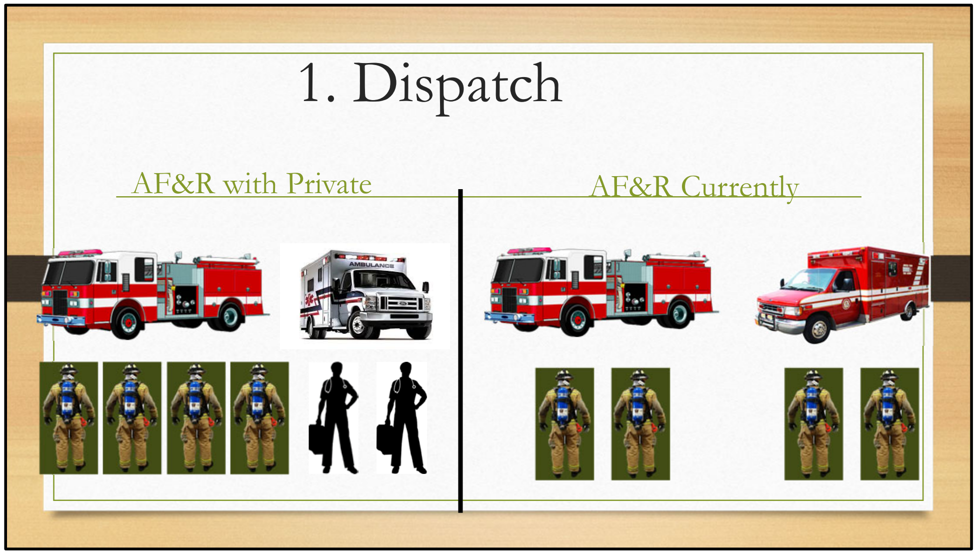
Ashland Fire with Loss of Ambulance Service and No Make up funding from Council

- Call volume will decrease by approximately 20 % from 4510 to 3608 (Remember in 2015 we had 3968 Calls with 30 firefighters)
- Fire Station 2 will close its doors
- We will lay off 6 firefighters taking staffing from 30 to 24 (1997 24 firefighters responded to 2146 calls for service)
- Staffing will move to 6/8
- Battalion Chiefs, Captains and Engineers will be demoted and only 1 Captain will remain on each shift

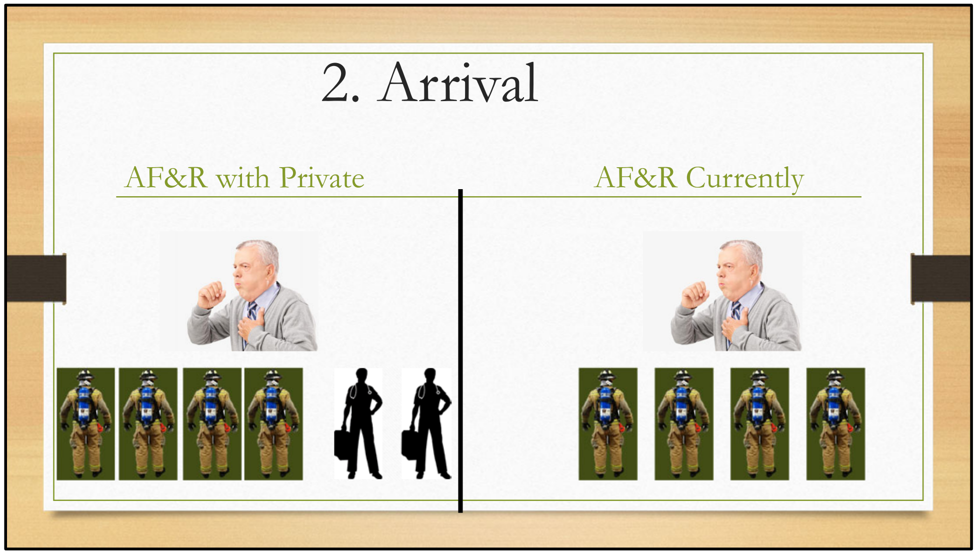
Ashland Fire with Loss of Ambulance Service and No Make up funding from Council

- We will remove the 5 Ambulances from Fleet and place more miles on the Fire Engines.
- We will only be able to respond to two calls for service
- Our ISO score will tank, and the citizens homeowner's insurance rates will increase and could be cancelled depending on their company.
- Our response to Dist. 5 will cause a decrease in their ISO rating
- Our response to structure fires will go from 14 staff to 12 with the national standard per NFPA 1710 at 18 firefighters needed

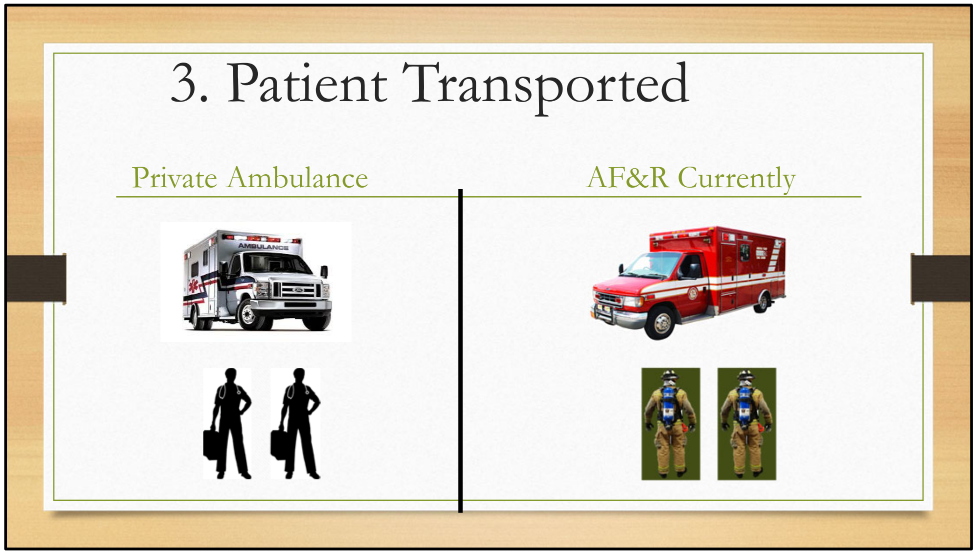
The following slides give an idea of what it might look like if the fire department did not transport. For the purpose of this comparison, we are assuming that someone living in the City of Ashland is suffering from chest pain and calls 911.



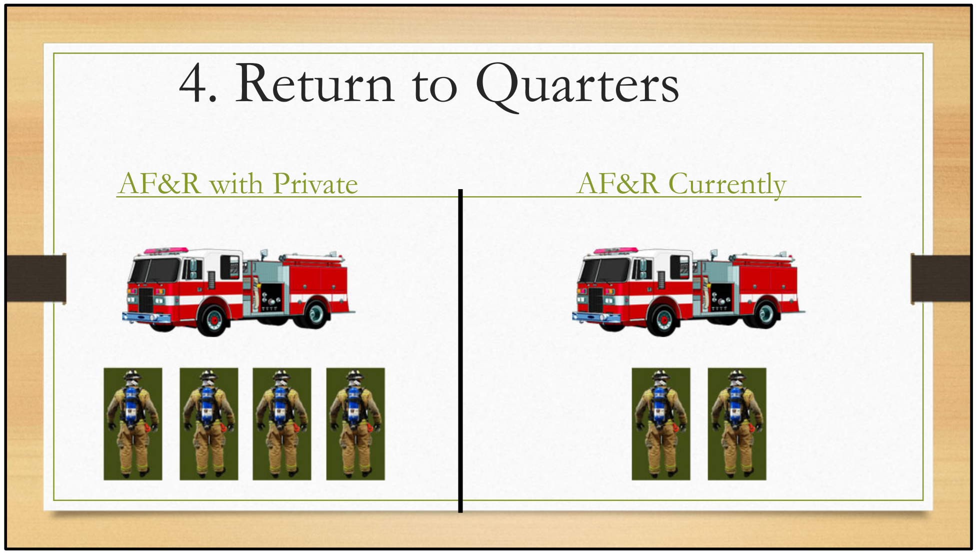
For this comparison, let's assume that someone living in the City of Ashland suffers from breathing difficulties. They have recognized that they need immediate assistance, they have called 911, and units are dispatched. As this is a "D" or David level response, both a fire engine and an ambulance are sent on the call. The right column shows how we currently respond; one of our fire engines with 2-firefighter/paramedics and one of our ambulances with 2-firefighter/paramedics will go enroute at the time of dispatch. The left column shows what would happen if we didn't have the ambulance service. One of our fire engines would respond with 4-Firefighter Paramedics, and the private ambulance provider would respond with 1-Paramedic and 1 EMT.



The units would arrive on scene and care would be initiated.



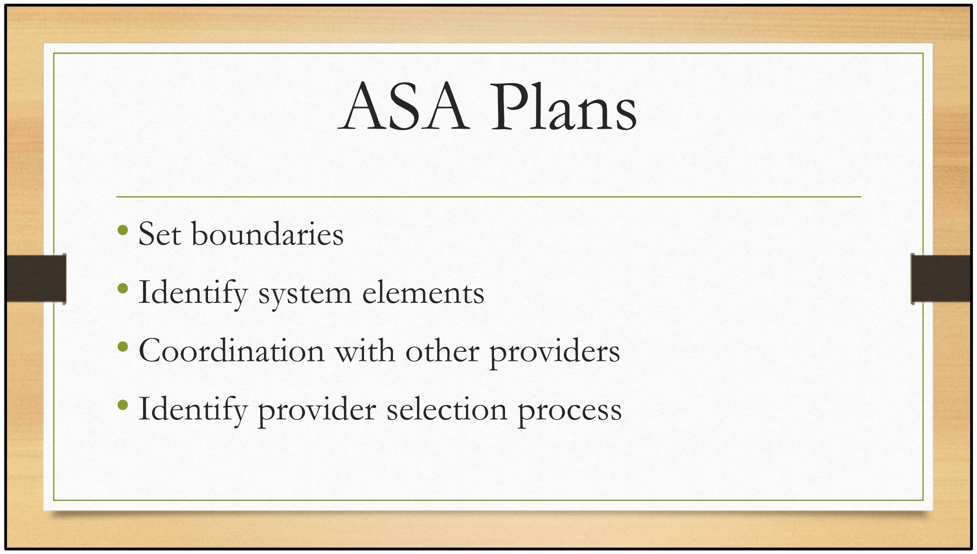
The patient would be transported to a local hospital.



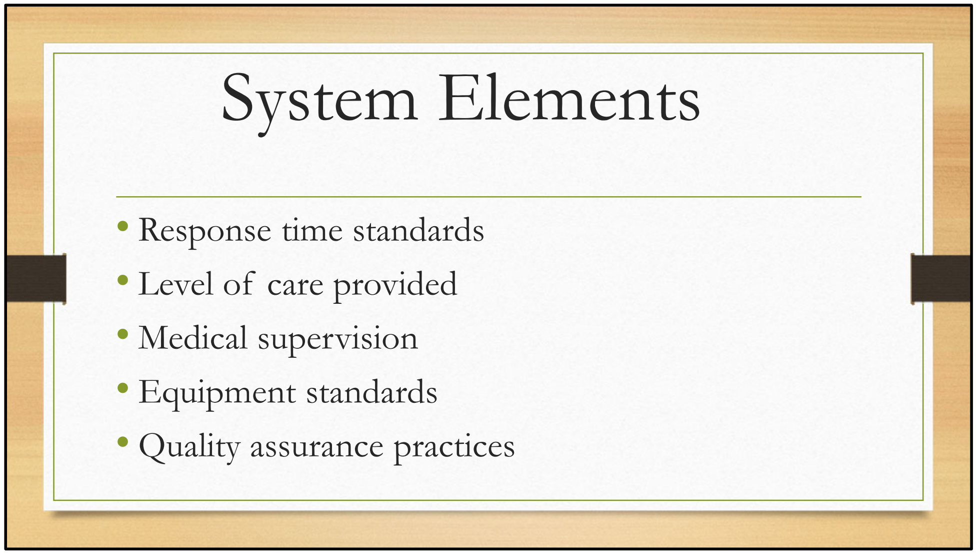
The fire engine would return to quarters. Once back at the station, the remaining personnel would ready themselves for the next call. Currently, with the ambulance, as 2 of the FF/Paramedics are transporting the patient to the hospital, the remaining crew will either staff a fire engine or an ambulance depending on the type of the next emergency. Without the ambulance, the four firefighters would ready the engine for the next response.

It is important to note that this entire presentation is built on the foundation of comparing existing services to those we might do with out and the finances associated with those decisions. What we have not talked about, but should be considered, are those things that the department still needs, especially if we continue to run the ambulance service, and associated finances

Additional Information

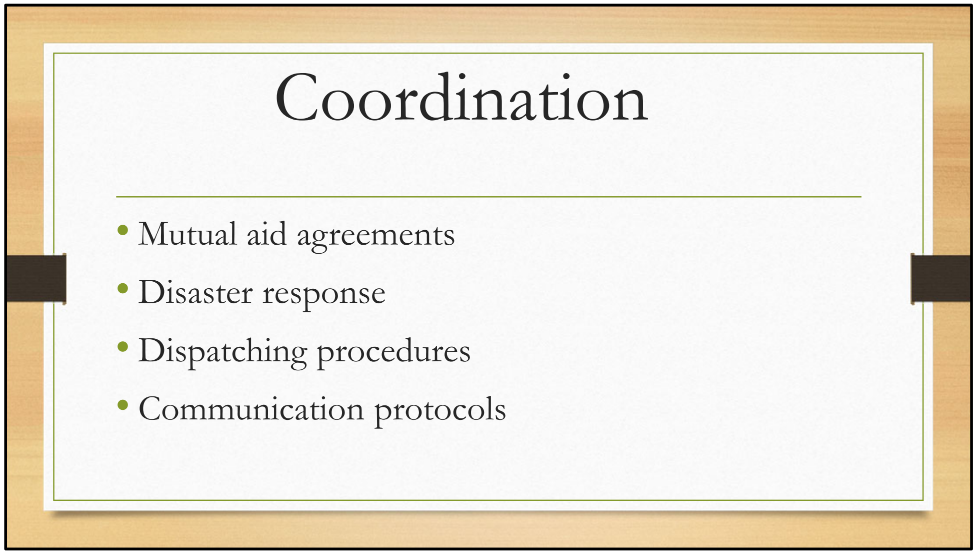


All county ASA Plans must contain four certain features as identified by state law. Those features are boundaries, system elements, coordination and provider selection.



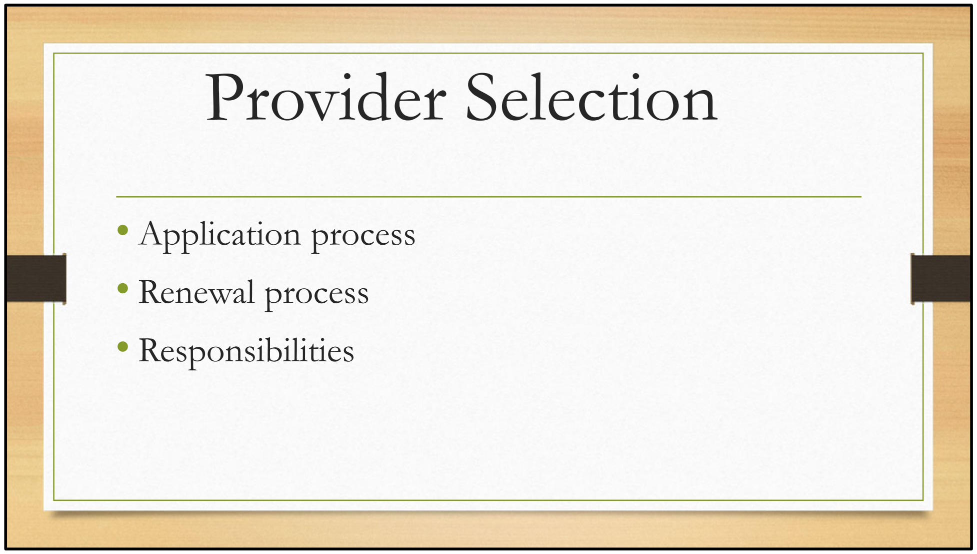
The next component of the ASA Plan are system elements. System elements are those things such as:

- Response time standards
- Level of care provided
- Medical supervision standards
- Equipment standards
- And Quality Assurance practices



Coordination is the next feature. Coordination identifies those things such as:

- Mutual aid agreements
- Disaster response
- Dispatching procedures
- And communication protocols



The last key feature of an ASA Plan speaks to how the county will assign an ambulance service area. Key components of provider selection include:

- The application process
- The renewal process
- And the responsibilities of ASA holders during their assignment

As previously shown, Ashland Fire & Rescue has maintained the contract for ASA #3 since 1996. We are currently in a three-year extension on our last contract Which was signed in November of 2020, and we will need to apply for the ASA contract by July of 2023.

- Assuming we do not apply for the 5-year contract, prior to July 4, the county will advertise that ASA #3 is open to interested parties.
- The county will expect letters of intent from any interested parties by September 2nd
- Applications must be completed by November 2nd.
- If we apply for the Application and there are no challenges, the Jackson County Board of Commissioners usually receives a report from the public health division manager and ASA holders are granted another five years.

- If there is a challenge to an ASA, there will be a hearing(s) that are presented to the JaCo BOC. The hearing(s) would include presentations, public testimony, introduction of evidence and rebuttals.

I keep hearing we need to talk to Mercy Flights. Mercy Flights is not the only player in the area. I have no issues with Mercy Flights as this was my second job in the valley many years ago and can I speak with their current CEO at anytime I need. There are just a few things that must be understood and keeps getting overlooked.

The City Council will have absolutely no say as to what entity receives the ASA contract from the County. There will be other private companies looking to bid for ASA 3 in Southern Oregon market such as Cal-Or Life Flight, AMR, Reach, Metro West, Faulk, Medic West, all companies who have much deeper pockets than Mercy Flights. These companies could bid well below the county transport charge to get their feet into ASA 3 and be direct competition for Mercy Flights own ASA when it comes up for bid in a few years. Additionally, District 3, District 5 or Medford Fire could also bid for the ASA in this open process should they choose.

Additionally, it has been asked that Mercy Flights conduct a presentation for how they would serve the City of Ashland at a lower cost than AFR. This presentation has been held before the Cost Review Ad Hoc Committee in 2019 where the Mercy CEO stated the following:

"If Mercy Flights served the Ashland ASA, we would post an additional 2 ambulances within the Ashland City limits and post an additional ambulance in

South Medford allowing for a fast move up to Talent, Ashland and other areas of ASA-3. With this posting plan, the ambulances per capita ratio within the Ashland City limits would be approximately one ambulance per 11,000 people, matching and/or exceeding the coverage provided by AFR today."

They also stated:

"With regard to how Mercy Flights would increase staff and ambulances: Mercy Flights would add 3 additional ambulances to our fleet, and we would hire an additional 8 paramedics and 8 Emergency Medical Technicians."

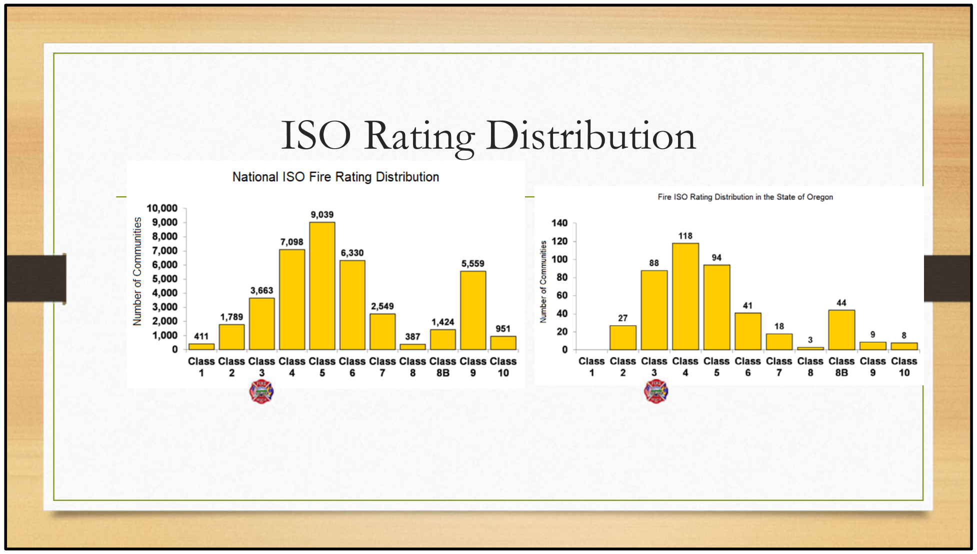
Let's look at some numbers for a private ambulance service looking at the ASA for their bid. I will use $100K for full salary and benefits for the employee, and I understand that the number may be lower for a single roll Basic EMT and a bit higher for a single roll Paramedic. I am trying to illustrate a general cost analysis; their cost analysis will be down to the dollar. By Mercy Flights statement above they would hire 16 system status single role EMT and Paramedics (8 each) to cover Ashland 24 hours a day with two ambulances in Ashland as AFR is currently doing. (This does not include any management, supervisory, ambulances, equipment, station rental fees and administration needs, only the staff on the ambulances). This is $1.6 million in salary and benefits for these 16 employees at the 100K salary and benefits.

AFR is bringing in a little over 1.1 million in transport revenue. How long can a not-for-profit organization loose 500K a year, before it has to change its staffing model? Or receive a true subsidy from the City?

Questions?

Insurance Services Offices
ISO

Last Completed March 27, 2015



How is ISO Calculated?

This is a complex process where evaluators review:

Emergency Communications: Emergency Reporting, Telecommunicators, and Dispatch circuits. This evaluation counts for 10% of the overall score.

They then examine the Fire department by looking at the following: Engine companies, reserve pumpers, pump capacity, ladder service companies, reserve ladder service, deployment analysis, company personnel, training, operational considerations, and Community Risk Reduction. This accounts for 50 % of the score.

The final 40% of the evaluation is water supply. For this they look at the supply system, hydrant size, type and installation, inspection programs and flow testing.

They put the numbers together and provide a PPC score with 10-point increments starting with a low score of 10 and the best score of 1.

What do we need to do to maintain our current ISO 3, and What would happen if we were evaluated today?

The calculations ISO uses are not something that one can get to determine their final numbers. We are provided information on what is graded. Some items can include what equipment is on a fire engine and how much water our engines can pump. These items are easy to understand. What is not is how they calculate staffing. When they are looking at staffing, they are looking at calls for service, number and type of structures, existing fire suppression demands, and so on.

I can say that in 2015, the fire department received .84 out of 4 points for ladder service, .0 points out of .50 points for reserve ladder service, 6.22 points out of 10 points for our deployment strategies, and 7.5 out of 15 points for staffing. (We received a total of .84 of 4.5 points for ladder service). To put this in teaching prospective and grading we received a solid A in Community Risk Reduction an overall D+ with an F in staffing and deployment which drew down the fire department score the most. If we could get the staffing and deployment to a C, we stand a very real chance of being a high ISO 2 and possibly the first ISO 1 in Oregon.

However, If ISO showed up today, I know we will lose points in some areas and gain points in others. In the gain, working with District 5, once their primary ladder truck is in service, we will receive partial credit for their ladder truck, but it will not be full points as it is not staffed per NFPA 1710. We will also receive points for the reserve ladder truck as they will have a truck that will count in this category for at least three more years. Due to increasing our training requirements in the first year of probation and promotion, we will receive an increase in our training category as we are now meeting national standards for first-year training assignments.

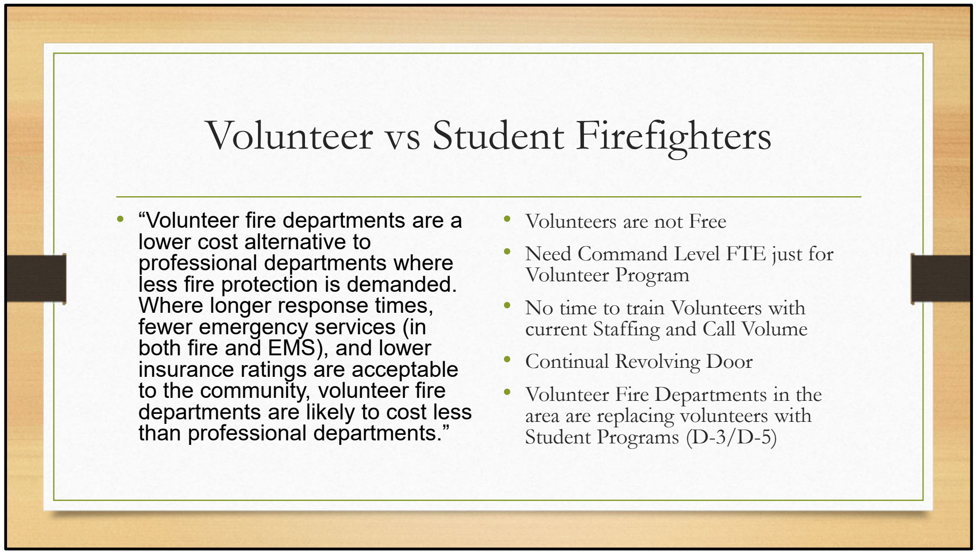
We will, however, lose some points in our community risk reduction with loss in community fire inspections. Our big hit will be in personnel again, remember the last time they evaluated us, we had 3968 calls for service with 8/10 staffing, availability of three executive officers, and an overlapping call volume of 1453 calls. In 2020 we had 4510 calls for service with 1687 overlapping calls for service (37.41% of the time) or an increase of 16.10% with three fewer firefighters from the 9/10 staffing and one fewer executive officer to respond or a net decrease in the staff of 11.11%. We cannot overcome this number without increasing our staffing.

How does ISO Play into Insurance Premiums? ISO is a part of the insurance premium assignment of several insurance companies. To set a rate for consumers to pay. 15-years ago, this was the only game in town, and therefore the number was the only thing looked at. Since that time, insurance companies have gone to multiple parts in the determination of premiums, and other such as State Farm use their own completely proprietary process.

The first thing I learned was they, for the most part, don't call it ISO anymore; they call it PC or Protection class. This is the same thing as ISO just used as a different name, and it assigns the same 1 thru 10 scores to the fire service of the area. The next part is looking at a Fire Lane Score, which is really important to Ashland as it is trees around the home and defensible fire spaces. Next, they look at fire loss data (Types of fires and dollar loss) for a specific area. Then they look in the area to determine their loss potential and decide if they do or do not want to insure a specific location. Then they have a proprietary credit scoring system that looks at all aspects of your life to determine what their risk calculations are for the company. Then finally, some companies use Data mining of the person to decide additional risks based on social media, hobbies, etc.

There is no way to know what an individual's score will be taking into account everything above. However, as the PC (ISO) classification gets closer to 10, the rates in the area on renewal will increase above the normal adjustments for inflation. This means if our ISO drops our citizens will pay more for their insurance when their renewal comes around, additionally, depending on the severity of the drop, some insurance sompanies in areas prone with fire have chosen to cancel policies as to great of a risk.

Questions?



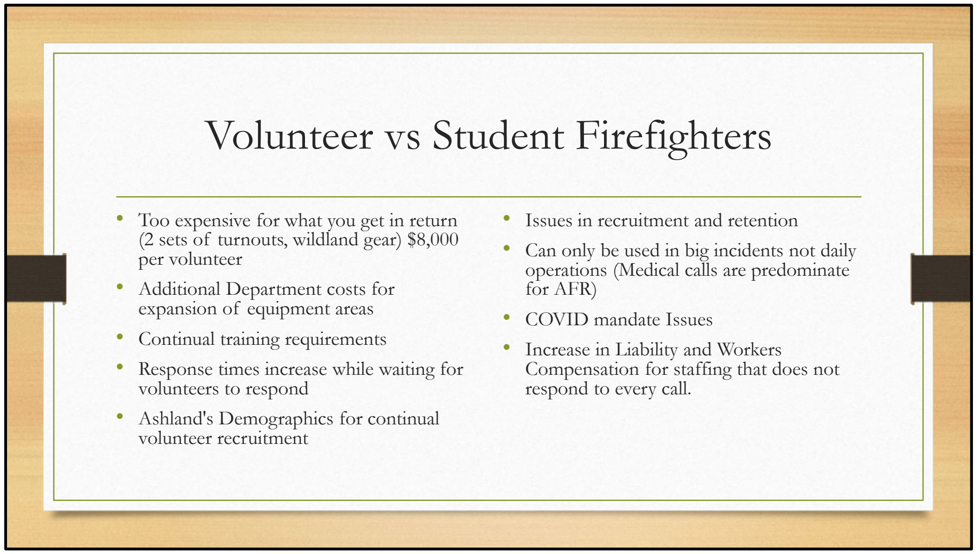
This quote is from the 2001 report volunteer vs professional FF-Study (Included in your packet).

Volunteer programs are time-intensive, place a strain on the department to consistently be recruiting and require a full-time retention officer or Chief of Volunteers. Volunteering is a noble pursuit, but in our current society with a decrease in an available work force, it is difficult to retain volunteers, so there is a constant revolving door of people willing to volunteer, which turns into a training nightmare for the volunteer who is also trying to maintain employment . Volunteer fire departments once depended on local employers who offered full-time jobs with benefits to their volunteers and were willing to have employees leave work to fight fires. Today a typical job is as a per-hour worker with unpredictable shifts.

According to a 2014 report from the National Fire Protection Association (NFPA). About 70 percent of America's firefighters are volunteers, and 85 percent of the nation's fire departments are all or mostly volunteer, according to NFPA with the smallest communities — those with fewer than 10,000 residents — are almost always served by volunteer departments.

Across the country, small, rural fire departments are struggling to recruit and retain volunteer firefighters. But even where the number of volunteer firefighters is holding steady, the number of calls is exploding. According to NFPA the number of volunteer firefighters nationwide has declined 15 percent between its all-time high in 1984 and its all-time low in 2011 and, because over that same period, the number of calls has increased nearly 300 percent (Most of that increase is in medical calls), existing firefighters are suffering from burnout.

Several local departments are moving away from volunteers due to the required work, time, and training. Fire Districts 3, 5 and Grants Pass have or are moving away from volunteers and replacing them with student firefighters. Some agencies are partnering with their colleges while others are conducting their own programs.



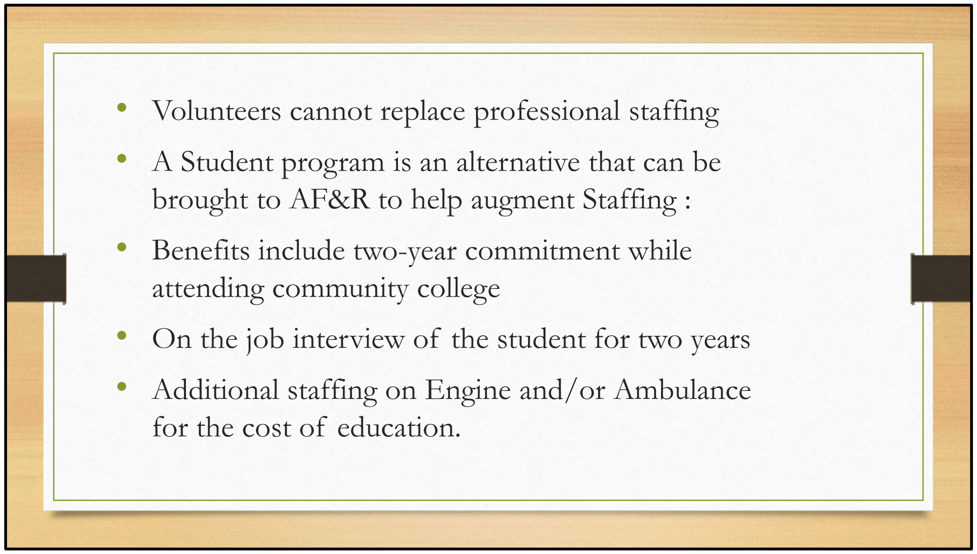
Volunteers must meet the exact requirements of professional Firefighters when assigned with a professional fire agency. With Ashland Fire and Rescue being an all-hazards department, this would be an expensive and nearly impossible task. Basic firefighting operations would be affected, and we might need to limit firefighters to defensive operations and not allow interior offensive operations due to the numbers needed and training required. Some volunteer agencies who cannot meet the minimum requirements are not allowed to enter a structure that is on fire.

To expect a volunteer to hold professional credentials and not get paid is absurd. The following are our training requirements for our professional firefighting staff, as stated this would not change for a volunteer. They include:

- DPSST Firefighter 1 and 2
- DPSST Driver
- DPSST Hazardous Materials awareness and operations
- DPSST Pumper operator
- DPSST Rope Rescue
- DPSST Trench Rescue

- DPSST Confined space rescue
- OHA Paramedic
- OHA EMT
- DPSST Fire Officer 1 and 2
- DPSST Wildland Credentials
- Oregon drivers license
- APD Background Check
- Psychiatric evaluation
- Health physical
- Annual physical fitness test

Training is not the only burden that volunteers carry along with career firefighters. Certain cancers, sudden cardiac death and trauma-induced mental health issues are additional health burdens carried by all firefighters.



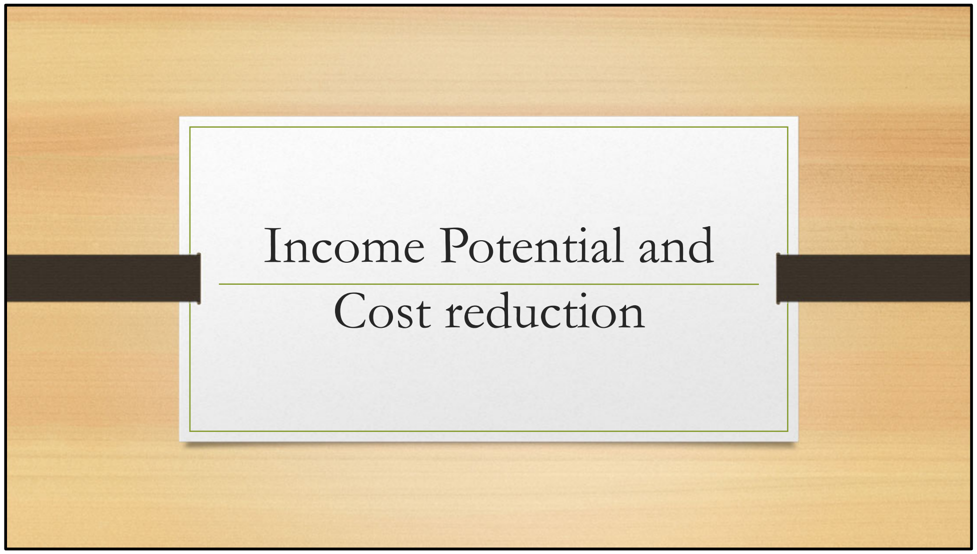
When speaking of ISO from the previous group of slides, the new NFPA 1710 staffing has added the following statement for volunteers counting towards professional staffing.

The FTEs would be several part-time employees whose combined hours equal a full-time employee. A simple example: if a fire department staffs a riding position 24/7 with 7 part time employees each working 24 hours a week while career personnel work 56 hours per week, the 7 part time personnel would constitute 1 FTE riding position.

This is to say it will take 7 volunteers to equal 1 professional firefighter for staffing

The best alternative for a professional agency looking to augment staffing at a reduced cost is to look towards student or journeyman firefighters.

Questions?



Some reduction in costs for services I have already implemented: Having attended the ad-hoc committee's meetings on budget reduction, also under the advisement of outgoing Chief Shepherd, we listened and implemented one of the plans by hiring three firefighters EMTs and not three more Paramedics to the open vacancies. This one step reduced over $30K in employee costs. I will not know the exact number per employee until the completion of their one year.

Before you ask if this is how we will move forward, the answer is yes and no, at this time, I have to keep paramedics to maintain an ALS presence, and with minimum staffing of 8, I cannot place one more EMT into permanent staffing. As our staffing numbers go up, I can hire more EMTs proportionately and further reduce staffing costs.

Another area where we have reduced costs already is in ambulances purchases. We were able to locate ambulances that were $80 K less than what we are currently purchasing. We cannot for the firefighters purchase the van-style ambulances such as you see for Mercy Flights as the equipment, we carry is different. We have to isolate the firefighter's protective clothing from the patient and crew compartment. However, if we add single roll positions into the department, this style of ambulance can be ordered extending the replacement time on our current fleet and reducing the cost of new ambulance purchases even further.

Some areas where we can increase revenue for the ambulance service: Since the passage of this budget, Ashland Fire and Rescue has been invited to participate in an additional GEMT revenue program and believes we will see an increase in the revenues this coming year. This is additional monies that are written off under Medicare/Medicaid. We must participate in phase one to be allowed into this next program. I sent out an RFP and am pleased to announce I have signed a multi-year contract based on recovery. What the additional amount of income will be at this time is not known. However, if we do not have an ambulance service, we do not get this income.

Ambulance Membership, we are looking at ways to take the time-consuming method of ambulance membership currently to a new system in Utility Billing. This will help streamline our process and allow us to market and try and expand the program. This has been placed on hold while we are waiting for the full-time finance director to be hired. Once this is complete, we can begin a membership drive to increase our membership fees outside of the city limits.

We will also need to re-negotiate the pay rate we receive for signing our citizens up with the air ambulance part of the Mercy Flights program. Additionally, as you heard, we should look at a citizen-wide opt-out ambulance membership service to increase the program and help protect the community from the cost of ambulance transport for those uninsured or underinsured.

Here is the big one, as you remember from a previous slide we aree leaving nearly 200K on the table every year. It appears this section is the reason for this. I cannot find out why or who started this with our Ambulance Membership, but we currently offer a 100% coverage write-off of uninsured patients in our basic membership fee. Mercy-flights has a write-off clause as well, but theirs is at 50%. What this means is, if a person has no health insurance and they sign up for our membership service, we will transport the patient every time and right off the entire amount. As you can see from the recovery side of the ledger, we are currently throwing away a significant amount of money in nonbillable ambulance membership transport fees. We need to reduce our write off clauses from 100% to at least 50% or less.

Our collection rate is increasing as we are getting more and more comfortable with data exchange and information collection between us and our new billing service. Because of government rules, we cannot collect the funding if we miss a form or miss-code something.

Additionally, with the passage of the new budget, we will be transitioning to new computer software for emergency reporting that will capture missed forms and codes and not allow the transport report to be complete until all the required information is submitted. The new system has a built-in quality assurance module that will assist us in assuring compliance in billing and the treatment modalities offered to the community under the license of our physician advisor. This new software should also reduce staff time on report writing as it is linked to ECSO and auto-populates in real-time as dispatch receives the information. This system is scheduled to go online on January 1, 2022.

Rate recovery for outside calls for service (IE.. I-5 MVC's). While this is an area we are currently struggling to realize, the new software will also capture this information better and allow for additional revenue collections. This will also be one of the duties of the Operations Chief to ensure this information is tracked and recovered appropriately. The absence of the Operation Chief has allowed things like this to fall through the cracks.

One of the largest areas of missed financial opportunity for Ashland Fire is in daily Ambulance interfacility transports. The transport requests are all over the board and because we have been operating at 8/10 staffing, we have not been able to get crews free for these non-emergent transfers. We are in the process of streamlining this with Asante Ashland Community Hospital, and it will take several months to accomplish the rollout to streamline the process but we are moving in the correct direction. However, we still need people to do the transports.

We are suffering from staff fatigue, mandatory overtime for minimum staffing almost everyday right now, and trying to get staff to come in on their limited days off to transport patients from one hospital to another is challenging to say the least. As of writing this report last year to this date, we ran 3128 calls with 1196 overlapping calls for service; this year, we have run 3326 calls for service with 1438 overlapping calls for service. This is an increase of 6.33% in call volume and a 20.23% increase in overlapping calls for service.

There is no other way to say this other than we need help with staffing immediately. I realize that we cannot hire 9 firefighters immediately to get us the additional staff we truly need. However, we can get temporary assistance and reduce the cost of the ambulance service while increasing the availability of transports with some steps.

Costs:

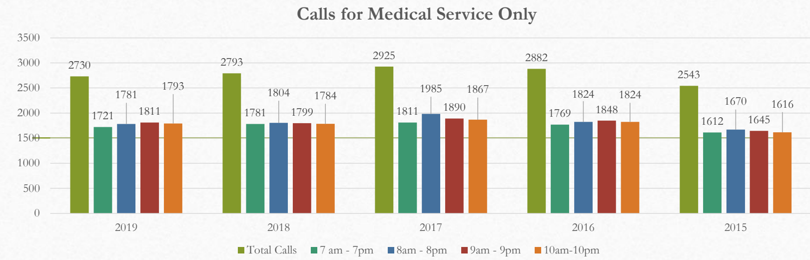
- AFR FF-P 5-year progressive w/29.65 PERS= $512,410.509
- EMT-P 5-year progressive w/25% PERS= $325,816.84

Savings= $186,593.669

- AFR FF-P 5-year progressive w/29.65 PERS = $512,410.509
- EMT-B 5-year progressive w/25% PERS = $261,597.945

Savings= $250,812.564

Total from Previous Slide

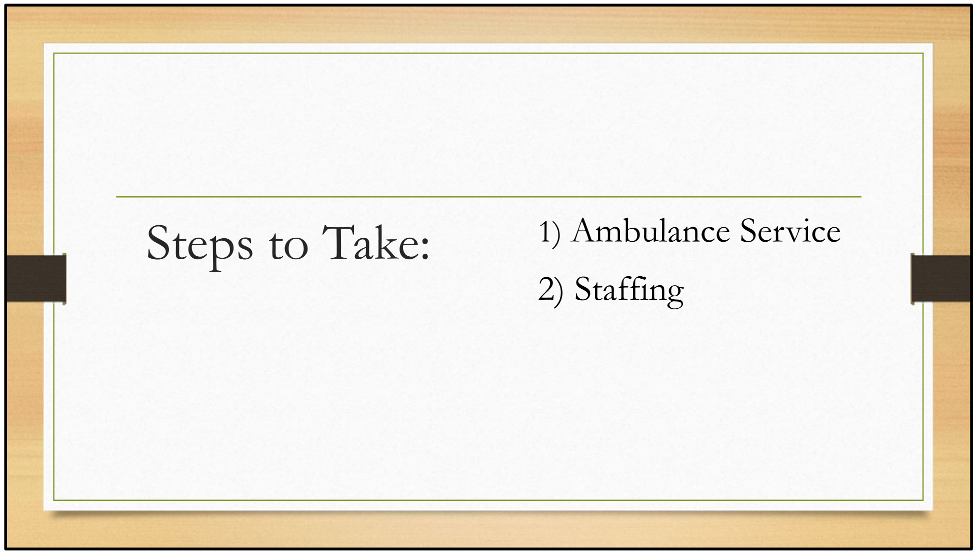


5-year average from 2015-2019

What did the previous slides tell us?

Year	Total Calls	Busy Time	# Calls	%	Per 12 hrs.
2019	2730	8 to 8	1811	66.34%	4.97
2018	2793	7 to 7	1804	64.59%	4.94
2017	2925	8 to 8	1985	67.86%	5.43
2016	2882	9 to 9	1848	64.12%	5.06
2015	2543	7 to 7	1670	65.67%	4.57

Medical Calls Only



1)Begin running the ambulance section of the fire department using private business models to reduce costs of service and bring the $840,900 to more of a neutral cost.

2) We need 3 firefighters immediately, and we also need to augment the firefighters with an ambulance single roll Paramedic and EMT as Lebanon, Albany and Klamath County District 1 does. This assistance will allow for an additional ambulance in the system during peak times, allow for transports and will decrease costs of the ambulance service.

There are two ways this can be done; we can ease into single roll medics with 1 Paramedic and 1 EMT working Monday thru Friday 8 hrs. a day from 10 am until 6pm. After a year if it does what we believe it will do in reduction of fatigue, an increase in transports, and an increase in available additional resources then we can add 1 additional Paramedic and 1 EMT and run this ambulance 7 days a week 10 hours a day. This provides a third Ambulance with 2 FTE's during a peak time 5 days a week.

Or we jump into this right now and hire 2 Paramedics and 2 EMT's and provide an additional 3rd ambulance to our system 7 days a week 10 hours a day during our peak times. Our call volume shows we need the FTE during daylight hours between 7 am and 9 pm and this ambulance will be available to assist in reducing this call load which occurs at 65%.

We also need the Deputy Fire Marshal as described previously.

There are other positions that are needed however, these 6 or 8 positions is what is needed to support the information provided to you in this document and protect this community immediately.

The call volume is not sustainable with the staffing model we are operating under.

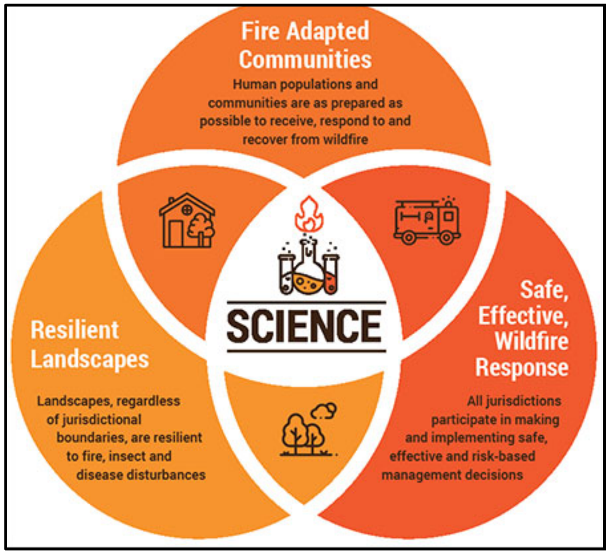
Questions?

Wildfire Division

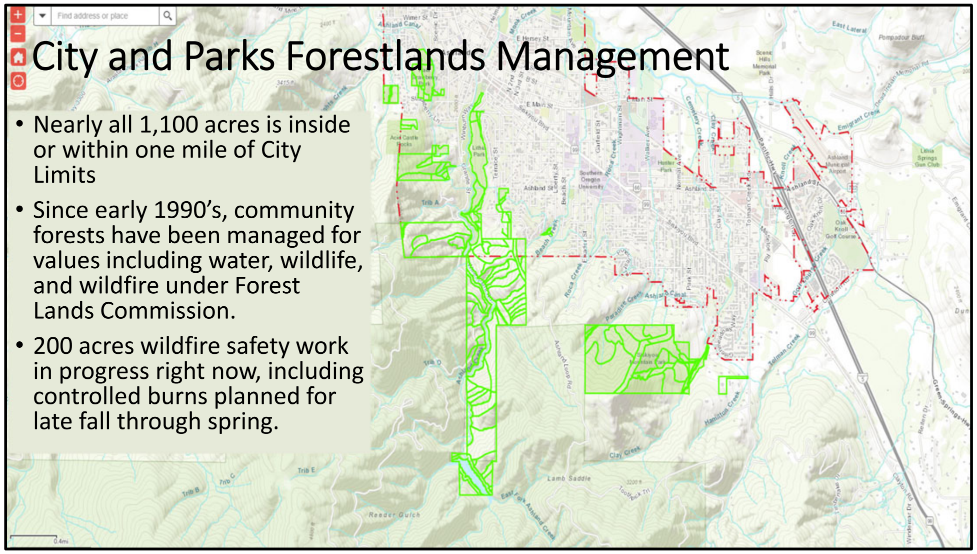
Fire Adapted Ashland

Ashland Forest Resiliency Stewardship Project

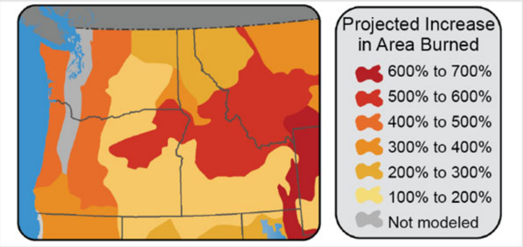

Ashland's Cohesive Approach to Wildfire Safety
www.fireadaptedashland.org
www.smokewiseashland.org
www.ashlandwatershed.org



National Cohesive Wildland Fire Management Strategy:
Ashland's Cohesive Programs

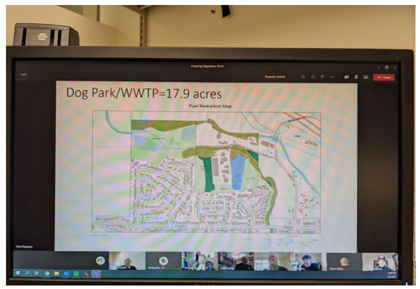

City and Parks Forestlands Management
• Nearly all 1,100 acres is inside or within one mile of City Limits
• Since early 1990's, community forests have been managed for values including water, wildlife, and wildfire under Forest Lands Commission.
• 200 acres wildfire safety work in progress right now, including controlled burns planned for late fall through spring.
Find address or place

Adapting City and Parks Forests to Climate Change



- **A cutting-edge plan is being put together via Forest Lands Commission to chart adaptation to changing climate on City/Parks forestlands**
- **Complements the City's Climate and Energy Action Plan and 2016 Ashland Forest Plan.**

Interdepartmental Vegetation Management Team



- **Inventoried all City/Parks property for fire hazards in 2020**
- **Majority is blackberry bushes along creeks**
- **151 acres of mowing/cutting fuel breaks already takes place *every year***
- **Implementing work plan to remove as much blackberry starting close to homes and maintain fire safety over time.**

FOREST SERVICE U.S. DEPARTMENT OF AGRICULTURE

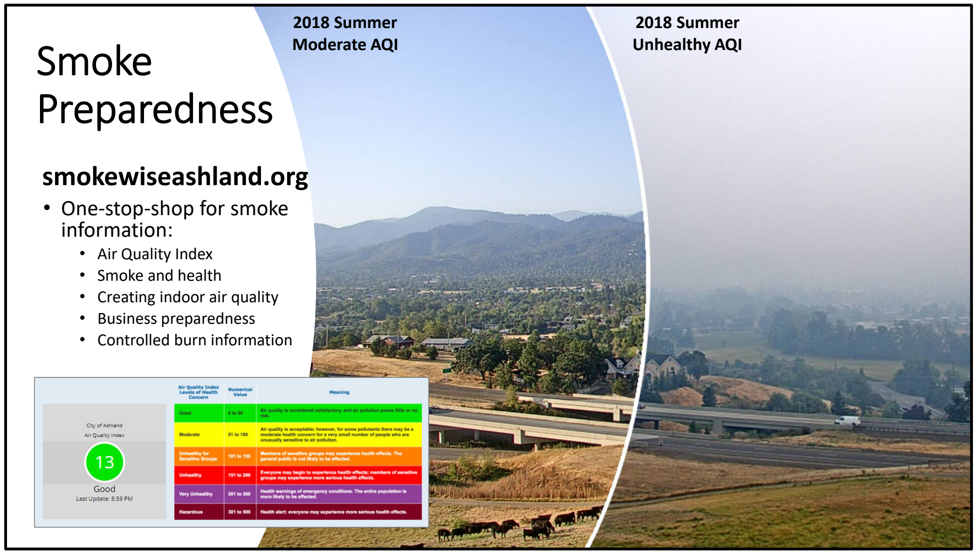
CITY OF ASHLAND

LOMAKATSI RESTORATION PROJECT

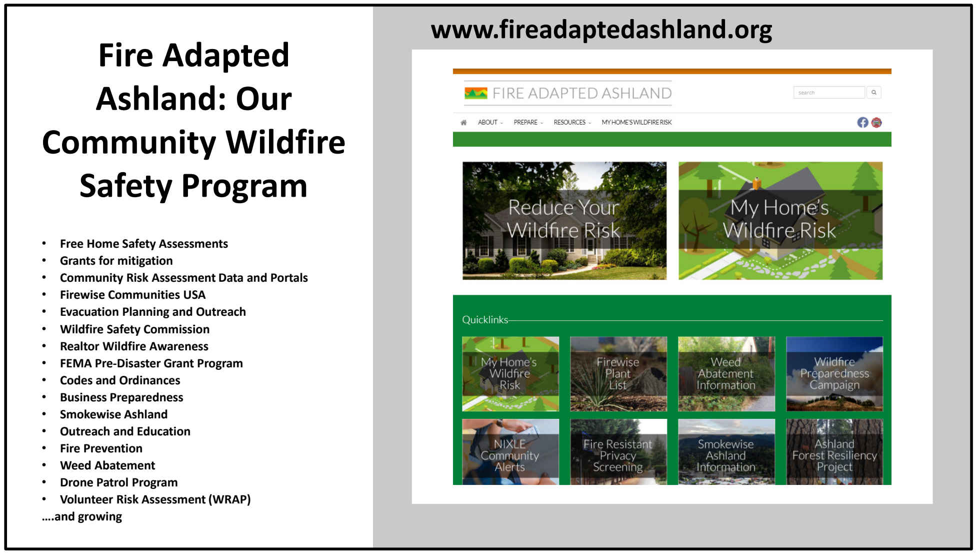
The Nature Conservancy
Protecting nature. Preserving life.™

Ashland Forest Resiliency Stewardship Project

- **10+ years of work across U.S. Forest Service and private lands has stitched together 13,000 acres of wildfire risk reduction on public and private land.**
- **City investment of $2.25 Million over 10 years has returned <u>$32.5 Million</u> in external funds!!**
- **Need to more than double controlled burning to greatly heighten fire safety and forest health.**



On the topic of smoke, we are also working really hard to keep our most smoke-vulnerable residents safe from wildfire smoke. Smoke is a common visitor to ashland, particulary in recent years. 2020 was no exception proving insult to injury after the Almeda fire
-I mentioned the smokewise ashland website. That website includes info on how to create and maintain clean air in your home, we post the current air quality in ashland, and provide information about how smoke impacts your health.



So that is a Fire Adapted Community in concept, but what does it look like in practice? In Ashland, we have several highlights that we are proud of that I will be sharing with you today, but in the spirit of the FAC concept, I'll also share some areas that we are actively working to improve –because becoming a Fire adapted Community never has an end point. To start, a lot of the information on our various FAC work can be found all in one place a website – fireadaptedashland.org – I do not know about Eugene, but Ashland likes to have as much custom information specific to our place as possible. We point everyone we talk to about wildfire in ashland to the various pages on this website. Information about the programs that I talk to you about today can all be found here, so I welcome you to check it out if anything peaks your interest.

Codes & Ordinances

- **Weed Abatement**
  - June 15th deadline - Dry Grass and Weeds 4 inches
- **Wildfire Safety Ordinance**
  - Affects New Development/Additions from 2018 on.
  - Wildfire Safety Requirements
    - Prohibited flammable plants list
    - Fence connections made of non-flammable material
    - No wood roofing

In ashland, we have several codes and ordinances that we can use to both tackle wildfire risks that currently exist in our community, and hault future fire risks from being planted or constructed in our community. We have a weed abatement ordinance that requires residents to cut their tall dry grass and weed each year by June 15th.. In 2018 we adopted our wildfire safety ordinance, which allows us to prevent new construction and landscaping that presents a wildfire risk. This includes requirements for defensible space to be created around new constructions and additions, prohibits installation of new bark mulch within 5 feet of the home and new plantings of a list of flammable plants which are listed on our website, and requires that newly constructed fences be constructed of non-flammable within the first 5 feet of attaching to the home.

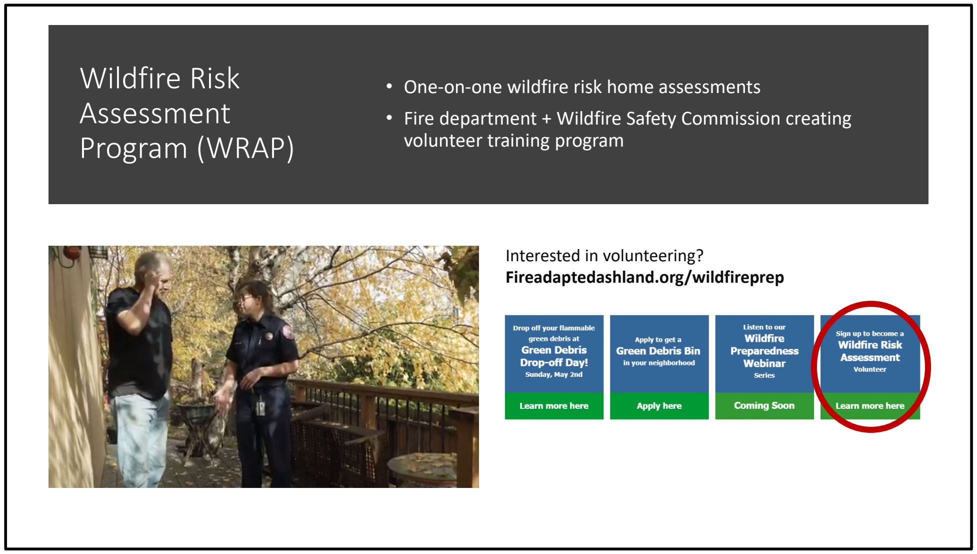
APRIL	MAY	JUNE	JULY
Harden your home! Protect against embers and flames	**Be Firewise!** Keep your yard lean, clean, and green	**Be Ready!** Prepare to evacuate or shelter in place	**Be Smokewise!** Prepare for smoke

Wildfire Safety Campaign

fireadaptedashland.org/wildfireprep

Harden Your Home!

This April, harden your home's exterior against embers.
We must all do this work to protect the community.



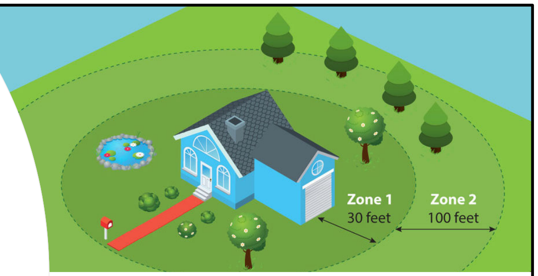
For all residents in our community, we offer 1-hour, one-on-one home wildfire risk assessments. We've offered this service for nearly a decade, and the program basically advertises itself. I conduct 100-150 home assessments per year. The assessment is no cost to the resident and provides an opportunity to provide advice about what risk reduction action is most important to take around the home. The wildfire safety commission is looking to expand this program, since one-on one interaction with homeowners is proven to be the most effective way to help residents take action to reduce their wildfire risk. So we have been working with OSU extensions program to develop a volunteer training. If you are interested in being one of these volunteers, go to fireadaptedashland.org/wildfireprep and click on this box.

Real Estate Wildfire Education Program

- Course for real estate professionals to learn about wildfire history, wildfire preparedness, and programs in the Ashland area
- Hosted course for home inspectors to understand the relationship between wildfire and the home structure

FEMA Mitigation Grant

- Defensible space around top 1,100 at-risk homes in Ashland
- Replace wood shake roofs with Class A or Class B shingles



FEMA

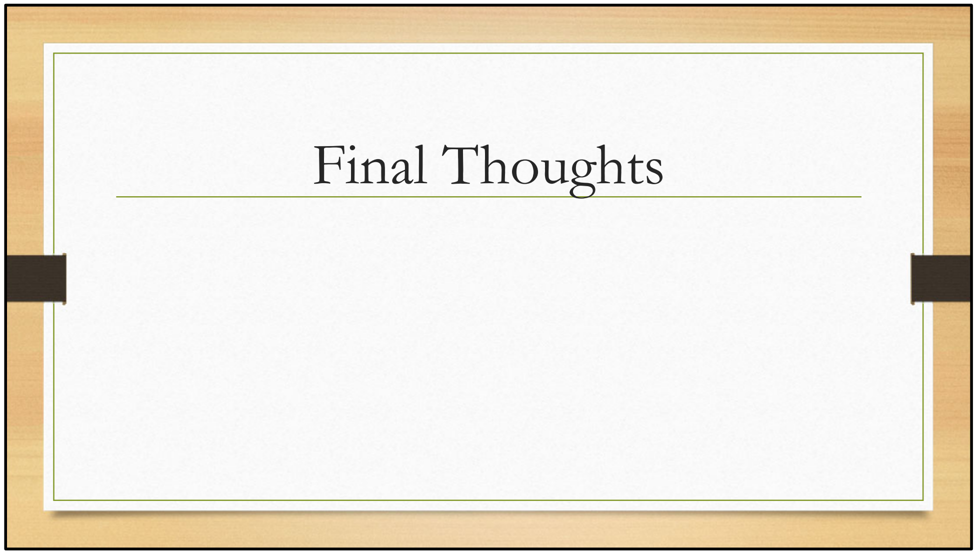
Wildfire Risk is Rising; There Will be Fire
What More Can We Do to Save our Community?

- Largest gap is the balance of over **6,000 homes and businesses** who we don't serve due to limited staff. Ashland Fire & Rescue and the Wildfire Safety Commission previously recommended a Wildfire Mitigation Assistant position to Council. Cost is approximately $70,000/year.
- Contract for an updated Community Wildfire Protection Plan, to include a Wildfire Recovery Plan. Cost: Approximately $75,000.
- Emergency Manager position to coordinate evacuation planning and outreach, public emergency notifications, preparedness, EOC training, County/State liaison, and to seek external funds (.5 FTE).

Questions?

Fire District/IGA/Agreements?

Fire agency consolidation, IGA's and Agreements will be a topic of discussion at the Regionalization Study Session now scheduled for November 1. The City Manager Pro Tem has solicited a proposal from Portland State University, Center for Public Service, for services to evaluate the feasibility of consolidation with one or more neighboring fire agencies



I believe that Ashland Fire & Rescue provides exceptional service to the citizens of our community. However, that service comes with a significant financial burden.

As shown in this presentation, we got behind the staffing needs over 24 years ago and have not come close to getting staffing caught up.

I have provided ways to bring the cost of the ambulance service to a more cost-neutral position through reductions and increasing income; however, we can't start until we get staffing help. We need Council to help us and get our staffing up. We need to staff our Ambulance Service properly to provide the proper response times, have an ability to respond to multiple calls for service at once, and still have staff available to respond to additional calls.

Thank you for listening to me tonight, and I look forward to working with you in addressing our communities needs.

ASSIGNMENT OF AMBULANCE SERVICE AREA #3
TO ASHLAND FIRE & RESCUE

This Assignment is made by Jackson County, a political subdivision of the State of Oregon, to Ashland Fire & Rescue, a political subdivision of the State of Oregon, referred to below as "Provider".

RECITALS:

1. This Assignment is made pursuant to ORS 682.062 and the Jackson County Ambulance Service Area Plan published in the Jackson County Codified Ordinances (JCCO), Chapter 1075 (the "ASA Plan").

2. Provider submitted an application to provide ambulance services in Jackson County Ambulance Service Area No. 3 (ASA 3).

3. Pursuant to JCCO Chapter 1075, on December 2, 2020, the Jackson County Board of Commissioners held a public hearing and approved Provider's request to provide ambulance services to ASA 3. Board Order No. 191-20.

IT IS AGREED:

Provider is assigned the exclusive right to provide ambulance services in ASA 3 under the ASA Plan subject to the following conditions:

1. Provider must conform to the requirements of JCCO 1075, as may be amended, and the Conditions of Assignment described in Exhibit A attached hereto and incorporated herein for all purposes.

3. The assignment of the exclusive right to provide ambulance services in ASA 3 is effective January 1, 2021, and extends through midnight, Dec. 31, 2023.

ASHLAND FIRE & RESCUE:

By: [signature]

Title: Acting Fire Chief

Date: December 2, 2020

JACKSON COUNTY:

By: [signature]

Title: County Administrator

Date: 12/15/20

Approved as to Legal Sufficiency:

[signature]

Madison Simmons
Assistant County Counsel

EXHIBIT A

CONDITIONS OF ASSIGNMENT

1. Provider will maintain a record of response times for each call in each time zone of the service area. Provider will prepare an "exception" report for each call that exceeds the designated response time for the zone. The exception report will explain why the required response time was exceeded and note what corrective measures, if any, have been implemented. The exception reports will be submitted to the Director of Jackson County Health and Human Services or his designee ("Director") on a monthly basis or as requested by the Quality Assurance Committee.

2. Provider will be notified by a Public Safety Answering Point (PSAP), which shall dispatch provider by direct dispatch or call relay. Provider's response time records shall be compatible with the records of the designated PSAP so that system response times can be traced.

3. Provider shall provide at least the minimum level of care required by Oregon law and the Jackson County Ambulance Service Area Plan ("ASA Plan") set forth in Jackson County Codified Ordinances ("JCCO") Chapter 1075. Provider shall provide Advanced Life Support ("ALS") to urban, suburban and semi-rural areas for all calls that are triaged as requiring ALS.

4. Provider will notify the Director immediately of any change in level of care provided. Copies of certificates for each Emergency Medical Technician "(EMT") shall be provided annually to the Director by March 1.

5. Current standing orders shall be provided in each unit. Each EMT shall review and sign off on standing orders before practicing in the field.

6. Basic Life Support (BLS) units shall be staffed with a minimum of one EMT-B and a certified driver. All ALS providers shall staff ALS units with a minimum of one EMT-P and one EMT-B. Provider shall maintain an in-house Quality Assurance program and peer review program. Provider shall participate in the County-wide Quality Assurance process. Provider's EMTs shall remain current with continuing education requirements.

7. Provider shall promptly submit to the Director all information requested by the Director or the Quality Assurance Committee. Provider shall submit all complaints regarding patient care to the Director. Provider shall cooperate fully with any investigation regarding such complaints that the Director, in his discretion, conducts.

8. Provider shall submit copies of revised mutual aid agreements immediately upon execution. Provider shall not refuse to respond to an emergency call for service if an ambulance is available for service. Provider shall not respond to a medical emergency located outside its assigned service area unless the response is for supplemental assistance, mutual aid, automatic aid, or in response to a request by the recognized dispatch center.

9. Provider shall remain in compliance with all applicable federal, state and local laws, as they now exist or shall be amended. It is Provider's sole responsibility to obtain, and Provider shall obtain and maintain in good standing, all permits, licenses, and approvals necessary for the lawful performance of the services contemplated by this Assignment. Provider shall equip and maintain all units as required by law, including ORS 682.017 through 682.991 and OAR 333-250-000 through 333-265-0100 as these sections may be amended. Provider shall equip each ambulance crew with hand-held radios as required by 6.6.C of the plan. Maintenance histories for each vehicle shall be submitted annually to the Director by March 1.

10. Provider shall comply with Section 7.4 of the ASA Plan regarding assignment, withdrawal or subcontracting for service in an area.

11. Provider shall not raise the rates charged for services provided without first obtaining the written consent of the Board of Commissioners. If Provider requests an increase in rates, the Board of Commissioners shall schedule a hearing on the proposed increase within sixty days of receipt of the request.

12. The Board of Commissioners have established a fee to recover the costs of administration of the ASA Plan. Providers shall remit the sums due within 30 days of the end of the month. Failure to pay fees within 60 days after written notice to do so shall be considered a material breach of this contract. All breaches of this contract shall be subject to the revocation procedures of Section 5.8.J and/or Section 7 of the ASA Plan.

13. Provider may propose housekeeping amendments or minor changes to its service area by submitting a written proposal before October 15 of each year this contract is in effect.

14. Provider shall provide and maintain during the term of this agreement Workers' Compensation Insurance for all non-exempt workers, as required by ORS.Chapter 656. Evidence of current workers' compensation insurance shall be provided to the Director before beginning service under this agreement.

15. Provider shall obtain and at all times keep in effect a comprehensive general liability insurance policy, issued by a company authorized to transact business in Oregon, which shall cover all of Provider's activities provided pursuant to this agreement. The policy shall name Jackson County, its' elected officials, officers, volunteers, agents and employees as an additional insured and shall provide for 30 days written notice to the Director prior to cancellation of the policy. Such liability shall provide limits of at least $50,000 to any claimant for any number of claims for damage to or destruction of property arising out of a single accident or occurrence, $200,000 for injury to any one person, and $500,000 for total injuries and/or damages arising out of a single accident or occurrence. These limits shall not limit the indemnities set out below. Evidence of current comprehensive general liability coverage in the stated amounts shall be provided to the Director annually as part of the year-end report. Provider shall not cancel the insurance without 30 days prior written notice to the Director, at which time a new certificate of insurance evidencing continuous coverage must be provided to the Director.

16. Provider shall defend, indemnity, and save harmless Jackson County, its elected officials, officers, agents and employees from and against any and all claims, suits or actions, including attorney's fees, of whatsoever nature resulting or arising out of the activities of Provider, its agents, subcontractors or employees, under this contract.

17. Provider agrees to comply with all applicable requirements of federal and state civil rights and rehabilitation statutes.

18. In cases of litigation arising out of this contract between Jackson County and Provider, the prevailing party to the litigation shall be entitled to reasonable attorney's fees at trial and upon appeal.

19. Provider hereby certifies under penalty of perjury that to the best of Provider's knowledge, Provider is not in violation of any Oregon tax laws in accordance with ORS 305.385.

20. Provider shall obtain and provide to the Director within 90 days new mutual aid agreements, any new licenses for the vehicles, any new certificates of insurance, and other necessary documents.

21. Violations of the terms and conditions of this contract are subject to administrative and/or legal action, which may result in revocation or suspension of the contract, damages, or other adverse action. Jackson County retains sole discretion, subject to JCCO Chapter 1075, to determine whether to impose adverse actions. Any adverse action taken by Jackson County shall not be a breach of the terms of this contract by Jackson County. Jackson County is not liable to Provider for any damages suffered by Provider as a result of any such adverse action.

22. This contract shall be governed and construed in accordance with the laws of the State of Oregon without resort to any jurisdiction's conflict of laws, rules or doctrines. Any claim, action, suit or proceeding (collectively, "the claim") between the County (and/or any other County or department of the State of Oregon) and the Provider that arises from or relates to this contract shall be brought and conducted solely and exclusively within the Circuit Court of Jackson County for the State of Oregon. If, however, the claim must be brought in a federal forum, then it shall be brought and conducted solely and exclusively within the United States District Court for the District of Oregon filed in Jackson County, Oregon. Provider, by the signature herein of its authorized representative, hereby consents to the in personam jurisdiction of said courts. In no event shall this section be construed as a waiver by Jackson County of any form of defense or immunity, based on the Eleventh Amendment to the United States Constitution, or otherwise, from any claim or from the jurisdiction.

23. Provider shall comply with all sections of the ASA plan. Any reference in this contract to specific provisions of the ASA plan shall not be construed to limit the generality of the previous sentence. Such references are included to highlight certain sections for the convenience of the parties only. Any reference to a legal authority such as the ASA plan, ORS, OAR, or JCCO, shall be construed to refer to the legal authority as amended and currently in effect on the date of the conduct.

24. Provider is authorized to increase rates charged for services provided under this contract only in accordance with this paragraph or with the written approval of the Jackson County Board of

Commissioners. Provider is authorized to annually increase any rates charged for any ambulance service in accordance with the Consumer Price Index as published by the Centers for Medicare and Medicaid Services.

Ambulance Transporting Services

Cost and Service Analysis

City of Ashland, Oregon

PUBLIC CONSULTING GROUP

June 17, 2021

CONTENTS

ACKNOWLEDGMENTS

We greatly appreciate the help of all individuals and organizations that provided data, insights, and contributed to the development of this report. While there are too many to mention individually, we wish to especially thank the following individuals for helping to launch, coordinate, and advise the project.

City of Ashland

Stakeholder Name	Agency
Adam Hanks, Interim City Administrator	City of Ashland
Ralph Sartain, Interim Fire Chief	City of Ashland Fire & Rescue
Brent Knutson, President, Ashland Firefighter's Association	IAFF Local-1269 – AF&R
Melanie Purcell, Finance Director	City of Ashland
Cindy Hanks, Accounting Manager	City of Ashland
Bryn Morrison, Financial Systems Manager	City of Ashland
Eric Bruhn, Senior Information Systems Analyst	City of Ashland
Emily Matlock, Administrative Analyst	City of Ashland Fire & Rescue

Outside Agencies

Stakeholder Name	Agency
Robert Horton, Fire Chief	Jackson County Fire District #3
Alana Meeks, Operations Assistant	Andres Medical, Limited/Fire Recovery EMS
Greg White	Owner/Agent Reinholdt & O'Hara Insurance

SECTION I: EXECUTIVE SUMMARY

PCG is pleased to submit this final report summarizing the results of a quantitative (financial) and qualitative (operational) analysis of the ambulance transporting services provided by Ashland Fire & Rescue (AF&R). AF&R provides ambulance services to the residents and visitors of the City and the residents of AF&R's Ambulance Service Area (ASA). The Jackson County Board of Commissioners assigns AF&R's ASA, which encompasses a 630 square mile area surrounding the City. AF&R utilizes dual-role firefighter/paramedics, staffing two advanced life support (ALS) ambulances. These units respond from AF&R's two strategically located fire stations.

Our approach to this study includes an in-depth fiscal analysis of AF&R's ambulance service, including operating and capital budget, revenues, and expenditures to determine the costs and benefits of operating the ambulance service and provide findings to assist the City in determining whether to continue or discontinue ambulance services. The report addresses each of the quantitative questions from the request for proposal (RFP).

The qualitative part of the study focuses on analyzing operational impacts such as optimal staffing to deliver all-hazards emergency services, including ambulance services. The RFP identified specific qualitative questions pertaining to current and future staffing recommendations and analysis of the impacts to the community if AF&R 's ambulance services are discontinued. To provide answers to these questions, a thorough description of the relevant national standards for fire department staffing were reviewed. Included in Section IV, Benchmarking, are detailed descriptions of the National Fire Protection Association (NFPA) and the Insurance Service Office (ISO) standards. These standards have an impact on both the fiscal and operational considerations of this study. These standards also play a major role in forming the findings and recommendations in this report.

To understand the study's focus and recommendations, it is essential to recognize how AF&R's performance and compliance with national standards may impact the community. The ISO rating indicates a fire department's ability to protect its community with Class-1 being the best fire safety rating and Class-10 the worst. ISO ratings are used to determine business and residential homeowner's insurance rates, and a change in ISO rating can have a significant fiscal impact to the business community and local homeowners. The City received its last ISO rating in March 2015. That rating included a **50% reduction** in points for staffing (***7.5*** out of ***15*** total possible points).

…although the revenues realized by the fire department ambulance service are generated by AF&R, these revenues are returned to the City's general fund.

This allows the City to redistribute these funds for programs and services across all the City departments and not specifically returned to the fire department.

PCG reviewed five-years of expenditures and revenues contained in the AF&R fire department budget. The FY 2018-2019 AF&R approved budget was **$10,040,008**. PCG identified that **the cost to operate the ambulance service is $2,267,063 or 23%** of the total budget. Currently, the AF&R ambulance service generates up to **$1.3 million in annual revenues** from 911 ambulance transports, inter-facility transfers, ambulance membership program, and other ambulance related fees. When the revenues generated by AF&R are considered, the average annual **cost to operate the ambulance transport service is $840,900 above and beyond the current cost to operate the fire department.**

The City must bear in mind that, although the revenues realized by the fire department ambulance service are generated by AF&R, these revenues are returned to the City's general fund. This allows the City to redistribute these funds for programs and services across all City departments and not specifically returned to the fire department. There are additional revenue options the City should consider including expansion of the ASA to include the Town of Phoenix, cost-recovery, expansion of the ambulance membership program and other non-resident fees, such as first-responder fees.

In conclusion, this report presents the City with findings and recommendations, both qualitative and quantitative, in objective terms that are designed to provide a balanced, objective analysis of the questions posed in the RFP Scope of Services. PCG would like to thank the City for selecting our firm to provide subject matter expertise to support its effort to address this critical public safety issue.

SECTION II: METHODOLOGY

The approach to this study consists of six key elements: kick-off meeting, background research, stakeholder interviews, data collection, analysis, and findings and recommendations. Due to COVID-19 restrictions, all stakeholder interviews and project updates were conducted using video conferencing.

Kickoff Meeting

We use kick-off meetings to confirm a project's scope and to present a detailed project work schedule to the client. Under the guidance of the AF&R fire chief and City staff, we gained an important understanding of the motivation and vision for this study and any desired outcomes not stated in the RFP. The attendees also provided key insights and background information.

Stakeholder Interviews

Key stakeholder interviews provided comprehensive information of the AF&R's operations and funding of the ambulance service, as well as valuable context into the historical, cultural, and political factors that impact current conditions. The City and AF&R provided PCG with a list of eight stakeholders to interview, which PCG examined in detail to understand the role each stakeholder plays regarding the study and eventual outcomes. Interviewed stakeholders' information is listed in the Acknowledgement section of this report.

Staff members from the City provided computer-aided dispatch (CAD), budgetary and operational data, as well as their expertise and opinions on the state of the ambulance service provided by AF&R. PCG analyzed all information collected via stakeholder interviews to inform findings and create recommendations.

Data Collection

In addition to the information provided in the RFP and insight provided stakeholder interviews, PCG's team collected and reviewed more than 20 documents, such as departmental expenditures, ambulance billing and collection data, CAD data, department assets, department policies and procedures, and the most recent ISO rating evaluation. A full list of documents is included in the Appendix. We used the data and documents to analyze department financial trends, response times, and the current department operations in relation to the provision of ambulance transport services.

Background Research

Conducting thorough research on the applicable standards and guidelines for the delivery of EMS and ambulance transporting services was essential to bringing all sources together to develop findings and recommendations. Our team reviewed the NFPA standard 1710, Commission on Ambulance Accreditation Services (CAAS) and the American Ambulance Association, as well as other applicable standards outlined in the Benchmarking Section IV.

We referred to best practices for fire services to define performance targets for standards of response, standards of coverage, staffing, and organizational requirements. These standards and benchmarking guidelines are documented in Section IV, Benchmarking Guidelines.

Approach to Financial (Quantitative) Analysis

PCG performed a comprehensive analysis of the AF&R's expenditures and ambulance service revenues for the 2015-2019 fiscal years, based on data provided by City of Ashland staff. Through the analysis, our consultants:

1. Identified the allocated expenditure categories and determined which costs were directly supporting the operations of the ambulance service (expenses such as billing and the ambulance business license, for instance).

2. Identified the expenditures that may indirectly support the operations of the ambulance service as a shared expense between the program and AF&R's other operating costs, (expenses such as firefighter/paramedic staff salaries and benefits, for instance).

3. Once indirect costs were identified, PCG utilized a CAD percentage calculation based on the department's transport volume and total unit response volume to measure how much shared cost should be allocated to the ambulance service operations.

4. Once ambulance expenditures were identified, we reviewed AF&R's ambulance revenue and applied the yearly ambulance revenues to the corresponding expenditures to calculate the net cost, or the subsidy, associated with operating the ambulance service. PCG then projected the ambulance service expenses, revenue, and net cost over a 10-year period using a straight-line trend analysis.

Approach to Operational (Qualitative) Analysis

There are two primary goals with the qualitative analysis section of this report. First, to educate and inform City policy makers with information critical to providing effective and efficient fire and emergency response services, including ambulance services, to the City of Ashland residents and visitors, as well as those residing or visiting any locations included in the ASA. Second, to provide policy makers with options for how best to proceed with the decision to either continue with ambulance services or discontinue providing the service through the fire department.

The qualitative (operational) analysis focuses on all the other operational service delivery programs provided by AF&R. To determine how to approach the analysis, consultants reviewed the Department's "Standards of Coverage" plan published by AF&R on April 16, 2009, see Appendix.

The Standards of Coverage plan is essential to performing the qualitative analysis of AF&R as it provides critical information pertaining to the essential services the Department needs to provide to fulfill its primary mission:

"Ashland Fire & Rescue is dedicated to protecting lives, property, and the environment. By delivering fire suppression, emergency medical, disaster management, fire prevention and public education services by professionally trained, dedicated personnel, we strive to achieve the highest quality of public service to our customers."

We use national standards in each of our project engagements because they serve as the model approach to fire department operations, no matter the jurisdiction or location. Most state agencies who oversee, coordinate, or regulate the delivery of fire and emergency service delivery use these national standards as the framework for development and implementation of regulations, statutes, policies, and procedures.

The Insurance Service Office is an important example. ISO is an international organization that uses standards developed and published by the National Fire Protection Association (NFPA) in rating fire departments throughout the United States. The Fire Suppression Rating Schedule (FSRS) forms the basis for determining a community's Public Protection Classification (PPC), more commonly known as the ISO Rating. A community's ISO rating is one of the tools insurance company underwriters use to determine the insurance rates businesses and homeowners pay for their annual premiums. **The better the ISO rating, the more favorable the rates are for the community.**

NFPA standards are also used to determine minimum staffing levels for public fire departments, both career (such as AF&R) and volunteer departments. The report makes extensive reference to these national standards as well as laws, regulations, statutes and ordinances for the State of Oregon, Jackson County, and the City of Ashland, that pertain to the operation of the AF&R.

AF&R's Standards of Coverage document is based on the State of Oregon's *Standards of Response Coverage* as well as the *Commission on Fire Accreditation International* (CFAI). Both documents provide detail on minimum staffing as well as the number and type of resources a community needs to provide safe, effective, and efficient emergency response services to the most common types of emergencies encountered by the department. Standards of Coverage focuses on the following critical elements of response:

- Community Baselines
- Community Risk Assessment
- Critical Task Analysis
- Establishing Response Objectives
- Response Reliability
- Conclusions

Approach to Findings and Recommendations

Our analysis of the City of Ashland's ambulance service is based on both the financial and operational aspects of AF&R's current ambulance service. Our findings are derived through stakeholder interviews, budget analysis, review of documents, and benchmarking with national, regional, and local standards. Based on this approach, PCG can present this comprehensive report answering the key questions related to the cost of ambulance services and fire department staffing.

SECTION III: BACKGROUND

Study Objectives

COVID-19, associated restrictions, and government-imposed closures heavily affected Ashland's tourism industry since the Centers for Disease Control (CDC) classified the outbreak as a pandemic. The City of Ashland has suffered a significant decrease in revenues from these industry closures over the past 12 months. A major wildland fire struck the area on September 8, 2020, adding to the calamity inflicted throughout Jackson County. This human-caused fire, pushed by 40+mph winds, burned a nine-mile-long path from North Ashland through the towns of Talent and Phoenix. The fire destroyed 2,800 homes and killed three residents. Thousands of residents lost their homes and businesses, adding to the major financial impacts to the area.

As a result, the City Council and leadership team have been forced to closely examine all city programs and determine which programs can or should be scaled back or eliminated due to budget shortfalls. AF&R's ambulance service is one of the programs the Council is evaluating. In examining the ambulance service, the City has contracted with PCG to provide analysis of this program from a quantitative (financial) and qualitative (operational) perspective.

On the quantitative side, the City hopes to understand all revenues and expenses related to ambulance service operations, determine the potential level of subsidy of the service, and identify any potential cost savings over a 10-year period if the ambulance service is discontinued.

Qualitatively, the City looks for PCG to identify the potential effects on the mission of AF&R if the ambulance services were discontinued, how future operations may be affected with the potential elimination of ambulance services, and a recommendation on department staffing solutions in the potential absence of the ambulance service. **The decision to discontinue the ambulance service will affect not only the residents in the City of Ashland, but also residents in areas surrounding Ashland** which are incorporated in the Ambulance Service Area (ASA) the boundaries of which are determined and assigned to AF&R by the Jackson County Board of Commissioners as depicted in Figure III.1 at right.

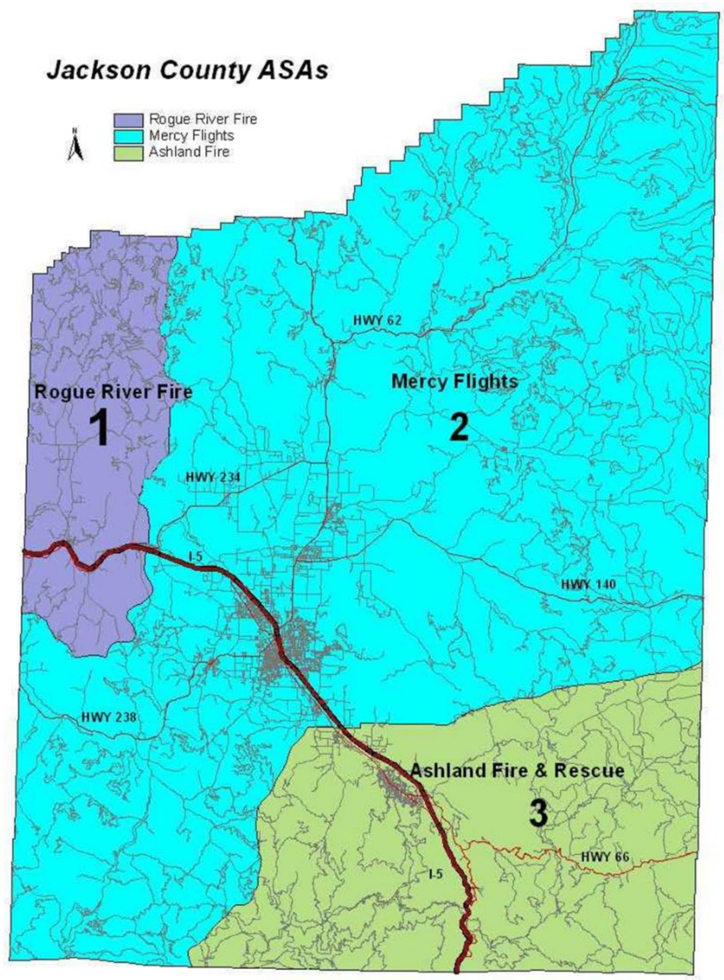


Figure III.1: Jackson County Ambulance Service Areas. Source: Jackson County EMS

City of Ashland Profile

Situated just north of the Oregon/California border directly on the Interstate 5 corridor, the City of Ashland is a beautiful community of 21,000 residents living in 9,789 housing units. The City is home to Southern Oregon University and the Oregon Shakespeare Festival. The university has just over 6,000 students and 350 faculty members. The festival has been in continuous operation since 1935 and hosts more than 400,000 visitors annually, running from February through November each year. In 2015, the festival hosted its 20-millionth visitor. Ashland is a popular recreational destination year-round with snow skiing on Mt. Ashland from early December thru mid-April and hiking and backpacking along the Applegate trail through the spring and summer months. Combined, these attractions and destinations make Ashland one of Oregon's premier year-round tourist destination spots. Because of this, Ashland and the surrounding communities rely heavily on tourism revenues to support city operations and programs.

City of Ashland 2019 Demographics	
Population Size (2019 estimate)	21,281
Households (2015-2019)	9,789
Median Income	$41,334
Median Age	42.9
Age Distribution	
Under 18 years	16%
18 to 24 years	16%
25 to 44 years	21%
45 to 64 years	30%
65+	18%

Table III.1: City of Ashland 2019 Demographics

Ashland Fire & Rescue Overview

According to information obtained from the City's website, AF&R first formed in 1887, with the first fire station built the following year in 1888. The City owned and operated the ambulance service from 1926 to 1936, until it was subsequently sold to Litwiller's Funeral Home that year. From 1973 through 1996, Ashland Life Support Ltd. provided first response life support to back up the ambulance service. In 1996, the City subsequently purchased Ashland Life Support and has been providing Advanced Life Support (ALS) level ambulance service since then.

Personnel assigned to line functions respond to emergencies from two strategically located, state-of-the-art fire stations. Fire Station 1 is located at 455 Siskiyou Blvd. and serves as AF&R's headquarters for the administrative staff. The station houses an engine company staffed by a fire captain and fire engineer and ALS ambulance staffed by two firefighter/paramedics. The on-duty shift commander (battalion chief) also responds from this station. Fire Station 2 is located at 1860 Ashland Street and houses an engine company staffed by a fire captain and fire engineer and an ALS ambulance staffed by two firefighter/paramedics.

AF&R is made up of four divisions: Administration, Operations, Wildfire, and Fire & Life Safety. Today's department consists of 39 total personnel, both sworn and civilian. The table of organization on the following page shows the number of personnel and their respective positions. The department is classified as a career fire department, meaning that all personnel are full-time employees and not volunteers.

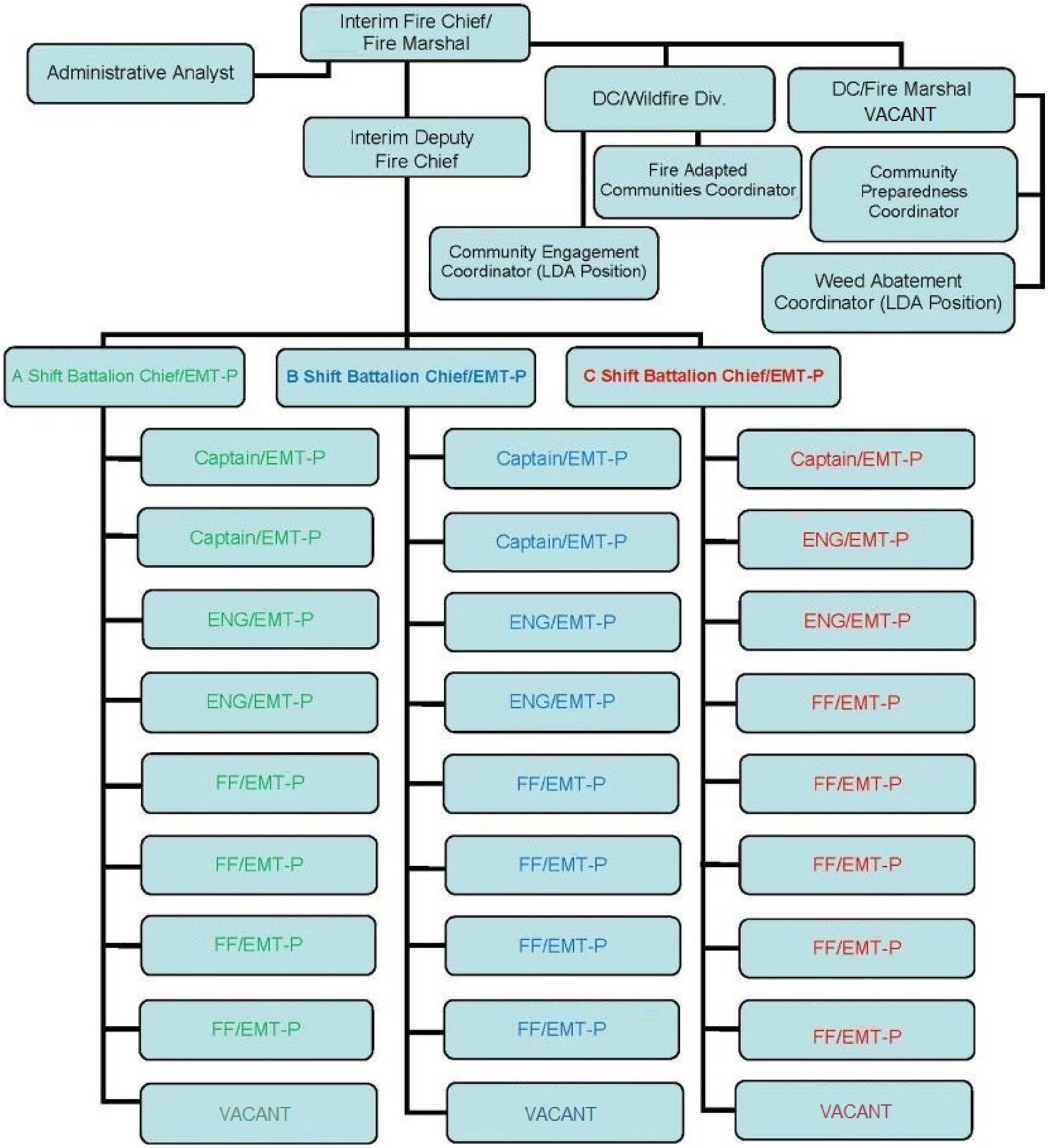


Figure III.2: AF&R Organization Chart

AF&R is classified as an all-hazards response organization providing emergency response to structure fires (residential, commercial, and industrial), wildland fires, vehicle accidents, technical rescues, and emergency medical services at the Advanced Life Support (ALS) level. AF&R also provides 911 ambulance services and interfacility transfers using fire department personnel certified at the paramedic level. In addition, AF&R provides non-emergency services to the community in the form of fire prevention inspections, plan reviews, public education, Community Emergency Response Teams (CERT) and community risk reduction assessments. AF&R holds a Class-3 rating from the Insurance Services Office (ISO) for areas within the city limits. AF&R participates in the Rogue Valley Fire & Rescue Mutual Aid System and receives and provides automatic-aid and/or mutual-aid from the fire departments and fire districts in both Jackson and Josephine County. AF&R is also part of the interstate mutual compact agreement with the California Department of Forestry & Fire Protection (CalFire) which allows AF&R resources to both provide and receive mutual aid across state lines.

Today, AF&R reports that it exceeds all the response time requirements of Jackson County EMS agency and averages an over 99% above average or higher score from customer satisfaction surveys.

SECTION IV: BENCHMARKING GUIDELINES

Identifying applicable and appropriate benchmarking standards of service, performance, and operations is critical to providing Fire/EMS response to communities. For this engagement, PCG consultants detailed two specific benchmarking standards because of their relevance to the central question of continuation of the AF&R ambulance service. Incorporating these standards in this report is essential to addressing the quantitative analysis called for in the RFP and PCG's response. The consultants applied ISO and NFPA standards.

PCG recognizes non-fire service professionals require a more detailed overview of our application of the standards in our analysis to ensure the reader gains a full understanding of their importance. This will greatly aid them to make a fully informed decision on the continuation of ambulance transporting services in the City and surrounding areas in the ASA. That information is provided in this section, along with an explanation of how elimination of this program may impact AF&R's ability to respond to other types of emergencies, not only in Ashland but also to surrounding communities through the Rogue Valley Fire & Rescue Mutual Aid Agreement.

Importance of Insurance Service Office (ISO) Rating

What is an ISO rating and what importance does it bear to a community? Property owners of residential occupancies and businesses of all types pay insurance premiums based on a rating scale used by ISO to determine the classification level of the fire protection services provided to the community. The better the classification, the more favorable the insurance premium rates are for annual property insurance, more commonly known as "Fire Insurance".

The figure below provides a list of fire departments from around the US and the ISO numerical classification ratings. **Ashland currently has an ISO classification rating of 3. Ashland received its most recent ISO classification rating on March 27, 2015.**

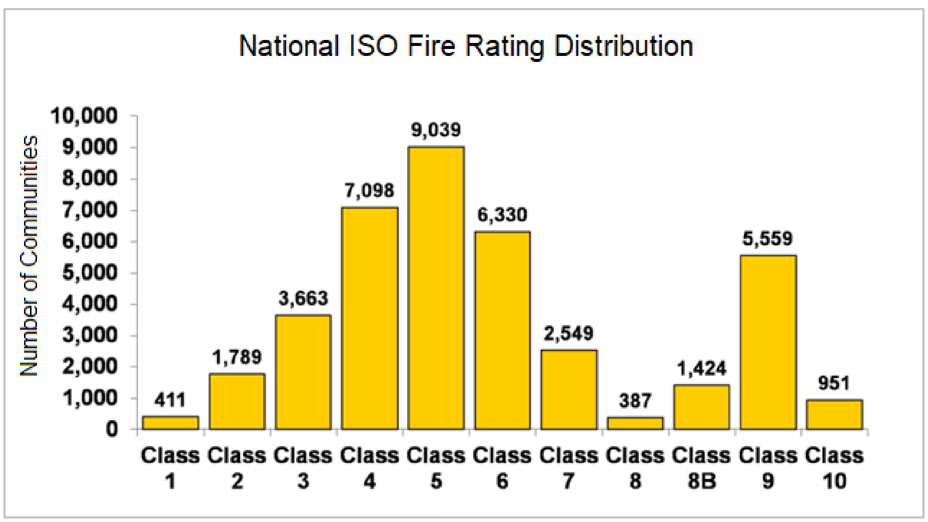


Figure IV.1: National ISO Fire Rating Distribution
Source: [ISO]

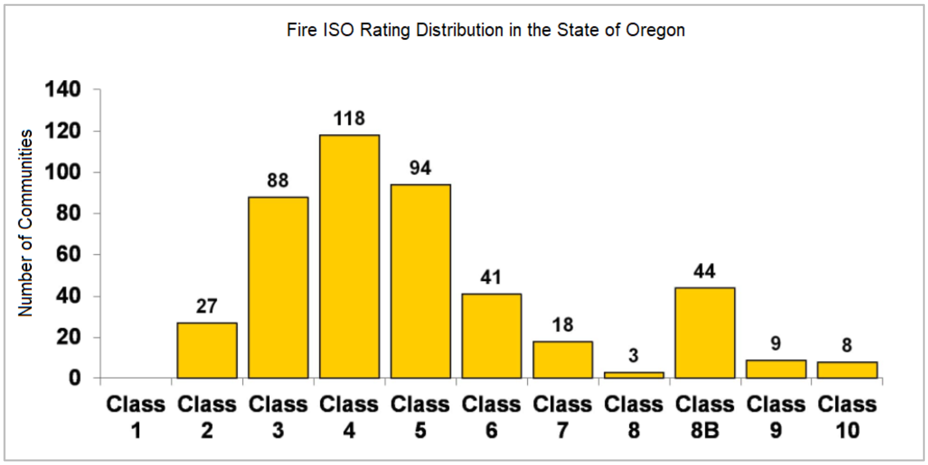


Figure IV.2: Oregon ISO Fire Rating Distribution
Source: ISO

ISO uses an assessment tool called the Fire Suppression Rating Schedule (FSRS) to determine a fire department's Public Protection Classification (PPC*)* rating. FSRS ratings range on a scale of 1 to 10 with PPC-1 being superior or the best rating a community can receive. ISO calculates the FSRS on a point system scale of 0 to 105.5 points. Typically, fire departments are graded once every 10 years by ISO. However, ISO will conduct re-evaluations of the department at the request of the fire chief or chief fire official of the community or jurisdiction.

The point scale used by ISO examines four primary areas to reach its final rate classification which are:

- **Emergency Communications**: Standard for processing 911 calls and notification of fire personnel and dispatching programs, circuits, and equipment.
- **Fire Department**: Staffing, Resource Deployment, Apparatus/Equipment & Training
- **Water Supply**: Does the water purveyor have and maintain a system that can provide sufficient water for the most extreme fire potential in a community and the presence of and spacing of fire hydrants within the community?
- **Community Risk Reduction**: The department's ability to recognize, categorize and initiate program(s) to minimize the most common types of *emergencies in a community* such as kitchen fires, in-home smoke detectors, elderly fall injuries, child drownings, etc.

Emergency Communications

A maximum of **10 points** of a community's overall rating is based on how well the 911 communications center receives, processes and dispatches emergency incidents. The rating criteria used by the ISO field representative that grades fire departments strictly follow the NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems, and assess the following criteria derived from the standard:

- The Emergency Reporting System: phone lines, type, and capacity
- The Communications Center, including the number of call-takers and dispatchers
- Computer Aided Dispatch (CAD facilities and backup capabilities
- Dispatch circuits and alerting systems that notifies firefighters as to the location of the emergency

NFPA 1221 establishes criteria for how quickly 911 calls must be answered, how quickly 911 calls are processed by call-takers and how quickly fire companies must be dispatched. NFPA 1221 also sets criteria for how quickly firefighters must react, known as "turnout time" to begin their response to emergencies. There are set turnout times for day-time hours and set times for night-time hours, as well as variances for fire versus EMS calls. Turn-out times for EMS emergencies are shorter because personnel are not required to don Personnel Protective Equipment (PPE) which could add 60 to 90 seconds to turn-out times.

ISO awarded AF&R a score of ***8.59*** out of ***10.*** This represents an above average score and is mostly beyond the control of AF&R leadership as they contract dispatching services to Jackson County Sheriff Office (JSO). Should AF&R leadership opt to seek out ways to gain the additional 1.4 points possible they can meet with JSO dispatch leadership and seek ways of improving call answering and call processing as the point reduction was listed under this category.

Fire Department

A maximum of **50 points** of a community's overall rating is based on the fire department itself. ISO field representatives review the following criteria:

- The distribution of fire companies (Fire Engines, Ladder Trucks and Specialty Apparatus) throughout the community. Response areas for fire engines is 1.5 linear highway miles travel distance and 2.5 linear highways miles travel distance for ladder trucks both to built-out areas of the jurisdiction.
- All fire apparatus equipped with a fire pump must be tested annually and pass in accordance with NFPA 1901 Standard for Automotive Fire Apparatus and NFPA 1911, Standard for the Inspections, Maintenance, Testing and Retirement of In-Service Automotive Fire Apparatus.
- The number of firefighters staffing each type of fire apparatus in compliance with 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
- Standard equipment carried on each type of fire apparatus (Standardized Equipment List) which includes the testing and maintenance of all equipment. NFPA 1911, Standard for the Inspections, Maintenance, Testing and Retirement of In-Service Automotive Fire Apparatus and NFPA 1915, Standard for Fire Apparatus Preventative Maintenance Program.
- The extent of training each firefighter receives annually according to the NFPA standard for their respective position. (240-hours of training annually for all line/uniformed personnel with fire officers requiring an additional 24-hours of training annually).

ISO awarded AF&R a score of ***33.46*** out of ***50***. Although this is an average score, it is important to note that the subcategories AF&R received low scoring in pertained to staffing (***7.5*** out of ***15***) and Ladder Truck (***0.0*** out of ***4***). The current AF&R staffing of nine on-duty personnel is well below NFPA 1710. Should the City decide to discontinue the ambulance service and reduce the on-duty staffing in the department, it will result in further reduction to the PPC rating. This will result in an across-the-board increase in property insurance premiums for home and business owners. Another rating category that AF&R received considerable deduction for is ***Pre-Fire Planning***. This is a process where line fire company personnel conduct annual walk-throughs of all occupancies (Except 1-4 family dwellings) to identify specific hazards, develop a layout of the design features and location of fire protection system connections such as sprinkler and/or standpipe systems and fire hydrants. Personnel must also identify any specific/unique hazards such as presence and specific location and quantities of hazardous materials. Certain known hazardous construction features that pose significant hazards to firefighters such as "Bow-String Truss Roofs" or Unreinforced Masonry construction.

Water Supply

A maximum of ***40*** points of the overall score is based on the community's water supply system – firefighters use the same water supply for fighting fires as citizens use for their homes. This affects the system in two equal ways. If a large fire requires multiple fire hydrants, residents near the fire are going to experience decreases in tap water volume and pressure. Conversely, if a lot of residents are using water in their homes simultaneously and a fire breaks out, then this could impact the fire department's ability to have sufficient water supply to combat the fire resulting in greater damage to the structure and its contents by the fire. ISO field representatives look at the following:

- Number of fire hydrants and the spacing distance between **hydrants:** Hydrants which are 300' apart receive the highest score. Hydrants that are 1,000' apart or greater receive a lower score. If an area of the community lacks hydrants, they receive the lowest score.

- **Fire hydrants Inspection and testing:** this should be performed annually, and records must be kept for every hydrant. Hydrants should be color-coded based on Gallon Per Minute GPM flow capacity in accordance with NFPA 291 Recommended Practice for Fire Flow Testing and Marking of Fire Hydrants.)

ISO awarded AF&R a score of ***35.38*** out of ***40.*** Ashland received this score because ISO identified areas that did not have sufficient fire flow capability for the demand required, i.e., 2,500 GPM available for two hours and 3,000 – 3,500 GPM obtainable for three hours. AF&R leadership should identify these locations and work with the district water purveyor to identify solutions.

Community Risk Reduction

The Community Risk Reduction component of the FSRS offers a maximum of **5.50** points to the community PPC rating. This component of the ISO rating is a relatively new addition to the rating process. Previous ISO PPC rating could receive a maximum score of 100. However, ISO realized that it should provide some benefit to communities who were taking proactive measures to address specific life safety hazards in their communities. Accordingly, ISO considers and assesses the following Community Risk Reduction Programs:

- **Code Enforcement:** Typically known in most communities, businesses, and owners of multi-family dwellings as a “fire inspection”. In most states, occupancies that fall under the provisions of the Fire & Life Safety Code NFPA 101 must be inspected at least annually.
- **Public Fire Safety Education:** These programs target specific audiences such as children and the elderly but also focus on special needs populations and impoverished areas of the community where accident, injury, and fire damage levels are greater.
- **Fire Investigations:** Also known by their commonly used name “arson investigators”. These highly specialized and trained firefighters must employ scientific methods and processes to determine the cause and origin of a fire. They determine if the fire was accidental or deliberately set. Because they perform this function, most are sworn peace officers, carry side arms and have the powers to arrest people just as police officers do.

ISO awarded AF&R a score of ***5.06*** out of ***5.50.*** **One area related to Community Risk Reduction AF&R leadership can focus on to improve this score is the initiation of a Pre-Fire Planning program which focuses on all non-residential occupancies (excluding assisted living and skilled care homes).** This was the source of point reduction in the last PPC survey.

National Fire Protection Association (NFPA) Standards

NFPA 1710 Standard

The NFPA 1710 standard is a key benchmark because it defines minimum staffing levels and response times for fire companies, initial full alarm response levels, and extra alarm response levels for municipal fire and emergency medical services apparatus. The full title of the NFPA 1710 standard is: Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments. It is based upon a combination of accepted practices and more than 30 years of study, research, testing, and validation.

The standard also defines minimum response times to an emergency and minimum fire and EMS company staffing levels. For municipal fire departments, NFPA 1710 calls for fire companies to be staffed with a minimum of four on-duty personnel. "Companies" are defined as groups of members (engine companies, ladder companies, squads, etc.) "operating with one piece of fire apparatus except where multiple apparatus are assigned that are dispatched and arrive together, are continuously operated together, and are managed by a single company officer. In addition, NFPA 1710 requires five to six personnel to staff fire apparatus in hazardous or high-risk areas such as high-rise office buildings or chemical processing/manufacturing plants. The historic hotel in downtown Ashland would fall into this category.
The response time objectives for fire suppression, EMS response, and other operations are:

- Turn-out time (the period between the time firefighters are notified of an emergency and the time they begin responding): **80 seconds for fire and special operations and 60-seconds for EMS**

- Arrival of first engine company at a fire: **240 Seconds (4 minutes) or less (travel time)**
- Arrival of the second engine company: **360 seconds (6 minutes)**
- Deployment of a full first alarm assignment to a fire scene (other than High-Rise): **480 Seconds** (**8 minutes)**
- Arrival of Basic Life Support EMS first responder: **240 Seconds** (**4 minutes)**
- Arrival of Advanced Life Support unit at an EMS incident: **480 Seconds (8 minutes)**
    - ***Each of the criteria above must be achieved 90% of the time.***

In addition to these time intervals, call processing time is added to the overall response time. Call process ing should be accomplished in **64 seconds or less 90% of the time**. However, NFPA 1710 has provisions that allow call processing of **90 seconds 90%** of the time and within **120 seconds 95%** of the time for the following call types:

- Calls requiring Emergency Medical Dispatch (EMD) questioning.
- Calls requiring language translation.
- Calls requiring use of TTY/TTD device or video relay services.
- Calls of criminal activity where safety of first responders is vital prior to dispatch of resources.
- Hazardous Materials Incidents.
- Technical Rescue (Rope, Confined Space).
- Calls with insufficient information about location.
- Calls received by text message.

The graphic below in Figure IV.3 depicts what NFPA 1710 Deployment Model is for the typical residential structure fire. ***** A "**typical residential structure"** is defined by NFPA 1710 as 2,000 square feet, 2-story single-family dwelling without a basement, 2-car attached garage, and no exposures.

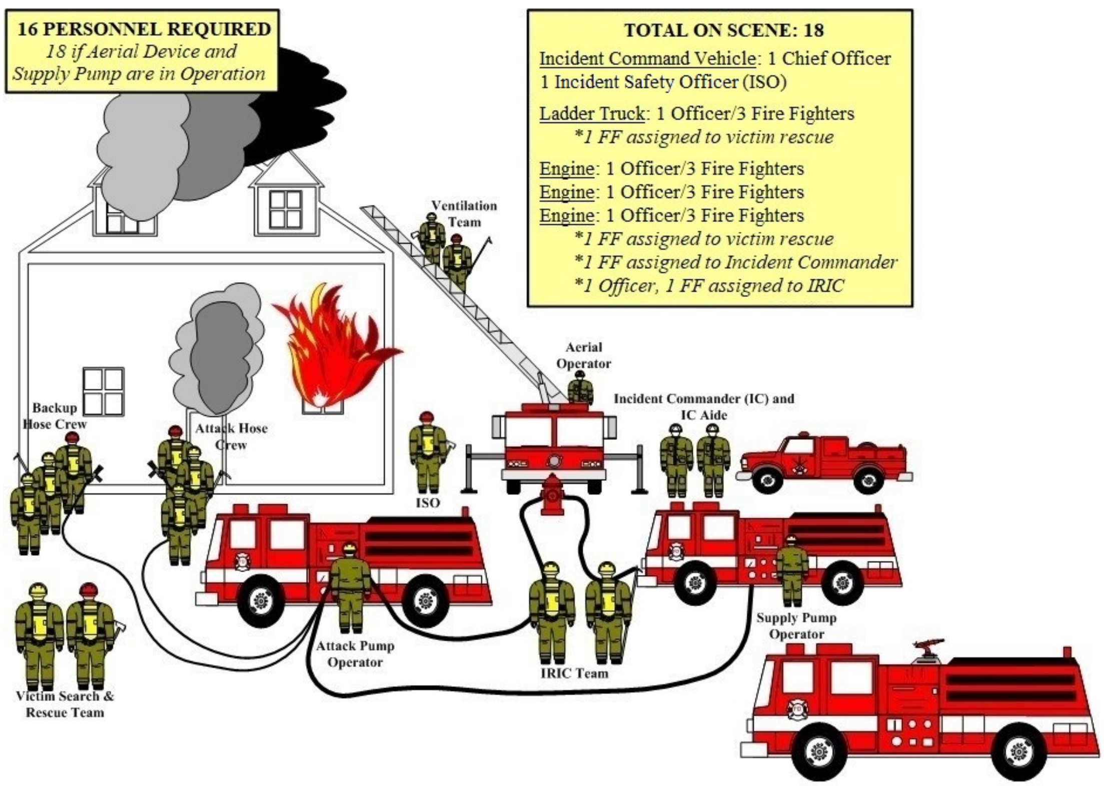


Figure IV.3: NFPA 1710 Staffing Configuration

NFPA 1710 calls for 18 personnel to a residential (low energy) structure fire, AF&R responds with nine personnel to the same classification of incident. This level of response commitment directly relates to a significant reduction in firefighter safety at an incident, decreased results with regards to confinement and containment of the fire to room of origin, as well as extinguishment of the fire prior to the most hazardous condition on the fire ground, flashover and greatly increases the potential for civilian loss of life.

As currently staffed, AF&R does not meet the staffing provisions of NFPA 1710 without the use of automatic or mutual aid. This is because AF&R has daily staffing of **nine personnel *when fully staffed***. Typical daily staffing for AF&R is eight personnel.

- One battalion chief (shift commander)
- Two engine companies (captain and engineer)
- Two ALS ambulances (two firefighter/paramedics)

Note: Technically, the two firefighter/paramedics are assigned to the engine companies and operate at fires as members of the engine company and supervised by the engine Captains. However, if the firefighters are committed on an EMS incident or performing a patient transport, then the engine company responds with only two personnel (Fire Captain and Engineer).

***** There are **two positions** on the Fire Ground, Hazardous Materials and Confined Space Rescue Incidents that are **required by law** under the guidelines set by the Occupational Safety & Health Administration (OSHA) under Title 29 CFR-1910. These positions are **Incident Commander** and **Incident Safety Officer.**

AF&R must rely on assistance from other departments in Jackson County to achieve staffing levels outlined in NFPA 1710. Because of this reliance on outside agencies, AF&R will not achieve response benchmarks outlined in 1710 without automatic or mutual aid.

Commission on Fire Accreditation International (CFAI)

CFAI provides a self-assessment and evaluation model that enables a fire department to evaluate past, current, and potential future service levels and performance and compare them to fire industry best practices so that a department may:

- Determine community risk and safety needs and develop community-specific standards of cover.
- Evaluate the performance of the department in relation to the standard of cover.
- Establish a methodology for achieving continuous organizational improvement in relation to the standard of cover.

CFAI provides the tools for a fire department to assess its performance against national standards or locally adopted performance goals. The program is voluntary and does not set standards. A successful process leads to accreditation; compliance reports must be made annually, and the assessment process is repeated every five years. A progressive fire department will be familiar with these and use them to establish response goals and performance measures appropriate for the community and the fire department in a standards of cover document. AF&R completed this assessment process in April 2009.

Commission on Accreditation of Ambulance Services (CAAS)

CAAS provides standards that ensure high-quality EMS and ambulance transportation services are provided to a community. In addition to the Standards, CAAS provides an accreditation program and mechanism where ambulance providers are evaluated by CAAS against the Standards.

The standards are very comprehensive but are flexible enough to relate to agencies regardless of size, scope, or service delivery model. There are over 100 standards, covering all aspects of ambulance operations. They include standards for agency management; financial management, budgeting, and strategic planning; relations with outside agencies; mutual aid and disaster coordination; community education and relations; human resources and personnel management, hiring, credentialing, training, problem resolution, and performance evaluations; clinical standards; quality improvement; safe operations and risk management; vehicles, equipment, and facilities; and communications/dispatch.

Oregon State Standards

Oregon Office of the Fire Marshal

OSFM Fire Service Mobilization Plan 2019-2020

Oregon Health Authority, Public Health Division, EMS and Trauma Systems Program

- EMS Provider Licensure Requirements
- Ambulance Service and Ambulance Licensing (Transport Ambulance Service Renewal, Non-Transport EMS Agency)
- Oregon Licensed Ambulance Services (Ambulance Service Area, Licensed Providers)

Oregon Department of Forestry

Rogue Valley State Mobilization Plan

Regional and Local Standards

- Jackson County EMS Office
- Rogue Valley Fire Chiefs, Regional Mobilization Plan
- RVFCA Mutual Auto Aid Agreement, Jackson/Josephine Counties, 2020

SECTION V: QUANTITATIVE (FINANCIAL) ANALYSIS

The City of Ashland requested a quantitative (financial) and qualitative (operational) analysis of the AF&R ambulance service. Financial analysis identifies all expenses related to the ambulance service operations that are above and beyond fire department operations. PCG analyzed all revenues associated with ambulance service operations, primarily ambulance transport fees and ambulance membership program fees. Additional revenues are received on an annual basis from the Oregon Health Authority, the state Medicaid agency, through the ambulance service supplemental payment program, also known as the Ground Emergency Medical Transport (GEMT) program. In addition, the City wants to know what the subsidy or cost is for ambulance service included in the fire department budget for fiscal years 2015 – 2019 and potential cost savings over a 10-year period if ambulance services were discontinued.

By evaluating the expenses and revenues related to the ambulance service, we determined the cost and value of operating an ambulance service. We also included additional analysis of AF&R's billing data to illustrate the Department's payor mix. The payor mix represents the different types of insurance coverage for ambulance transportation; it is made up of Medicare, Medicaid, Commercial insurance or private pay and various subsets, like workers compensation and automobile insurance.

To carry out the analysis, we focused on these four areas:

- Ambulance service expenditures
- Ambulance service revenues
- Subsidy, or the net cost, for the ambulance service
- 10-year projections of the net cost for the ambulance service

The sub-sections that follow document the analysis of each focus area with assumptions and descriptions of the methodology used for any costs considered shared between AF&R and the ambulance service. Our approach is based not only on our local experience with other Fire and EMS providers in Oregon, but also our experience and understanding of national standards for the delivery emergency medical services or fire services.

Ambulance Service Expenditures

This section includes an analysis of Ashland Fire & Rescue's cost to provide ambulance services. We analyzed expenditures that were directly and indirectly related to the provision of ambulance services.

Assumptions

- If the ambulance service is discontinued, AF&R will not be downgrading facilities; therefore, utilities expenses cannot be allocated partially to ambulance and will not change if the ambulance service is discontinued.
- The expenses of dispatching and medical/physician oversight will remain to service EMS calls.
- There are no recurring ambulance specific training costs, and the expense of EMS training will remain to service EMS calls.

Analyzing Expenditures

PCG obtained expenditures data from OpenGov and analyzed five years' worth of AF&R expenses for fiscal years 2015 to 2019 to identify direct and indirect ambulance related costs. The City of Ashland's finance team also provided general ledger data broken down by vendor for further review. Table V.1 shows AF&R's budget breakdown by cost center for fiscal years 2015-2019. The budget included the following three cost centers (with the Operations cost center having two sub-cost centers):

- Fire and Life Safety
- Wildfire
- Operations
    - Operations (Fire EMS)
    - Operations (Fire Operations)

	Fire and Life Safety	Wildfire	Operations (Fire EMS)	Operations (Fire Operations)	Total Expenditures
FY15	$410,554	$311,440	$2,768,370	$3,441,963	$6,932,327
FY16	$414,222	$274,693	$3,142,446	$3,835,605	$7,666,966
FY17	$527,106	$938,589	$2,968,292	$3,612,630	$8,046,617
FY18	$382,011	$1,717,786	$2,693,808	$4,516,694	$9,310,299
FY19	$385,320	$1,998,197	$2,912,383	$4,744,108	$10,040,008

Table V.1: AF&F Total Expenditures Data FY15-FY19

It is important to note that after fiscal year 2019, AF&R changed their budget structure, creating a new Administration cost center and discontinuing the use of the Operations (Fire EMS) sub-cost center. Going forward, any EMS or ambulance costs were reported together with fire costs under Operations (Fire Operations). From interviews with AF&R staff, we concluded that this change had a significant impact on the supplemental payment that AF&R received through the Ground Emergency Medical Transportation (GEMT program in fiscal year 2020). The re-organization of EMS expenditures (Operations: Fire EMS) into the Administration cost center made it difficult to identify EMS costs. As a result, AF&R may have underreported EMS expenses in the GEMT Cost Report which could have negatively impacted their reimbursement.

From the total expenditures, we can see that the budget has steadily increased year over year.

In 2017, Oregon experienced one of the worst wildfire seasons on record. Looking specifically at the Wildfire cost center in the table above, these expenditures increased significantly in fiscal year 2017 and again in fiscal year 2018. **The spike in costs associated with responding to wildfires resulted in a 242% increase in fiscal year 2017 and an 83% increase in fiscal year 2018 within the Wildfire cost center.** In an interview with the AF&R Wildland Fire Administrator he stated that the department has been very successful in receiving grants from the State of Oregon. These funds are state grant funds specifically earmarked for fuels/vegetation management, community risk reduction programs specific to wildland fire threat mitigation such as FireSmart, and public education efforts. As is typical of all grant programs, funding levels fluctuate considerably from year-to-year as demonstrated here. It is important to note that although these funs are reflected in the AF&R budget, they are not tied to the City's general fund allotments to AF&R in any way.

Figure V.1 below shows a visual representation of AF&R's high-level total expenditures data between fiscal years 2015 to 2019 including the percent change of total expenditures between fiscal years.

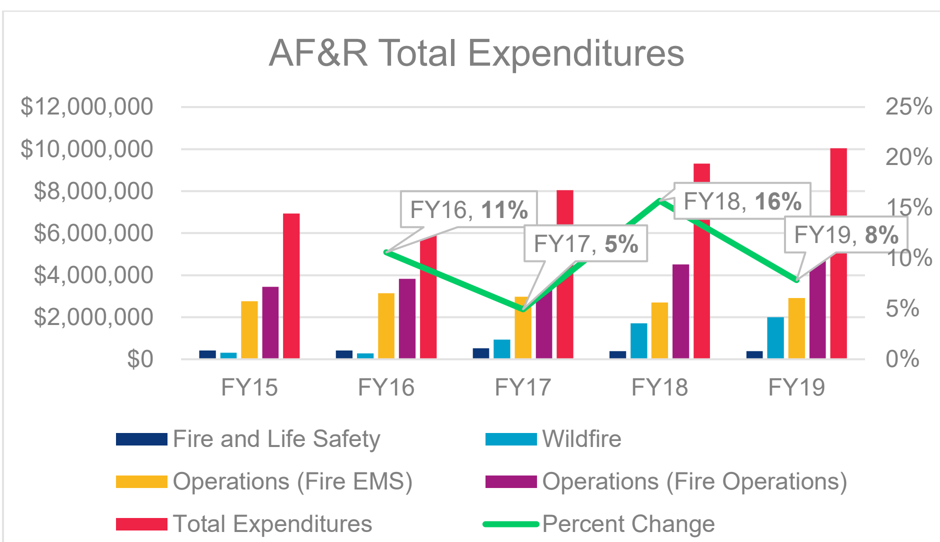


Figure V.1: AF&R Total Expenditures Data FY15-FY19

From AF&R's total expenditures data, total expenditures have increased over the five fiscal years with an average percent change of 10%. Within the Wildfire cost center specifically, expenditures increased significantly in fiscal year 2017 and again in fiscal year 2018 in response to the extreme wildfire season of 2017. This, along with increased Fire Operations costs, contributed to the largest percent change seen in the graph above; in fiscal year 2018, total expenditures increased by 16%.

Shared Costs

To determine the appropriate ambulance-related costs from expenses that are shared between the fire and ambulance services, PCG applied an allocation statistic to total expenses within the total Operations cost center. PCG calculated the allocation statistic by analyzing AF&R's computer aided dispatch (CAD) data to determine what percent of unit responses resulted in a transport. The CAD allocation statistic was applied to shared expenses for personnel costs, uniforms, fuel, vehicle repair and parts, computers and radios, insurance, and training.

> **Note:** Due to data access limitations, CAD percentage for fiscal year 2015 is based on calls from January 2015 to June 2015 only.
>
> **Assumptions**: In the CAD data, if an ambulance call had a transport date and time (fields "_unit_beg_tran" and "_unit_end_tran"), these were assumed to be transports and counted as such. Eric Bruhn who provided the CAD data also validated that this was a safe assumption.

Table V.2 below shows the allocation statistic derived from AF&R's CAD data. This percentage is calculated by dividing the total number of calls that result in a transport by the total number of unit responses. Using unit responses rather than just the total number of calls ensures that we have taken into account incidents where multiple apparatuses are dispatched on a single call.

	Total Unit Responses	Total Transports	CAD Allocation Statistic
FY15	2,934	884	30%
FY16	6,263	1,934	31%
FY17	6,496	2,115	33%
FY18	6,408	2,065	32%
FY19	6,364	2,023	32%

Table V.2: CAD Allocation Statistics for Ambulance Transports

The low volume of transports for fiscal year 2015 is attributed to analyzing only half a year of data. Assuming the first half of fiscal year 2015 was consistent with the rest of the fiscal year, the CAD allocation statistic calculation should still reflect an appropriate transport percentage.

Fiscal year 2017 saw AF&R's highest unit response volume and highest transport volume at 6,496 and 2,115, respectively. This can be attributed to the wildfires that took place in 2017 which was one of the worst wildfire seasons on record.

Table V.3 below shows the result of applying the calculated transport CAD percentage to total operations personnel costs.

	Total Operations Personnel Costs	Ambulance Personnel Costs
FY15	$4,706,082	$1,418,403
FY16	$4,845,552	$1,498,209
FY17	$4,919,705	$1,604,004
FY18	$5,399,631	$1,742,770
FY19	$5,894,849	$1,876,224

Table V.3 Total Operations Personnel Costs vs. Ambulance Personnel Costs based on CAD Allocation Statistic

The ambulance personnel costs above represent a portion of the total operations and personnel costs based on the transport CAD percentage of between 30-33% which was calculated in the previous figure.

Table V.4 below shows the result of applying that same transport CAD percentage to other shared costs for uniforms, fuel, vehicle repair and parts, computers and radios, insurance, and training.

Total Other Shared Costs		Ambulance Shared Costs
FY15	$129,294	$38,969
FY16	$163,613	$50,588
FY17	$133,224	$43,436
FY18	$183,600	$59,258
FY19	$151,366	$48,177

Table V.4 Other Shared Costs vs. Ambulance Shared Costs based on CAD Allocation Statistic

Table V.5 on the following pages shows a full breakdown of ambulance expenditures. The shared costs as shown above are reflected in the figure on the following pages along with all other expenses which were found to be ambulance specific costs from reviewing AF&R's general ledger and interviews with AF&R staff.

Total Ambulance Expenditures

Table V.5 on the following page shows the detailed expenses related to the ambulance service ONLY, this is a sub-set of EMS costs. These numbers were derived from reviewing AF&R's general ledger vendor breakdown, discussions with AF&R's finance team, and/or applying the transport CAD percentage to total Operations expenses that were considered shared as described in the previous section.

Note: PCG was not able to obtain AF&R's detailed general ledger for fiscal year 2017. To estimate the value of professional services, dues, and other expenses for that fiscal year, we calculated an average expense amount for each category using the data for the other four fiscal years.

Table V.5 below shows AF&R's detail ambulance expenditures data between fiscal years 2015 to 2019.

AF&R Ambulance Expenditures for FY2015 to FY2019					
Expenditure Type	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**
Personnel Services	**$1,418,403**	**$1,498,209**	**$1,604,004**	**$1,742,770**	**$1,876,224**
Salaries & Wages	**$922,936**	**$982,449**	**$1,035,690**	**$1,092,915**	**$1,176,043**
Regular Employees	$707,233	$731,714	$831,455	$877,630	$897,670
Holiday Pay Out	$24,929	$24,027	$30,575	$31,218	$35,452
Sick Leave Pay Out	$1,071	$512	$573	$561	$286
Vacation Pay Out	$12,772	$18,844	$1,393	$8,858	$11,733
Temporary Employees	$13,404	$10,970	$0	$0	$8,962
Overtime	$84,750	$114,125	$101,551	$107,773	$154,050
Emergency Overtime	$25,997	$28,021	$10,487	$0	$0
FLSA	$52,780	$54,235	$59,656	$66,874	$67,890
Fringe Benefits	**$495,466**	**$515,761**	**$568,314**	**$649,855**	**$700,181**
FICA/MEDICARE Contribution	$68,384	$73,301	$77,712	$81,744	$87,761
PERS Employer's Share	$161,660	$179,838	$185,095	$240,559	$255,487
PERS Employee Share Paid by City/Pks	$53,922	$56,793	$60,446	$63,164	$68,666
Prepayment for PERS	$38,505	$0	$0	$0	$0
HRAVEBA	$18,060	$19,268	$20,714	$21,612	$23,301
Deferred Comp	$0	$1,353	$4,842	$4,868	$4,888
Other Benefits	$0	$0	$523	$1,104	$584
Group Health Insurance	$133,679	$159,914	$192,017	$208,961	$233,488
Workers Compensation	$21,256	$25,293	$26,966	$27,843	$26,006
Material and Services	**$341,828**	**$382,890**	**$390,547**	**$390,353**	**$390,839**
Supplies	**$6,408**	**$13,913**	**$10,219**	**$17,036**	**$14,305**
Uniforms - Clothing	$6,408	$13,913	$10,154	$4,235	$7,155
Uniforms - Other	$0	$0	$65	$12,802	$7,150
Rental, Repair, Maintenance	**$7,599**	**$6,850**	**$6,657**	**$8,517**	**$9,068**
Fuel	$7,492	$5,846	$6,416	$7,988	$8,100
Vehicle Repair and Parts	$108	$1,004	$241	$529	$968
Communications	**$8,266**	**$11,324**	**$9,409**	**$16,730**	**$12,801**
Computers	$890	$3,788	$2,602	$2,396	$179
Radios	$7,375	$7,536	$6,807	$14,334	$12,622
Contractual Services	**$71,192**	**$85,860**	**$85,290**	**$95,068**	**$89,039**
Professional Services	$70,332	$77,254	$82,893	$95,008	$88,979
Other	$860	$8,606	$2,397	$60	$60
Internal Charges & Fees	**$236,253**	**$250,981**	**$269,066**	**$243,744**	**$261,223**
Bad Debt Expense	$140,122	$145,950	$163,349	$137,651	$155,832
Licensing	$0	$0	$0	$569	$0
Internal Chg - Insurance Svc	$8,656	$9,056	$9,742	$9,549	$9,416
Internal Chg - Fleet Maint	$43,700	$48,070	$48,070	$48,070	$48,070
Internal Chg - Equip Replacement	$43,775	$47,905	$47,905	$47,905	$47,905
Other Purchased Svcs	**$12,110**	**$13,962**	**$9,906**	**$9,258**	**$4,403**
Advertising	$382	$147	$0	$122	$0
Printing & Binding	$1,408	$1,969	$445	$0	$0
Training	$8,040	$9,445	$7,409	$7,426	$2,587
Dues	$2,280	$2,401	$2,052	$1,710	$1,816
Grand Total	**$1,760,231**	**$1,881,099**	**$1,994,551**	**$2,133,123**	**$2,267,063**

Table V.5: Detail Ambulance Expenditures

From this assessment, we determined the values in the Grand Total row. The table above includes the total expenditures associated with operating the ambulance service between fiscal years 2015 and 2019. Ambulance expenditures increased steadily each year with an increase of $126,708 per year on average.

The combined costs to operate the AF&R ambulance service including direct and indirect, or shared costs in FY 2018-2019 is **$2,267,063.**

Figure V.2 below shows a visual representation of AF&R's ambulance expenditures data between fiscal years 2015 to 2019 including the percent change over the years.

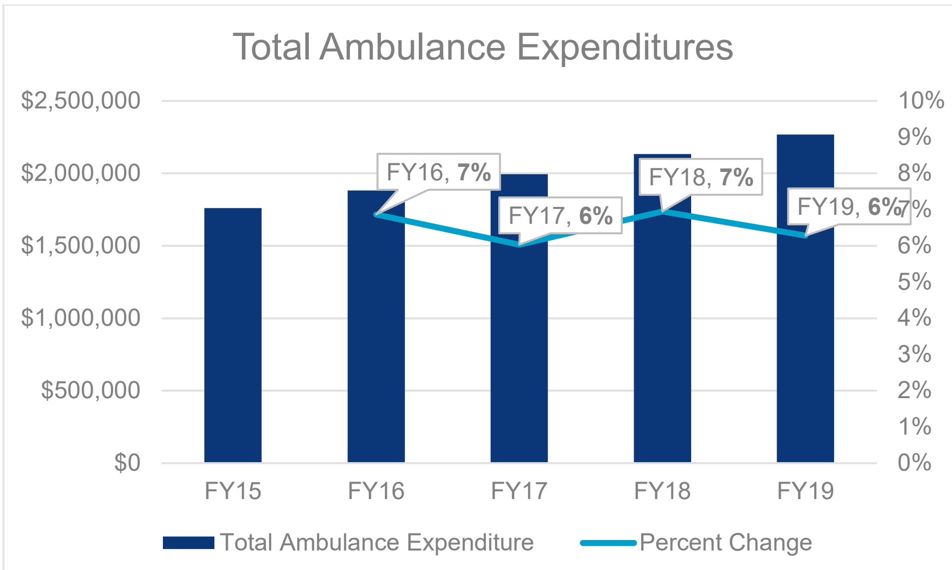


Figure V.2: Ambulance Expenditure Data FY15-FY19

The figure above shows that ambulance expenditures increased steadily each year with a percent change of 7% on average.

Ambulance Service Revenues

AF&R generates revenue for the City by providing ambulance services to the residents of Ashland and others residing in the AF&R ambulance service area. AF&R ambulances are staffed with dual-role cross trained firefighter/paramedics. These paramedics and AF&R ambulances provide emergency and non-emergency medical transportation for patients going to hospitals, medical centers, and other health care facilities in Jackson County. AF&R charges fees for a variety of EMS and ambulance related services including 911 transportation services, interfacility-transfers, and ambulance membership fees. A complete list of these fees is included in Appendix.

PCG reviewed five years of AF&R ambulance revenue data for fiscal years 2015 to 2019, including billing data, to understand ambulance related revenue and AF&R's current payor mix. Payor mix refers to the types of insurance coverage for ambulance transportation and includes Medicare, Medicaid, Commercial insurance or private pay and various subsets, like workers compensation and automobile insurance.

In 2019, AF&R began receiving supplemental payments through participation in the Oregon Medicaid Ground Emergency Medical Transportation (GEMT) program. AF&R has received two reimbursement payments through the program thus far. The first ambulance supplemental payment was $156,439 and received in December of 2019. The second payment was $126,008 and received in August of 2020. As mentioned earlier, the re-organization of EMS expenditures (Operations: Fire EMS) into the Administration cost center may have made it difficult to accurately identify all EMS expenses (including shared expenses) and may explain the lower supplemental payment received in 2020.

Revenue Data

PCG requested revenue data from AF&R and has summarized the sources of revenue by fiscal year.

Table V.6 shows the ambulance revenue data between fiscal years 2015 to 2019.

	911 Transports		Interfacility-Transfers		AF&R Ambulance Membership Program		Total Ambulance Revenue
FY15	$1,017,293	93.6%	$836	0.1%	$69,117	6.4%	$1,087,246
FY16	$1,089,835	93.8%	$3,250	0.3%	$68,267	5.9%	$1,161,352
FY17	$1,187,678	94.2%	$4,646	0.4%	$68,558	5.4%	$1,260,883
FY18	$1,061,335	93.9%	$4,124	0.4%	$65,132	5.8%	$1,130,591
FY19	$1,119,974	94.0%	$5,468	0.5%	$66,050	5.5%	$1,191,492

Table V.6: Ambulance Revenue Data FY15 – FY19

Between fiscal years 2015 and 2019, **AF&R's largest ambulance revenue source was from 911 transports which brought in $1,095,223 per year on average, consistently making up between 93-94% of ambulance service revenue.** Additionally, revenue from interfacility-transfers was $3,665 per year on average. **AF&R also brought in $67,425 per year on average from the Ambulance Membership Program.**

Figure V.3 below shows a simple, visual representation of the total ambulance revenue between fiscal years 2015 to 2019.

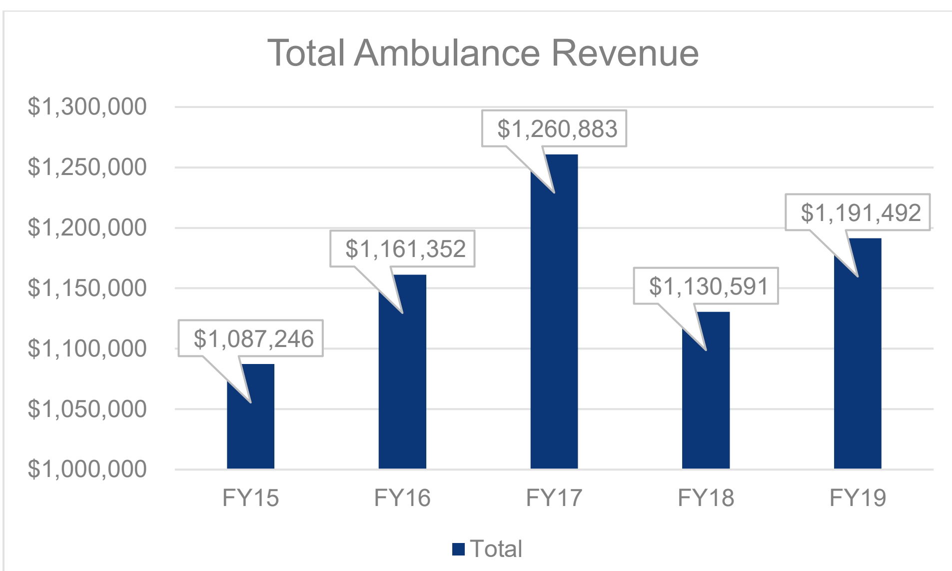


Figure V.3: Total Ambulance Revenue FY15-FY19

The figure above shows the total ambulance revenue by fiscal year. Fiscal year 2017 saw AF&R's highest revenue which can be attributed to the higher transport volume seen in the CAD data and billing data for that fiscal year.

The total ambulance revenue reviewed in this section will be used on the following pages to calculate the subsidy, or net cost, of the AF&R ambulance service as well as 10-year projections.

Billing Data

PCG requested billing data from AF&R's former biller, Springfield Account Services, to review the revenue AF&R brings in from ambulance trips and the payor mix. Billing data was provided for fiscal years 2016 through 2019.

Note: PCG was not able to obtain billing data for fiscal year 2015.

Assumptions:

- Within the billing data, trips with N/A as the payor were excluded from this review under the assumption that these were not billed.
- Payments within the billing data are slightly lower (between 9-12% lower) compared to the revenue data from transports that AF&R provided. We assume this may be due to payment adjustments; however, we were not able to obtain clarification from AF&R.
- The number of trips within the billing data is slightly higher (between 3-6% higher) than the transport volume found in the CAD data. We assume this may be due to a limitation of the CAD data.

Table V.7 below shows the charges and payments for ambulance billing between fiscal years 2016 to 2019.

	Trips	Gross Charges	Contract Allow	Net Charges	Payments
FY16	2,068	$2,329,765	$1,158,313	$1,171,451	$992,886
FY17	2,205	$2,501,085	$1,277,595	$1,223,490	$1,039,694
FY18	2,120	$2,394,233	$1,267,111	$1,127,122	$954,093
FY19	2,085	$2,423,855	$1,223,857	$1,199,998	$1,007,568

Table V.7 Billing Data FY16-FY19

In the table above, the volume of trips represents the transports made by an AF&R ambulance that could be billed to a payor. The gross charges represent the total charges for the trips prior to any contractual allowances, also known as contractual adjustments. The contractual allowances represent the difference between gross charges and the amount that can be paid based on contractual terms. The subsequent net charges represent the billed amount after contractual allowances. Finally, the payments represent the amount collected for the trips billed.

For these four fiscal years, the net collection rate, which is calculated by dividing the payment amount by the net charges, is consistently between 84-85%. This collection rate is in line with other providers in Oregon.

Table V.8 below shows the comparison of average payor mix based on trips and average payor mix based on billing payments for ambulance transportation between fiscal years 2016 to 2019.

Payor Type	Average Annual Trips	Payor Mix by Trips	Average Annual Payment	Payor Mix by Billing Payments
Medicare	1,299	61%	$523,114	52%
Medicaid	385	18%	$134,091	13%
Insurance	301	14%	$301,744	30%
Facility Contract	32	2%	$24,364	2%
Bill Patient	104	5%	$15,246	2%

Table V.8: Average Payor Mix Based on Trips vs. Billing Payments FY16-FY19

From this comparison above, we can see that Medicare and Medicaid combined make up 79% of AF&R's payors based on trips billed. Based on payments received, those same two payors make up 65% of payments. AF&R has an opportunity to maximize revenue by continuing to participate in the GEMT program and accurately report EMS costs. From interviews with AF&R staff, we understand that the department's consultant may have inadvertently reported lower EMS costs in the fiscal year 2020 GEMT cost report resulting in a lower supplemental payment.

Figure V.4 below shows a visual representation of the average payor mix based on trips for ambulance transportation between fiscal years 2016 to 2019.

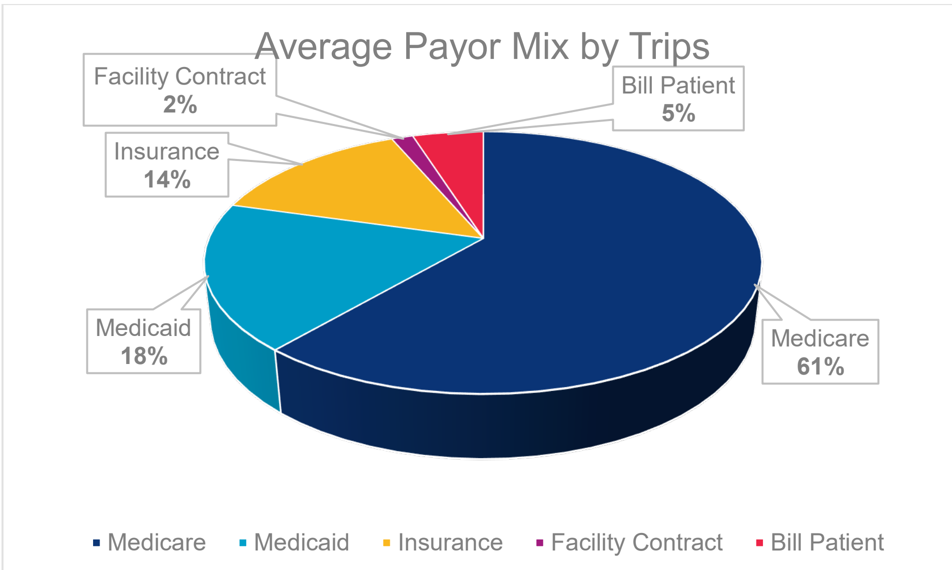


Figure V.4: Average Payor Mix Based on Trips Billed FY16-FY19

Medicare is AF&R's largest payor based on trips billed per year on average (61%) followed by Medicaid (18%), then private insurance (14%).

Figure V.5 below shows a visual representation of the average payor mix based on billing payments for ambulance transportation between fiscal years 2016 to 2019.

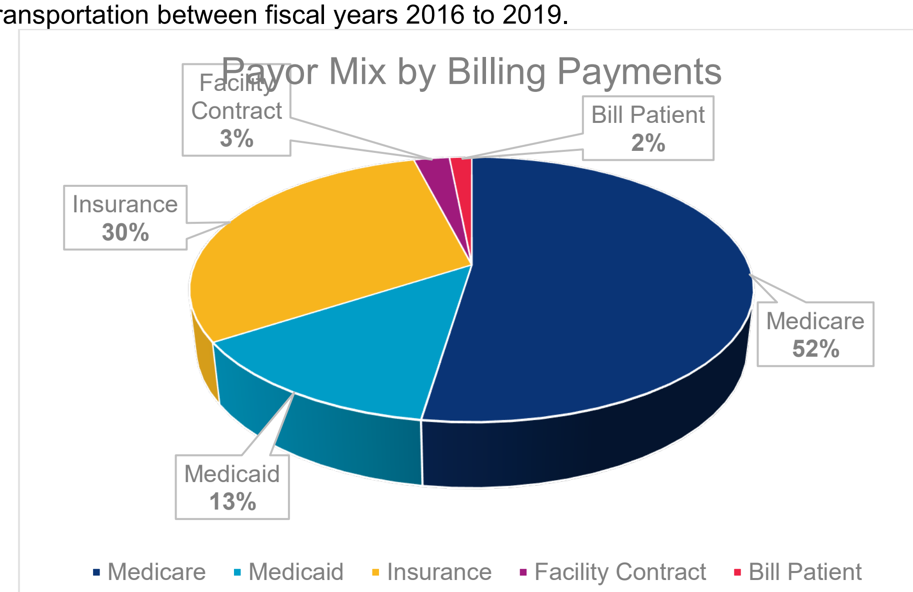
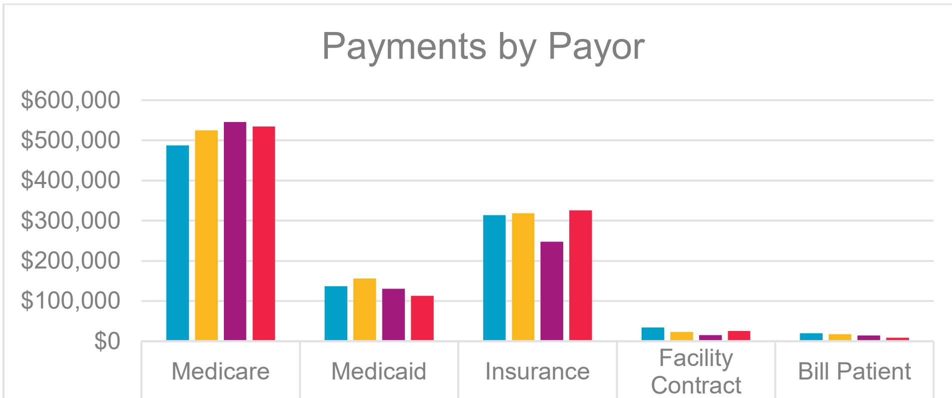


Figure V.5: Average Payor Mix Based on Billing Payments FY16-FY19

Medicare is also AF&R's largest payor based on payments per year on average (52%) followed by private insurance (30%), then Medicaid (13%).

Figure V.6 below shows a visual representation of the billing payments by payor between fiscal years 2016 to 2019.



	Medicare	Medicaid	Insurance	Facility Contract	Bill Patient
FY16	$487,624	$136,899	$314,117	$34,051	$20,194
FY17	$524,523	$155,975	$318,715	$22,964	$17,516
FY18	$545,832	$130,443	$248,053	$15,390	$14,376
FY19	$534,478	$113,048	$326,090	$25,052	$8,899

FY16 FY17 FY18 FY19

Figure V.6: Billing Payments by Payor

Medicare is AF&R's largest payor based on trips billed per year on average (61%) and is also the largest payor in terms of payments, consistently making up 50% or more of total billing payments. Although Medicaid is the second largest payor in terms of trips billed per year on average (18%), private insurance is the second largest payor in terms of payments, making up 30% of payment on average.

Ambulance Service Subsidy

The term "subsidy" usually is not used to identify the net cost of a service provided by a governmental agency.

> Oxford Dictionaries defines subsidy as:
> *a sum of money granted by the government or a public body to assist an industry or business so that the price of a commodity or service may remain low or competitive.*
>
> Wikipedia describes a subsidy as:
> *A subsidy or government incentive is a form of financial aid or support extended to an economic sector (business, or individual) generally with the aim of promoting economic and social policy. Although commonly extended from the government, the term subsidy can relate to any type of support – for example from NGOs or as implicit subsidies. Subsidies come in various forms including direct (cash grants, interest-free loans) and indirect (tax breaks, insurance, low-interest loans, accelerated depreciation, rent rebates).*

Ambulance service subsidies were prevalent in the 1970s and 1980s and still exist today in many parts of the country. They are provided to private ambulance services by cities, counties, and other governmental agencies to cover the financial losses from 911 transport billing due to non-insured and contractual write-offs. It is our assumption that the term "subsidy" in context with the AF&R ambulance service means the "net cost" to operate the ambulance service.

Using the information gathered from reviewing AF&R's expenditures and revenue related to ambulance services, PCG determined the subsidy, or net cost, of operating the ambulance service.

Table V.9 below shows the total ambulance expenditures, revenue, and net cost for fiscal years 2015 to 2019.

	Ambulance Expenditures	Ambulance Revenue	Net Cost
FY15	-$1,760,231	$1,087,246	-$672,985
FY16	-$1,881,099	$1,161,352	-$719,747
FY17	-$1,994,551	$1,260,883	-$733,668
FY18	-$2,133,123	$1,130,591	-$1,002,532
FY19	-$2,267,063	$1,191,492	-$1,075,571

Table V.9: Total Ambulance Expenditures, Revenue, and Net Cost FY15-FY19

Upon completion of the fiscal analysis, we have determined that after deducting ambulance transport service revenues from program expenditures, averaged over the past five years, there is a fiscal imbalance of $840,900. This is the true amount of General Fund monies expended annually to operate the AF&R Ambulance transporting service. The amount reflected is an average for fiscal years 2015 thru 2019.

The Net Cost identified in the table above and the projected costs in the section below does not take into consideration any cost savings or revenue enhancements that can be undertaken by AF&R and the City.

Projections and Potential Cost Savings

With the data points gathered in the previous analyses of five years' of actual expenses and revenue, PCG projected expenditures, revenue, and net cost over a 10 year period. A straight line trend analysis was used to project expenditures, revenue, and net cost of the ambulance service.

Net cost projections should not be considered potential savings if the AF&R ambulance service were to be discontinued. Such interpretation would be premature and ultimately false. We have anticipated that this assumption may arise from a quick review of this analysis and have gone into further detail in this report to explain why that assumption is incorrect.

Table V.10 below shows the projections of ambulance expenditures, revenue, and net cost over a ten-year period.

	Ambulance Expenditures	Ambulance Revenue	Net Cost
FY22	-$2,640,118	$1,255,248	-$1,384,870
FY23	-$2,766,616	$1,273,024	-$1,493,593
FY24	-$2,893,461	$1,290,848	-$1,602,613
FY25	-$3,019,958	$1,308,623	-$1,711,335
FY26	-$3,146,456	$1,326,399	-$1,820,058
FY27	-$3,272,954	$1,344,174	-$1,928,780
FY28	-$3,399,798	$1,361,998	-$2,037,801
FY29	-$3,526,296	$1,379,773	-$2,146,523
FY30	-$3,652,794	$1,397,549	-$2,255,245
FY31	-$3,779,292	$1,415,324	-$2,363,968

Table V.10: Projections Over a Ten-Year Period

The amounts in the table above have been projected over a 10-year period by applying a straight-line trend analysis to AF&R's actual ambulance expenditures and revenue. Although this analysis shows that the ambulance service is operating at a net loss, we discuss how these costs would be higher if the ambulance service were to be operated separately by the City of Ashland.

Ambulance Assets

If the ambulance service is discontinued, the assumption is that AF&R would sell the ambulances. To calculate revenue from the sale of the ambulances, PCG reviewed AF&R's current asset data and determined the resale prices.
Table V.11 below shows the estimated ambulance resale prices for AF&R's ambulance units.

Unit	Year	Make / Model	Mileage	Estimated Resale Price
8831 (1069)	2018	Ford F450 4x4	44,000	$90,000
8832 (963)	2015	Ford F450 4x4	99,650	$24,900
8833 (845)	2011	Ford F550 4x4	168,294	$28,500
8834 (552)	2006	Ford F450 4x4	130,797	$15,710
8835 (615)	2008	Ford F450 4x4	104,033	$15,690

Table V.11: Estimated Ambulance Resale Prices

F450 and F550 chassis are heavy-duty ambulances and, if they have been well-maintained, could be listed at the estimated resale values above. These resale values were obtained through research of current listings for ambulances of similar year, make/model, and mileage. For older ambulances with higher mileage, it is important to have maintained documentation of continuous maintenance.

The additional capital equipment (cardiac monitors, etc.) needed to provide ALS or paramedic level services would be maintained by AF&R for the delivery of first-response EMS delivery. PCG did not calculate the cost of ambulance equipment that could be sold, i.e., electric stretchers, etc.

SECTION VI: QUALITATIVE (OPERATIONAL) ANALYSIS

For the qualitative analysis of this report, PCG is tasked with analyzing three specific focus questions:

1. Identify if current operations (with the ambulance service) are either enhanced or a detriment to the fire department's mission.
2. Identify how future operations may be impacted (positively or negatively) if the department ended the ambulance transport service.
3. What is a recommendation on department staffing levels that will provide an effective firefighting/EMS/all hazards response force in absence of the ambulance service?

Current Operations

Does the ambulance transport program provided by AF&R represent **an enhancement** or, is it a detriment to the fire department's mission and current operations?

To address this question, one must first look at the AF&R mission statement and then conduct the two-sided analysis posed by the question.

> ***Ashland Fire & Rescue is dedicated to protecting lives, property, and the environment. By delivering fire suppression, emergency medical, disaster management, fire prevention and public education services by professionally trained, dedicated personnel, we strive to achieve the highest quality of public service to our customers.***

The department's mission statement speaks to providing dedicated emergency medical services (EMS) to their customers. What the mission statement does not specify is whether EMS delivery includes the ambulance transporting service component that has been provided since 1996. AF&R has been providing the ambulance services for over 25 years and has established itself as a primary provider of this service in the state designated ambulance service area. Services provided by AF&R are to be provided by "professionally trained" and "dedicated personnel."

The ambulance service is an enhancement, not a detriment, for the City.

The current AF&R staffing profile appears to meet this commitment within the mission statement. All AF&R personnel are trained and certified to perform each of their assigned duties. With regards to EMS care, treatment, and transportation of sick or injured persons, firefighters who are also paramedics represent the highest level of care and quality a fire department can provide. Stakeholder interviews, a review of the AF&R expenditures and revenues, and a review of national standards and benchmarks, and the current dual-role multi-hazard staffing model used by AF&R clearly indicates that the ambulance transport is **an enhancement, not a detriment,** for the City.

AF&R leadership should consider updating the departments mission statement to more accurately reflect services provided, i.e., *Advanced Life Support (ALS) care, treatment, and ambulance transportation*.

Based on the analysis of the fiscal considerations, factoring in compliance with national standards and the fiscal impact to the community on a broader sense, the community's ISO rating, the answer again is a resounding yes and for the reasons listed below and throughout this report

Staffing two ALS ambulances with dual-role firefighter/paramedics provides four additional personnel to the daily department staffing and helps ensure both residents and visitors receive the highest level of pre-hospital care and all-hazards capabilities in a timely manner within timeframes of national standards as detailed in NFPA 1710. The use of firefighter/paramedics in an all-hazards response agency is a best practice in the delivery of emergency services. **If AF&R discontinues ambulance services, there would be additional costs such as fuel consumption, increased apparatus maintenance costs, greater**

down time for each of the engine companies for preventative maintenance services, fluid changes, brakes, transmission, turbo charger etc.

If all personnel respond on engine companies, other administrative and operational programs may suffer. This includes training, pre-fire planning (something the department received a poor score from ISO for), company-level fire inspections and the inability to respond to concurrent emergency incidents. Concurrent incidents means that there are more than one incident occurring at the same time. Depending on the number of concurrent incidents, AF&R does not have sufficient apparatus and personnel to respond to more than four concurrent incidents at one time. These would be single resource responses. **If the City decided to eliminate the ambulance transportation program, it will cut the department's ability to respond to concurrent calls by 50%.**

Figure VI.1 below shows the number of times a year that AF&R contends with concurrent incidents. Combining the non-EMS and EMS concurrent incidents reveals that AF&R experiences an average of four to seven concurrent responses every day. Discontinuation of AF&R's ambulance program will reduce the number of available response units by the two ambulances. This means that only the two engine companies will be responding to incidents. This will have a considerable impact on AF&R personnel but will also require a significant increase in the number of automatic and mutual aid responses from Jackson County Fire District #5 response units. This raises two issues: 1) increased response times to incidents due to Jackson County units responding from further away; 2) there will be a reduction in the standard of care because Jackson County units provide BLS care and AF&R provide ALS level of care. This second issue is more concerning for patients who have critical need emergencies such as severe respiratory distress, heart attack, stroke or requiring an ALS level of care.

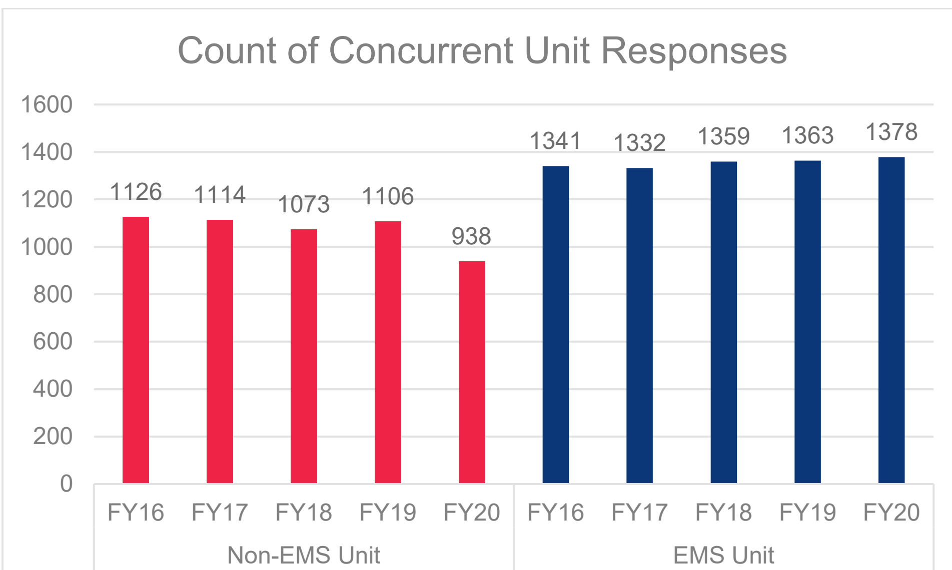


Figure VI.1: Concurrent Unit Responses, FY16-20

As mentioned in Benchmarking, Section IV, NFPA 1710 identifies the minimum number of firefighters needed to combat the most common structure fire safely, efficiently, and effectively. Ashland typifies the national trend in structure fires, single family dwellings, as most structure fires in Ashland also occur in single family dwellings that closely mirror the structure fire scenario used in NFPA 1710. Having four additional on-duty firefighter/paramedics assigned to ambulances places AF&R closer to achieving compliance with national standards for conducting fire-ground operations. AF&R will continue to rely on the support from neighboring fire districts/departments to satisfy NFPA 1710 requirements.

However, if the current staffing levels are reduced, the City will be shifting the burden of supplying enough personnel to achieve compliance with the standard to the surrounding fire districts/departments. Any reduction to AF&R staffing could also impact the ISO rating of surrounding jurisdictions who rely on AF&R resources to provide automatic or mutual aid with structure fires. The current ISO Class-3 rating was assigned in March 2015 when staffing minimums were higher than the current minimum on-duty AF&R staffing.

The 2015 ISO report stated that AF&R is critically under-staffed for the number and type of structures and the existing fire suppression demands faced at that time. If ISO were to rate the city today, there is a potential of further decrease in points for staffing. This could result in a lower ISO grade to possible Class 4 or 5 rating, as well as a decrease in firefighter safety specifically on structure and wildland fires. Given these considerations, it is detrimental to the overall mission of AF&R to consider reductions in firefighter/paramedic staffing by discontinuing ambulance transportation services.

Future Operations

The impact to future AF&R fire operations would be **negatively affected** if the City decided to discontinue ambulance transportation services. Based on the quantitative (fiscal) analysis conducted, the AF&R ambulance transportation program generates up to **$1.3 Million annually** for the City of Ashland. Fire departments that do not provide ambulance services generate minimal revenue from traditional fire services programs, such as fire inspection fees, plan review and other similar services.

Based on five years of data analysis, the average **actual direct costs** for the City to provide ambulance services above and beyond the cost to provide combined fire, EMS and ambulance transportation services is **$840,900** annually. This does not include any of the shared costs for a combined fire service agency that provides ambulance services. Section V provides a detailed analysis of the expenditure and revenues associated with operating a fire-based ambulance service. Based on the operational analysis, any reduction in on-duty fire department staffing could result in a decrease in the City's ISO Class-3 rating and possibly the surrounding jurisdiction's ISO ratings, as well as non-compliance with national standards, i.e., NFPA. The full impact is addressed in more detail in Section IV.

City government departments are not intended to be for-profit ventures. Most states have laws that specifically prohibit government entities from engaging in for-profit ventures with use of public derived funding sources, with the noted exception of "enterprise funds". This is particularly true for government public safety departments such as law enforcement, fire, and EMS. This is not to say that departments cannot institute programs designed to generate revenue and help offset operating costs such as the AF&R ambulance transportation program.

Enterprise funds are typically set up by government entities to ensure certain programs can self-sustain through fees for service, membership program fees or contract services. Revenues generated by enterprise fund programs that exceed annual administrative and operating costs are typically earmarked for placement in capital improvement or replacement accounts. Ashland currently operates several enterprise-funded programs. Currently, the City does not have an established enterprise fund for the ambulance transportation program. Instead, the City redistributes revenues generated by the ambulance transportation program to multiple other City departments.

The future impact the changes in the ISO rating could have to both business and residential property owners will be considerable to property insurance premiums.

AF&R's ambulance transport program serves as a classic example of how a municipal department can provide an essential community service that also generates revenues that support other City functions and/or services provided to the community. The City should consider that discontinuing the AF&R ambulance transport program will result in decreased revenues.

As an unintended consequence of discontinuing AF&R's ambulance services, and eliminating firefighter/paramedic positions, the City may have to contend with a possible decrease in the ISO rating. This could result in costly increases to insurance premiums for businesses and residents. Elimination of firefighter/paramedic positions may result in a reassessment of the PPC rating for the City of Ashland. ISO has already determined that AF&R was critically short of personnel and apparatus, one ladder truck and one engine company and associated personnel. Additional reductions in staffing will most likely result in a reduction of the ISO rating from the current level of Class 3 to most likely a rating of Class 5.

Table VI.1 below reflects what the **potential differences** could be **in property insurance premiums** in Ashland if the ISO PPC rating changes from a Class-3 to a Class-5. For this simulation, we used a licensed insurance agent located in Ashland and posed the question of rate changes between the two classification ratings – Class-3 and Class-5. Given that NFPA and NIST both used the "typical residential structure fire" scenario of a 2,000 square foot single family home we wanted to reflect this same home size and type for comparison. However, in discussion with the insurance agent it was identified that Ashland's medium-sized homes are larger. To provide a broader range of rate changes, a home in the 3,000 square foot size range was added.

For this simulation, all coverage levels and deductible amounts were identical for each size home.

Home Size	ISO-3**	ISO-5
2,000 Sq. Ft	$579.00	$662.00
3,000 Sq. Ft.	$1,198.00	$1,374.00

Table VI.1: ISO Ratings and Deductibles by Home Size
*****Current AF&R ISO Rating***

This simulation clearly reflects the fact that our assumption is correct regarding a correlation between ISO classification rating changes and reductions in staffing. A reduction to the existing ISO rating will lead to increases in annual property insurance premiums for Ashland residents. PCG acknowledges that this is a generic comparison and that actual rate changes are calculated on each individual dwelling based on; age, exact size, location, contents, and proximity to a fire hydrant and within specified distance from a fire station and are not meant to be actual amounts for all dwellings.

The Almeda Fire in September 2020 may have affected insurance rates for the areas of Jackson County impacted by that fire, including the northern parts of Ashland where the fire originated. This compounds the mounting fiscal impact to businesses the COVID-19 pandemic may have already inflicted. Though many businesses were forced to close due to the pandemic, owners are still required to maintain insurance coverage on their business properties. Any increases to property insurance may have additional impacts and may even be sufficient cause for the business to close permanently.

Recommendations on Effective Staffing Levels

To determine the appropriate staffing for an "all-hazards" emergency response force, PCG reviewed the April 2010 National Institute of Standards & Technology (NIST) report on fire department staffing. The study was jointly funded by the Department of Homeland Security/Federal Emergency Management Agency (DHS/FEMA) and the US Fire Administration. The study provided the most comprehensive and effective analysis of safe and effective fire service staffing levels in the United States over the past 30 years. The results of the NIST study must be considered when addressing the question of "what an effective firefighting/EMS/all hazards force is in absence of the ambulance service provided by AF&R."

The April 2010 NIST study included the following statement:

> "Every statistical analysis of the fire problem in the United States identifies **residential structure fires as a key component in firefighter and civilian deaths**, as well as direct property loss. Consequently, community planners and decision-makers need tools for optimally aligning resources with the service commitments needed for adequate protection of citizens."

Also from the April 2010 NIST study:

> “Over the past three decades, fire department response has expanded from fire prevention and fire suppression to include multiple other community services such as emergency medical services, hazardous materials response, and special rescue.
>
> Today, service demands, and public expectations placed upon local fire departments continue to rise as threats to communities from both natural and man-made disasters including terrorism reach new highs. A Multi-Phase Study on firefighter safety and the deployment of resources is being conducted with funding provided through DHS/FEMA’s Grant Program Directorate for FY 2006 Assistance to Firefighters Grant Program - Fire Prevention and Safety Grants.
>
> The multiple stages of the larger study include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and property losses.
>
> This report focuses on the residential fire ground experiments. For these experiments, a 2,000 sf, two-story residential structure was designed and built at Montgomery County Public Safety Training Academy in Rockville MD. Fire crews from Montgomery County, MD and Fairfax Co. VA were deployed in response to live burns within this facility. In addition to varying the arrival times of the first and subsequent fire apparatus, crew size was varied from two to five-person staffing. Each deployment performed a series of 22 timed tasks, while the thermal and toxic environment inside the structure was measured. *“**Results presented in this report quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of key fire ground tasks**.”*

Our report provides considerable information in the Benchmarking Section IV to provide context to staffing. The AF&R staffing levels have both fiscal and operational considerations. AF&R staffing is an important question because it relates specifically to physical protection of the community as well as complies with national standards.

Relevant industry national standards provide the most effective, efficient and safety-centric means for staffing fire and emergency medical service departments. NFPA 1710 and NFPA 1500 are widely recognized as the best and most comprehensive practices for addressing the critical question of staffing.

For several decades, the highest form of recognition and achievement for fire departments nationally is being awarded an ISO Class-1 rating. In the US there are only 411 ISO Class-1 fire departments out of more than 65,000 fire departments nationally. This report has placed a significant level of emphasis on educating readers about the importance of ISO and the PPC rating system. The City of Ashland’s ISO rating can have a significant impact on the lives of citizens and local businesses related to fire insurance premimium costs. Because of the wildfire threat in Jackson and Josephine Couny, fire insurance premiums, especially after the 2017 and 2018 fire seasons, may increase considerably, as happened to several communities in Marion and Lincoln counties as a result of the Mega-Fires that occurred there in September of 2020.

Based on our assessment and analysis, if the City discontinues ambulance service, the most effective all-hazards staffing for AF&R is listed below:

AF&R transitions to a first responder ALS delivery model for EMS responses. Firefighter/paramedic’s currently assigned to ambulances will be reassigned to AF&R engine companies. Engine companies will be staffed with a minimum of:

- One fire captain
- One fire engineer

- One firefighter/paramedic (primary care provider)
- One firefighter/paramedic (secondary care provider)

Reassigning the firefighter/paramedics to the engine companies will provide for four-person staffing as identified in the NIST study as being the safest and most efficient staffing level for performing engine company functions on the fire ground. NFPA 1710 also states that minimum **staffing on an engine company shall be four personnel.**

From a technical perspective, assigning the AF&R firefighter/paramedics to the engine companies is a physical exercise more than anything else. All of the firefighter/paramedics are "technically" assigned to the two engine companies for all emergency responses other than EMS incidents, particularly those requiring patient transport. NFPA 1710 does allow personnel to be assigned in what is referred to, in fire service terms, as "Cross-Staffing" or even "Split-Staffing". This simply means that personnel assigned to a station or company staff or split between multiple response units. Many fire departments do this during wildland fire season where firefighters assigned to an engine company will cross-staff a brush truck or even a water tender.

AF&R currently employ's this staffing configuration where the captain and engineer respond on the engine company and the firefighters respond on the ambulance. When both units arrive on scene of a structure fire, vehicle accident, technical rescue or hazardous materials incident, all four personnel function as one crew supervised by the fire captain. This is a standard industry practice nation-wide.

This staffing configuration will also allow for staffing on engine companies to remain at three, when patient care conditions mandate a firefighter/paramedic accompany a critical patient to the hospital. Although three-person staffing of an engine company is not ideal from a standards perspective. It is certainly more effective and safer that the current two-person staffing the department currently has. An additional factor is that by keeping the second FF/Paramedic with the engine crew, should another EMS incident occur the crew can still respond and maintain the standard of care for the patient.

The AF&R SoC document identified the most critical hazards in the community through a comprehensive risk assessment tool developed for the fire service by the CFAI. The CFAI tool is a component piece of a broader document used by fire departments around the world who choose to receive accreditation from the Centers for Public Safety Excellence (CPSE). This process has been around for nearly two decades and, like many other certification and/or achievement recognition processes, is designed to proclaim that a fire department (CFAI), EMS provider (CAAS) and law enforcement agency (Commission on Accreditation for Law Enforcement Agencies) have achieved a level of excellence that sets them apart from peer organizations throughout their region, state and even nationally.

AF&R's SoC Risk Assessment identified the following response types as critical tasks:

- Structure Fires
- EMS Incidents
- Wildland Fires
- Technical Rescues (High and Low Angle and Confined Space Rescue)

Staffing for All-Hazards Response

The Benchmarking Section of this report provided considerable information regarding NFPA 1710 staffing guidelines including the recommended number of firefighters necessary to combat a working residential structure fire safely, efficiently, and effectively. Eighteen personnel are the minimum recommended by NFPA 1710. That number is supported by the extensive study performed by NIST and published in the April 2010 report. How does this compare to what AF&R currently responds with to a working residential structure fire?

As has been identified in this report, AF&R provides the following staffing to structure fires:

- One (1) Fire Battalion Chief Incident Commander
- Two (2) Engine Companies (2, Fire Captains & 2, Fire Engineers)
- Two (2) ALS Ambulances (2, Firefighter/Paramedics per Unit)
- **Total AF&R Personnel = Nine (9)**

****Note:** Due to staffing reductions put in place in 2020, the department has held three (3) firefighter positions vacant as a cost savings measure. This has resulted in each shift being staffed with 8 personnel. The department has received approval to fill the three firefighter positions and the Fire Chief has indicated that these positions will be Firefighter/EMT's. Although this will help bring the staffing back up it is still below what the department staffed during the last ISO rating meaning the City will lose more points for the PPC rating in this category.

This means that to achieve compliance with NFPA 1710 staffing recommendations, AF&R will require an additional **nine** firefighters through either automatic-aid or mutual-aid from neighboring fire departments. For AF&R the closest mutual aid resources are in Jackson County Fire District #5. However, the additional nine personnel are not available because Jackson County resources are staffed with either two personnel or three personnel. Jackson County Fire District #5 has a total of three fire stations with a total on-duty compliment of eight personnel. Jackson County Fire District #5 provides two engine companies through automatic aid to Ashland for working structure fires.

A second chief officer is provided on all structure fires into Ashland to function as the Incident Safety Officer. This chief officer is responding from the City of Medford which is 24 miles away. This brings the total number of firefighters responding to a working structure fire in Ashland to **13-14 personnel**. This equates to **4-5 fewer personnel** at a structure fire than is recommended by NFPA 1710. It is important to state the fact that the Rogue Valley Fire Chief's Association has developed a very comprehensive fire & rescue mutual-aid response plan that provides multiple options for incident commanders at working structure fires to request additional response resources to an incident as fire conditions demand. However, it is equally important to point out that those resources are coming from distances as far away as Grants Pass and may results in delays of an hour or greater.

A series of heat maps that provide a comprehensive breakdown of the number and types of emergencies AF&R has responded to over a five-year period are included in the Appendix. These heat maps illustrate responses in three categories, fire, medical, and other. The significance of including these heat maps is that is graphically depicts the level and volume of responses AF&R provides not only to the City of Ashland but to the ASA response area and support to neighboring fire departments and districts.

The map in Figure VI.2 identifies all the fire departments and fire districts that are part of the Rogue Valley Fire & Rescue Mutual Aid System.

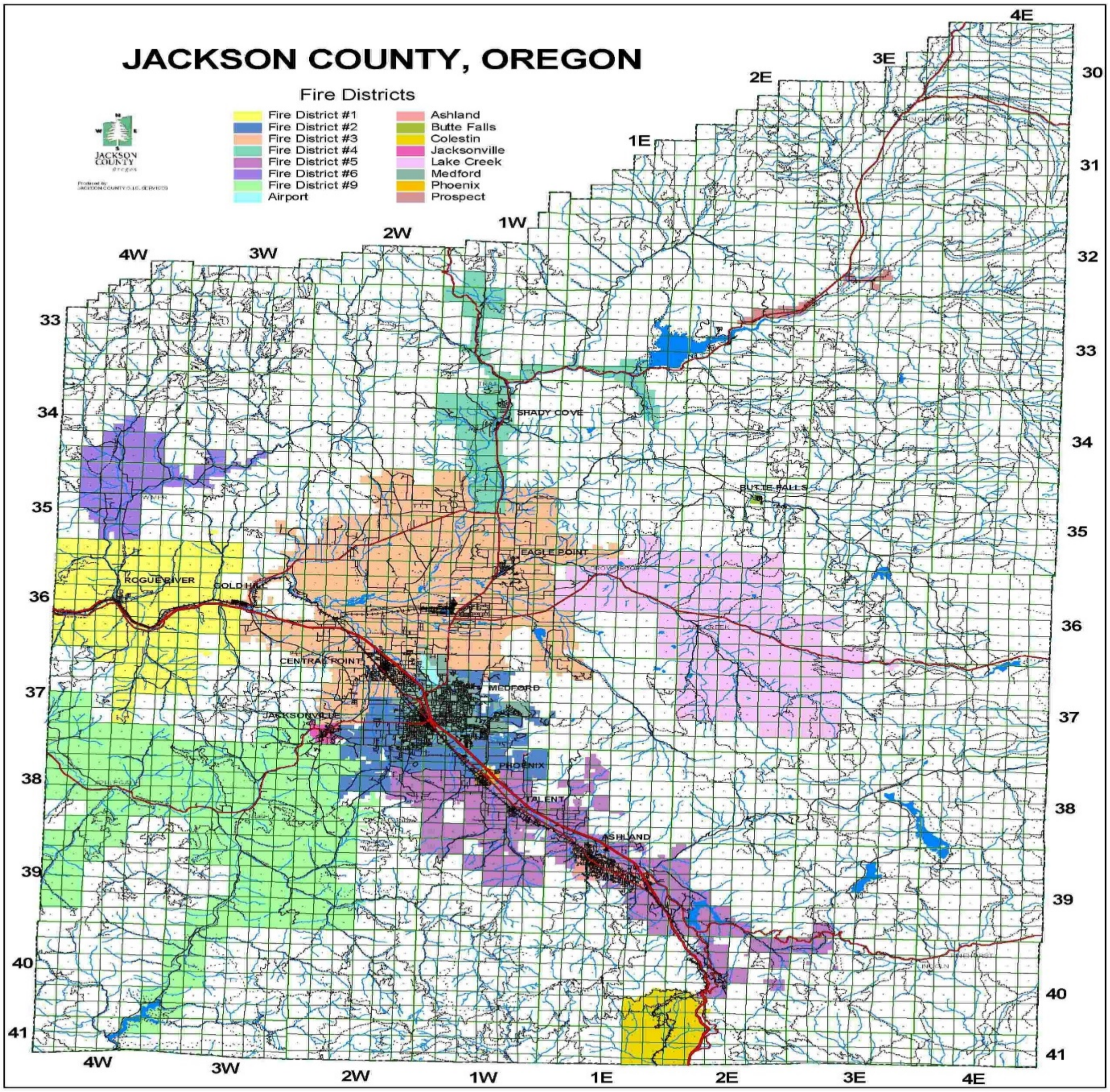


Figure VI.2 Jackson County Fire District Boundaries

SUMMARY VII: SUMMARY OF FINDINGS AND RECOMMENDATIONS

Quantitative (Financial) Analysis Conclusion

PCG reviewed five-years of expenditures and revenues contained in the AF&R fire department budget. Direct and indirect costs to provide ambulance services were identified. The FY 2018-2019 AF&R approved budget was $10,040,008. PCG identified that the cost to operate the ambulance service in FY18/19 was $2,267,063 or 23% of the total budget. Currently, the AF&R ambulance service generates up to $1.3 million in annual revenues from 911 ambulance transports, inter-facility transfers, ambulance membership program and other ambulance related fees. When the revenues generated by AF&R are considered, the average annual **cost to operate the ambulance transport service is $840,900 above and beyond the current cost to operate the fire department.**

Most of the net cost is derived from personnel costs: FY19 shows 83% of ambulance expenditures were personnel costs. **Should the city opt to discontinue the ambulance transport program, firefighter/paramedics currently staffing ambulances would be reassigned to the two engine companies, meaning the personnel cost will not be eliminated and the financial burden to the department would increase respectively.**

Additionally, if the city discontinues the ambulance transport program and eliminates the ambulances and associated equipment, AF&R will still respond to EMS incidents but do so with fire apparatus that is substantially more costly to operate and maintain than an ambulance. This also means that costs such as fuel, fleet maintenance, and vehicle replacement will increase. Therefore, eliminating the ambulance transport program will result in overall higher operating costs for AF&R.

Discontinuation of the ambulance transport program will result in elimination of the future revenues, projected to be an average of $1.3 million as reflected in Table V.10 on page 28 of this report. When combined with higher operating costs for AF&R, the City will be compelled to identify funding sources to replace the lost AF&R revenue that currently supports other City departments as well as fund the increased AF&R operating costs.

Qualitative (Operational) Analysis Conclusion

AF&R Ambulance Services

Analysis of the three qualitative questions posed in the RFP shows that **discontinuing AF&R's ambulance transporting service and associated staffing results in both a fiscal and operational detriment to the City**. This analysis is supported by staffing guidelines in national standards for firefighter staffing and supported by fiscal impacts brought about by changes to Ashland's ISO rating. Further considerations regarding the ISO rating impact to surrounding jurisdictions must also be a compelling factor.

The City of Ashland has additional revenue opportunities by operating the ambulance service. Coordination and scheduling of inter-facility transfers can generate additional revenues. Implementation of a mobile integrated healthcare or community paramedic program in conjunction with the local and regional medical facilities can also generate revenues. Additionally, mentioned previously are non-resident user fees, such as first-responder fees charged to non-residents. PCG would also recommends the City implement a cost-recovery program that can provide additional revenues to off-set the costs of AF&R.

Separate City Ambulance Service

One interpretation of this analysis could be to discontinue the ambulance service provided by AF&R because it is operating at a net loss. However, that decision would not result in savings. To address that interpretation, we have prepared a sample scenario to demonstrate how operating a City-owned ambulance service separate from the fire department would increase costs.

By operating the ambulance service and fire service out of the same department, economies of scope are realized by producing two services out of the same department and sharing the costs associated with the

two services. **If ambulance and fire were to be operated separately**, **the cost of the ambulance service would increase.**
In this scenario, a new, separately operated ambulance service would need to hire personnel including paramedics, an ambulance director, a training officer, and an administrative assistant at a minimum. TableVII.1 below shows the total personnel costs for operating a separate ambulance service. Below the figure, details concerning the source of the analysis are provided.

Position	Number of Positions	Total Personnel Costs
Paramedic	18	$1,769,040.00
Paramedic (Overtime)	N/A	$404,352.00
Ambulance Director	1	$128,712.00
Training Officer	1	$110,736.00
Administrative Assistant	1	$62,400.00
Total	**33.00**	**$2,475,240.00**

Table VII.1: Total Personnel Costs Operating a Separate Ambulance Service

PCG calculated salaries and benefits based on hourly wages, overtime pay and a 25% yearly salary benefit package for each of the positions.

Comparing Annual Costs

Next, we add all of the personnel costs that have been calculated and add an operating cost to get the total expenditures for the new, separate ambulance service. This cost is compared to AF&R's current total expenditures for the ambulance service.

Table VII.2 below shows the total estimated annual expenditures associated with operating an ambulance service separate from the fire department and the actual annual expenditures AF&R incurs from operating the ambulance service.

Estimated Annual Expenditures of a Separately Operated City Ambulance Service	
Personnel Costs	$2,475,240
Operating Costs (based on FY19 actuals)	$390,839
Estimated Total Annual Expenditures	**$2,866,079**

Actual Annual Expenditures of AF&R Ambulance Service (FY19)	
Personnel Costs	*$1,876,224*
Operating Costs	*$390,839*
Actual Total Annual Expenditures	***$2,267,063***

Table VII.2: Estimated Additional Annual Costs to Operate a Separate Ambulance Service

The tables above demonstrates the financial cost of operating a city ambulance service separate from the fire department. If the ambulance service were to operate separately, it would cost an estimated **$599,016 more per year** than the actual cost of AF&R's current ambulance service.

This sample scenario focused specifically on the increase in personnel costs; however, it is important to note that other operating costs that were previously shared between ambulance and fire, such as future capital improvement costs, would be incurred individually. This would mean any economies of scope that were previously afforded to the joint services would be eliminated.

If the ambulance service were to operate separately, it would cost an estimated $599,016 more per year than the actual cost of AF&R's current ambulance service.

Privatize Ambulance Service

One option the City can consider as replacement of AF&R's ambulance transporting service would be to issue an RFP to have transport services provided by a private, for-profit EMS provider such as AMR or even a non-profit provider such as Mercy Flight. PCG believes this is the least appealing option for the City due to loss of program revenue, loss of local control, and loss of continuity of patient care. Each of these concerns is described in detail below.

Loss of Program Revenue

This report provides considerable analysis of revenues and expenditures associated with operations of the AF&R ambulance transportation program. Considerable focus has been directed on the important question of how the City would replace the annual revenue generated by the AF&R ambulance transporting service that provides $1.3 Million back to the general fund that supports other City departments.

This option eliminates all revenues the City currently receives from the ambulance transporting service as all revenues would immediately shift to the provider awarded the ASA operating license.

This single issue should be sufficient justification/rational to dissuade the City from considering this option. Particularly considering the current fiscal crisis facing the City where all revenue-programs and options should be expanded or enhanced.

Loss of Local Control

Private EMS providers are, first and foremost, for-profit companies. Before submitting a bid on an ASA contract, private companies will closely analyze the level of resource commitment needed and can they provide services and remain within the profit margins.

Private companies use staffing configurations that fluctuate with system demand. On days of the week and times of the day where call volume is historically low, the company reduces the number of units/crews on-duty and days and times when call volume is historically higher, they will increase staffing with additional units. This process is commonly known as "System Status Management".

This can be an effective staffing/management tool for maintaining profitability. However, it is not a system without critical flaws. Emergencies are, by their very nature, unpredictable so if, at any time, the number of emergencies increases beyond levels the company has sufficient staffing for, private EMS providers do not have the ability to rely on automatic or mutual aid as fire departments do to cover the increase in call volume/demand.

The only option for private EMS companies is to pull units into areas of increased demand to provide coverage. This results in significantly longer response times for these units that may be responding from as far away as Medford or even further out rural areas of the county or ASA.

This means that fire department units on-scene with a patient will have considerably longer on-scene wait times and patients requiring rapid transport to the hospital are forced to wait for the ambulance. In events such as heart attack, stroke or traumatic injuries resulting in internal or external bleeding, patients cannot afford to have extended on-scene wait-times for an ambulance.

These critical events require short response times, rapid field assessments and even more rapid transports. This is one of the significant advantages of fire-based EMS programs over private companies. Although not common, there have been multiple instances where private EMS companies have ceased operating in contract communities and there are even documented instances where private companies have done this without providing advanced notice to the community.

Research into such occurrences identified that in December 2013, a private EMS provider with contracts in six US states, covering 70 communities, executed a no-notice shutdown impacting several major cities in Ohio, Delaware, North Carolina, and Tennessee.

In May 2017, a Denver-based private EMS provider executed a no-notice shutdown that left patients scheduled for transport stranded at medical facilities and unable to receive critical medical procedures such as dialysis. Employees of this company were owed as much as two-months back wages that they were unable to claim.

Once again, although such occurrences are rare, policy makers must still be aware of the potential.

Loss of Continuity of Patient Care

An additional issue to take into consideration is one that deals with the human factor of patient care, treatment, and transport.

Continuity of care refers to having the same caregiver from the start of the incident through the delivery of the patient at the hospital. EMS training curriculums across the country addresses the physical, emotional, and psychological importance of maintaining continuity of care with patients, especially when it comes to the elderly and small children.

When EMS responders arrive on scene of an emergency, one of their first and essential elements of providing care is to establish a positive relationship between the care provider and the patient. It is critical to understand that the patient, and first responder, are meeting for the very first time, are complete strangers and the EMS care provider must engage in very personal and intimate actions such as touching the patient to begin the assessment process. This initial assessment establishes the bond between care giver and patient and can have a profound impact on the patient’s overall outcome.

In systems where patients are handed off from one care provider to another, the continuity of care is interrupted, and this increases the patients already elevated level of anxiety as well as the potential of the patient’s initial care and treatment not being relayed correctly to the receiving facility or hospital.

In certain critical medical events such as heart attacks, strokes, mental health crisis, and instances where the patient may have an altered level of consciousness such as diabetic, seizures or head injuries maintaining continuity of care takes on a more critical necessity.

Elevated levels of anxiety in a patient with already compromised systems, such as elevated blood pressure, can have profoundly negative impacts on patient outcomes and must be given its due consideration.

Additional Findings and Recommendations

AF&R Ambulance Membership Program

The City of Ashland has had an ambulance membership program for several years that generates an **average of $67,425 per yea**r. The original program, FireMed, was managed by an ambulance billing vendor located in Eugene, Oregon. FireMed has a long history in Oregon and has the largest network of ground and air ambulance providers across the state. In the 1980s many fire departments implemented ambulance subscription or membership programs that were modeled after the FireMed program. The use of the term “membership” program is preferred over the term “subscription” as “membership” tends to be more valued by the community’s members. AF&R’s new billing vendor offers ambulance membership management services, but the fee is outside the department’s budget.

Ambulance membership programs allow the member to avoid any out-of-pocket expenses such as co-pays or deductibles in conjunction with their medical insurance plan if they need ambulance transportation. AF&R’s ambulance membership includes all family members living together for a one fee regardless of the number of family members. AF&R accepts the insurance companies' payment of the ambulance bill and considers this as payment in full. For those that do not have medical insurance, their membership fee covers the ambulance bill, and they have no further responsibility.

These programs have come under legal scrutiny in the past and in some states are viewed as a form of insurance and regulated by the state insurance agency. There have been several legal reviews at the state level regarding these programs and their legal status and compatibility with other state and federal programs, statutes, and regulations. Because of these legal issues many ambulance membership programs require that the members be fully advised of the program's actual coverage and limitations that members must agree to if they want to participate in the program. AF&R's membership application includes the legal declarations and notifications required, see Appendix.

After the billing vendor changed, AF&R continued the ambulance membership program and took over the coordination, marketing, and management of the membership program in-house. The AF&R administrative analyst handles this responsibility. Processing membership applications and membership payments is extremely labor intensive as it involves paper applications and payments being mailed to the City. The current process consists of the potential member going to the AF&R website, downloading, and printing an application, completing the paper application, and mailing it back with payment by check or by providing credit card information. AF&R's staff receives the mailed application and manually processes each application that includes entering the information into a database, generating a membership confirmation letter, and finally mailing the letter to the member.

In addition to this process, the AF&R website and Mercy Flight's website list a phone number to call for ambulance membership information for Ashland's program. The number of phone calls at times is overwhelming and time consuming. Because of this labor-intensive process and competing priorities, there is very little incentive to market the ambulance membership program that could potentially generate additional revenues for the City. Continuous marketing of the program is a key component to ambulance membership program success.[1]

The AF&R Ambulance Membership Program also includes two types of memberships: AF&R Basic and AF&R Plus. Basic membership includes ground ambulance services only and Plus membership includes ground ambulance services plus air ambulance services. Air ambulance services are provided by Mercy Flights, not AF&R. The membership program descriptions and rates from AF&R's website are listed below.

AF&R Basic

Emergency Ground Ambulance Services $66/year
Membership Benefits Include:

- Emergency prehospital, medical treatment and transportation.
- Emergency paramedic rescue.
- Emergency ambulance transportation to all local hospitals.
- Automatic insurance billing service.

[1] How ambulance membership programs help patients defray ambulance cost, Fitch & Associates, July 16, 2019. https://www.ems1.com/ems-products/billing-administration/articles/how-ambulance-membership-programs-help-patients-defray-ambulance-cost-xewUtZeS7FnfTrmG/

<u>AF&R Plus</u>
Emergency Ground **PLUS** Air Ambulance Services $112/year
AF&R Plus includes:

- AF&R Basic services
- Emergency air ambulance
- Inter-hospital transport
- Air transport fees can cost more than $7,000 out of pocket

Most (62%) of the ambulance membership applications included the air ambulance option. That adds one more manual step to the processing of ambulance membership applications, making sure Mercy Flights gets the member's information and their portion of the membership fee which is $46 minus $5 that AF&R keeps for processing the application.

Mercy Flights benefits directly and indirectly from AF&R's combined membership application opportunity because of the passive marketing on the AF&R website, the applications AF&R processes on behalf of Mercy Flights, and the fees generated for Mercy Flights. The City should examine this relationship to ensure both parties are contributing equally to the management, marketing, and coordination of the program.

For calendar year 2020, the AF&R ambulance membership program included 1,184 households in the ambulance membership program. There were 452 households with AF&R Basic membership and 729 households have the AF&R Plus membership for calendar year 2020, representing 12% of Ashland's households. The **2020 ambulance membership program revenues** for Basic membership were $29,832 and the Plus membership generated $51,759 **resulting in $81,591 for the City**. Mercy Flights received $29,889 for air ambulance memberships from AF&R's ambulance membership program for their share of revenues.

Successful ambulance membership programs that are voluntary can expect between 20% and 35% of eligible residents to participate. US Census data reveals that between 2015 and 2019 there were 9,879 households in Ashland. Using this data, the ambulance membership program could generate additional revenues based on increasing the percentage of participants in the City and could look like this:

- 15% of the households: 1,482 at $66 per household would generate $97,912 annually
- 20% of the households: 1,976 at $66 per household would generate $130,416 annually
- 30% of the households: 2,964 at $66 per household would generate $195,624 annually

These are conservative revenue estimates because it does not include the eligible households outside the city limits, that are within the current AF&R ambulance service area. An additional $5 per membership is generated if members choose the Mercy Flights air ambulance option.

AF&R Ambulance Membership Program Recommended Options

- The City of Ashland should automate the entire ambulance membership application process and payment processing to an online process, reducing the burden on the current staff managing the program.
- Outsource the management of the ambulance membership program.
- Examine the relationship with Mercy Flights from an equitable contribution perspective and return on investment (ROI) of AF&R's current efforts managing this program and including Mercy Flights membership program option on the AF&R application.
- Increase the marketing efforts for the AF&R Ambulance Membership program, but only if the processing component is automated or outsourced.

The AF&R Ambulance Membership Program generates average annual revenues of $67,425. Automating the membership application and payment processes to an online or mobile platform will encourage increased marketing of the program. Additional marketing efforts could double or triple the amount of revenue currently generated on an annual basis.

Additional Considerations for AF&R

AF&R leadership can take steps to reduce capital and operating expense by making a few adjustments. In addition, additional or enhanced revenue avenues should be explored. Consideration should be given to the following:

- Reducing the current cost for new ambulances – revise specifications, consider remounts, group purchasing contracts, etc.
- Enhancing reimbursements from the Medicaid ASPP/GEMT program.
- Hiring firefighter/emergency medical technician (FF/EMT) personnel for some positions.
- Expanding the AF&R current ASA to include portions of the Jackson County Fire District #5, including Phoenix and surrounding areas where AF&R has been providing services.
- Implementing a cost recovery program for motor vehicle accidents and other at-fault incidents where a responsible party can be billed for services, usually paid by insurance carriers.

Update/Revision of the AF&R Standards of Coverage Plan

Once the City has determined a course of action for the future of the ambulance transporting service, the 2009 Standards of Coverage document should be revised to reflect staffing and apparatus needs based on the City's decision and that also reflects the response profiles identified by the Rogue Valley Fire Chief's Association's response guidelines, policies, and procedures.

APPENDICES

Appendix 1: Client Documents Reviewed

- Billing
    - Activity summaries for FY16-FY19
- CAD
    - 2015-2020 reports
- Expenditures and Revenue
    - Ambulance Asset Data report
    - FY15-FY19 Detail Data reports
    - FY15-FY19 Expenditures reports
    - FY15-FY19 Detail Revenue reports
    - Other Revenue Sources 2018-2020
    - Fee Schedule
    - SAFER Grant data
- Incident Count Per Zone
- Incident Count per Zone by Incident Status for Incident Status for a Date Range (2020)
- Count of Overlapping Incidents for State for a Data Range (In Service Time Used)
- Accreditation Approval from DPSST to provide in-house training
- Oregon State EMS Training Requirements
- Credentials and employee credentials status
- Department certifications
- Standard Operating Guidelines
- Training & Education Plan
- Yearly Training Calendar for 2019-2023
- ISO 3 Rating – AF&R report
- AF&R ASA Report
    - 2020 ASA Report Data
- 2018-2022 IAFF Agreement
- Engine Response Guideline – January 2019
- Mutual or Automatic Aid Given by FDID for Incident Type for a Data Range
- Ashland Fire Rescue Standard of Cover (2009)

Appendix 2: Ambulance Service Area III 2020 Transport Rates

Ambulance rates are for 2020, Base Rates will be adjusted each year by the most current posted CMS "Ambulance Inflation Factor" (AIF). Other rates and mileage charges will be adjusted only by approval of the County Commissioners.

Effective January 1, 2020 the CMS Ambulance Inflation Factor (AFI) for CY 2020 is 0.9%

BASE RATE (advanced life support) = $1,105.00
The City charges an "All Inclusive" Base Rate. There are no additional supply charges. The Base Rate becomes effective upon the emergency response of the ambulance. This serves as a minimum charge to support the City's fixed expenses.

BASE RATE (basic life support) = $1105.00

Basic Life Support covers non-emergent basic transport services such as scheduled transfers to nursing facilities, assisted living facilities or home.

MILEAGE = $14.43 per mile

Fees for mileage reflect the distance traveled (to the nearest mile, one mile minimum) from the point of pick up to the patient's ultimate destination (i.e., home or accident scene to hospital).

CONTINUATION OF SERVICE
If the patient is transferred to another facility within one hour, only one Base Rate is charged.

TRANSFERS OUT OF AMBULANCE SERVICE AREA

BASE RATE (advanced life support) = $1,105.00

MILEAGE = $14.43 per mile

Mileage is figured from point of pick up to point of destination. (Patient miles only). This rate is applied to "pre-arranged" transfers that conform to Department policies.

MULTIPLE PATIENT SITUATIONS

When a medic unit transports more than one patient from the same incident or from unrelated incidents, each patient is charged a full base rate. This is in recognition that each patient receives the same care and transportation services as when only one patient is transported. However, an adjustment will be made for mileage charges. In instances where more than one patient is transported in the same medic unit, the normal mileage charge will be split among the number of patients transported, i.e., if two patients are transported, they will each be charged a full base rate but only be charged 50% of the normal mileage charge; three patients would be charged 33-1/3% of the normal mileage charge, etc.

SIT-UP PATIENTS

Patients who, because of multiple patient situations or whose condition did not require movement by stretcher and are transported sitting up in a regular seat in the medic unit will be charged 50% of the regular Base Rate. If other patients are being transported in the same medic unit, sit-up patients will be charged mileage as a Multiple Patient as described above.

BASE RATE (advanced life support) = $552.50 (50% of the regular Base Rate).

MILEAGE = $14.43 per mile (100% of the Regular Mileage unless Multiple Patient situation applies).

EXTRA ATTENDANT = $45.00

When a patient's condition warrants that an extra emergency medical technician assist the medic unit crew during transport, a fee for the extra attendant will be charged. Situations and conditions where an extra attendant charge is applicable include: an acute/critical patient, a disturbed/combative patient, or an extremely obese patient (300 pounds or more). In each case, diagnosis or documentation must indicate medical necessity.

AID CALLS

The Aid Call rate is used whenever services are rendered, especially when an advanced life support procedure or supply was administered, but the patient was not transported.

This charge may also be used for expired patients under the following conditions:

1. Calls where death is not certain and assessment and/or care are necessary to determine death, will be handled as an "aid call." Cases of obvious death, i.e., rigor mortis, decapitation, etc., where NO evaluation or treatment is performed, will be handled as "no patients."
2. Use of the monitor/defibrillator, solely for the purpose of confirming death, rather than for active patient care, will not constitute a charge, however, if the monitor/defibrillator is used for resuscitation, appropriate charges will be made.

Service Fee = $330.00

WAITING TIME = $25.00 per half-hour

If the waiting time is extraordinarily long and constitutes an unusual circumstance, waiting time may be charged. Unusual circumstances would occur when there are medical complications requiring additional time, effort, or expense. The reason for the waiting time must be documented. Waiting time is billed in thirty-minute increments. The first thirty minutes are not billed, they are included in the base rate.

STANDBYS

All pre-arranged paid standbys are billed at an hourly rate. There is no Base Rate or Mileage charge to the person/organization requesting the standby. If a patient is treated and transported from the standby event, the patient will be billed normal rates. Standby time is charged from the time personnel first arrive at the station to prepare for the standby, until they have arrived back at the station and have completed all duties related to the standby. A standby crew consists of two crew members with a dedicated paramedic unit. In the event of an emergency, the standby may be cancelled, or the paramedic unit may be recalled from the standby event without notice.

STANDBY = $100.00 per hour (two-hour minimum charge)

Patients treated and/or transported from a standby event will be charged in accordance with normal rates for services provided.

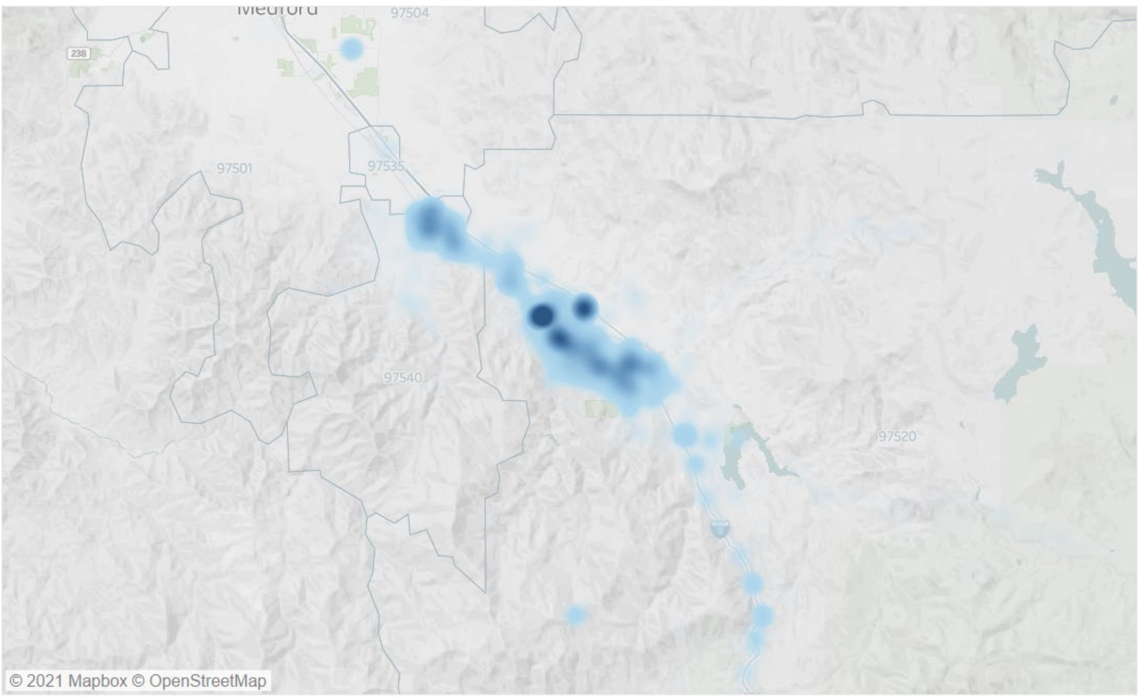
On-Scene Coordinator = $50.00 per hour (50% of the Standby rate)

If an event requires two or more medic units, an on-scene coordinator may be required.

Appendix 3: Heat Maps with AF&R's Responses to Fires, EMS, and Other Calls: 2016-2020

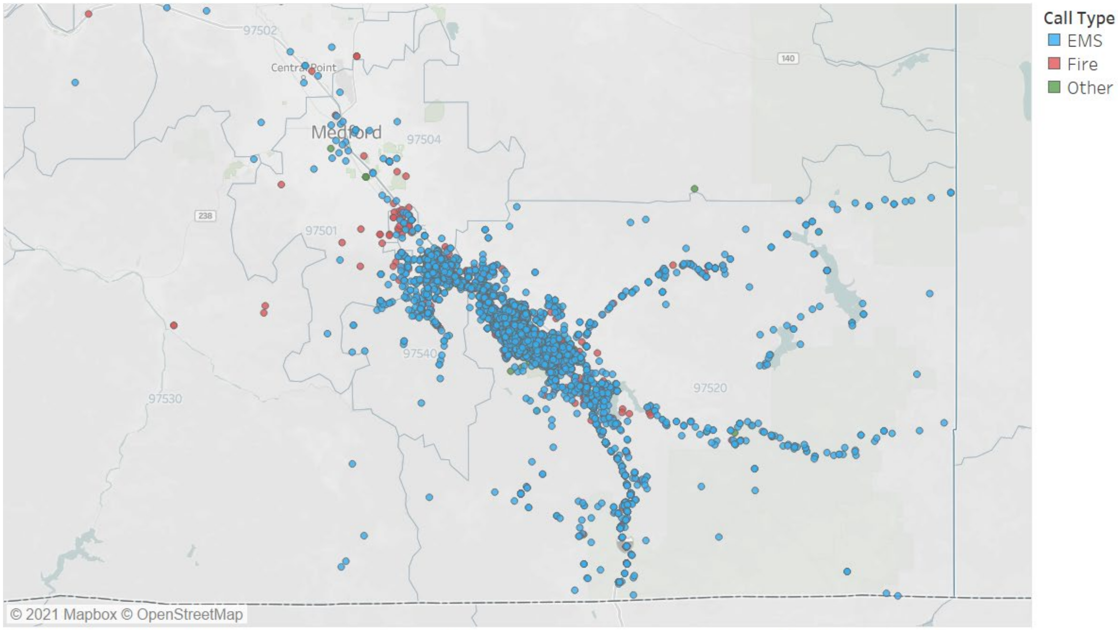
On the following twelve (12) pages are maps that provide information specific to emergency incidents AF&R has responded to over the five years period encompassing 2015 to 2019. This information is specific to incident type (fire, medical and other), incident locations (City of Ashland proper and ASA coverage area, and automatic and mutual aid response areas).

DensityMap



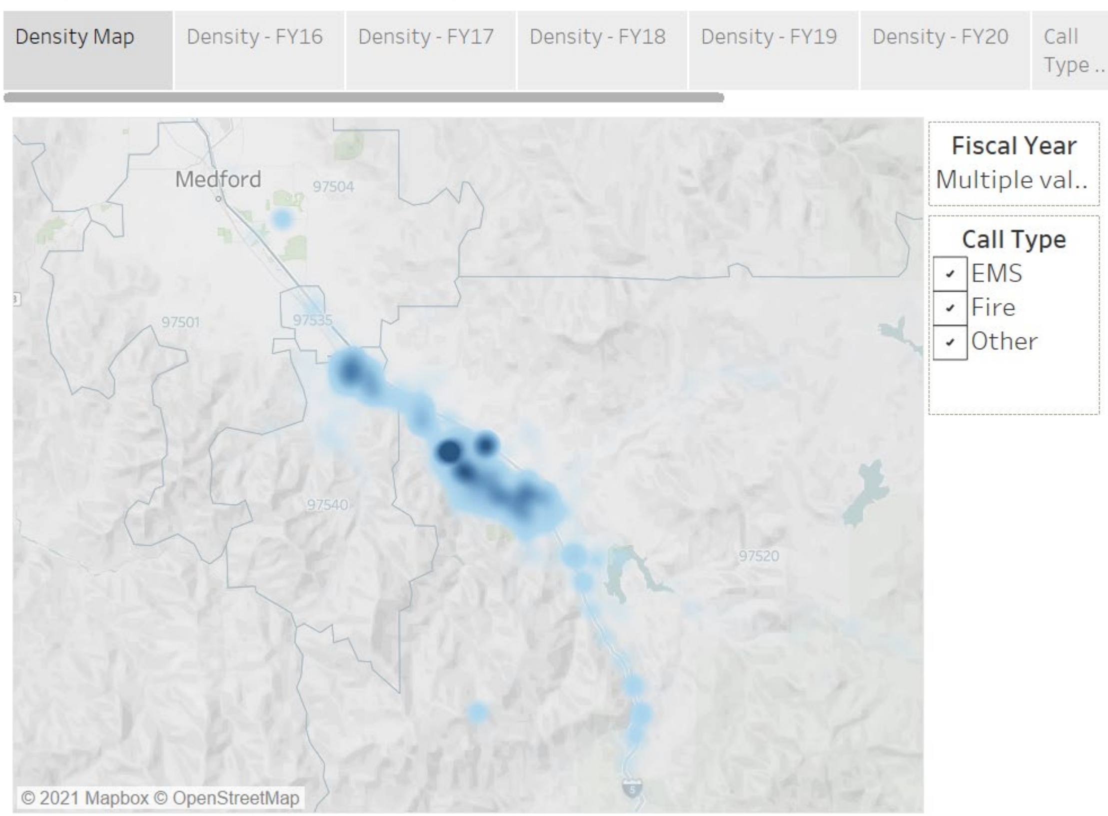
Map based on average of Longitude and average of Latitude. Details are shown for Call No. The data is filtered on Fiscal Year and Call Type. The Fiscal Year filter keeps FY15, FY16, FY17, FY18 and FY19. The Call Type filter keeps EMS, Fire and Other.

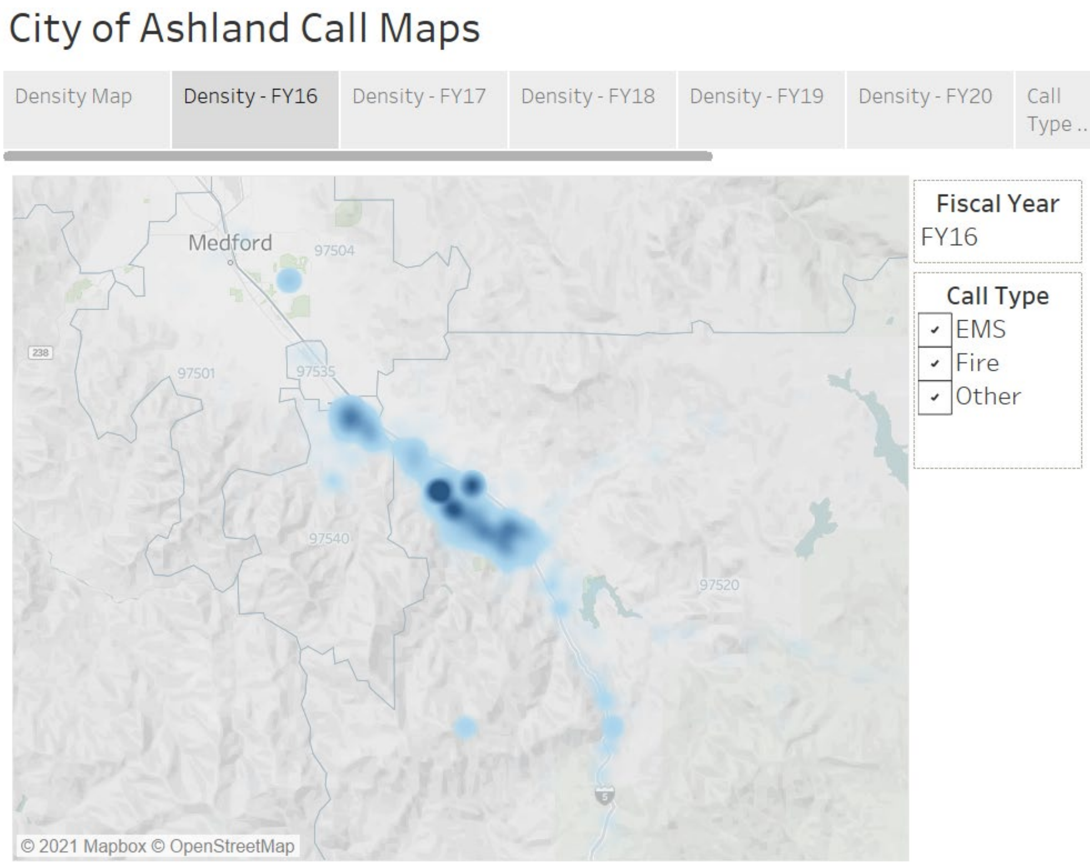
CallTypeMap

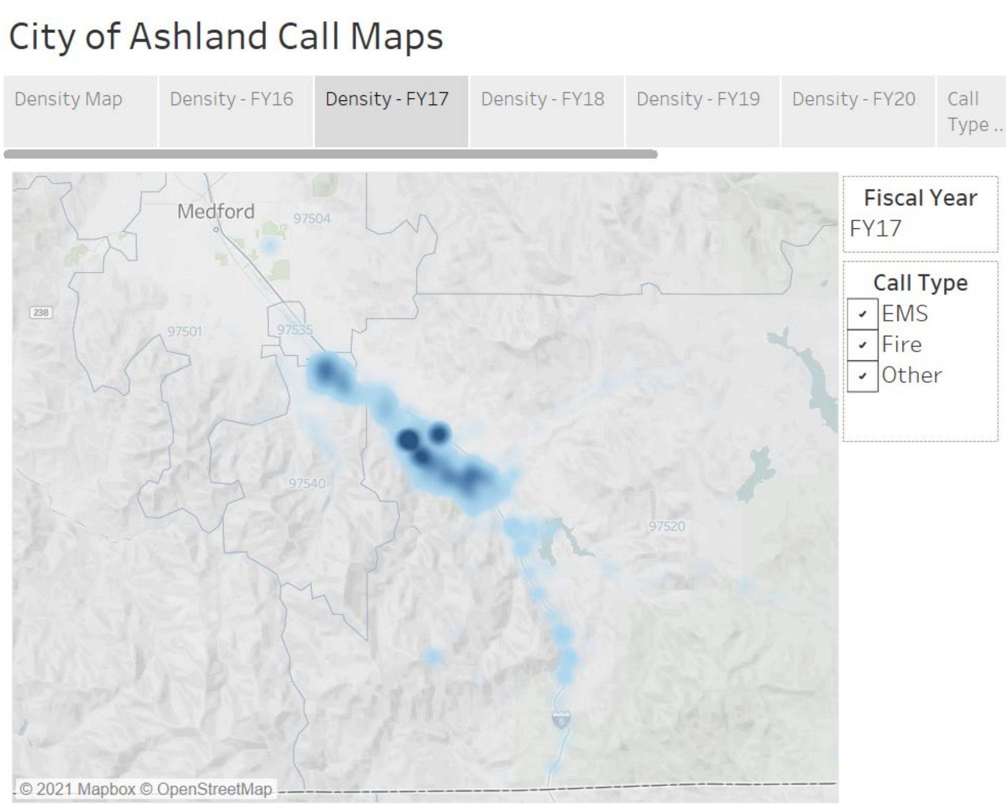


Map based on average of Longitude and average of Latitude. Color shows details about Call Type. Details are shown for Call No.
The data is filtered on Fiscal Year, which keeps FY15, FY16, FY17, FY18 and FY19.

City of Ashland Call Maps




City of Ashland Call Maps
Density Map
Density - FY16
Density - FY17
Density - FY18
Density - FY19
Density - FY20
Call Type ..
Medford
97504
97501
97535
97540
97520
238
Fiscal Year
FY16
Call Type
EMS
Fire
Other
© 2021 Mapbox © OpenStreetMap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Density - FY18
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Call Type ..
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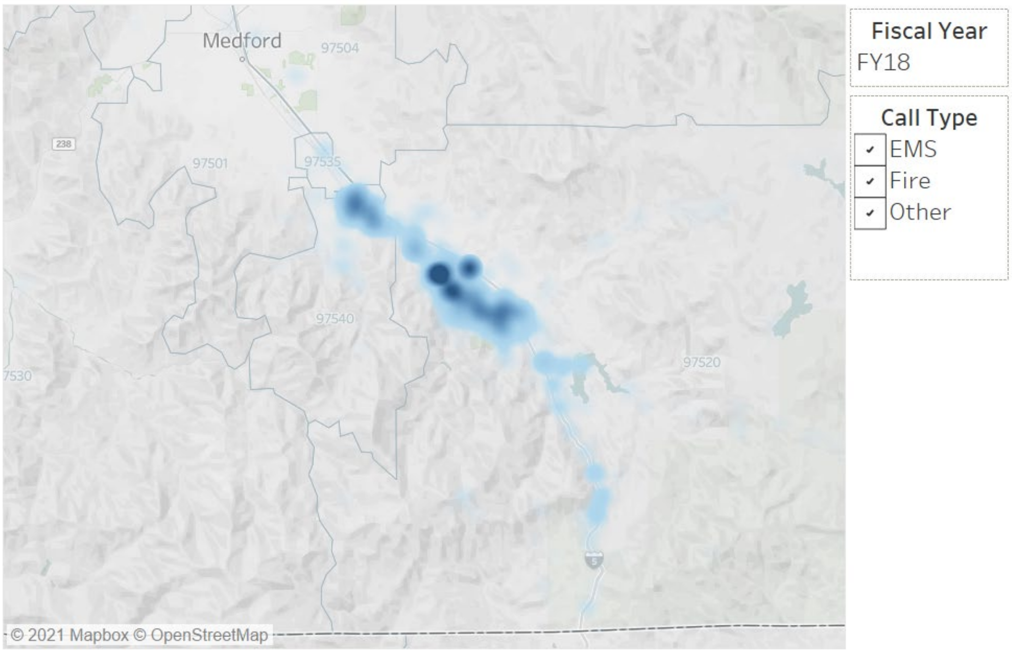
97535
97540
97520
238
Fiscal Year
FY17
Call Type
EMS
Fire
Other
© 2021 Mapbox © OpenStreetMap

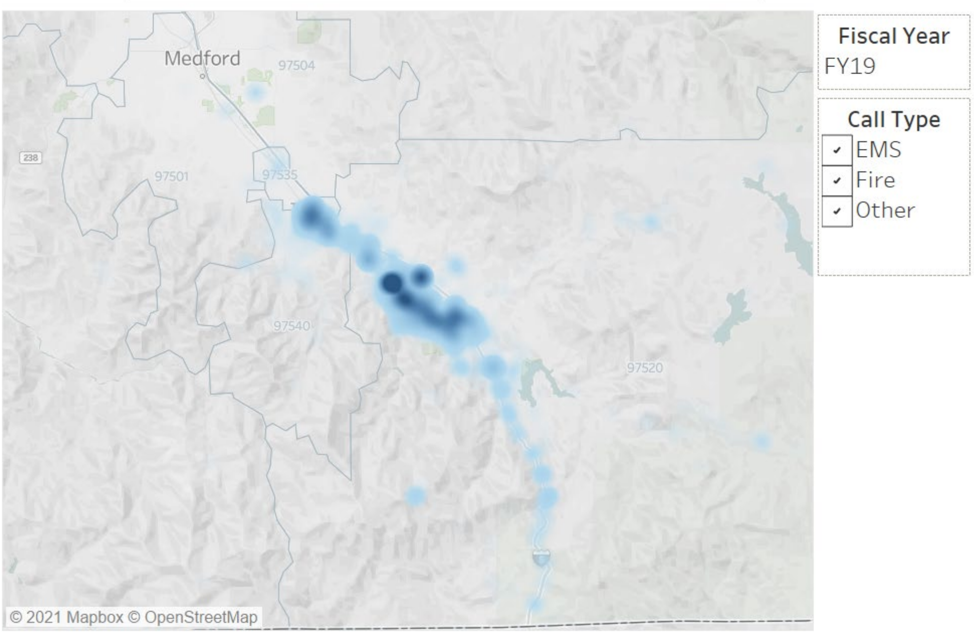
City of Ashland Call Maps

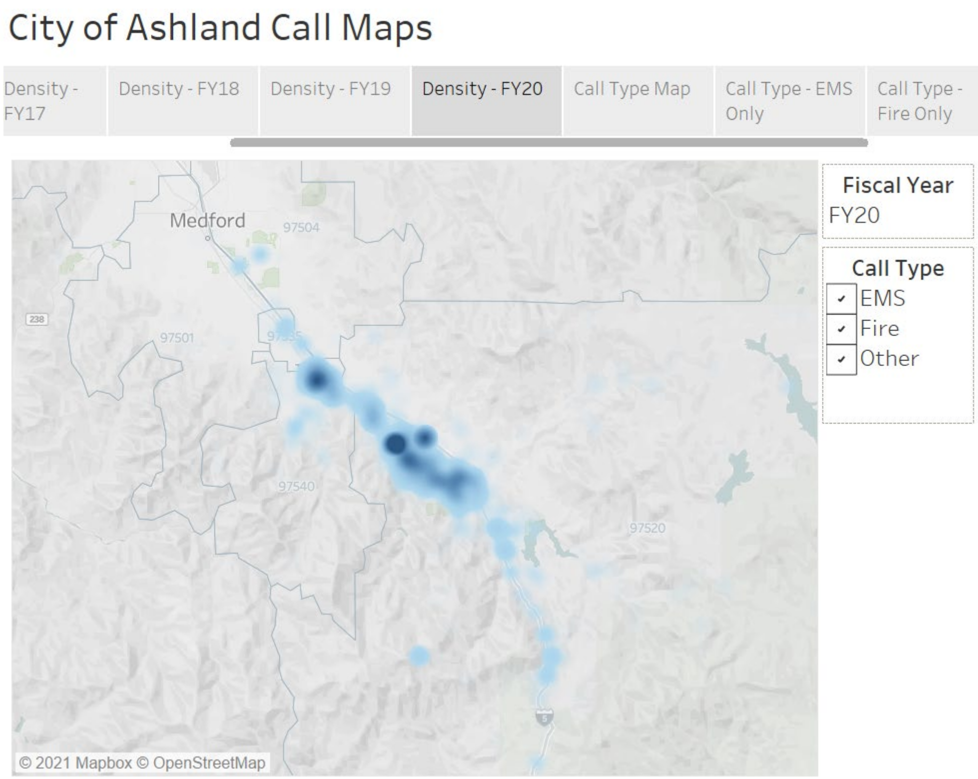
Density Map | Density - FY16 | Density - FY17 | Density - FY18 | Density - FY19 | Density - FY20 | Call Type Map



City of Ashland Call Maps

Density - FY16 | Density - FY17 | Density - FY18 | Density - FY19 | Density - FY20 | Call Type Map | Call Type - EMS Only




City of Ashland Call Maps
Density - FY17
Density - FY18
Density - FY19
Density - FY20
Call Type Map
Call Type - EMS Only
Call Type - Fire Only
Fiscal Year
FY20
Call Type
EMS
Fire
Other
Medford
97504
97501
97540
97520
238
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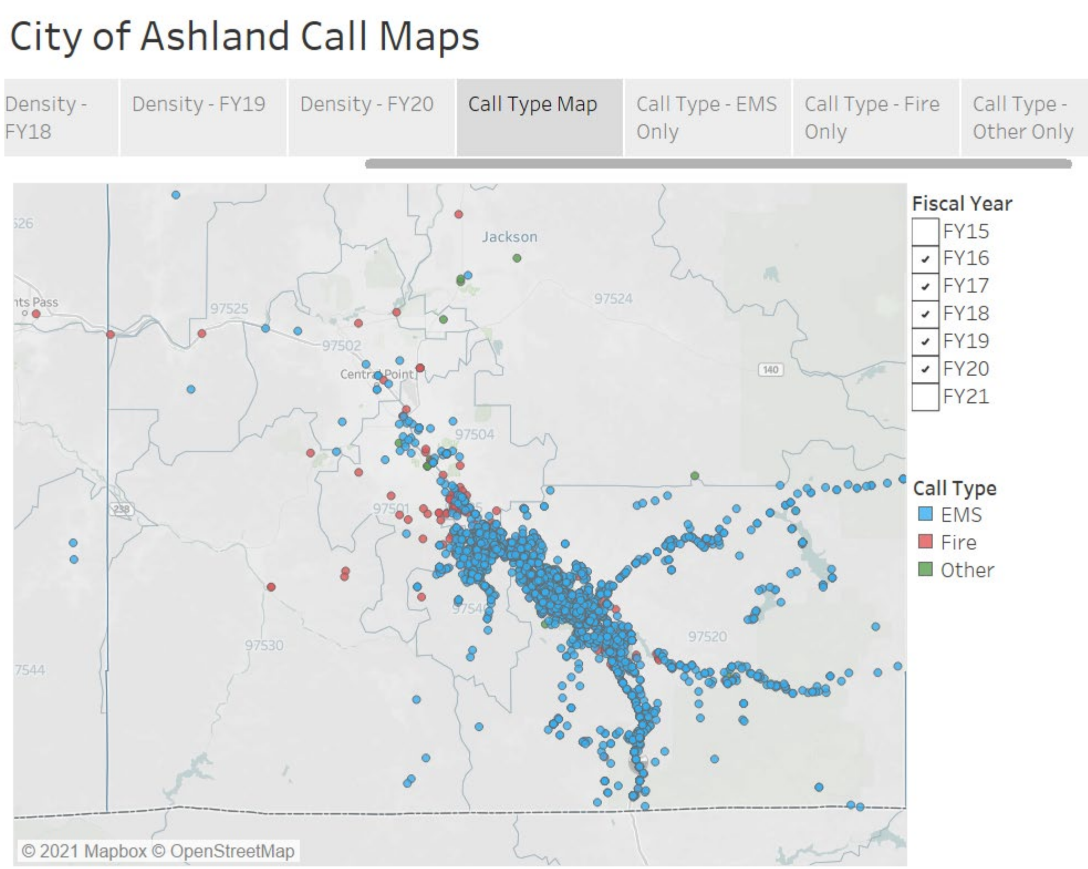
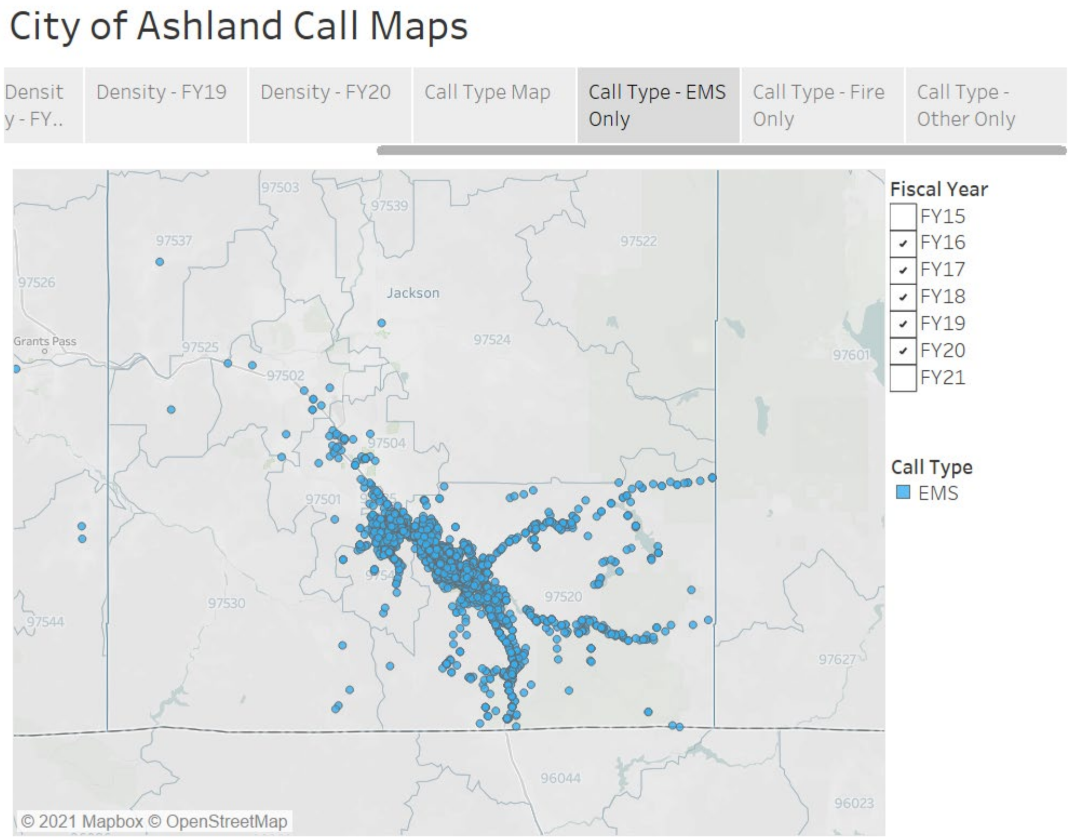

City of Ashland Call Maps
Density - FY18
Density - FY19
Density - FY20
Call Type Map
Call Type - EMS Only
Call Type - Fire Only
Call Type - Other Only
Fiscal Year
FY15
FY16
FY17
FY18
FY19
FY20
FY21
Call Type
EMS
Fire
Other
Jackson
97524
97525
97502
Central Point
97504
97501
97530
97520
140
238
© 2021 Mapbox © OpenStreetMap


City of Ashland Call Maps
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Density - FY19
Density - FY20
Call Type Map
Call Type - EMS Only
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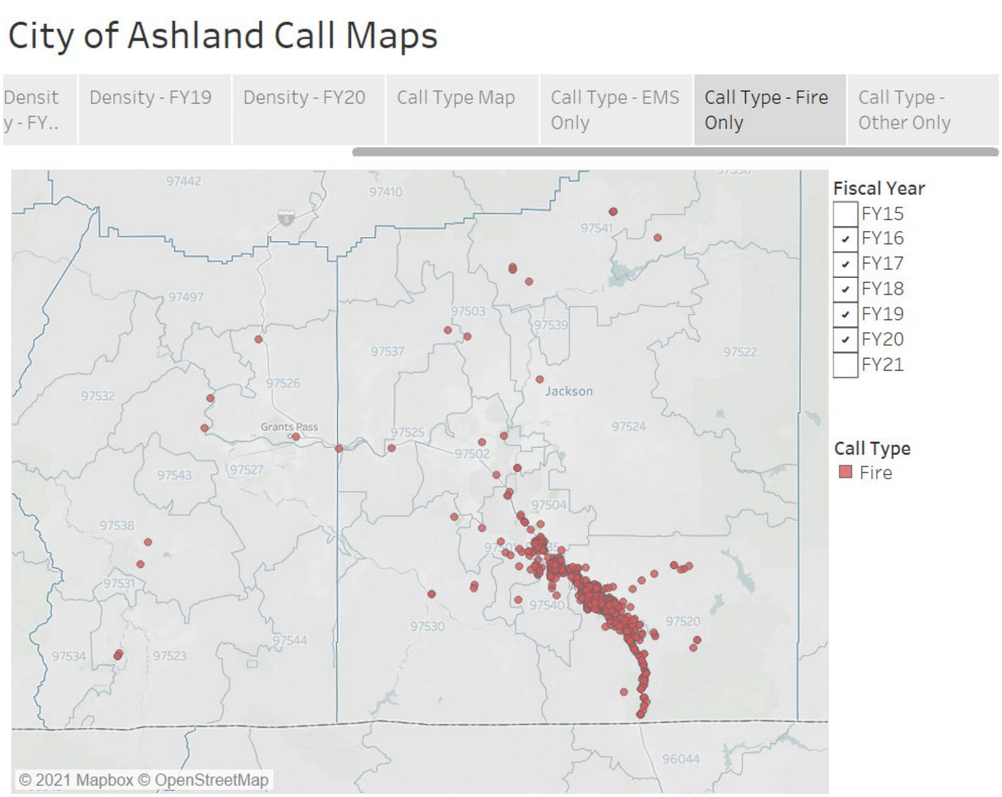
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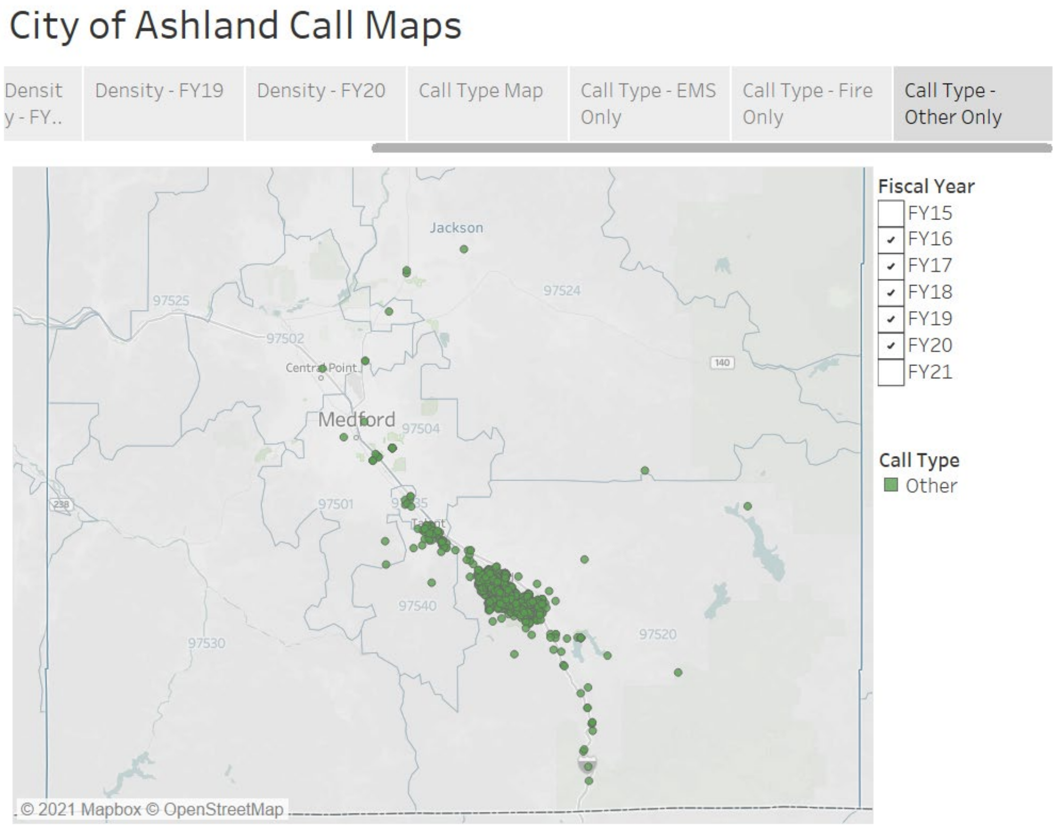
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Appendix 4: Ambulance Membership Application

The membership application is included in the following two pages.

Membership Application

455 Siskiyou Blvd., Ashland, OR 97520 541-488-6009 **ashland.or.us/ambulancemembership**

Membership will expire ONE year from processed application

Please complete and return this form along with your membership fee. Should you use emergency ambulance services during your membership coverage period, AF&R will bill your insurance, if any, and accept their partial payment as payment in full.

Choose your coverage:

- ☐ **AF&R Basic** $66/year — Emergency Ground Ambulance Only
- ☐ **AF&R Plus** $112/year — Emergency Ground + Air Ambulance with Mercy Flights

Household Information

Home Address

City | State | Zip Code

Mailing Address (if different from above)

City | State | Zip Code

Primary Contact

Telephone

Please provide your email address to help us become more efficient with our resources.

Email Address

AF&R ambulance membership includes all persons who are primary residents of the same single-family occupancy, non-commercial residence within the city's ambulance service area, living together as a family unit, but not to include roomers or boarders. Membership is also extended to include household members living in substitute care.

Last Name	First Name	Middle Initial	Date of Birth (MM/DD/YYYY)
Primary Member:			
Additional Household Members:			

Would you like to give a donation to Ashland Fire & Rescue? $

Submission of this application with payment constitutes acceptance of the AF&R Membership terms of agreement on the reverse side of this form.

Payment Information

Please return this form with payment.

☐ Please bill my credit card. ☐ Enclosed is my check, payable to **AF&R**.

☐ Visa ☐ MasterCard

Credit card number

Expiration date (MM/YY)

OFFICE USE ONLY

TOTAL $

DATE

CC CA CK#

DONATION

OTHER

Your check or credit card statement is your receipt. You will receive membership confirmation in the mail in 3-4 weeks.

AF&R Ambulance Membership Program Terms of Agreement

By Joining AF&R, members agree to abide by the Terms of Agreement below.

DEFINITION: AF&R is a voluntary ambulance membership program operated by the City of Ashland. **AF&R is not insurance**. All coverage for services is in addition to any medical benefits members may have. AF&R will bill insurance or other coverage that members may have for ambulance services costs that members may have incurred and AF&R is entitled to all benefits paid by insurance for ambulance services rendered, up to the total dollar amount of services incurred.

MEMBERSHIP BENEFITS: Membership covers applicable patient out-of-pocket expenses for medically necessary ground ambulance transportation to any local area hospital. "Medically necessary ground ambulance transportation" means that the patient must be transported to a hospital for medically necessary services, and transportation in any other vehicle could endanger their health.

BASIC MEMBERSHIP BENEFITS OUTSIDE OF LOCAL SERVICE AREA: Other participating reciprocal agencies may extend member benefits to areas outside our ambulance service area. These benefits are limited to the terms of agreement in effect by the participating agency providing services at the time benefits are used. Members who receive ambulance service from any other participating agency are eligible for benefits offered by that agency. The member agrees to abide by the participating agency's terms of agreement. AF&R is not responsible for the type, level, or quality of services provided by a participating agency nor is AF&R financially responsible for any costs or charges incurred by a member from any other ambulance provider. AF&R is not responsible for the withdrawal of participating reciprocal agencies. Participating agencies are subject to change without notice.

MEMBER RESPONSIBILITIES: Members pay an annual membership fee and will assign and transfer to AF&R all rights and reimbursements for ambulance services from all insurance policies, plans, or other benefit programs members may have, including all rights in any claim or third party recovery, up to the total dollar amount of services incurred, where ambulance services were provided by AF&R. Should any person covered under this membership receive any payment for ambulance services rendered by AF&R, they will immediately forward such payment to AF&R. Members authorize the release of medical and other information by or to AF&R as necessary for ambulance billing. Members agree to provide, when requested, any or all information concerning insurance policies, plans, third party recovery, or other benefit programs they may have, and will cooperate and assist as necessary in any efforts to bill and collect such ambulance reimbursements, including the completion and submission of documents or claim forms.

MEMBERSHIP ELIGIBILITY: Residents of the AF&R ambulance service area are eligible to join by properly completing an enrollment application available from AF&R and by paying the appropriate annual membership fee. AF&R household membership includes all persons who are permanent residents of the same single-family occupancy, non-commercial residence, within the AF&R ambulance service area, living together as a family unit, including domestic partners, but not to include roomers or boarders. Membership benefits include dependent household members living in substitute care (e.g. nursing homes) in the AF&R ambulance service areas. Others not included in this definition are required to obtain their own separate membership. The first person listed on the application form is called the "Primary Member." Anyone who joins a household after the membership goes into effect can be included under the membership from the date the "Primary Member" notifies AF&R of the addition. Only those persons who meet the membership eligibility requirements AND are listed in the membership record at the time services are rendered are eligible for benefits.

DURATION: Membership coverage begins upon acceptance of a properly completed application form with payment and extends one year from this date.

TO THE MEMBER'S INSURANCE CARRIER (FOR MEMBERS WITH INSURANCE): As an AF&R member, I authorize a copy of this agreement to be used in place of the original on file at the AF&R office. I assign and authorize payment of benefits for ambulance services directly to AF&R, according to the AF&R terms of agreement and as itemized on claim forms. My membership fee covers any applicable deductible, co-insurance, or co-payment and I expect the usual and customary ambulance reimbursement on my behalf to be sent directly to AF&R.

DISCLAIMER: AF&R reserves the right to add, modify, or delete any of the program terms and conditions completely or in part. All interpretations of the membership terms and conditions shall be at the sole discretion of AF&R. Membership is non-transferable and non-refundable. Persons who receive Medicaid, Department of Medical Assistance Programs, Oregon Health Plan or other government medical assistance benefits need not be members in order to have full coverage for services covered under these programs. Any such membership constitutes a voluntary contribution only. Violations of the terms of agreement may result in membership revocation, forfeiture of benefits associated with membership and an obligation to pay all balances in full.

AF&R PLUS BENEFITS IN ADDITION TO BASIC, MERCY FLIGHTS INC. AIR AMBULANCE OPTION: Mercy Flights services include ground ambulance within the Mercy Flights Jackson County assigned service area, Fixed Wing Air Ambulance within 1000 air miles and Helicopter Ambulance within 150 air miles of Medford, OR, in the continental United States. I understand that Mercy Flights is not an insurance plan, and will bill whatever insurance or medical benefits I may have and/or be entitled to for services rendered by Mercy Flights. I also understand that Mercy Flights membership fees are non-refundable and there is a 30-day waiting period for member benefits to take effect. I understand that I will be responsible for any denied, disallowed, or non-medically necessary transports, as determined by my insurance company or other third party payer. If I do not have any insurance, I will be responsible for a portion of the bill. Should I or a covered family member receive payment from insurance or other medical benefits for ambulance services rendered by Mercy Flights, I will immediately forward such payment to Mercy Flights. The Mercy Flights membership is not solicited from persons who receive Medicaid medical benefits and such membership constitutes a voluntary contribution only. I understand that violation of such terms of this agreement or substantiated abuse of ambulance services may result in cancellation.

MERCY FLIGHTS ELIGIBILITY: Eligible household members consist of the head of household, spouse/significant other/life partner, unmarried children under 26 years of age, disabled children of any age, elderly parents living at the same physical location, disabled children or spouse living in a care facility. Qualifying household members also include: disabled children, minor children of non-custodial parents, domestic partners, and dependent parents residing at the same physical location. Disabled children and dependent parents will continue their membership, if they move from the household into a care facility.

NOTICE: This Mercy Flights, Inc. Ambulance Plan is not an insurance program. Membership benefits are for services provided by Mercy Flights, Inc. only. It will not compensate or reimburse another ambulance company that provides emergency transportation to you or your family. Other ambulance company transports may occur if Mercy Flights is unable to perform within a medically appropriate time frame. This may occur, but is not limited to, a mechanical or maintenance problem or being on another call. This may also occur if the emergency location is outside of Mercy Flights' assigned service area. If the other transporting ambulance company has a signed reciprocity agreement with Mercy Flights, that agency's membership benefits will be applicable to the transport. For complete Mercy Flights membership terms of agreement, refer to our website at https://www.mercyflights.com/membership-details/

For further information on AF&R Basic and AF&R Plus, please call any of our staff at 541-488-6009.

 A large print version of this text is available upon request.

By sending your check, you authorize AF&R to use the information on your check to make a one-time electronic debit from your account. Your original check will be destroyed once processed, and you will not receive your cancelled check back. If you do not wish to participate in this check conversion program or have further questions regarding this process please call AF&R Membership Services: 541-488-6009, Monday-Friday, 8-4:30 pm. Thank You.

Appendix 5: Standards of Cover Document

The Standards of Cover document is included in the following 41 pages.

STANDARDS OF COVERAGE
2009

ASHLAND FIRE & RESCUE STANDARDS OF COVERAGE

INTRODUCTION

This document examines Ashland Fire & Rescue's ability to respond to and mitigate emergency incidents created by natural or human-made disasters. It differs from the Ashland's Emergency Management Program and Emergency Management Plan because it provides overall planning and coordination for emergencies, and it is a comprehensive analysis of detailed Fire, EMS, and Rescue systems.

The format of this document is based on the State of Oregon's Standards of Response Coverage, a critical element of the accreditation process of the Commission on Fire Accreditation International (CFAI). "Standards of Response Coverage" are those written procedures that determine the distribution and concentration of the fixed and mobile resources of a Fire and EMS organization. A systems approach to deployment, rather than a one-size-fits-all prescriptive formula, allows for local determination of the level of deployment to meet the risks presented in each community. In this comprehensive approach, each agency can match local need (risks and expectations) with the costs of various levels of service. In an informed public policy debate, a City Council "purchases" the Fire, Rescue, and EMS service levels (insurance) the community needs and can afford.

The Standards of Coverage are developed through the evaluation of Ashland Fire & Rescues present practices, regulatory requirements, historical response data, and a comprehensive risk analysis. The response analysis will help the City Council and the community, visualize what the current, or a possible, response system can and cannot deliver.

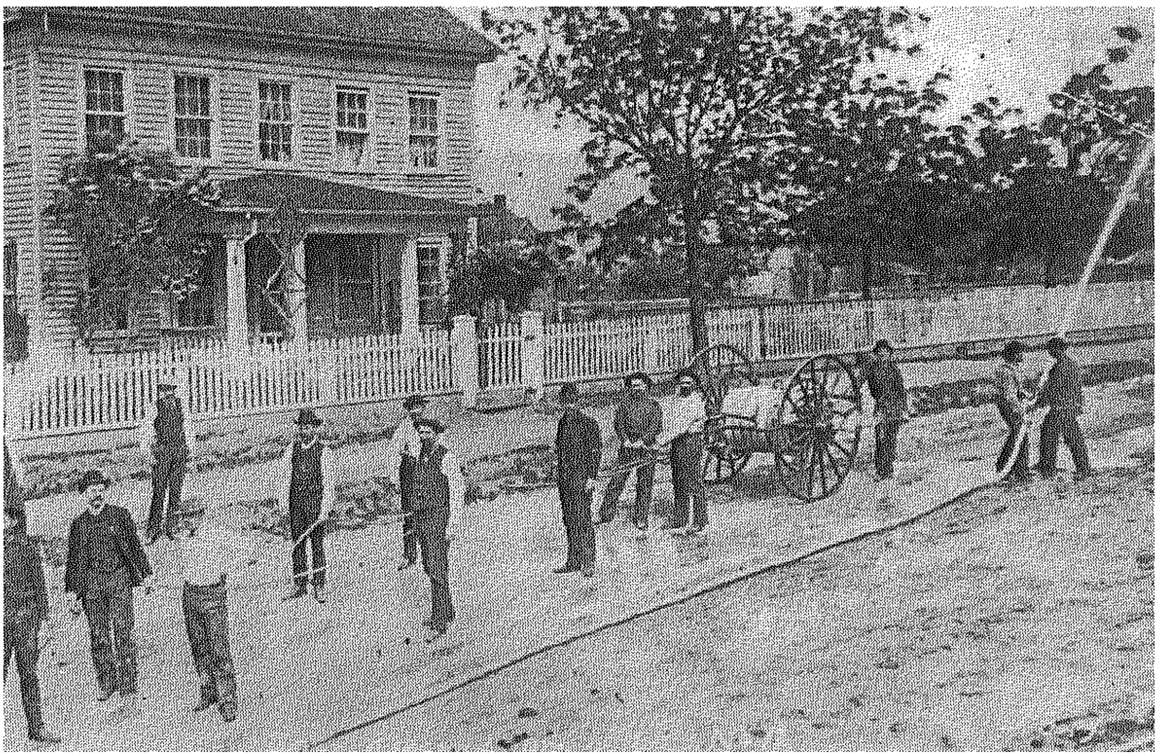
**** Printing of this document was done in black and white as a cost savings measure. A color version is available via electronic medium on request.**

TABLE OF CONTENTS

SECTION ONE: COMMUNITY BASELINES

A. History of Ashland Fire & Rescue

Like many towns across America, Ashland has literally been shaped by fire. On March 11, 1879, a devastating fire that began in a blacksmith's shop destroyed many of the businesses on the west side of the plaza. Many of the masonry structures that replaced the wooden buildings are still standing today.



Ashland Hose Company No. 1, East Main Street, 1887

On August 3, 1885 the "Ashland Fire Committee" was formed under City Council ordinance No. 14. In 1891, the City Council passed Ordinance No. 105 establishing the Ashland Fire Department, consisting of two hose companies. The first Fire Chief was appointed in 1913. Today, Ashland Fire & Rescue (hereafter referred to as "AF&R") is organized as a municipal service department

B. Governance

The City of Ashland operates under the strong Mayor – Council form of government with the Mayor elected for a four year term and six Council Members elected, at-large, for four-year overlapping terms. Day-to-day operational activities are overseen by a City Administrator who coordinates the duties and responsibilities of eight Department Directors including the Fire Chief. The budget process, organized under Oregon budget law, utilizes seven citizens as lay members of the city budget committee, who are joined by the Mayor and Council. The Budget Committee approves the budget, which is the annual spending plan for the City. The City Council adopts the budget following a public hearing. The adopted budget for AF&R in 2009 was approximately 5 million dollars. AF&R generates over 700,000 dollars of revenue which accrues in the General Fund.

C. Geography

Urban Growth Boundary: The emergency medical services and fire suppression auto/mutual aid boundaries of Ashland Fire & Rescue extend beyond the Urban Growth Boundary of the City. The City Urban Growth Boundary is as follows:

Northern Boundary	- Jackson Rd. @ Hwy 99 North, Bear Creek, East Main St.
Eastern Boundary	- Dead Indian Memorial Rd., Tolman Creek
Southern Boundary	- Upper Strawberry Lane, Pinecrest Terrace, Green Meadows Way
Western Boundary	- Ashland Mine Rd.

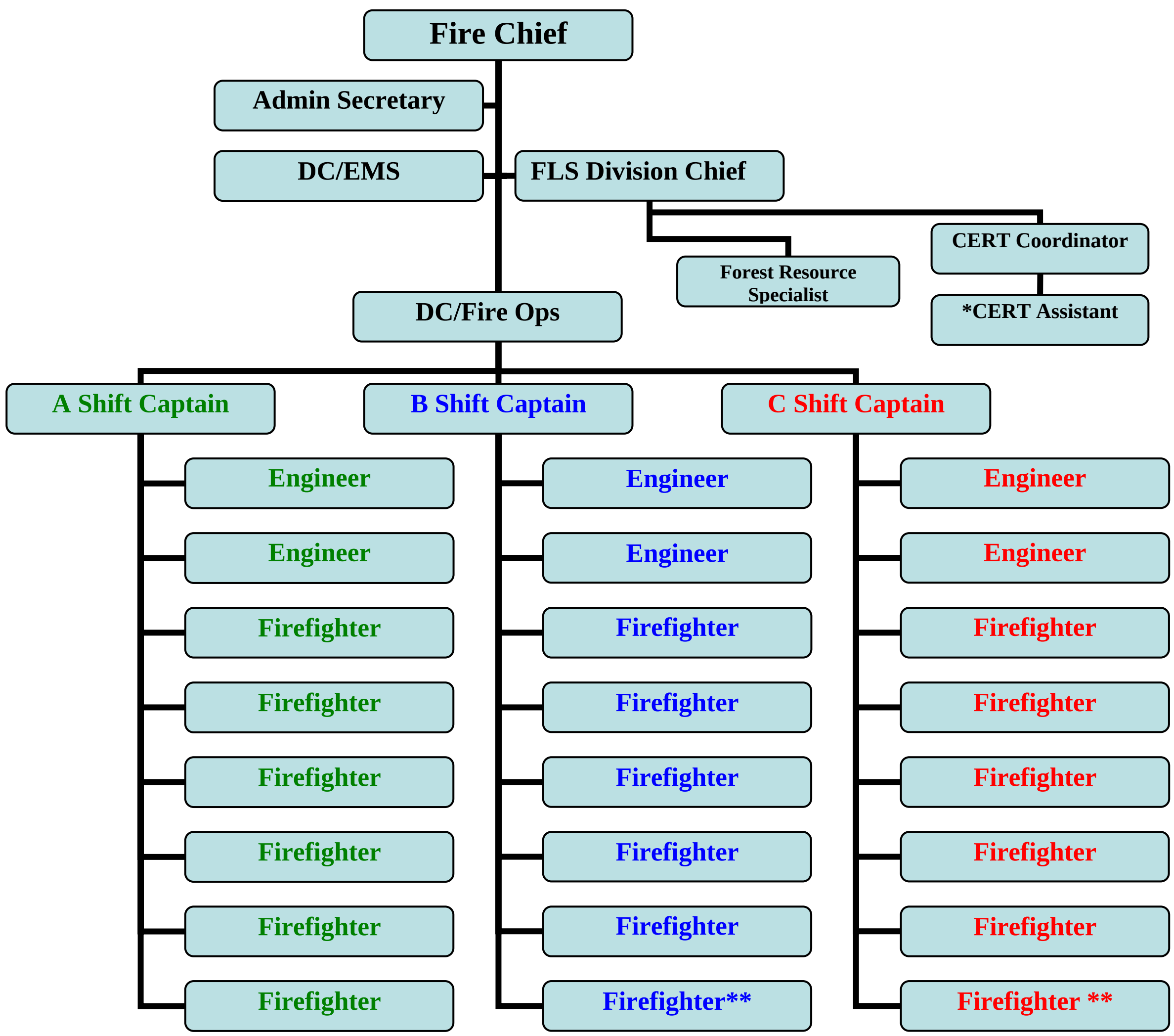
Primary topography: Ashland's elevations vary from 1,760 – 3,560 feet above sea level, and are located on the edge of the eastern foothills of the Siskiyou Mountain Range. The surrounding lands are a combination of livestock grazing lands and pasture lands and forested mountainous terrain. The valley floor consists mostly of farmland and pastureland, while the mountain slopes and mid to higher elevations are forested.

The City is bordered to the east by Neil Creek, to the north by Bear Creek. and to the west by Wright's Creek. To the south lies the Ashland Creek watershed, source of the city's drinking water. All drainages ultimately run into the Rogue River. The Talent Irrigation District maintains a major canal which runs from southeast to northwest through the city, continuing into rural farmland.

Weather: Summer months have typically very low humidity, often less than 20%. High temperatures range between 80 and 105 degrees Fahrenheit from June through September. These conditions create extreme fire conditions during most fire seasons. Winter months have typically moderate temperatures of 40 to 60 degrees with occasional lows in the teens and twenties. In addition, winters usually bring snow, ice and wind. This is particularly true for elevations above the valley floor.

D. Existing Fire Deployment

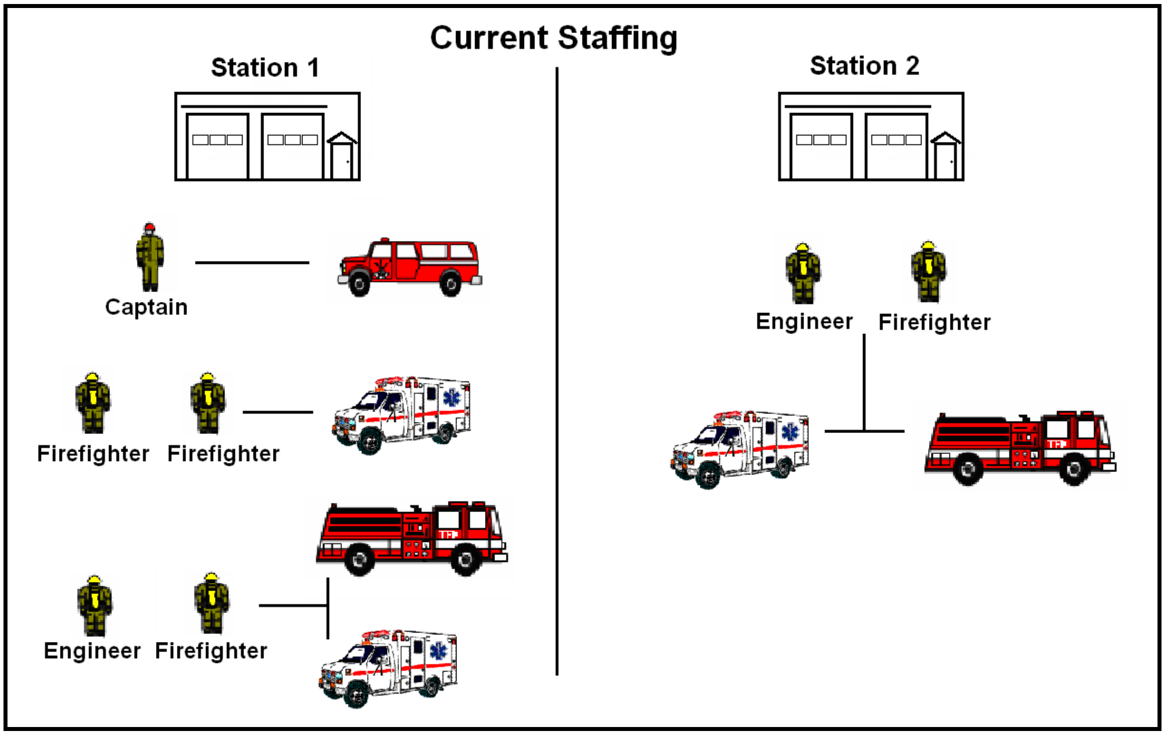
Ashland Fire & Rescue employs thirty-four full time personnel (Two positions are currently unfilled due to budget short falls). There are 6 Firefighters, 2 Engineers and 1 Captain on each shift. There are three emergency response shifts. Each shift works a 24 hour day, rotating days on and days off during a nine day cycle. Each of the three shifts is under the command of the shift Captain. While each shift is comprised of 9 personnel, the minimum daily required staffing is 7 personnel (1 Captain, 2 Engineers, and 4 Firefighters). These 7 - 9 personnel operate out of the City's two fire stations. Fire Station No. 1 is also utilized for administrative offices. The administrative staff includes the Fire Chief, Operations Division Chief, EMS Division Chief, Fire & Life Safety (FLS) Division Chief and Secretary. The following is the department's organizational chart:

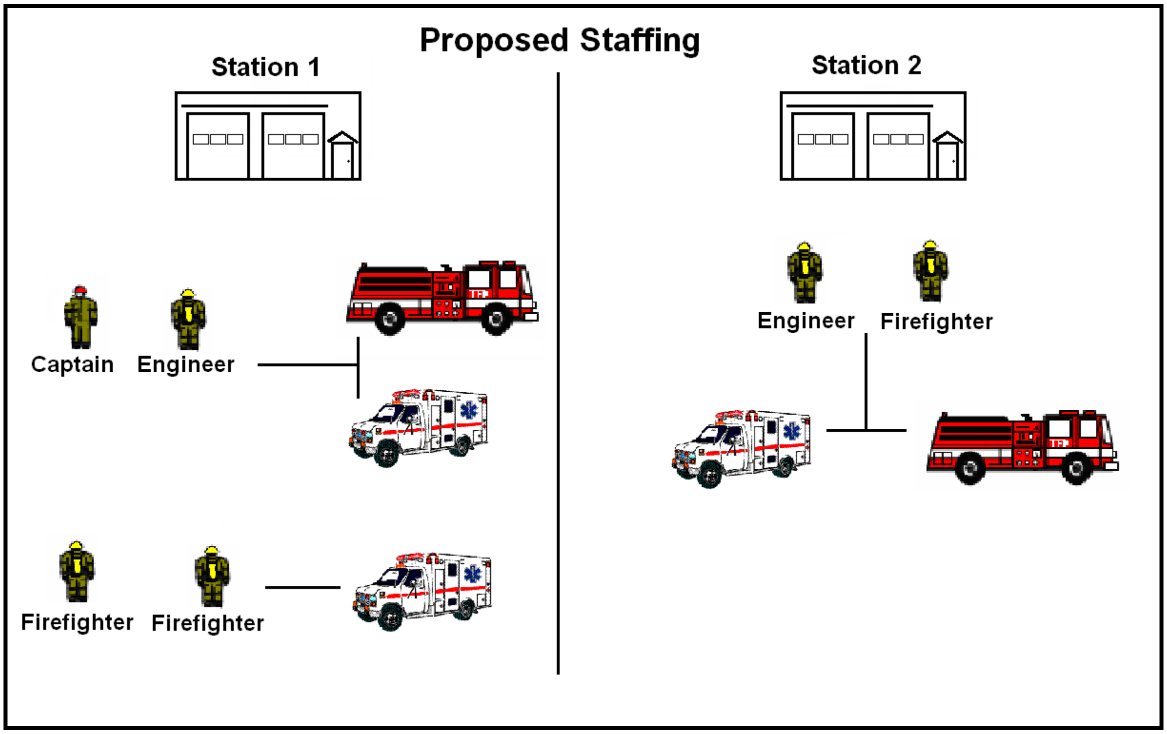


indicates part time position funded by grant funds

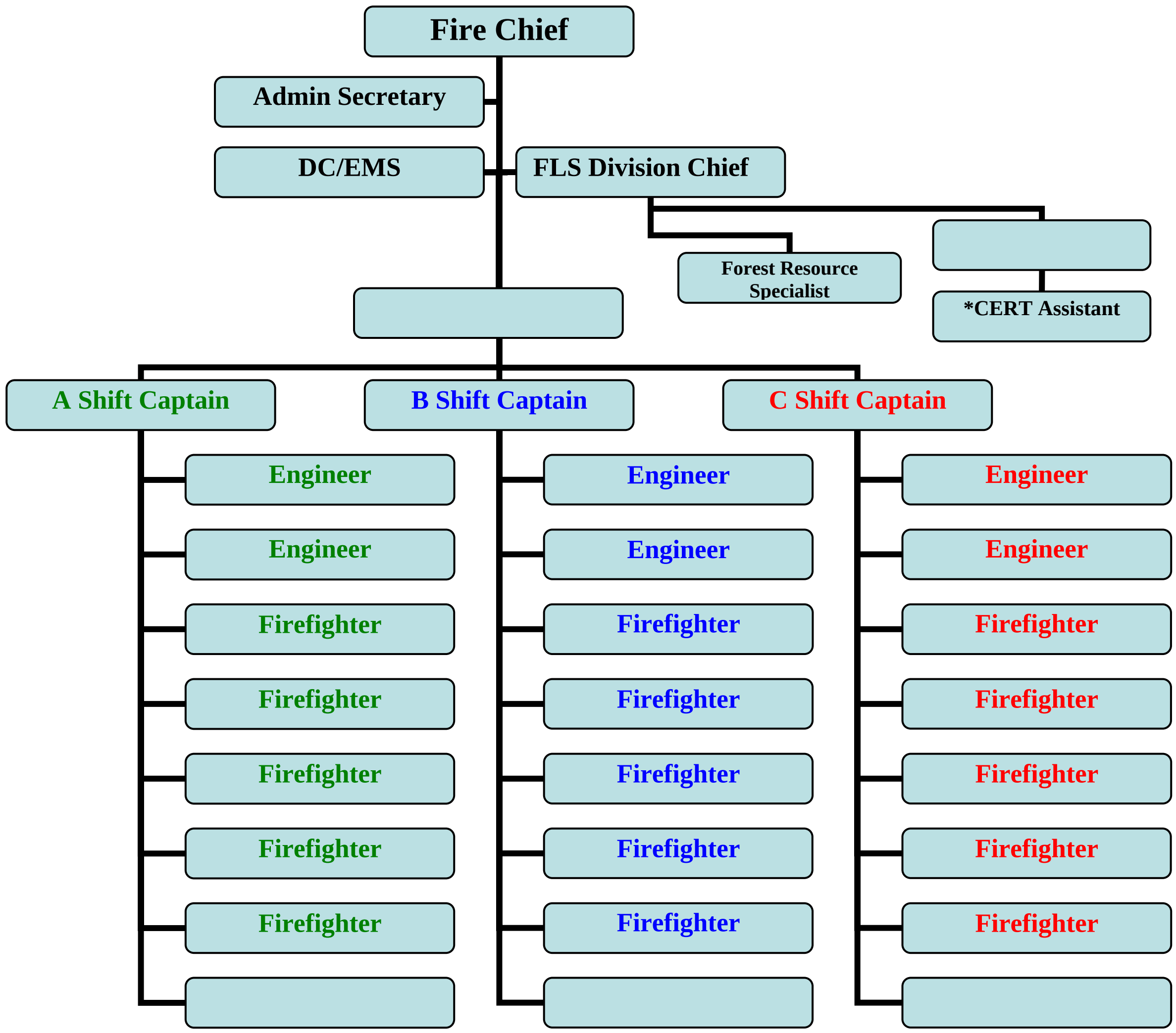
***** indicates positions that have not been filled due to lack of funding in the current 2008-2009 budget year.***

Minimum Daily Staffing





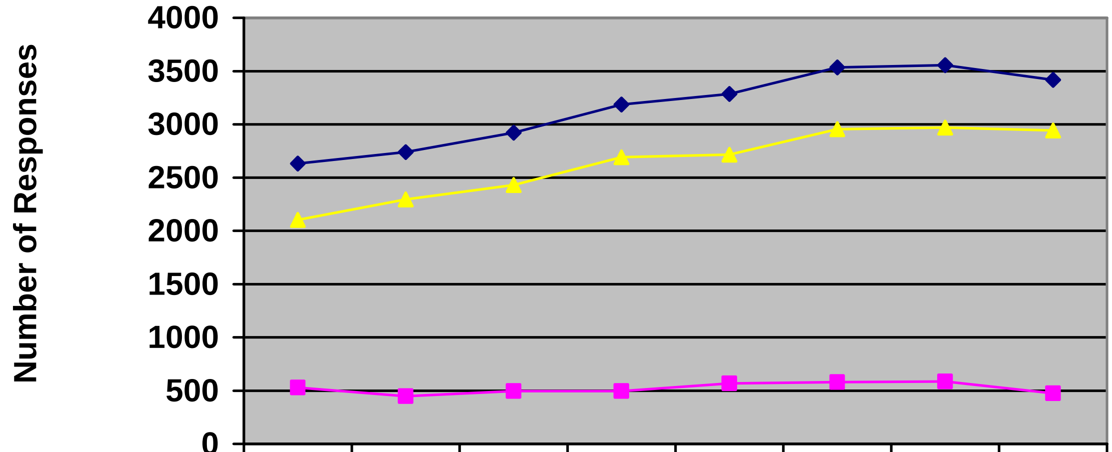
The following will be the department's organizational chart with the proposed budget cuts scheduled to take effect July 1, 2009 for the 2009-2010 budget year). Full time staff will decrease to twenty-nine personnel (Down from thirty two full time funded positions). In addition to the two firefighter positions that have not been filled, the department would need to cut another two firefighters and the C.E.R.T. coordinator. The Operations Division Chief position would be left vacant and that individual placed on a shift to augment line staff. Minimum daily staffing would then be reduced to 6 firefighters (3 Firefighters, 2 Engineers, and 1 Captain).



indicates part time position funded by grant funds

Calls for service

During the 2008 calendar year, Ashland Fire & Rescue responded to 3,418 calls for service. Of these requests for service, 86% were related to Emergency Medical Services, 14% were Fire related emergencies.



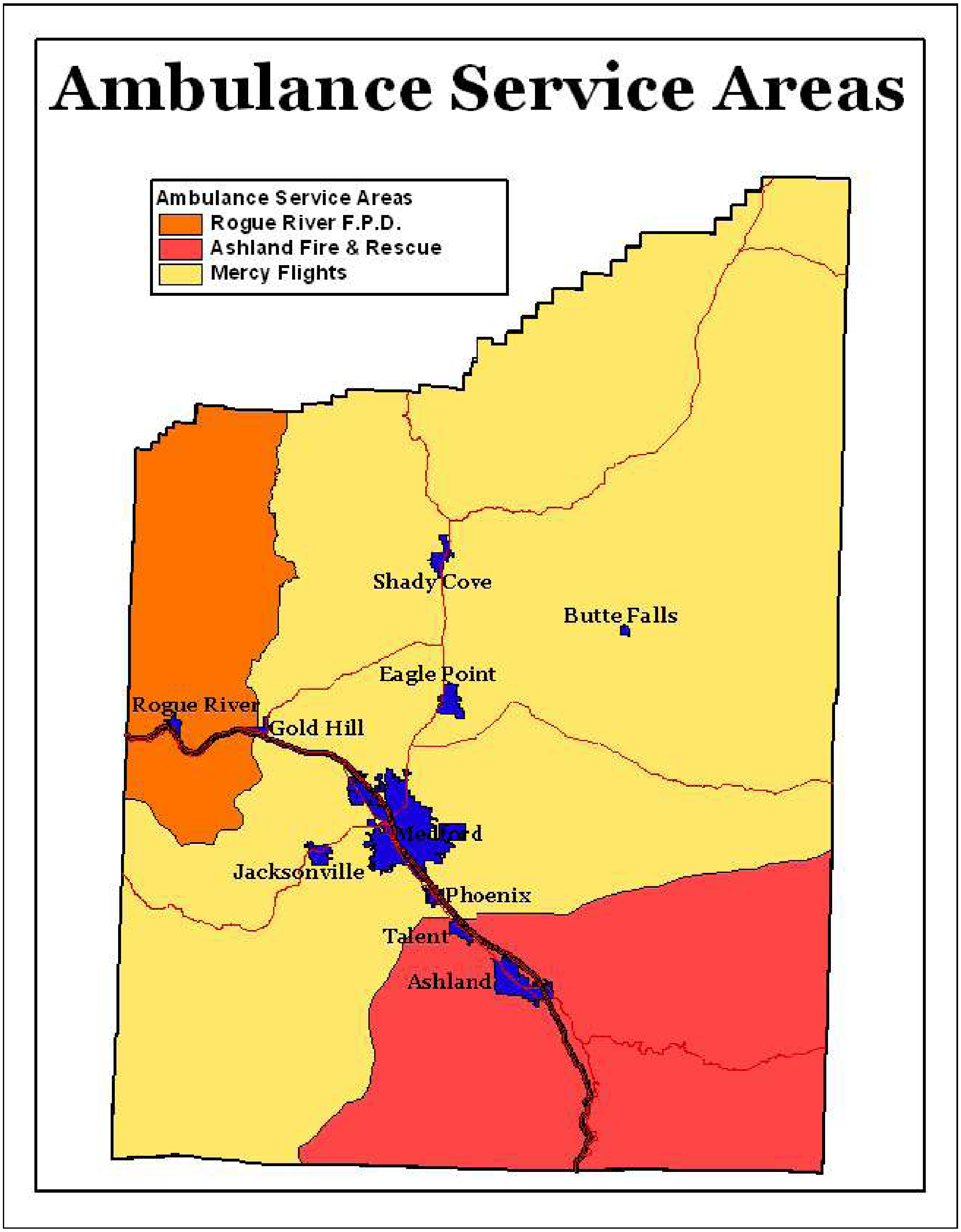
	2001	2002	2003	2004	2005	2006	2007	2008
Total Calls	**2630**	**2740**	**2922**	**3186**	**3285**	**3534**	**3556**	**3418**
Fire Responses	**528**	**446**	**494**	**496**	**569**	**579**	**587**	**474**
Medical Calls	**2102**	**2294**	**2428**	**2690**	**2716**	**2955**	**2969**	**2944**

- **Note – While multiple units may respond on an emergency response, it is only counted one (1) time for statistical purposes.**

Fire Response numbers include the following:

Structure Fires
Brush Fires
Car Fires
Fire Alarms Sounding
Ruptured Gas Lines
Smoke Detector/CO Alarms
Power Line Hazards
Rescue Situations
Lift Assists to the Disabled
Miscellaneous Other

The following map shows AF&R's ambulance response area outside of the city limits.



SECTION TWO: RISK ASSESSMENT

A. Risk Assessment Model

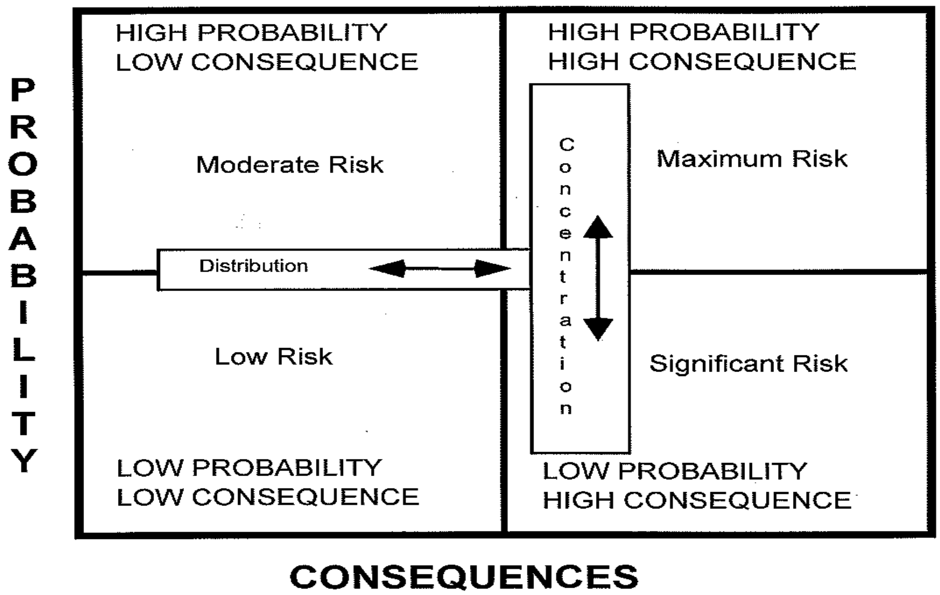
The City of Ashland must assess risks based upon the potential frequency (probability of an incident occurring) and consequence (potential damage should an event occur). For example, a terrorist act has a low probability; however, if a terrorist act occurs, the damage and the psychological impact are potentially very high. This same outlook regarding risk assessment can also be applied to natural disasters. For example, an earthquake generally does not hit the same community every year; but if it does strike, the damage can be great. Conversely, medical emergencies happen every day. The overall potential damage from medical emergencies to the community as a whole is not nearly as significant as that from an earthquake or other natural disaster though these individual incidents greatly affect those requiring the service. To design future deployment strategies, the department must be able to compare the potential frequency and potential damage of events that may affect the community and service area.

Risk management is the analysis of the chance of an event occurring and the resulting damage that could occur as a result of the event.

For example: structure fires are relatively infrequent in comparison to medical incidents in the City of Ashland and its service areas; however, the loss of subsequent dollars, loss of irreplaceable items, and loss of business or jobs make the consequences of such fires high; activation of automatic fire alarms is high probability with low consequence; earthquakes or a large hazmat incident may be infrequent but represent a large potential loss to life and property. Comparatively, a dumpster fire may be a high probability but have little consequence outside of the fire response. With an understanding of the different levels of probability and consequences, proper strategic planning in respect to risk management and resource deployment can take place.

The challenge in community risk management does not lie solely in the work necessary to assess the probabilities of an emergency event in a community, but in the political arena as well. It is the policy makers who will determine the level of service to be delivered to the area being served.

The following Risk Matrix helps identify the elements that must be considered when assessing community risk. Each of the four categories represents a specific level of risk based on the probability of that risk occurring and ties the probability to the consequences that will be experienced if the risk occurs. Each risk that a community faces can be identified and categorized using this measurement of probability/consequences. As the level of risk increases, a different commitment of fire resources is needed to keep the risk from escalating.



1. Maximum Risk: Maximum risk includes a high probability and maximum consequence. This level of risk has the potential for a high level of life and property loss as well as significant property damage across the entire geographic area. Maximum risks will certainly have a devastating impact on the community's ability to maintain its commercial, residential and industrial tax base. An event of this magnitude would severely impact the community in multiple ways and challenge the community's ability to recover. An event of this nature would most likely include a disaster declaration by the Governor and/or the President of the United States. An example of a Maximum Risk event would be Hurricane Katrina, the Loma Prieta Earthquake, the Oakland Hills Fire or the bombing of the World Trade Center in New York.

2. Significant Risk: Significant risk level has a low probability of occurrence and a high level of consequences. This risk level has the potential for high to moderate life and property loss. A significant risk may vary in magnitude and may create varying threats to those people in the immediate area of impact. Significant risks can also impact those in close proximity to the immediate threat zone. The financial impact related to a significant risk is usually high by threatening the community's economic and social structures. A significant risk will require an extended recovery period but a community that has prepared can recover within a reasonable period of time.

3. Moderate Risk: Moderate risk has a high probability of occurrence and a low level of consequence. This level of risk can present a potential for life and property loss but these are usually limited to only those areas, properties and residents in the immediate threat zone. A moderate risk usually has an impact both financially and socially but is limited to specific areas unless the community has allocated adequate resources to respond to a risk of this level. Inadequate resource allocations for moderate risk incidents can cause them to escalate to a significant level of risk requiring additional resources and the possibility for increased life and property loss. Recovery from a moderate risk is usually completed within a brief period of time. Moderate risk incidents seldom require assistance from outside the jurisdictional area.

4. Low Risk: Low risk has a low probability of occurrence and a low level of consequence. This risk level presents little threat to the community's ability to function unless the community does not have adequate resources allocated to handle this level of risk. The occurrence of this type of event is infrequent and presents little, if any, potential for significant life and property loss or damage.

The relationships between probability and consequence and the community's adopted service level goals determine the needed concentration and distribution of resources. Distribution is the location of resources throughout the city. Concentration is the number of resources needed in a given area within the city. This varies depending on many factors including the number of events (calls for service); the risk factors of the area; the availability, reliability, and time of arrival of secondary responding units; etc. A challenge will be to find the proper balance for the distribution and concentration of resources needed to meet the service level goals today and in the future as the city and the department service areas continue to grow.

Distribution: The term distribution is used in the fire service to describe the location of fire department emergency response resources in an effort to ensure their availability to provide intervention for all risk levels. Because of the cost related to the allocation of fire resources, fire departments use a static response system. A static response system is a system in which fire stations are strategically located in designated response areas across the community, or coverage area. This allows fire department units to travel from one point to another in a pre-designated period of time known as response times or performance objectives.

A key component to a static response system is to ensure fire department resources are properly placed based on current and future growth. Properly spaced fire stations are needed to assure a rapid deployment of emergency resources in order to respond to and mitigate average, or routine, emergency calls for service in a timely manner.

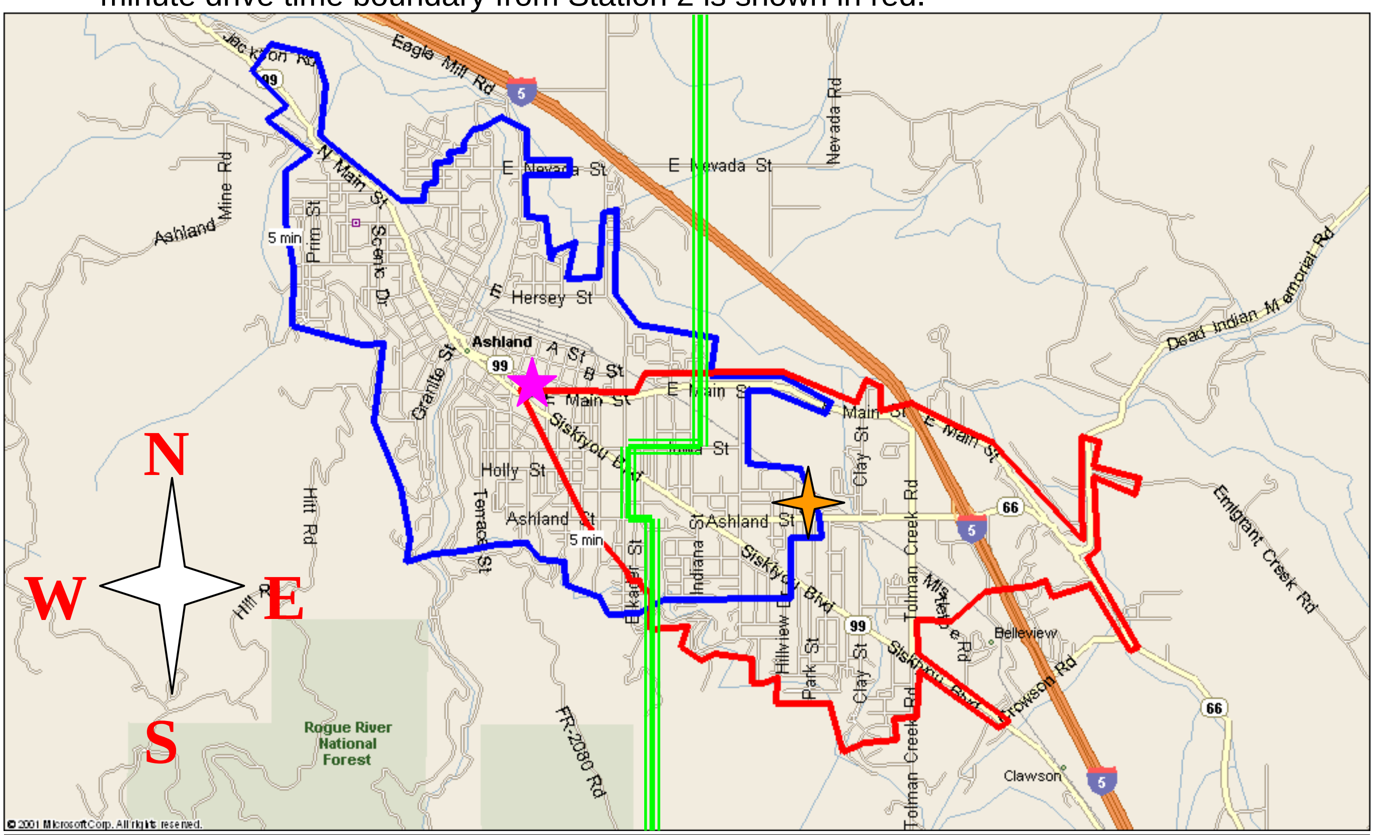
Concentration: The term concentration is used to describe the spacing of multiple fire department resources so a fire department can assemble an "effective response force" at the scene of an emergency incident. An effective response force is that which will most likely stop the escalation of the emergency incident as it is categorized in each risk type. Differing incident types require different levels of initial and secondary staffing based on the nature of the incident. These incident specific resource requirements are called critical tasking and are explained in detail later in this document.

It is a critical factor for fire departments to develop specific service level objectives to address the concentration of resources for each risk area.

Fire Station #1 is located at 455 Siskiyou Boulevard. Current minimum staffing is 1 Captain, 1 Engineer and 3 Firefighters who staff one command vehicle, one engine and one ambulance. The station also houses an unstaffed backup ambulance, engine, brush truck and wildland urban interface engine. Personnel can be moved off one type of equipment and onto another to better respond to emergency needs. Station 1's first in response area is that part of the city to the west of the triple green line.

Station #2 is located at 1860 Ashland Street. Current minimum staffing is 1 Engineer and 1 Firefighter who will respond in an engine or ambulance depending on the type of call. Station 2 houses backup ambulances, a brush truck and a technical rescue response trailer. Station 2's first in response area is east of the triple green line.

The blue line shows the boundary for a 5 minute drive time from Station 1. The 5 minute drive time boundary from Station 2 is shown in red.



❖ **It should be noted that those areas outside of the blue & red lines have a drive time greater than 5 minutes**

B. Risk Type

Understanding community risk is important when conducting a fire department response coverage assessment. Each risk presents the need for varying fire resources. Based on the potential posed, each risk type may require an increased number of fire department personnel, apparatus, equipment, and water supply to keep a potential event from escalating beyond the department's mitigation capabilities. This section explains the various risk types in the community.
The potential risks include the following categories; Structure Fires, Emergency Medical Services, Wildland Fires, and Technical Rescue.

1. Structure Fire Risk

A building categorized as Maximum Risk will be significant in size, absent of automatic fire protection and alarm systems, require a large amount of water to contain a fire and have a potential for a high life loss due to existing and non-conforming exiting. These buildings will have an irreplaceable or a major financial or social impact on the community if lost. A key factor that places a building in this category is inadequate water availability for fire suppression operations at the site of this building. An example of a building categorized as Maximum would be as follows: An older, multi-story, non-reinforced masonry building considered to have historical significance. This building would have no fire protection or alarm systems, poor exiting, and a marginal water supply for firefighting operations.

A building categorized as Significant Risk will be substantial in size and have the potential for life and property loss. The potential for life loss varies between those occupants in the immediate area to threatening the lives of all of the people in the building. The financial impact to the community created by this level can be high due to loss of jobs and/or loss of tax revenue. These buildings usually have automatic fire protection and alarm systems. Examples of Significant buildings include common hallway apartments, warehouses, office complexes, moderate to large sized retail stores, hospitals, medical buildings, and older downtown buildings that have retrofitted their buildings with fire protection systems.

Buildings categorized as Moderate Risk are average in size and can present a potential for a high life loss but are usually limited to threatening only the immediate occupants of the structure. The financial impact due to the loss of this structure has an impact on the occupants or owners, but not the surrounding properties. Examples of these buildings vary widely with the most typical in this class being a single family residence. Smaller apartment buildings and smaller businesses are also included in this category.

Buildings categorized as Low Risk have a very limited exposure. They are small structures that are not normally occupied by people. They also generally have a reduced amount of fire load, require small amounts of water to extinguish, have limited potential to spread to other buildings, and have little financial impact to the owners or the community. An example of a building in the Low Risk category would be a carport, shed, or out-building with limited potential for spreading to nearby buildings.

The table below illustrates the types and numbers of building occupancies that can be found within the City of Ashland.

CLASSIFICATION	# of BUILDINGS
Single Family Residential	7,800
Multi- Family Residential	258
Offices/Mercantile/Assembly	338
Educational Facilities	28
Fabrication & Manufacturing	27
Hazardous Materials	65
Health Care Facilities	4
Stand Alone Large Mercantile	28
Storage	6
Totals	**8,554**

**** There are 1770 businesses that operate in the City of Ashland**
**** It is important to note that the above table shows buildings only. There are many structures that have multiple businesses within them.**

2. Emergency Medical Services (EMS) Risk

Routine, single patient emergency medical service incidents in the Fire Department's coverage area can be considered "Low" to "Moderate" risk. These types of incidents have a very high probability of occurring but their consequences only affect the patient and their immediate family. EMS incidents with multiple patients, also known as Mass Casualty Incidents (MCI's) can be considered "Moderate" to "Significant" risks. These call types occur less frequently but have the potential to affect a greater number of people.

Emergency Medical Service (EMS) incidents make up the largest percentage of responses for AF&R. This fact is also true for the fire service nationwide. During the past 15-20 years fire departments across the country have taken a lead role in providing basic and advanced life support services in their protection areas in an effort to provide comprehensive pre-hospital care for the citizens they protect. Nationally, EMS calls for service make up approximately 70% of any fire department's overall emergency call volume

Assessing the risk related to the EMS system involves understanding the history and types of EMS calls being responded to as well as the location in which those calls are occurring. As the population in the United States ages, calls for emergency medical service are certain to increase. During difficult economic times, fire departments experience an increase in calls for EMS service.

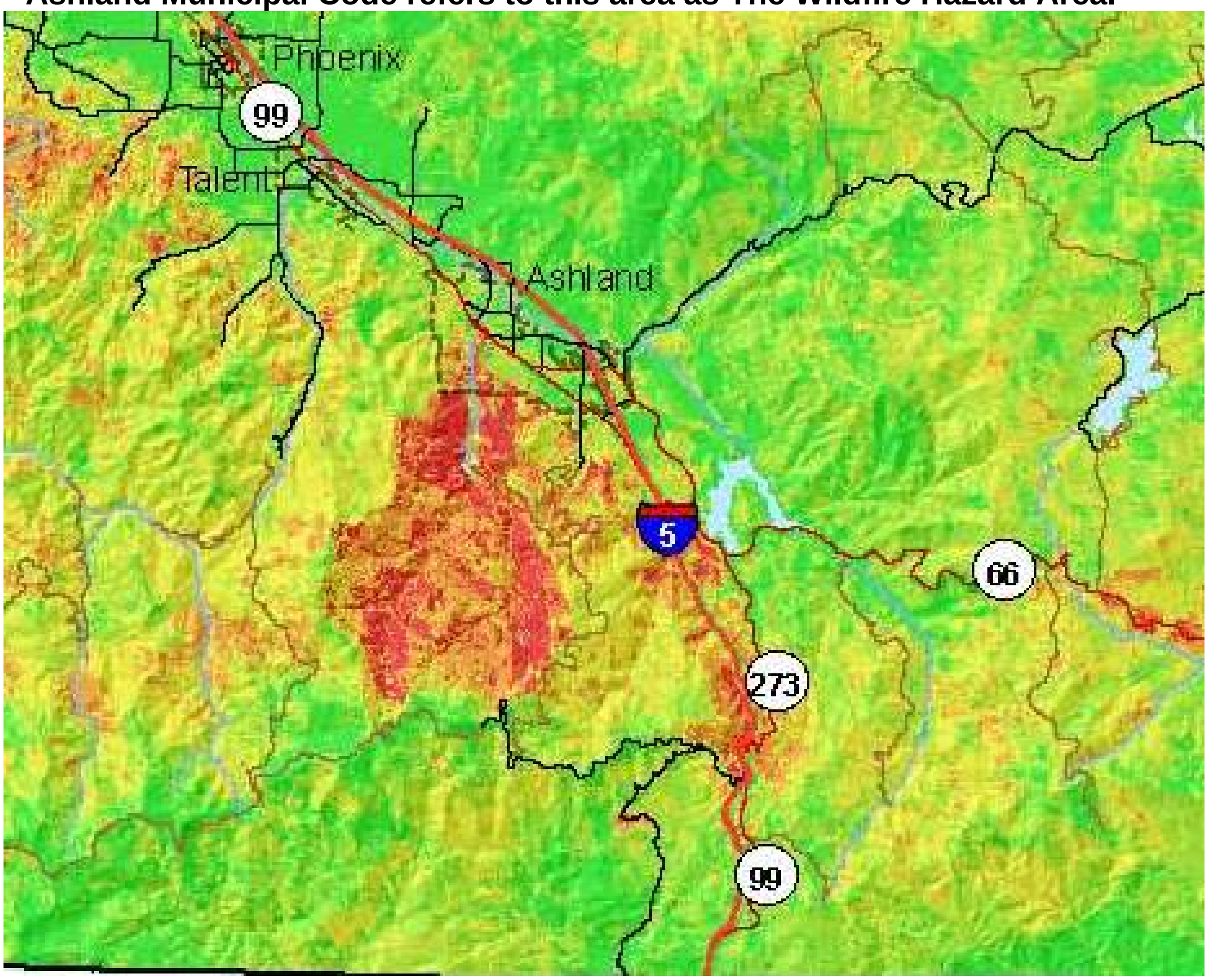
Emergency Medical Service (EMS) responses are the most prevalent incident type for AF&R. During FY 07/08 the Fire Department responded to 3,418 calls for emergency service. Of those calls, 86% were calls related to emergency medical services. The most typical types of patient symptoms generating EMS calls were altered level of consciousness, cardiac arrest, chest pains, shortness of breath, falls and seizures.

3. Wildland Fire Risk

Assessing Ashland's Wildfire Risk

Wildland fire risk and hazards have been documented as "High" (High is the highest rating) in both the primary and mutual aid response areas of Ashland Fire & Rescue. The State of Oregon and Jackson County wildfire risk assessments rate the Ashland wildland urban interface (WUI) as among the most hazardous in the State and the highest ranked community in Jackson County (State of Oregon Wildfire Risk Assessment 2005, Jackson County Integrated Fire Plan, 2005). The primary factors used for assessing a community's wildfire risk are the vegetation types (fuels), steepness of the topography, housing density, fire starts, and protection capabilities. The key factors that lead to Ashland's high rating are the fuel loads that surround Ashland, the density of homes in the WUI zone, and the upslope Ashland Municipal Watershed.

*** Ashland Municipal Code refers to this area as The Wildfire Hazard Area.**



Composite Wildfire Assessment Map, Jackson County Integrated Fire Plan (2005). Red is high risk.

Wildfire Behavior and Suppression

Wildland fire behavior is driven by three primary factors: fuel, weather, and topography. All three factors combine in the Ashland WUI to create potentially extremely hazardous wildfires. The intensity and rate of spread (together referred to as behavior) of a wildfire determine what suppression tactics will be effective. Flame heights over 4 feet dictate the use of fire engines and bulldozers in a direct or indirect attack strategy and flames over 8 feet dictate the use of aerial resources and construction of firelines well away from the fire front.

Wildfire Fuel Conditions

The fuel (vegetation) in and around Ashland is often heavy although a significant area of fuels has been modified through an ongoing AF&R fuels reduction program. According to a City commissioned study in 2002, just over 80% of the WUI area is either Extreme or High hazard vegetation types (not including Federal lands), meaning flame lengths of at least 4 feet and more likely 8 feet and greater over a larger proportion of the protection area. The fuels reduction program has decreased the potential fire behavior and increased potential suppression effectiveness on 1,431 acres of City and private land since 2002. However, without regular maintenance these acres will revert back to pre-2002 conditions. The Forest Resource Specialist is a staff position dedicated to wildland fire prevention and fuels mitigation.

Structure Vulnerability

An important unknown factor is the flammability of homes. As explained above the wildfire risk is well quantified, but each individual home has its own hazard rating depending on the construction and the immediate 100 foot area, often called the “defensible space” zone, surrounding the home. There are 1,879 structures (2008) in the Ashland WUI zone, but it is unknown how many have adequate defensible space for effective fire protection. Looking at WUI wildfires in similar communities across the West, the prognosis for structure survival during a major wildfire in Ashland looks grim. Factors include high housing density, narrow and winding streets, a finite water supply (no water in many rural portions in the mutual aid area), commonly hot and dry days, steep topography, and highly flammable vegetation surrounding the community all spell out a potentially challenging and hazardous environment for firefighting with limited chances for avoiding home loss. Outreach and education efforts continue by AF&R to encourage homeowner preparations, but the loss of the City's Code Compliance Officer (2008-2009) increases difficulty in code enforcement when hazardous situations are identified by AF&R. This decreases the effectiveness of suppression and home protection actions and increases the risk to firefighter's safety.

4. Technical Rescue Risk

In general, technical rescue is the application of special knowledge, skills and equipment to safely resolve unique and/or complex rescue situations.

For a wide variety of reasons, victims become stranded and/or injured in the areas in and around our city. Easy access to hiking and biking trails along with extremes in the geography create technical rescue situations each year.

Furthermore, vaults, tanks, tunnels and trenches spread throughout the City pose a risk to the employees who work in them and the citizens who might become trapped in them. Maintaining a rescue response is not only mandated by OSHA but is the prudent approach to these threats.

Rope Rescue

Rope rescue is defined as any rescue attempt that requires rope and related equipment to safely gain access to, and remove victims from, hazardous geographic areas with limited access such as slopes, cliffs, and buildings, above or below grade structures, by means of rope systems. Rope rescues are divided into two general categories, low/steep angle and high angle.

Toothpick Trail Rescue - 2002

Both of these categories exist in and around the City. Each year AF&R is called to treat and rescue injured victims from our watershed, park lands and frontier areas we serve. Many of these victims are located in remote regions accessible only by 4x4 vehicles, by foot, and in some cases helicopter. These calls for service range from litter carry outs to technical rescues involving multiple agencies and extended times to accomplish the mission.

<u>Confined Space/Trench Rescue Risk</u>

Confined spaces exist in the City in a variety of forms. Federal OSHA regulations define a confined space as a space that:

•Is large enough and so configured that an employee can bodily enter and perform assigned work; and

•Has limited or restricted means for entry or exit; and

•Is not designed for continuous employee occupancy.

Examples of confined spaces in Ashland include:

- Sewers and sewer facilities (throughout city and at the waste water treatment plant)
- Storm drains
- Electrical and communication vaults (serviced by Ashland Electric and AFN)
- Tanks (fixed and mobile)
- Manholes
- Trenches and excavations (City Streets, Water and Electric departments and private contractors)
- Tunnels (SOU)

Confined space rescue represents one of the most challenging and dangerous operations undertaken by fire departments in America today. Nearly 60% of all confined space deaths are would-be rescuers associated with secondary entries. This includes fellow employees, bystanders and untrained or poorly trained responders.

SECTION THREE: CRITICAL TASK ANALYSIS OF AF&R

In order to provide life safety and emergency mitigation efforts in an effective manner it is imperative that firefighters respond to emergencies in a timely manner and with enough trained firefighters to safely mitigate the emergency. Critical tasks are those duties that must be conducted by firefighters in order to safely control emergency incidents.

In order to effectively determine AF&R's ability to ensure effective service delivery while maintaining a safe working environment the department must conduct a critical task analysis. The critical task analysis is the process of matching AF&R's resource deployment to each type of risk. A critical task analysis identifies the necessary staffing level required to safely perform each task and successfully mitigate each risk. A critical task analysis was conducted for the following risk types:

- **Structure Fires**
- **Emergency Medical Calls**
- **Wildland Fires**
- **Technical Rescues**

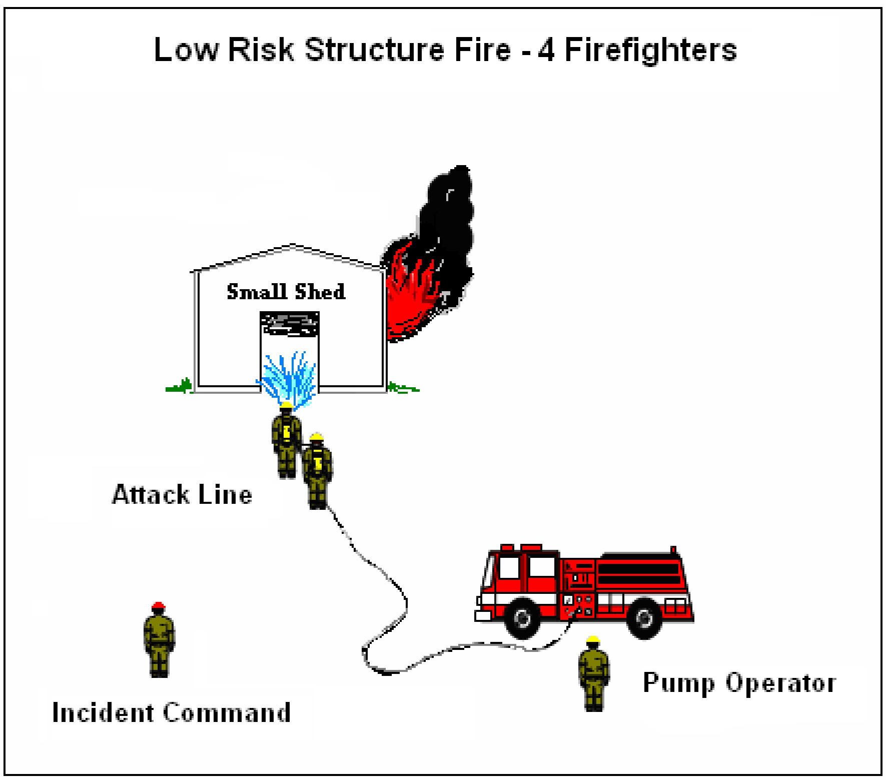
A. Structure Fires

Low Risk Fires

The following table provides a task analysis for Low Risk structure fires and/or incidents like rubbish fires, small grass fires, vehicle fires and incidents that involve a light fire load. The example also takes into consideration that the potential for injury or loss of life is non-existent and that the potential for exposure issues related to adjacent properties is non-existent.

CRITICAL TASK	PERSONNEL
Command / Safety	1
Pump Operator	1
Attack Line	2
Total Number of Firefighters	**4**

Low risk fires are normally handled by one fire unit and 4 firefighters as demonstrated in the following diagram:



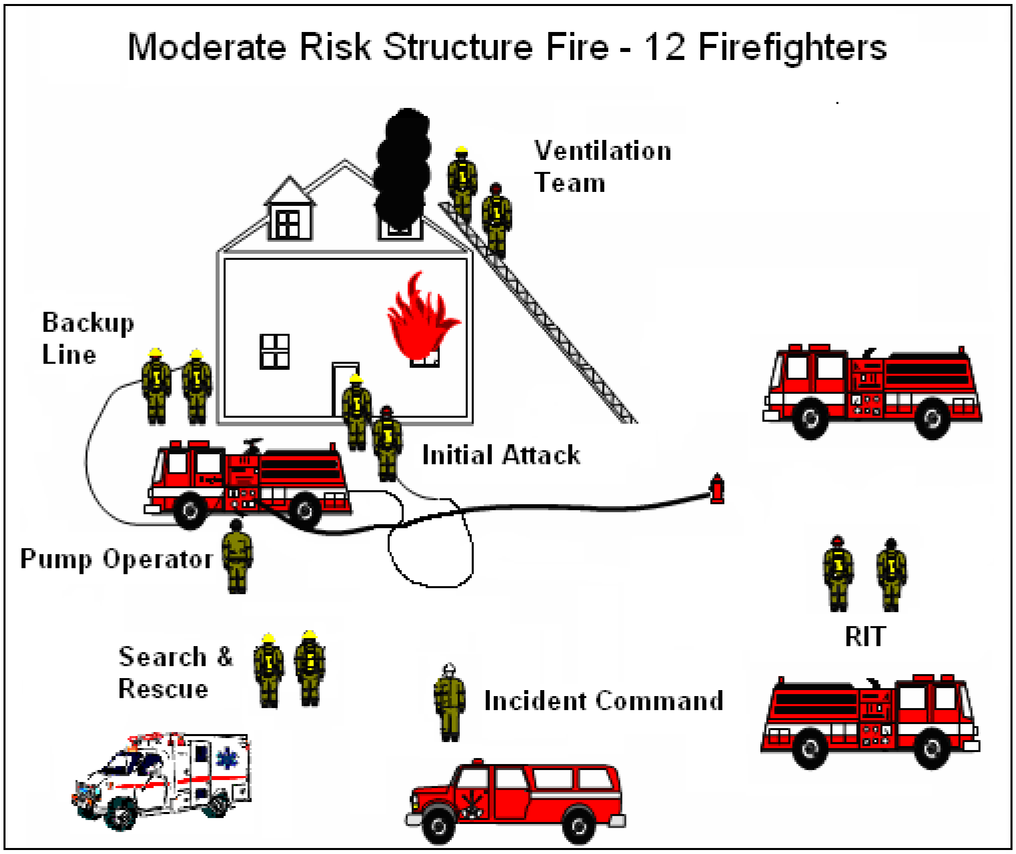
Moderate Risk Fires

The following table and diagram represent the critical task assignments and personnel requirements for an initial alarm assignment at a "Moderate Risk" structure fire.

CRITICAL TASK	PERSONNEL
Command / Safety	1
Pump Operator	1
Attack Line	2
Back-up Line *	2
Support / Search and Rescue	2
Ventilation	2
RIT **	2
Total Number of Firefighters	**12**

*** Back-up Line is required to meet OSHA's 2-IN / 2-OUT Policy.**

** **Rapid Intervention Team (RIT).** A dedicated crew of firefighters who are assigned for rapid deployment to rescue lost or trapped members.



- **NFPA recommends a minimum of 14 firefighters for initial response on these types of fires**

- **Currently, at minimum staffing, AF&R is able to deploy 7 firefighters, plus an additional 2 firefighters from Jackson County Fire Dist. #5 for a total of 9 firefighters. Therefore, fire attack and rescue often cannot be conducted simultaneously.**

- **After July 2009, we will be able to deploy 6 firefighters, plus 2 additional firefighters from Jackson County Fire Dist. #5 for a total of 8 firefighters.**

- **AF&R must at times operate in split or less then ideal modes on the fire ground until sufficient staffing is on scene.**

- **Equipment and personnel responding may be reduced because of multiple emergencies or extenuating circumstances.**

Significant and Maximum Risk Fires

Fire departments should maintain the capability to provide additional alarm assignments when situations are beyond the capacity of the initial first alarm assignment. The National Fire Protection Agency (NFPA) standard recommends when an incident escalates beyond an initial full alarm assignment, or when a significant risk is presented, the Incident Commander (IC) upgrade the number of resources at the incident scene to provide for the increase of the Rapid Intervention Team (RIT) from a partial crew of 2 firefighters to a full Rapid Intervention Crew of 4 firefighters. NFPA further recommends that the IC also deploy a safety officer.

CRITICAL TASK	PERSONNEL
Command / Safety	4
Pump Operators	2
Attack Lines	4
Back-up Lines	4
Search and Rescue	4
Ventilation	4
RIT	4
Total Number of Firefighters	**26**

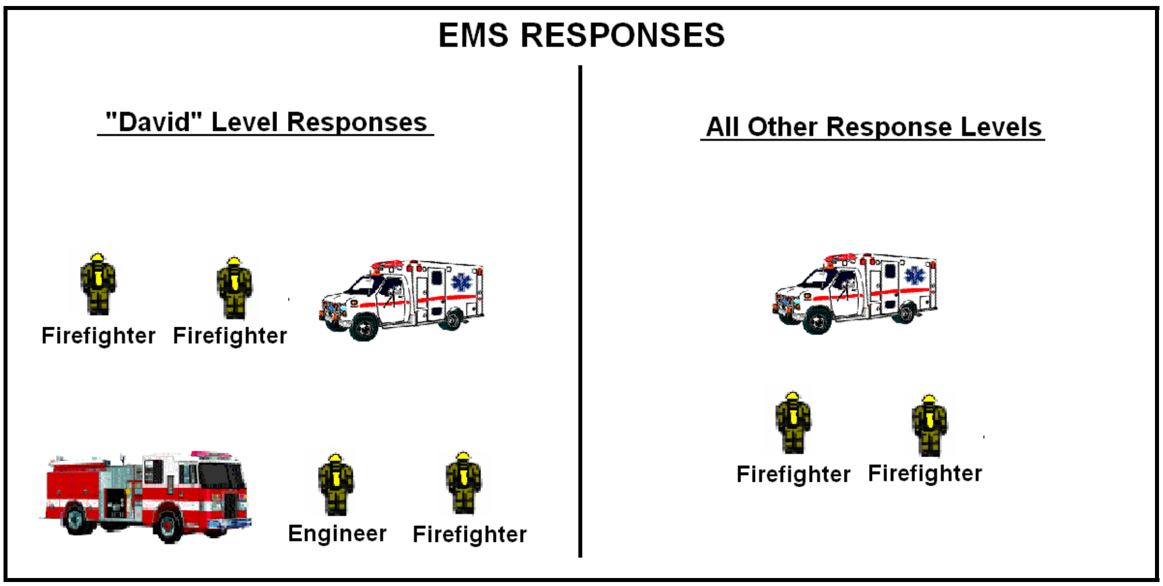
- **Equipment and personnel responding may be reduced because of multiple emergencies or extenuating circumstances.**

B. Emergency Medical Services

Routine, Single Patient EMS Incident

AF&R has determined that 2 Firefighter/Paramedics are able to provide the necessary EMS care for the majority of EMS Responses. In those cases where a significant life threatening emergency has been identified by the dispatch center, 2 more personnel are dispatched to the scene to assist with the additional critical tasks that these kinds of calls generate. These calls are coded a “David” response.

The following illustration shows the resources needed at most medical emergencies.



- ❖ **Equipment and personnel responding may be reduced because of multiple emergencies or extenuating circumstances.**

- ❖ **Motor vehicle accidents and airplane incidents both start at the “David” level response on first alarms.**

“David” responses can be defined as those types of medical emergencies which are immediately life threatening and will require more than 2 personnel to help mitigate the crisis.

Mass Casualty Incident

To provide the resources needed to handle the needs during a mass casualty incident that goes beyond the capability of local resources, Jackson County has implemented the Ambulance Resource Management System (A.R.M.S.). The A.R.M.S. allows one strategic dispatch to utilize all ambulance resources available to respond to emergencies.

C. Wildland Fires

During peak fire season AF&R units respond to multiple wildland incidents both inside and outside of the primary boundaries of our response area. AF&R's primary responsibility is protection of life including evacuation of residents from the fire area. Secondary to life, property protection is prioritized, meaning that the advance of the fire may continue until protection of both life and property are addressed. Mutual aid from Jackson County District #5, Oregon Department of Forestry (ODF), and the U.S. Forest Service is absolutely critical to address potentially overwhelming demands for protection of life and property, and to suppress the wildfire itself if AF&R units are fulfilling primary goals first.

Small Wildland Fire

Two acre fire in Lithia Park

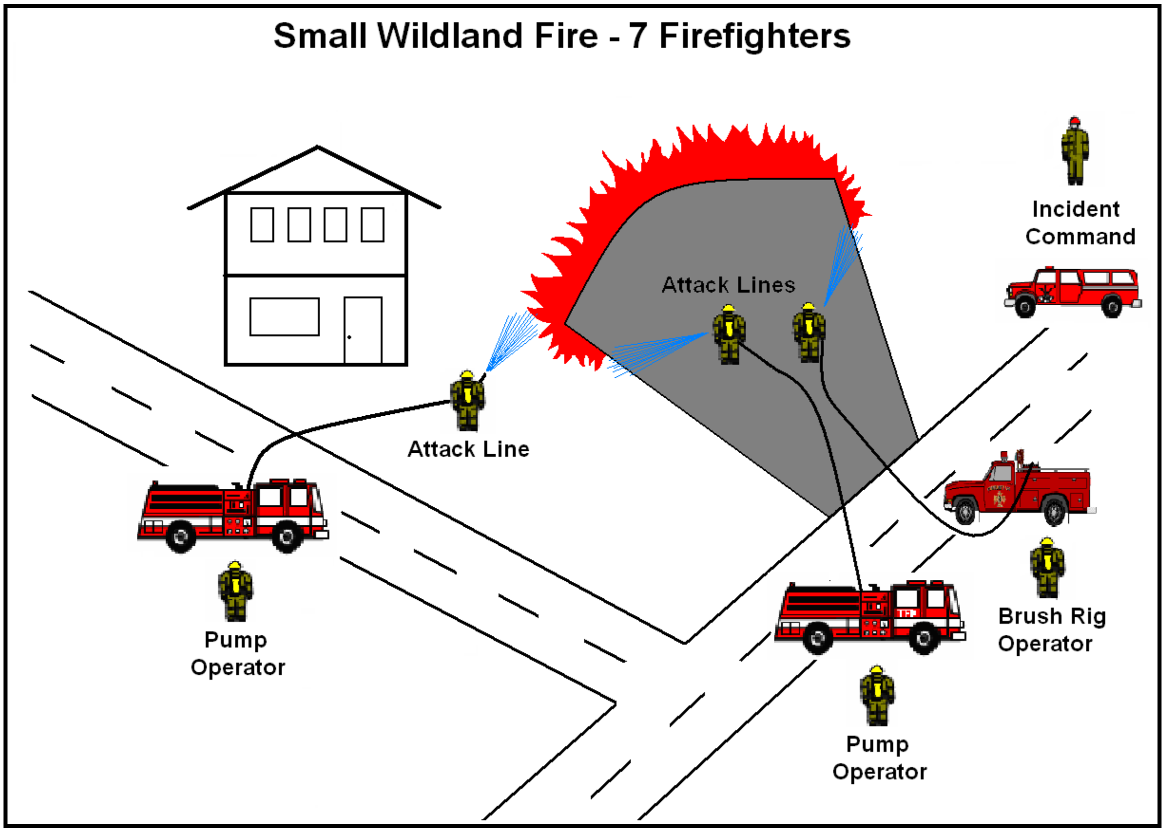
Because wildland fires could have such a disastrous effect upon the City, AF&R has placed a significant interest in extinguishing any small brush/grass fires as quickly as possible. Initial alarm assignments have all available personnel responding to the scene. The fire pictured above occurred in Lithia Park in late July. The mitigating factors that stopped the fire from spreading to upslope homes and toward the watershed were a rapid response from fire crews and the fuels reduction program, which had eliminated ladder fuels from the area.

The following chart shows the initial alarm assignment for any wildland fire that occurs within the City.

Small Wildland Fires (less than one acre)

CRITICAL TASK	**PERSONNEL**
Command/Safety	1
Pump Operators	2
Attack Lines	3
Brush Rig Operator	1
TOTAL	**7**

- **At minimum staffing, the above numbers do not leave any personnel available to staff an ambulance**
- **During the fire season AF&R will also receive assistance from ODF and the U.S. Forest Service, including helicopter and fixed wing aerial resources.**
- **Equipment and personnel responding may be reduced because of multiple emergencies or extenuating circumstances.**



Large Wildland Fire

When wildland fires escalate beyond a first alarm assignment, additional resources must be requested through additional alarms. Additionally, Strike Teams and Task Forces may be requested from Jackson and Josephine Counties. Further escalation of the incident or the potential for serious impacts to the community can necessitate declaration of a conflagration in order to mobilize State-wide resources. Typical critical tasks required during a large wildland fire are listed below:

- Establish a Unified Incident Command Structure
- Provide an Incident Safety Officer

- Evacuate residents as needed
- Delegate Division and Group Supervisor responsibility
- Request and direct fire control activities using air tankers and helicopters
- Fire control/structure protection with engines
- Fire control with dozers
- Fire control with hand crews
- Provide mobile water supply
- Tactical planning including structure triage and GIS mapping

D. Technical Rescue

The following graph indicates the minimum number and type of responders needed to perform a Technical Rescue. At this time, because of the elimination of the training funds for Technical Rescue, there is no actual "Team". As it stands, there are several individuals on each shift who have a basic understanding of various rescue disciplines. In cases where we need additional expertise or services, AF&R might be able to utilize outside organizations for assistance with a significant delay.

Incident type	Technical Rescue Trained Firefighters	Firefighters	Total
Reach and Treat Medical	1	3	4
Low Angle	1	6	7
High Angle	9	6	15
Confined Space (no rigging)	6	4	10
Confined Space (with rigging)	9	6	15

SECTION FOUR: ESTABLISHING OBJECTIVES

This section discusses the basis for fire department response objectives. Fire department response objectives are typically based on:

1. The dynamics of fire growth.
2. The events involved in a life threatening emergency medical incident.

These two types of emergency responses have extensive scientific information available thus making them quantifiable. This section provides the definitions of response times, a discussion on each of the above items, and the associated department goals.

A. The Elements of Response Time

Response times are a critical component in the control and mitigation of an emergency incident. Understanding the standardized elements of response time is important in order for a fire department to measure its response effectiveness.

The National Fire Protection Association definitions concerning fire responses are as follows:

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

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

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

Jackson County Ambulance Service Plan defines ambulance response times as follows:

Notification Time - The length of time between the initial receipt of the request for EMS by either a provider or an emergency dispatch center (911) and the notification of the ASA provider.

Response Time - The length of time between the notification of each provider and the arrival of each provider's emergency medical service unit(s) at the incident scene or at the end of an ambulance access point.

On-Scene Time - The point at which the responding unit arrives on the scene of the emergency.

System Response Time - The elapsed time from when the Public Safety Answering Point receives the call until the arrival of the appropriate provider unit(s) on scene.

B. Dynamics of Fire Growth and Flashover

In order for firefighters to provide the most effective service, and to significantly reduce the risk of life and property loss, they must arrive at a structure fire in a short period of time with adequate resources. Matching the arrival of resources with a specific point in the fire's growth is one of the greatest challenges for a fire department. Finding the specific point in a fire's growth can be accomplished by identifying the stages of a fire.

Stages of a Fire

Regardless of the speed of growth, or length of burn time, all fires inside a compartment or building go through the same stages. A fire in a compartment begins with the "Ignition" stage and when left unaddressed will develop through the Growth, Flashover, Fully Developed, and Decay stages. One particular stage emerges as being very significant because it marks a critical change in conditions. This phase is called the "Flashover" phase.

The following provides a brief overview of the stages of fire within a compartment:

Ignition Stage – Ignition describes the period when a heat source is applied to a combustible fuel package, in the presence of oxygen, and a continuous chemical chain reaction known as combustion begins. At this point the fire is small and generally confined to the material (fuel) first ignited.

Growth Stage – During this stage, the combustion process continues to release increased levels of heat while nearby objects reach their ignition temperature, and begin to burn. Superheated gases rise to the ceiling, spread outward and begin to bank down the walls of the enclosure consuming all available oxygen in the room and raising the heat levels to reach the next stage.

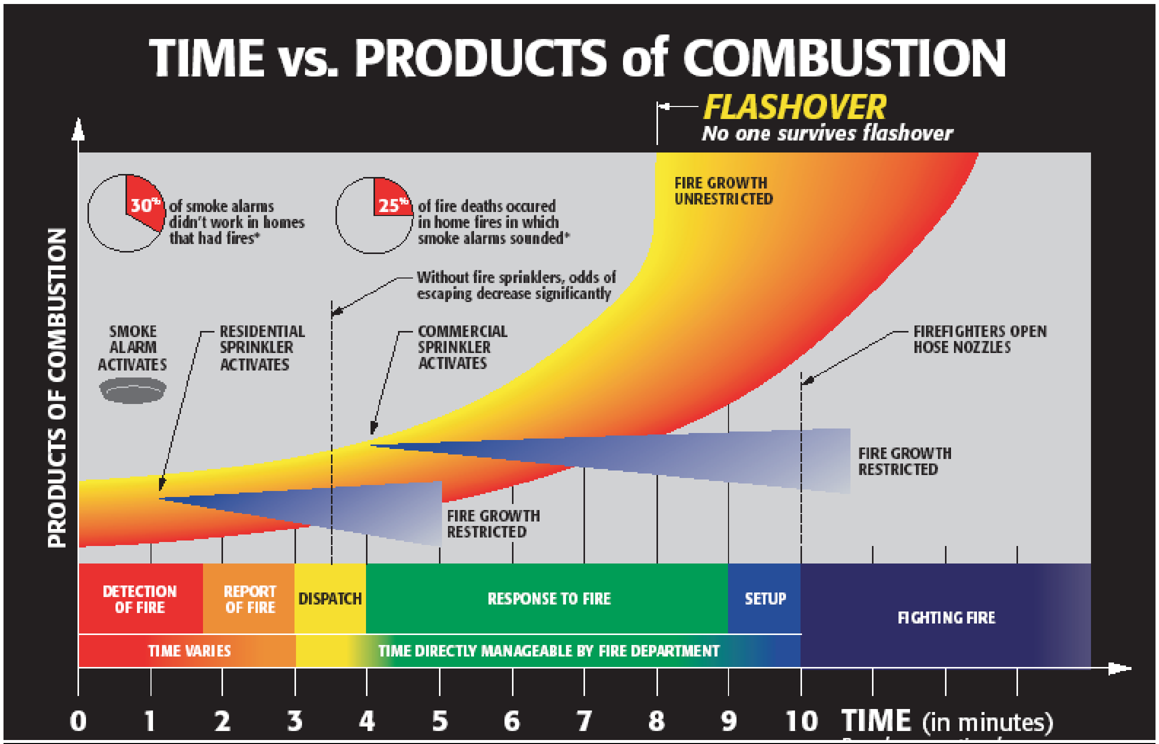
Flashover Stage – Flashover is the transition between the growth and the fully developed fire stages. During flashover, the conditions in the compartment change very rapidly, and the fire changes from one that is dominated by the burning material first ignited, to one that involves all of the exposed combustible surfaces within the compartment.

Fully Developed Stage – The fully developed fire stage occurs when all combustible materials in a compartment are involved in fire. During this period of time, the burning fuels in the compartment are releasing the maximum amount of heat possible for the available materials, and producing large volumes of fire gasses. A fire at this stage requires significantly more resources (water, hoses, and personnel) to control, due to the massive amount of heat energy involved. Also, during this stage, hot unburned fire gasses are likely to begin flowing from the compartment of origin into adjacent spaces or compartments. These gasses ignite as they enter a space where air is more abundant, causing the fire to spread further.

Decay Stage – During this stage, the fire diminishes and temperatures begin to decline because the fire has already consumed the available fuels in the compartment.

Flashover
"Flashover" is a critical stage of fire growth for various reasons. The predominate reasons that this phenomenon is so critical is that no living thing can survive in the flashover room, and that it creates a rapid increase in the rate of combustion which requires a greater amount of water to reduce the burning material below their ignition temperature. After flashover has occurred the fire burns much hotter and spreads at a much more significant pace. Once flashover has occurred search and rescue efforts become more difficult in the remainder of the building. Also, the occurrence of flashover causes an increased need for fire suppression personnel to mitigate the incident in a timely manner.

The following graph represents the stages of fire growth. This graph also identifies the time elements involved in flashover such as the detection and reporting of the fire, dispatch processing time, and the fire department's response time.



The following table compares pre and post flashover conditions:

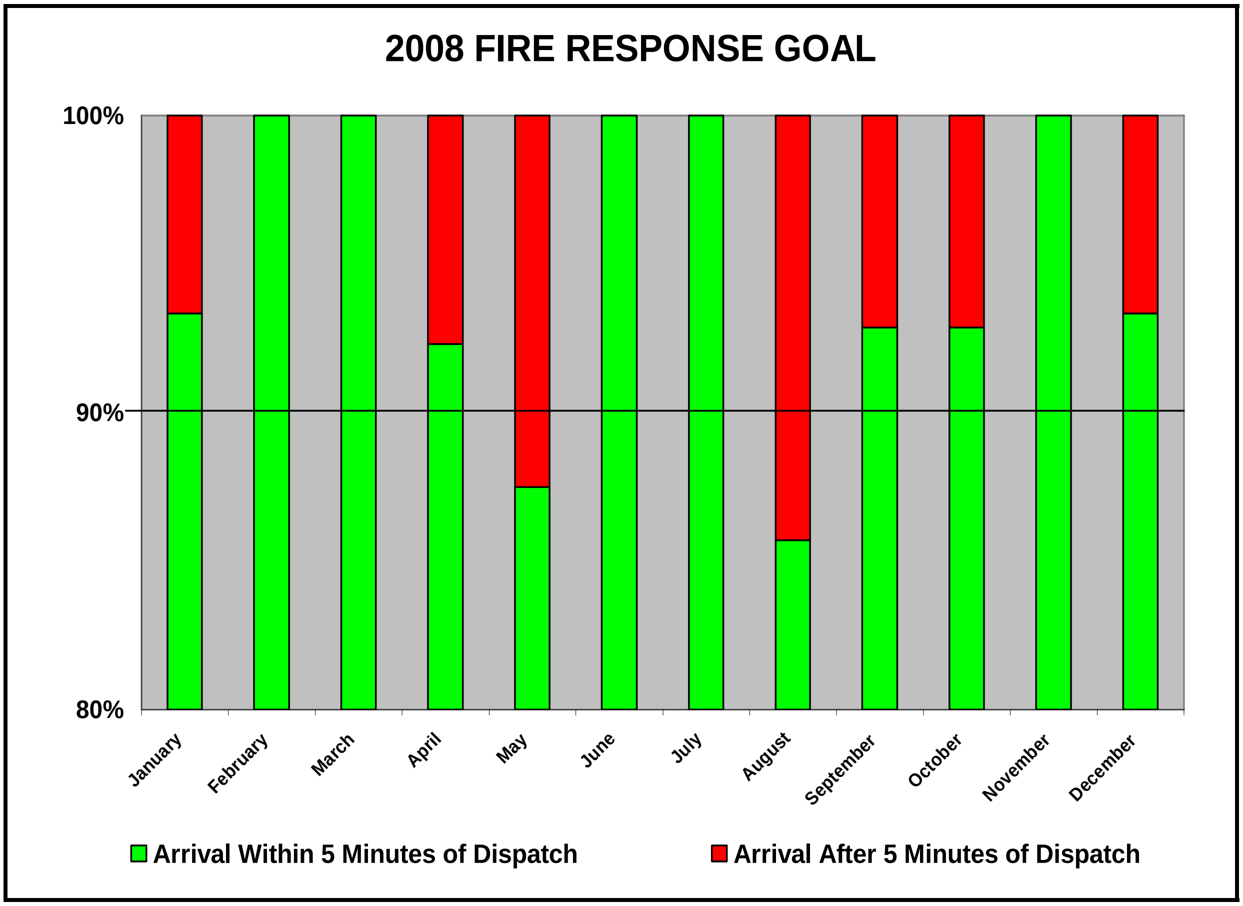
Before Flashover	After Flashover
Limited to one room	May spread beyond one room
Requires smaller attack lines	Requires more, and larger attack lines
Search and Rescue is easier/safer	Compounds Search and Rescue
Initial assignment can handle	Requires additional companies

Staffing and equipment needs can be reasonably predicted for different risk levels and fire stages. The correlation of staffing and equipment needs with fires according to their stage of growth is the basis for response coverage. The goal is to maintain and strategically locate enough firefighters and equipment so a minimum acceptable response force can reach a reasonable number of fire scenes before flashover occurs.

To minimize risk, the department strives to extinguish small fires quickly before they reach flashover potential to minimize risk. As flashover is such a significant fire event, preventing this stage of fire behavior is imperative. Time is a key factor in this effort. Once flashover potential is reached, an exponential increase occurs not only in the rate of combustion, but in the amount of resources necessary to mitigate the fire emergency. For these reasons Ashland Fire & Rescue has established the following goal:

Goal #1

AF&R will respond to 90% of all fire suppression calls inside the City of Ashland with a response time of 5 minutes or less. * AF&R will use the NFPA established measuring criteria concerning emergency fire response times.

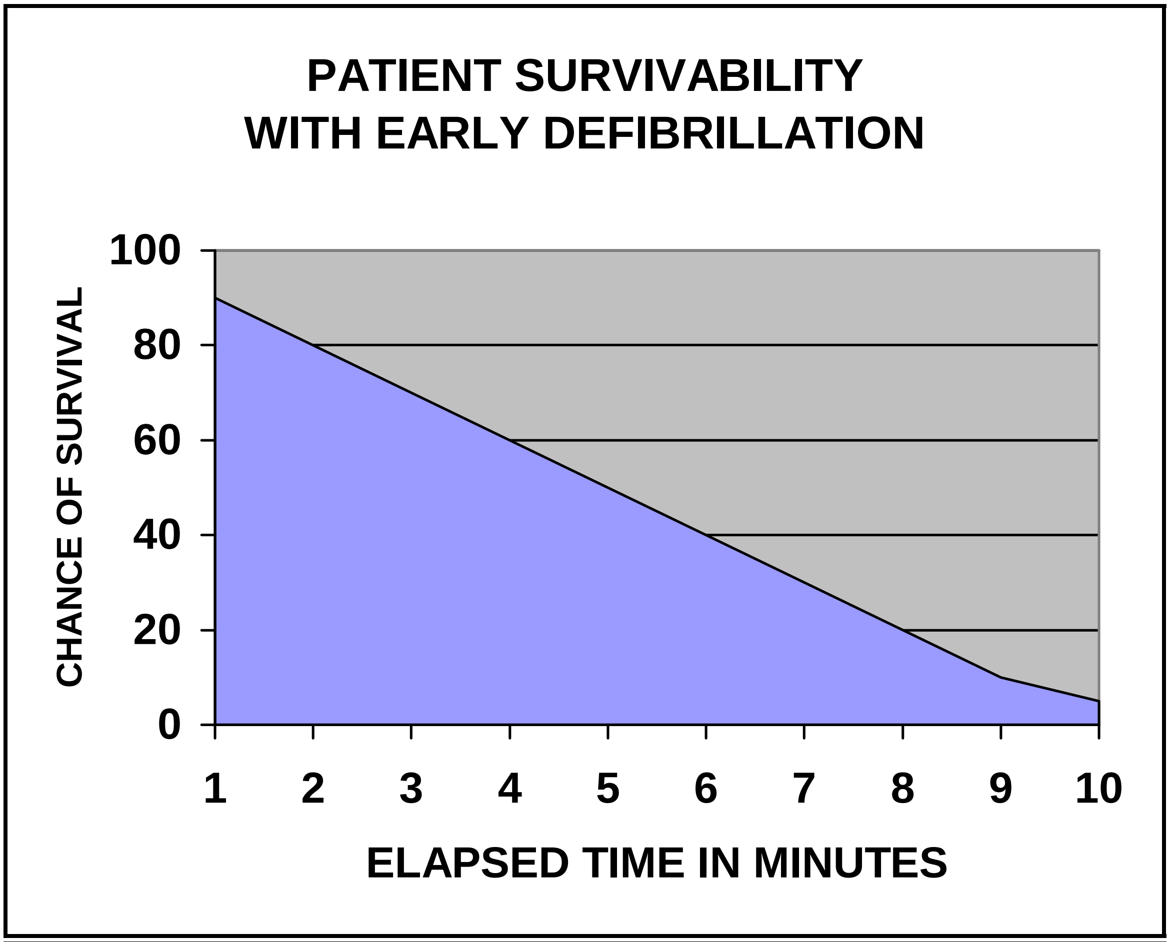


- **Fire suppression calls include: Structure Fires, Wildland Fires, Vehicle Fires, and Fire Alarm Sounding calls.**

C. Emergency Medical Services Benchmarks and Expectations

Life Threatening Medical Emergencies – Basis for Response Objectives

Using life threatening medical emergencies as a basis for setting EMS response time performance objectives has become a fire and EMS industry norm. The American Heart Association has shown that the likelihood of a patient surviving a life threatening medical emergency is improved if CPR and defibrillation are initiated within 4 minutes of the onset of the medical emergency.



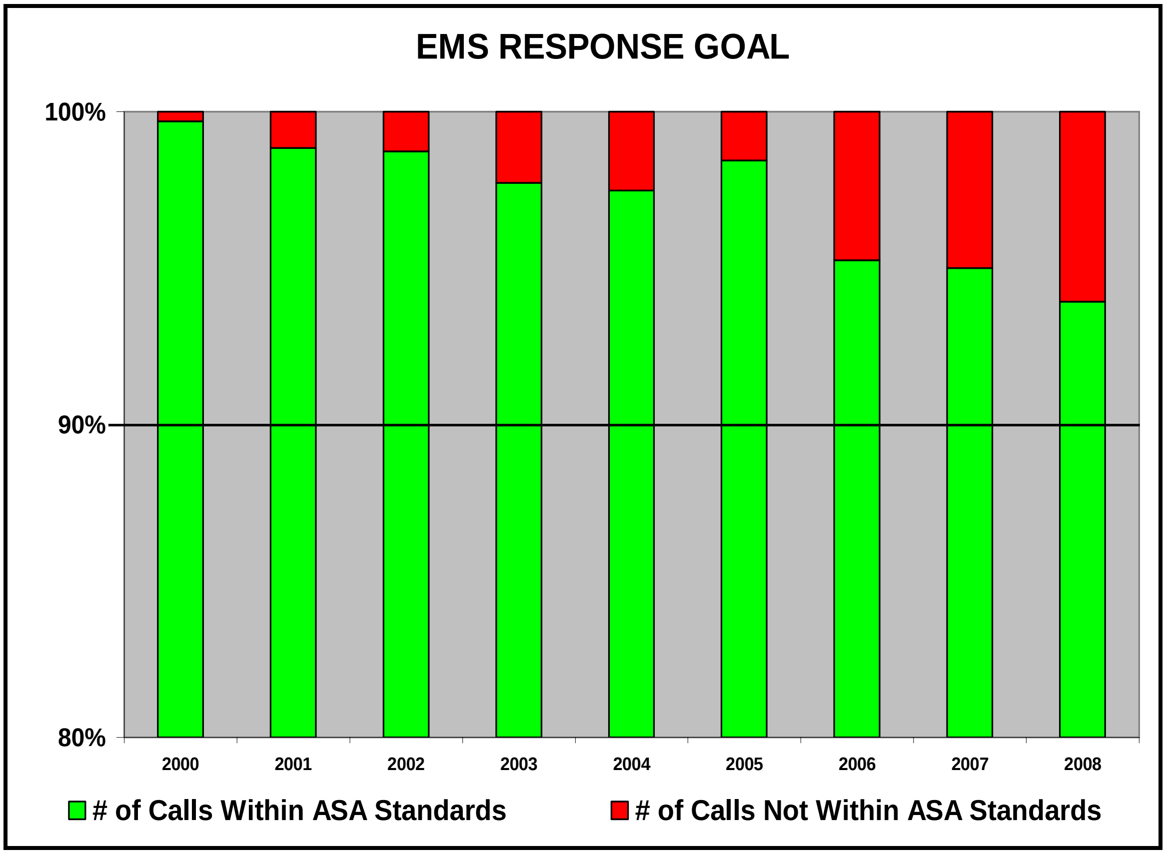
From an emergency medical perspective, the service-level objective typically is to provide medical intervention within a six-minute timeframe, as brain damage is very likely at six minutes without oxygen. However, in a cardiac arrest situation, survivability dramatically decreased beyond four minutes without appropriate intervention. Intervention includes early recognition and bystander CPR.

Early defibrillation is often called the critical link in the chain of survival because it is the only way to successfully treat most sudden cardiac arrests. When cardiac arrest occurs, the heart starts to beat chaotically (fibrillation) and cannot pump blood efficiently. Time is critical. If a normal heart rhythm is not restored in minutes, the person will die. In fact, for every minute without defibrillation, the odds of survival drop seven to ten percent. A sudden cardiac arrest victim who is not defibrillated within eight to ten minutes has virtually no chance of survival. The shortest possible response times create the highest probabilities of resuscitation. For these reasons Ashland Fire & Rescue has established the following goal:

Goal #2

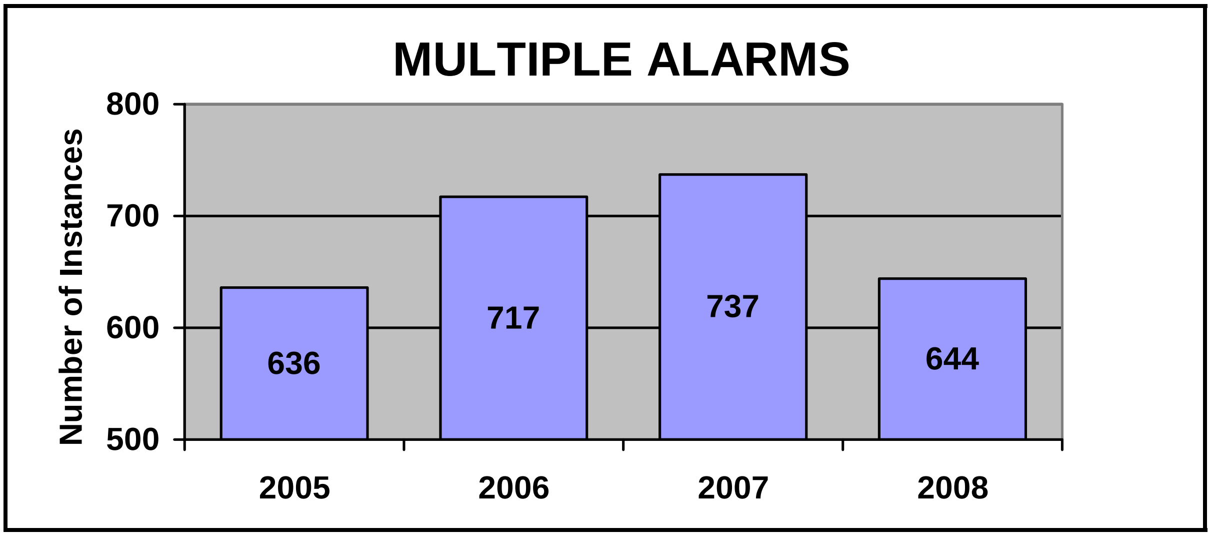
AF&R will provide emergency medical services to 90% of patients within ASA time standards.

ZONE	STANDARD
Urban	8 minutes
Suburban	15 minutes
Rural	45 minutes
Frontier	2 Hours



SECTION FIVE: RESPONSE RELIABILITY

Response reliability addresses the probability that the required amount of staffing and apparatus will be available when a fire or other emergency call is received. If every piece of apparatus in each station were available every time a fire call was received, the response reliability for each station would be 100%. As the number of calls per day increases, and line staffing decreases, the likelihood that a needed piece of equipment and/or personnel will already be busy with an existing incident will increase. For example, in January of this year there were 27 times when two overlapping emergency responses occurred, 8 times when three overlapping emergency responses occurred and 3 times when four overlapping emergency responses occurred. Consequently, during these times, AF&R's response reliability decreases. The following chart shows the number of times there have been multiple alarms occurring at the same time:



While AF&R utilizes mutual aid agreements to receive equipment and manpower from neighboring departments, response times will be longer than those recommended by NFPA and ASA standards. The following steps have been taken to help with low staffing levels and multiple alarms:

1) All firefighting personnel have been issued a pager and are encouraged to return to duty when a "call-back" for personnel is initiated.

.

2) An Automatic and Mutual Aid Agreement is maintained with all fire and ambulance agencies in Jackson and Josephine Counties.

3) Automatic Aid is pre-programmed through six alarm assignments, providing a systematic method to bring additional resources to the incident as needed.

4) AF&R maintains Automatic and Mutual Aid Agreements with the Oregon Department of Forestry and the United States Forest Service for grass, brush and forest fires.

SECTION SIX: CONCLUSION

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 describes what an optimal fire department emergency response would be, to safely and efficiently handle different types of emergencies. Although AF&R is unable to meet these standards at this time, AF&R will continue to use NFPA 1710 standard as a goal for improvement in the future. AF&R will continue its efforts to meet the community's needs for fire protection, emergency medical services, response to hazardous conditions, community emergency preparedness, plans review, interface fuel reduction and planning with the available resources.

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March 30, 2015

Mr. Dave Kanner, Administrator
Ashland
20 East Main St
Ashland, Oregon, 97520

RE: Ashland, Jackson County, Oregon
Public Protection Classification: 03
Effective Date: July 01, 2015

Dear Mr. Dave Kanner,

We wish to thank you, Mr. Steve Walker and Chief John Karns for your cooperation during our recent Public Protection Classification (PPC) survey. ISO has completed its analysis of the structural fire suppression delivery system provided in your community. The resulting classification is indicated

Enclosed is a summary of the ISO analysis of your fire suppression services. If you would like to know more about your community's PPC classification, or if you would like to learn about the potential effect of proposed changes to your fire suppression delivery system, please call us at the phone number listed below.

ISO's Public Protection Classification Program (PPC) plays an important role in the underwriting process at insurance companies. In fact, most U.S. insurers – including the largest ones – use PPC information as part of their decision- making when deciding what business to write, coverage's to offer or prices to charge for personal or commercial property insurance.

Each insurance company independently determines the premiums it charges its policyholders. The way an insurer uses ISO's information on public fire protection may depend on several things – the company's fire-loss experience, ratemaking methodology, underwriting guidelines, and its marketing strategy.

Through ongoing research and loss experience analysis, we identified additional differentiation in fire loss experience within our PPC program, which resulted in the revised classifications. We based the differing fire loss experience on the fire suppression capabilities of each community. The new classifications will improve the predictive value for insurers while benefiting both commercial and residential property owners. We've published the new classifications as "X" and "Y" — formerly the "9" and "8B" portion of the split classification, respectively. For example:

- A community currently graded as a split 6/9 classification will now be a split 6/6X classification; with the "6X" denoting what was formerly classified as "9."
- Similarly, a community currently graded as a split 6/8B classification will now be a split 6/6Y classification, the "6Y" denoting what was formerly classified as "8B."
- Communities graded with single "9" or "8B" classifications will remain intact.

PPC is important to communities and fire departments as well. Communities whose PPC improves may get lower insurance prices. PPC also provides fire departments with a valuable benchmark, and is used by many departments as a valuable tool when planning, budgeting and justifying fire protection improvements.

ISO appreciates the high level of cooperation extended by local officials during the entire PPC survey process. The community protection baseline information gathered by ISO is an essential foundation upon which determination of the relative level of fire protection is made using the Fire Suppression Rating Schedule.

The classification is a direct result of the information gathered, and is dependent on the resource levels devoted to fire protection in existence at the time of survey. Material changes in those resources that occur after the survey is completed may affect the classification. Although ISO maintains a pro-active process to keep baseline information as current as possible, in the event of changes or questions, please call customer service at 1-800-444-4554, option 2 to expedite the update activity.

ISO is the leading supplier of data and analytics for the property/casualty insurance industry. Most insurers use PPC classifications for underwriting and calculating premiums for residential, commercial and industrial properties. The PPC program is not intended to analyze all aspects of a comprehensive structural fire suppression delivery system program. It is not for purposes of determining compliance with any state or local law, nor is it for making loss prevention or life safety recommendations.

If you have any questions about your classification, please let us know.

Sincerely,

Dominic Santanna

Dominic Santanna
Manager - National Processing Center

Encl.

cc: Mr. KEVIN HARRIS, Operations Manager, EMERGENCY COMMUNICATIONS OF SOUTHERN OREGON
Mr. Steve Walker, Water Supervisor, Ashland Public Works
Chief John Karns, Chief, ASHLAND FIRE DEPARTMENT

Public Protection Classification

(PPC™)

Summary Report

Ashland

OREGON

Prepared by

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Background Information

Introduction

ISO collects and evaluates information from communities in the United States on their structure fire suppression capabilities. The data is analyzed using our Fire Suppression Rating Schedule (FSRS) and then a Public Protection Classification (PPC™) grade is assigned to the community. The surveys are conducted whenever it appears that there is a possibility of a PPC change. As such, the PPC program provides important, up-to-date information about fire protection services throughout the country.

The FSRS recognizes fire protection features only as they relate to suppression of first alarm structure fires. In many communities, fire suppression may be only a small part of the fire department's overall responsibility. ISO recognizes the dynamic and comprehensive duties of a community's fire service, and understands the complex decisions a community must make in planning and delivering emergency services. However, in developing a community's PPC grade, only features related to reducing property losses from structural fires are evaluated. Multiple alarms, simultaneous incidents and life safety are not considered in this evaluation. The PPC program evaluates the fire protection for small to average size buildings. Specific properties with a Needed Fire Flow in excess of 3,500 gpm are evaluated separately and assigned an individual PPC grade.

A community's investment in fire mitigation is a proven and reliable predictor of future fire losses. Statistical data on insurance losses bears out the relationship between excellent fire protection – as measured by the PPC program – and low fire losses. So, insurance companies use PPC information for marketing, underwriting, and to help establish fair premiums for homeowners and commercial fire insurance. In general, the price of fire insurance in a community with a good PPC grade is substantially lower than in a community with a poor PPC grade, assuming all other factors are equal.

ISO is an independent company that serves insurance companies, communities, fire departments, insurance regulators, and others by providing information about risk. ISO's expert staff collects information about municipal fire suppression efforts in communities throughout the United States. In each of those communities, ISO analyzes the relevant data and assigns a PPC grade – a number from 1 to 10. Class 1 represents an exemplary fire suppression program, and Class 10 indicates that the area's fire suppression program does not meet ISO's minimum criteria.

ISO's PPC program evaluates communities according to a uniform set of criteria, incorporating nationally recognized standards developed by the National Fire Protection Association and the American Water Works Association. A community's PPC grade depends on:

- **Needed Fire Flows**, which are representative building locations used to determine the theoretical amount of water necessary for fire suppression purposes.
- **Emergency Communications**, including emergency reporting, telecommunicators, and dispatching systems.
- **Fire Department**, including equipment, staffing, training, geographic distribution of fire companies, operational considerations, and community risk reduction.
- **Water Supply**, including inspection and flow testing of hydrants, alternative water supply operations, and a careful evaluation of the amount of available water compared with the amount needed to suppress fires up to 3,500 gpm.

Data Collection and Analysis

ISO has evaluated and classified over 48,000 fire protection areas across the United States using its FSRS. A combination of meetings between trained ISO field representatives and the dispatch center coordinator, community fire official, and water superintendent is used in conjunction with a comprehensive questionnaire to collect the data necessary to determine the PPC grade. In order for a community to obtain a grade better than a Class 9, three elements of fire suppression features are reviewed. These three elements are Emergency Communications, Fire Department, and Water Supply.

A review of the **Emergency Communications** accounts for 10% of the total classification. This section is weighted at **10 points,** as follows:

- Emergency Reporting — 3 points
- Telecommunicators — 4 points
- Dispatch Circuits — 3 points

A review of the **Fire Department** accounts for 50% of the total classification. ISO focuses on a fire department's first alarm response and initial attack to minimize potential loss. The fire department section is weighted at **50 points,** as follows:

- Engine Companies — 6 points
- Reserve Pumpers — 0.5 points
- Pump Capacity — 3 points
- Ladder/Service Companies — 4 points
- Reserve Ladder/Service Trucks — 0.5 points
- Deployment Analysis — 10 points
- Company Personnel — 15 points
- Training — 9 points
- Operational considerations — 2 points
- Community Risk Reduction — 5.5 points (in addition to the 50 points above)

A review of the **Water Supply** system accounts for 40% of the total classification. ISO reviews the water supply a community uses to determine the adequacy for fire suppression purposes. The water supply system is weighted at **40 points,** as follows:

- Credit for Supply System — 30 points
- Hydrant Size, Type & Installation — 3 points
- Inspection & Flow Testing of Hydrants — 7 points

There is one additional factor considered in calculating the final score – **Divergence**.

Even the best fire department will be less than fully effective if it has an inadequate water supply. Similarly, even a superior water supply will be less than fully effective if the fire department lacks the equipment or personnel to use the water. The FSRS score is subject to modification by a divergence factor, which recognizes disparity between the effectiveness of the fire department and the water supply.

The Divergence factor mathematically reduces the score based upon the relative difference between the fire department and water supply scores. The factor is introduced in the final equation.

PPC Grade

The PPC grade assigned to the community will depend on the community's score on a 100-point scale:

PPC	Points
1	90.00 or more
2	80.00 to 89.99
3	70.00 to 79.99
4	60.00 to 69.99
5	50.00 to 59.99
6	40.00 to 49.99
7	30.00 to 39.99
8	20.00 to 29.99
9	10.00 to 19.99
10	0.00 to 9.99

The classification numbers are interpreted as follows:

- Class 1 through (and including) Class 8 represents a fire suppression system that includes an FSRS creditable dispatch center, fire department, and water supply.
- Class 8B is a special classification that recognizes a superior level of fire protection in otherwise Class 9 areas. It is designed to represent a fire protection delivery system that is superior except for a lack of a water supply system capable of the minimum FSRS fire flow criteria of 250 gpm for 2 hours.
- Class 9 is a fire suppression system that includes a creditable dispatch center, fire department but no FSRS creditable water supply.
- Class 10 does not meet minimum FSRS criteria for recognition, including areas that are beyond five road miles of a recognized fire station.

New PPC program changes effective July 1, 2014

We have revised the PPC program to capture the effects of enhanced fire protection capabilities that reduce fire loss and fire severity in Split Class 9 and Split Class 8B areas (as outlined below). This new structure benefits the fire service, community, and property owner.

New classifications

Through ongoing research and loss experience analysis, we identified additional differentiation in fire loss experience within our PPC program, which resulted in the revised classifications. We based the differing fire loss experience on the fire suppression capabilities of each community. The new PPC classes will improve the predictive value for insurers while benefiting both commercial and residential property owners. Here are the new classifications and what they mean.

Split classifications

When we develop a split classification for a community — for example 5/9 — the first number is the class that applies to properties within 5 road miles of the responding fire station and 1,000 feet of a creditable water supply, such as a fire hydrant, suction point, or dry hydrant. The second number is the class that applies to properties within 5 road miles of a fire station but beyond 1,000 feet of a creditable water supply. We have revised the classification to reflect more precisely the risk of loss in a community, replacing Class 9 and 8B in the second part of a split classification with revised designations.

What's changed with the new classifications?

We've published the new classifications as "X" and "Y" — formerly the "9" and "8B" portion of the split classification, respectively. For example:

- A community currently displayed as a split 6/9 classification will now be a split 6/6X classification; with the "6X" denoting what was formerly classified as "9".
- Similarly, a community currently graded as a split 6/8B classification will now be a split 6/6Y classification, the "6Y" denoting what was formerly classified as "8B".
- Communities graded with single "9" or "8B" classifications will remain intact.

Prior Classification	New Classification
1/9	1/1X
2/9	2/2X
3/9	3/3X
4/9	4/4X
5/9	5/5X
6/9	6/6X
7/9	7/7X
8/9	8/8X
9	9

Prior Classification	New Classification
1/8B	1/1Y
2/8B	2/2Y
3/8B	3/3Y
4/8B	4/4Y
5/8B	5/5Y
6/8B	6/6Y
7/8B	7/7Y
8/8B	8/8Y
8B	8B

What's changed?
As you can see, we're still maintaining split classes, but it's how we represent them to insurers that's changed. The new designations reflect a reduction in fire severity and loss and have the potential to reduce property insurance premiums.

Benefits of the revised split class designations

- To the fire service, the revised designations identify enhanced fire suppression capabilities used throughout the fire protection area
- To the community, the new classes reward a community's fire suppression efforts by showing a more reflective designation
- To the individual property owner, the revisions offer the potential for decreased property insurance premiums

New water class
Our data also shows that risks located more than 5 but less than 7 road miles from a responding fire station with a creditable water source within 1,000 feet had better loss experience than those farther than 5 road miles from a responding fire station with no creditable water source. We've introduced a new classification —10W — to recognize the reduced loss potential of such properties.

What's changed with Class 10W?
Class 10W is property-specific. Not all properties in the 5-to-7-mile area around the responding fire station will qualify. The difference between Class 10 and 10W is that the 10W-graded risk or property is within 1,000 feet of a creditable water supply. Creditable water supplies include fire protection systems using hauled water in any of the split classification areas.

What's the benefit of Class 10W?
10W gives credit to risks within 5 to 7 road miles of the responding fire station and within 1,000 feet of a creditable water supply. That's reflective of the potential for reduced property insurance premiums.

What does the fire chief have to do?
Fire chiefs don't have to do anything at all. The revised classifications went in place automatically effective July 1, 2014 (July 1, 2015 for Texas).

What if I have additional questions?
Feel free to contact ISO at 800.444.4554 or email us at PPC-Cust-Serv@iso.com.

Distribution of PPC Grades

The 2015 published countrywide distribution of communities by the PPC grade is as follows:

Assistance

The PPC program offers help to communities, fire departments, and other public officials as they plan for, budget, and justify improvements. ISO is also available to assist in the understanding of the details of this evaluation.

The PPC program representatives can be reached by telephone at (800) 444-4554. The technical specialists at this telephone number have access to the details of this evaluation and can effectively speak with you about your questions regarding the PPC program. What's more, we can be reached via the internet at www.isomitigation.com/talk/.

We also have a website dedicated to our Community Hazard Mitigation Classification programs at www.isomitigation.com. Here, fire chiefs, building code officials, community leaders and other interested citizens can access a wealth of data describing the criteria used in evaluating how cities and towns are protecting residents from fire and other natural hazards. This website will allow you to learn more about the PPC program. The website provides important background information, insights about the PPC grading processes and technical documents. ISO is also pleased to offer Fire Chiefs Online — a special, secured website with information and features that can help improve your PPC grade, including a list of the Needed Fire Flows for all the commercial occupancies ISO has on file for your community. Visitors to the site can download information, see statistical results and also contact ISO for assistance.

In addition, on-line access to the FSRS and its commentaries is available to registered customers for a fee. However, fire chiefs and community chief administrative officials are given access privileges to this information without charge.

To become a registered fire chief or community chief administrative official, register at www.isomitigation.com.

PPC Review

ISO concluded its review of the fire suppression features being provided for Ashland. The resulting community classification is **Class 03**.

If the classification is a single class, the classification applies to properties with a Needed Fire Flow of 3,500 gpm or less in the community. If the classification is a split class (e.g., 6/XX):

- The first class (e.g., "6" in a 6/XX) applies to properties within 5 road miles of a recognized fire station and within 1,000 feet of a fire hydrant or alternate water supply.
- The second class (XX or XY) applies to properties beyond 1,000 feet of a fire hydrant but within 5 road miles of a recognized fire station.
- Alternative Water Supply: The first class (e.g., "6" in a 6/10) applies to properties within 5 road miles of a recognized fire station with no hydrant distance requirement.
- Class 10 applies to properties over 5 road miles of a recognized fire station.
- Class 10W applies to properties within 5 to 7 road miles of a recognized fire station with a recognized water supply within 1,000 feet.
- Specific properties with a Needed Fire Flow in excess of 3,500 gpm are evaluated separately and assigned an individual classification.

FSRS Feature	Earned Credit	Credit Available
Emergency Communications		
414. Credit for Emergency Reporting	3.00	3
422. Credit for Telecommunicators	3.79	4
432. Credit for Dispatch Circuits	1.80	3
440. Credit for Receiving and Handling Fire Alarms	8.59	10
Fire Department		
513. Credit for Engine Companies	6.00	6
523. Credit for Reserve Pumpers	0.30	0.50
532. Credit for Pump Capacity	3.00	3
549. Credit for Ladder Service	0.84	4
553. Credit for Reserve Ladder and Service Trucks	0.00	0.50
561. Credit for Deployment Analysis	6.22	10
571. Credit for Company Personnel	7.50	15
581. Credit for Training	7.60	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	33.46	50
Water Supply		
616. Credit for Supply System	25.83	30
621. Credit for Hydrants	2.55	3
631. Credit for Inspection and Flow Testing	7.00	7
640. Credit for Water Supply	35.38	40
Divergence	-4.31	--
1050. Community Risk Reduction	5.06	5.50
Total Credit	78.18	105.50

Emergency Communications

Ten percent of a community's overall score is based on how well the communications center receives and dispatches fire alarms. Our field representative evaluated:

- Communications facilities provided for the general public to report structure fires
- Enhanced 9-1-1 Telephone Service including wireless
- Computer-aided dispatch (CAD) facilities
- Alarm receipt and processing at the communication center
- Training and certification of telecommunicators
- Facilities used to dispatch fire department companies to reported structure fires

	Earned Credit	Credit Available
414. Credit Emergency Reporting	**3.00**	3
422. Credit for Telecommunicators	**3.79**	4
432. Credit for Dispatch Circuits	**1.80**	3
Item 440. Credit for Emergency Communications:	**8.59**	**10**

Item 414 - Credit for Emergency Reporting (3 points)

The first item reviewed is Item 414 "Credit for Emergency Reporting (CER)". This item reviews the emergency communication center facilities provided for the public to report fires including 911 systems (Basic or Enhanced), Wireless Phase I and Phase II, Voice over Internet Protocol, Computer Aided Dispatch and Geographic Information Systems for automatic vehicle location. ISO uses National Fire Protection Association (NFPA) 1221, *Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems* as the reference for this section.

Item 410. Emergency Reporting (CER)	Earned Credit	Credit Available
A./B. Basic 9-1-1, Enhanced 9-1-1 or No 9-1-1 For maximum credit, there should be an Enhanced 9-1-1 system, Basic 9-1-1 and No 9-1-1 will receive partial credit.	20.00	20
1. E9-1-1 Wireless Wireless Phase I using Static ALI (automatic location identification) Functionality (10 points); Wireless Phase II using Dynamic ALI Functionality (15 points); Both available will be 25 points	25.00	25
2. E9-1-1 Voice over Internet Protocol (VoIP) Static VoIP using Static ALI Functionality (10 points); Nomadic VoIP using Dynamic ALI Functionality (15 points); Both available will be 25 points	25.00	25
3. Computer Aided Dispatch Basic CAD (5 points); CAD with Management Information System (5 points); CAD with Interoperability (5 points)	15.00	15
4. Geographic Information System (GIS/AVL) The PSAP uses a fully integrated CAD/GIS management system with automatic vehicle location (AVL) integrated with a CAD system providing dispatch assignments.	15.00	15
Review of Emergency Reporting total:	100.00	100

Item 422- Credit for Telecommunicators (4 points)

The second item reviewed is Item 422 "Credit for Telecommunicators (TC)". This item reviews the number of Telecommunicators on duty at the center to handle fire calls and other emergencies. All emergency calls including those calls that do not require fire department action are reviewed to determine the proper staffing to answer emergency calls and dispatch the appropriate emergency response. NFPA 1221, *Standard for the Installation, Maintenance and Use of Emergency Services Communications Systems,* recommends that ninety-five percent of emergency calls shall be answered within 15 seconds and ninety-nine percent of emergency calls shall be answered within 40 seconds. In addition, NFPA recommends that ninety percent of emergency alarm processing shall be completed within 60 seconds and ninety-nine percent of alarm processing shall be completed within 90 seconds of answering the call.

To receive full credit for operators on duty, ISO must review documentation to show that the communication center meets NFPA 1221 call answering and dispatch time performance measurement standards. This documentation may be in the form of performance statistics or other performance measurements compiled by the 9-1-1 software or other software programs that are currently in use such as Computer Aided Dispatch (CAD) or Management Information System (MIS).

Item 420. Telecommunicators (CTC)	**Earned Credit**	**Credit Available**
A1. Alarm Receipt (AR) Receipt of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	**20.00**	**20**
A2. Alarm Processing (AP) Processing of alarms shall meet the requirements in accordance with the criteria of NFPA 1221	**14.77**	**20**
B. Emergency Dispatch Protocols (EDP) Telecommunicators have emergency dispatch protocols (EDP) containing questions and a decision-support process to facilitate correct call categorization and prioritization.	**20.00**	**20**
C. Telecommunicator Training and Certification (TTC) Telecommunicators meet the qualification requirements referenced in NFPA 1061, *Standard for Professional Qualifications for Public Safety Telecommunicator,* and/or the Association of Public-Safety Communications Officials - International (APCO) *Project 33.* Telecommunicators are certified in the knowledge, skills, and abilities corresponding to their job functions.	**20.00**	**20**
D. Telecommunicator Continuing Education and Quality Assurance (TQA) Telecommunicators participate in continuing education and/or in-service training and quality-assurance programs as appropriate for their positions	**20.00**	**20**
Review of Telecommunicators total:	**94.77**	**100**

Item 432 - Credit for Dispatch Circuits (3 points)

The third item reviewed is Item 432 "Credit for Dispatch Circuits (CDC)". This item reviews the dispatch circuit facilities used to transmit alarms to fire department members. A "Dispatch Circuit" is defined in NFPA 1221 as "A circuit over which an alarm is transmitted from the communications center to an emergency response facility (ERF) or emergency response units (ERUs) to notify ERUs to respond to an emergency". All fire departments (except single fire station departments with full-time firefighter personnel receiving alarms directly at the fire station) need adequate means of notifying all firefighter personnel of the location of reported structure fires. The dispatch circuit facilities should be in accordance with the general criteria of NFPA 1221. "Alarms" are defined in this Standard as "A signal or message from a person or device indicating the existence of an emergency or other situation that requires action by an emergency response agency".

There are two different levels of dispatch circuit facilities provided for in the Standard – a primary dispatch circuit and a secondary dispatch circuit. In jurisdictions that receive 730 alarms or more per year (average of two alarms per 24-hour period), two separate and dedicated dispatch circuits, a primary and a secondary, are needed. In jurisdictions receiving fewer than 730 alarms per year, a second dedicated dispatch circuit is not needed. Dispatch circuit facilities installed but not used or tested (in accordance with the NFPA Standard) receive no credit.

The score for Credit for Dispatch Circuits (CDC) is influenced by monitoring for integrity of the primary dispatch circuit. There are up to 0.90 points available for this Item. Monitoring for integrity involves installing automatic systems that will detect faults and failures and send visual and audible indications to appropriate communications center (or dispatch center) personnel. ISO uses NFPA 1221 to guide the evaluation of this item. ISO's evaluation also includes a review of the communication system's emergency power supplies.

Item 432 "Credit for Dispatch Circuits (CDC)" = 1.80 points

Fire Department

Fifty percent of a community's overall score is based upon the fire department's structure fire suppression system. ISO's field representative evaluated:

- Engine and ladder/service vehicles including reserve apparatus
- Equipment carried
- Response to reported structure fires
- Deployment analysis of companies
- Available and/or responding firefighters
- Training

	Earned Credit	Credit Available
513. Credit for Engine Companies	**6.00**	6
523. Credit for Reserve Pumpers	**0.30**	0.5
532. Credit for Pumper Capacity	**3.00**	3
549. Credit for Ladder Service	**0.84**	4
553. Credit for Reserve Ladder and Service Trucks	**0.00**	0.5
561. Credit for Deployment Analysis	**6.22**	10
571. Credit for Company Personnel	**7.50**	15
581. Credit for Training	**7.60**	9
581. Credit for Operational Considerations	**2.00**	2
Item 590. Credit for Fire Department:	**33.46**	**50**

Basic Fire Flow

The Basic Fire Flow for the community is determined by the review of the Needed Fire Flows for selected buildings in the community. The fifth largest Needed Fire Flow is determined to be the Basic Fire Flow. The Basic Fire Flow has been determined to be 3000 gpm.

Item 513 - Credit for Engine Companies (6 points)

The first item reviewed is Item 513 "Credit for Engine Companies (CEC)". This item reviews the number of engine companies, their pump capacity, hose testing, pump testing and the equipment carried on the in-service pumpers. To be recognized, pumper apparatus must meet the general criteria of NFPA 1901, *Standard for Automotive Fire Apparatus* which include a minimum 250 gpm pump, an emergency warning system, a 300 gallon water tank, and hose. At least 1 apparatus must have a permanently mounted pump rated at 750 gpm or more at 150 psi.

The review of the number of needed pumpers considers the response distance to built-upon areas; the Basic Fire Flow; and the method of operation. Multiple alarms, simultaneous incidents, and life safety are not considered.

The greatest value of A, B, or C below is needed in the fire district to suppress fires in structures with a Needed Fire Flow of 3,500 gpm or less: **3 engine companies**

a) **2 engine companies** to provide fire suppression services to areas to meet NFPA 1710 criteria or within 1½ miles.

b) **3 engine companies** to support a Basic Fire Flow of 3000 gpm.

c) **3 engine companies** based upon the fire department's method of operation to provide a minimum two engine response to all first alarm structure fires.

The FSRS recognizes that there are **3 engine companies** in service.

The FSRS also reviews Automatic Aid. Automatic Aid is considered in the review as assistance dispatched automatically by contractual agreement between two communities or fire districts. That differs from mutual aid or assistance arranged case by case. ISO will recognize an Automatic Aid plan under the following conditions:

- It must be prearranged for first alarm response according to a definite plan. It is preferable to have a written agreement, but ISO may recognize demonstrated performance.
- The aid must be dispatched to all reported structure fires on the initial alarm.
- The aid must be provided 24 hours a day, 365 days a year.

FSRS Item 512.D "Automatic Aid Engine Companies" responding on first alarm and meeting the needs of the city for basic fire flow and/or distribution of companies are factored based upon the value of the Automatic Aid plan (up to 1.00 can be used as the factor). The Automatic Aid factor is determined by a review of the Automatic Aid provider's communication facilities, how they receive alarms from the graded area, inter-department training between fire departments, and the fire ground communications capability between departments.

For each engine company, the credited Pump Capacity (PC), the Hose Carried (HC), the Equipment Carried (EC) all contribute to the calculation for the percent of credit the FSRS provides to that engine company.

Item 513 "Credit for Engine Companies (CEC)" = 6.00 points

Item 523 - Credit for Reserve Pumpers (0.50 points)

The item is Item 523 "Credit for Reserve Pumpers (CRP)". This item reviews the number and adequacy of the pumpers and their equipment. The number of needed reserve pumpers is 1 for each 8 needed engine companies determined in Item 513, or any fraction thereof.

Item 523 "Credit for Reserve Pumpers (CRP)" = 0.30 points

Item 532 – Credit for Pumper Capacity (3 points)

The next item reviewed is Item 532 "Credit for Pumper Capacity (CPC)". The total pump capacity available should be sufficient for the Basic Fire Flow of 3000 gpm. The maximum needed pump capacity credited is the Basic Fire Flow of the community.

Item 532 "Credit for Pumper Capacity (CPC)" = 3.00 points

Item 549 – Credit for Ladder Service (4 points)

The next item reviewed is Item 549 "Credit for Ladder Service (CLS)". This item reviews the number of response areas within the city with 5 buildings that are 3 or more stories or 35 feet or more in height, or with 5 buildings that have a Needed Fire Flow greater than 3,500 gpm, or any combination of these criteria. The height of all buildings in the city, including those protected by automatic sprinklers, is considered when determining the number of needed ladder companies. Response areas not needing a ladder company should have a service company. Ladders, tools and equipment normally carried on ladder trucks are needed not only for ladder operations but also for forcible entry, ventilation, salvage, overhaul, lighting and utility control.

The number of ladder or service companies, the height of the aerial ladder, aerial ladder testing and the equipment carried on the in-service ladder trucks and service trucks is compared with the number of needed ladder trucks and service trucks and an FSRS equipment list. Ladder trucks must meet the general criteria of NFPA 1901, *Standard for Automotive Fire Apparatus* to be recognized.

The number of needed ladder-service trucks is dependent upon the number of buildings 3 stories or 35 feet or more in height, buildings with a Needed Fire Flow greater than 3,500 gpm, and the method of operation.

The FSRS recognizes that there are **2 ladder companies** in service. These companies are needed to provide fire suppression services to areas to meet NFPA 1710 criteria or within 2½ miles and the number of buildings with a Needed Fire Flow over 3,500 gpm or 3 stories or more in height, or the method of operation.

The FSRS recognizes that there are **0 service companies** in service.

Item 549 "Credit for Ladder Service (CLS)" = 0.84 points

Item 553 – Credit for Reserve Ladder and Service Trucks (0.50 points)

The next item reviewed is Item 553 "Credit for Reserve Ladder and Service Trucks (CRLS)". This item considers the adequacy of ladder and service apparatus when one (or more in larger communities) of these apparatus are out of service. The number of needed reserve ladder and service trucks is 1 for each 8 needed ladder and service companies that were determined to be needed in Item 540, or any fraction thereof.

Item 553 "Credit for Reserve Ladder and Service Trucks (CRLS)" = 0.00 points

Item 561 – Deployment Analysis (10 points)

Next, Item 561 "Deployment Analysis (DA)" is reviewed. This Item examines the number and adequacy of existing engine and ladder-service companies to cover built-upon areas of the city.

To determine the Credit for Distribution, first the Existing Engine Company (EC) points and the Existing Engine Companies (EE) determined in Item 513 are considered along with Ladder Company Equipment (LCE) points, Service Company Equipment (SCE) points, Engine-Ladder Company Equipment (ELCE) points, and Engine-Service Company Equipment (ESCE) points determined in Item 549.

Secondly, as an alternative to determining the number of needed engine and ladder/service companies through the road-mile analysis, a fire protection area may use the results of a systematic performance evaluation. This type of evaluation analyzes computer-aided dispatch (CAD) history to demonstrate that, with its current deployment of companies, the fire department meets the time constraints for initial arriving engine and initial full alarm assignment in accordance with the general criteria of in 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.*

A determination is made of the percentage of built upon area within 1½ miles of a first-due engine company and within 2½ miles of a first-due ladder-service company.

Item 561 "Credit Deployment Analysis (DA)" = 6.22 points

Item 571 – Credit for Company Personnel (15 points)

Item 571 "Credit for Company Personnel (CCP)" reviews the average number of existing firefighters and company officers available to respond to reported first alarm structure fires in the city.

The on-duty strength is determined by the yearly average of total firefighters and company officers on-duty considering vacations, sick leave, holidays, "Kelley" days and other absences. When a fire department operates under a minimum staffing policy, this may be used in lieu of determining the yearly average of on-duty company personnel.

Firefighters on apparatus not credited under Items 513 and 549 that regularly respond to reported first alarms to aid engine, ladder, and service companies are included in this item as increasing the total company strength.

Firefighters staffing ambulances or other units serving the general public are credited if they participate in fire-fighting operations, the number depending upon the extent to which they are available and are used for response to first alarms of fire.

On-Call members are credited on the basis of the average number staffing apparatus on first alarms. Off-shift career firefighters and company officers responding on first alarms are considered on the same basis as on-call personnel. For personnel not normally at the fire station, the number of responding firefighters and company officers is divided by 3 to reflect the time needed to assemble at the fire scene and the reduced ability to act as a team due to the various arrival times at the fire location when compared to the personnel on-duty at the fire station during the receipt of an alarm.

The number of Public Safety Officers who are positioned in emergency vehicles within the jurisdiction boundaries may be credited based on availability to respond to first alarm structure fires. In recognition of this increased response capability the number of responding Public Safety Officers is divided by 2.

The average number of firefighters and company officers responding with those companies credited as Automatic Aid under Items 513 and 549 are considered for either on-duty or on-call company personnel as is appropriate. The actual number is calculated as the average number of company personnel responding multiplied by the value of AA Plan determined in Item 512.D.

The maximum creditable response of on-duty and on-call firefighters is 12, including company officers, for each existing engine and ladder company and 6 for each existing service company.

Chief Officers are not creditable except when more than one chief officer responds to alarms; then extra chief officers may be credited as firefighters if they perform company duties.

The FSRS recognizes **8.00 on-duty personnel** and an average of **0.00 on-call personnel** responding on first alarm structure fires.

Item 571 "Credit for Company Personnel (CCP)" = 7.50 points

Item 581 – Credit for Training (9 points)

Training	Earned Credit	Credit Available
A. Facilities, and Use For maximum credit, each firefighter should receive 18 hours per month in structure fire related subjects as outlined in NFPA 1001.	35.0(	35
B. Company Training For maximum credit, each firefighter should receive 16 hours per month in structure fire related subjects as outlined in NFPA 1001.	25.00	25
C. Classes for Officers For maximum credit, each officer should be certified in accordance with the general criteria of NFPA 1021. Additionally, each officer should receive 12 hours of continuing education on or off site.	12.00	12
D. New Driver and Operator Training For maximum credit, each new driver and operator should receive 60 hours of driver/operator training per year in accordance with NFPA 1002 and NFPA 1451.	2.83	5
E. Existing Driver and Operator Training For maximum credit, each existing driver and operator should receive 12 hours of driver/operator training per year in accordance with NFPA 1002 and NFPA 1451.	5.00	5
F. Training on Hazardous Materials For maximum credit, each firefighter should receive 6 hours of training for incidents involving hazardous materials in accordance with NFPA 472.	1.00	1
G. Recruit Training For maximum credit, each firefighter should receive 240 hours of structure fire related training in accordance with NFPA 1001 within the first year of employment or tenure.	3.00	5
H. Pre-Fire Planning Inspections For maximum credit, pre-fire planning inspections of each commercial, industrial, institutional, and other similar type building (all buildings except 1-4 family dwellings) should be made annually by company members. Records of inspections should include up-to date notes and sketches.	0.60	12

Item 580 "Credit for Training (CT)" = 7.60 points

Item 730 – Operational Considerations (2 points)

Item 730 "Credit for Operational Considerations (COC)" evaluates fire department standard operating procedures and incident management systems for emergency operations involving structure fires.

Operational Considerations	Earned Credit	Credit Available
Standard Operating Procedures The department should have established SOPs for fire department general emergency operations	**50**	**50**
Incident Management Systems The department should use an established incident management system (IMS)	**50**	**50**
Operational Considerations total:	**100**	**100**

Item 730 "Credit for Operational Considerations (COC)" = 2.00 points

Water Supply

Forty percent of a community's overall score is based on the adequacy of the water supply system. The ISO field representative evaluated:

- the capability of the water distribution system to meet the Needed Fire Flows at selected locations up to 3,500 gpm.
- size, type and installation of fire hydrants.
- inspection and flow testing of fire hydrants.

	Earned Credit	Credit Available
616. Credit for Supply System	**25.83**	30
621. Credit for Hydrants	**2.55**	3
631. Credit for Inspection and Flow Testing	**7.00**	7
Item 640. Credit for Water Supply:	**35.38**	**40**

Item 616 – Credit for Supply System (30 points)

The first item reviewed is Item 616 "Credit for Supply System (CSS)". This item reviews the rate of flow that can be credited at each of the Needed Fire Flow test locations considering the supply works capacity, the main capacity and the hydrant distribution. The lowest flow rate of these items is credited for each representative location. A water system capable of delivering 250 gpm or more for a period of two hours plus consumption at the maximum daily rate at the fire location is considered minimum in the ISO review.

Where there are 2 or more systems or services distributing water at the same location, credit is given on the basis of the joint protection provided by all systems and services available.

The supply works capacity is calculated for each representative Needed Fire Flow test location, considering a variety of water supply sources. These include public water supplies, emergency supplies (usually accessed from neighboring water systems), suction supplies (usually evidenced by dry hydrant installations near a river, lake or other body of water), and supplies developed by a fire department using large diameter hose or vehicles to shuttle water from a source of supply to a fire site. The result is expressed in gallons per minute (gpm).

The normal ability of the distribution system to deliver Needed Fire Flows at the selected building locations is reviewed. The results of a flow test at a representative test location will indicate the ability of the water mains (or fire department in the case of fire department supplies) to carry water to that location.

The hydrant distribution is reviewed within 1,000 feet of representative test locations measured as hose can be laid by apparatus.

For maximum credit, the Needed Fire Flows should be available at each location in the district. Needed Fire Flows of 2,500 gpm or less should be available for 2 hours; and Needed Fire Flows of 3,000 and 3,500 gpm should be obtainable for 3 hours.

Item 616 "Credit for Supply System (CSS)" = 25.83 points

Item 621 – Credit for Hydrants (3 points)

The second item reviewed is Item 621 "Credit for Hydrants (CH)". This item reviews the number of fire hydrants of each type compared with the total number of hydrants.

There are a total of 1266 hydrants in the graded area.

620. Hydrants, - Size, Type and Installation	Number of Hydrants
A. With a 6 -inch or larger branch and a pumper outlet with or without 2½ -inch outlets	986
B. With a 6 -inch or larger branch and no pumper outlet but two or more 2½ -inch outlets, or with a small foot valve, or with a small barrel	37
C./D. With only a 2½ -inch outlet or with less than a 6 -inch branch	242
E./F. Flush Type, Cistern, or Suction Point	1

Item 621 "Credit for Hydrants (CH)" = 2.55 points

Item 630 – Credit for Inspection and Flow Testing (7 points)

The third item reviewed is Item 630 "Credit for Inspection and Flow Testing (CIT)". This item reviews the fire hydrant inspection frequency, and the completeness of the inspections. Inspection of hydrants should be in accordance with AWWA M-17, *Installation, Field Testing and Maintenance of Fire Hydrants.*

Frequency of Inspection (FI): Average interval between the 3 most recent inspections.

Frequency	Points
1 year	30
2 years	20
3 years	10
4 years	5
5 years or more	No Credit

Note: The points for inspection frequency are reduced by 10 points if the inspections are incomplete or do not include a flushing program. An additional reduction of 10 points are made if hydrants are not subjected to full system pressure during inspections. If the inspection of cisterns or suction points does not include actual drafting with a pumper, or back-flushing for dry hydrants, 20 points are deducted.

Total points for Inspections = 4.00 points

Frequency of Fire Flow Testing (FF): Average interval between the 3 most recent inspections.

Frequency	Points
5 years	40
6 years	30
7 years	20
8 years	10
9 years	5
10 years or more	No Credit

Total points for Fire Flow Testing = 3.00 points

Item 631 "Credit for Inspection and Fire Flow Testing (CIT)" = 7.00 points

Divergence = -4.31

The Divergence factor mathematically reduces the score based upon the relative difference between the fire department and water supply scores. The factor is introduced in the final equation.

Community Risk Reduction

	Earned Credit	Credit Available
1025. Credit for Fire Prevention and Code Enforcement (CPCE)	**2.02**	2.2
1033. Credit for Public Fire Safety Education (CFSE)	**2.04**	2.2
1044. Credit for Fire Investigation Programs (CIP)	**1.00**	1.1
Item 1050. Credit for Community Risk Reduction	**5.06**	**5.50**

Item 1025 – Credit for Fire Prevention Code Adoption and Enforcement (2.2 points)	Earned Credit	Credit Available
Fire Prevention Code Regulations (PCR) Evaluation of fire prevention code regulations in effect.	10.00	10
Fire Prevention Staffing (PS) Evaluation of staffing for fire prevention activities.	8.00	8
Fire Prevention Certification and Training (PCT) Evaluation of the certification and training of fire prevention code enforcement personnel.	3.38	6
Fire Prevention Programs (PCP) Evaluation of fire prevention programs.	15.41	16
Review of Fire Prevention Code and Enforcement (CPCE) subtotal:	36.79	40

Item 1033 – Credit for Public Fire Safety Education (2.2 points)	Earned Credit	Credit Available
Public Fire Safety Educators Qualifications and Training (FSQT) Evaluation of public fire safety education personnel training and qualification as specified by the authority having jurisdiction.	7.00	10
Public Fire Safety Education Programs (FSP) Evaluation of programs for public fire safety education.	30.00	30
Review of Public Safety Education Programs (CFSE) subtotal:	37.00	40

Item 1044 – Credit for Fire Investigation Programs (1.1 points)	Earned Credit	Credit Available
Fire Investigation Organization and Staffing (IOS) Evaluation of organization and staffing for fire investigations.	8.00	8
Fire Investigator Certification and Training (IQT) Evaluation of fire investigator certification and training.	4.14	6
Use of National Fire Incident Reporting System (IRS) Evaluation of the use of the National Fire Incident Reporting System (NFIRS) for the 3 years before the evaluation.	6.00	6
Review of Fire Prevention Code and Enforcement (CPCE) subtotal:	18.14	20

Summary of PPC Review
for
Ashland

FSRS Item	Earned Credit	Credit Available
Emergency Reporting		
414. Credit for Emergency Reporting	3.00	3
422. Credit for Telecommunicators	3.79	4
432. Credit for Dispatch Circuits	1.80	3
440. Credit for Receiving and Handling Fire Alarms	**8.59**	**10**
Fire Department		
513. Credit for Engine Companies	6.00	6
523. Credit for Reserve Pumpers	0.30	0.5
532. Credit for Pumper Capacity	3.00	3
549. Credit for Ladder Service	0.84	4
553. Credit for Reserve Ladder and Service Trucks	0.00	0.5
561. Credit for Deployment Analysis	6.22	10
571. Credit for Company Personnel	7.50	15
581. Credit for Training	7.60	9
730. Credit for Operational Considerations	2.00	2
590. Credit for Fire Department	**33.46**	**50**
Water Supply		
616. Credit for Supply System	25.83	30
621. Credit for Hydrants	2.55	3
631. Credit for Inspection and Flow Testing	7.00	7
640. Credit for Water Supply	**35.38**	**40**
Divergence	**-4.31**	**--**
1050. Community Risk Reduction	**5.06**	**5.50**
Total Credit	**78.18**	**105.5**

Final Community Classification = 03

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Ashland

County Oregon(Jackson), State OREGON (36) Witnessed by: Insurance Services Office Date: Dec 10, 2014

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM $Q=(29.83(C(d^2)p^{0.5}))$ INDIVIDUAL HYDRANTS			TOTAL	PRESSURE PSI STATIC	RESID.	FLOW -AT 20 PSI NEEDED **	AVAIL.	REMARKS***	MODEL TYPE
1		100 Walker - front	Ashland Public Works, Granite Low 1	1030	1030	0	2060	116	50	7000	2500		
10		Beach and Henry	Ashland Public Works, Crowson High 1	1480	0	0	1480	110	90	3000	3300		
11		1177 Iowa	Ashland Public Works, Granite Low 1	1210	0	0	1210	88	66	3000	2200		
12R		1133 Green Meadows	Ashland Public Works, Alsing	1450	0	0	1450	135	110	1000	3300		
13R		420 Strawberry	Ashland Public Works, Fallon	1420	0	0	1420	120	105	500	4000		
14R		2910 Wedgewood	Ashland Public Works, Crowson Zone 2	1520	0	0	1520	125	110	1000	4300		
15R		1031 Ivy Ln	Ashland Public Works, Crowson Zone 3	650	0	0	650	95	25	750	700		
16R		769 Lisa Street	Ashland Public Works, Crowson Zone 4	1130	0	0	1130	60	40	750	1600		
17		1290 Siskiyou Boulevard	Ashland Public Works, Crowson Zone 5	1400	0	0	1400	90	78	2500	3600		
18R		Prim St - south of WTP	Ashland Public Works, WTP	1560	0	0	1560	90	75	1000	3600		
2		1070 Tolman Creek - front hyd	Ashland Public Works, Crowson High 1	1540	0	0	1540	112	95	4500	3800		
2A		1070 Tolman Creek - front hyd	Ashland Public Works, Crowson High 1	1540	0	0	1540	112	95	3000	3800		
3		525 A Street	Ashland Public Works, Crowson Zone 2	1280	0	0	1280	120	108	3500	4000		
4		789 Jefferson	Ashland Public Works, Crowson Zone 2	1160	0	0	1160	98	56	3000	1600		
5		1521 E Main	Ashland Public Works, Granite Low 1	1420	0	0	1420	120	110	3000	4900		
6		2235 Ashland	Ashland Public Works, Crowson Zone 6	1460	0	0	1460	128	98	3000	2900		

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

THE AVAILABLE FLOWS ONLY INDICATE THE CONDITIONS THAT EXISTED AT THE TIME AND AT THE LOCATION WHERE TESTS WERE WITNESSED.

*Comm = Commercial; Res = Residential.

**Needed is the rate of flow for a specific duration for a full credit condition. Needed Fire Flows greater than 3,500 gpm are not considered in determining the classification of the city when using the Fire Suppression Rating Schedule.

*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

INSURANCE SERVICES OFFICE, INC.

HYDRANT FLOW DATA SUMMARY

City Ashland

County Oregon(Jackson), State OREGON (36) Witnessed by: Insurance Services Office Date: Dec 10, 2014

TEST NO.	TYPE DIST.*	TEST LOCATION	SERVICE	FLOW - GPM INDIVIDUAL HYDRANTS			FLOW - GPM TOTAL	PRESSURE PSI STATIC	PRESSURE PSI RESID.	FLOW - AT 20 PSI NEEDED **	FLOW - AT 20 PSI AVAIL.	REMARKS***	MODEL TYPE
7		555 West Nevada Street	Ashland Public Works, Crowson Zone 2	1060	0	0	1060	86	42	3000	1300		
8		555 Clover Lane	Ashland Public Works, Crowson Zone 2	1230	0	0	1230	90	74	3500	2700		
9		100 Walker	Ashland Public Works, Crowson High 1	1030	1030	0	2060	116	50	3000	2500		

THE ABOVE LISTED NEEDED FIRE FLOWS ARE FOR PROPERTY INSURANCE PREMIUM CALCULATIONS ONLY AND ARE *NOT* INTENDED TO PREDICT THE MAXIMUM AMOUNT OF WATER REQUIRED FOR A LARGE SCALE FIRE CONDITION.

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*** (A)-Limited by available hydrants to gpm shown. Available facilities limit flow to gpm shown plus consumption for the needed duration of (B)-2 hours, (C)-3 hours or (D)-4 hours.

City of Ashland
Cost Review Ad Hoc Committee
Additional Ambulance Service Questions
October 22nd, 2019

1. **Mercy mentions a demand model for deployment. Is there any way to get a "today" snapshot of the resources they have available and where they are located? It is great to see Technology being used in the ambulance field. I know we wouldn't be able to require ambulance placement, but it would be great to see a snapshot (maybe a weekend night) of where their ambulances are located. How many units would they have if they had the Ashland ASA? How does that compare for units/population?**

   Response

   High and low demand deployment: Mercy Flights has a total of 25 ambulances in our fleet with sufficient numbers to handle any equipment malfunctions; backup ambulances are ready for deployment immediately. There is a total of 8 ambulances on-duty during the peak 9-1-1 demand (2:00 p.m. to 5:30 p.m.) seven days a week, and 5 ambulances during the lowest 9-1-1 demand (2:00 a.m. to 5:30 a.m.).

   If Mercy Flights served the Ashland ASA, we would post an additional 2 ambulances within the Ashland City limits and post an additional ambulance in South Medford allowing for a fast move up to Talent, Ashland and other areas of ASA-3. With this posting plan, the ambulances per capita ratio within the Ashland City limits would be approximately one ambulance per 11,000 people, matching and/or exceeding the coverage provided by AFR today.

   Please see the attached posting locations document and map that depicts where our ambulances are posted in ASA-2 and our proposal for ASA-3.

2. **Also, the demand on an ambulance for Mercy is .39 which according to studies is close to the max before more resources are needed. How would Mercy increase their staffing and ambulance model to cover the new ASA if they took over for Ashland Fire and Rescue. On the same note what is the turnover rate at Mercy. Might not be an issue but might have times of hiring/training that reduces the staffing model, especially if more are hired.**

Response

With regard to how Mercy Flights would increase staff and ambulances: Mercy Flights would add 3 additional ambulances to our fleet, and we would hire an additional 8 paramedics and 8 Emergency Medical Technicians.

Regarding our staff turnover rates, please see the response to question #4 on the follow pages.

Regarding the unit hour utilization (UHU) figure: It is important to note that most EMS systems calculate this number differently (for different reasons). It is important to understand what the number means, and that it is a small puzzle piece in a much larger picture. If you need more clarification after reading the response below we would be happy to explain further.

During Mercy Flights' presentation to the City of Ashland Cost Review AD Hoc Committee, we were asked about our average ambulance UHU of 0.39 for 2018. The 0.39 figure provided in our original response is a basic calculation showing maximum possible UHU using a standard calculation which counts each 9-1-1 call as one full hour, and also counts cancellations as one hour. We use this calculation as a quick snapshot to know that we are operating well below saturation. Actual "time on task" is rarely one hour for ambulance call(s)/cancellation(s).

In real life, ambulance calls do not all take one full hour; actual "time on task" is generally less. Cancellations, for example, run about 10 minutes.

<u>Comparison example of "time on task" basic calculation:</u>
If an ambulance is in service for 12 hours and it receives 6 assignments, the basic calculation would show a UHU of 0.5 which does not accurately reflect the actual numbers as the basic calculation counts assignments as 6 full hours.

However, when using real life "time on task" inputs based on actual responses, those 6 assignments would look like this:

2 cancellations (typically taking 10 mins) = 20 minutes total
1 on scene response with no transport = 40 minutes total
3 on scene response with transport to hospital = 3 hours total

In this example, the real time spent on 6 assignments = 4 hours (not 6 hours), generating a UHU of 0.33.

Summary: After receiving your follow up questions and noting your specific interest in UHU, we performed a detailed calculation showing actual "time on task" for 2018 including all tasks, such as 9-1-1 transports, cancelled calls and inter-facility transports. Mercy Flights UHU for 2018 using the "Time on Task" method was **0.33**. As mentioned above, EMS operators use different methods of calculating UHU. For example, some include cancellations, some do not, therefore skewing the final result. UHU is simply a data point that can help one do a quick assessment on operational activities, but it does not show a complete picture of employee satisfaction, quality of care, equipment usage, etc. In fact, on the surface it appears that the lower the UHU the better, but there is a tipping point that if an EMS operation is underutilizing staff, proficiency and alertness suffers, and long-term financial sustainability may be jeopardized.

3. **What does Fee-per-use basis system mean for billing. Based on my google searches it means that they have a structure in place for non transport calls or additional charges for different types of calls. Is that accurate? Does it generate a sustainable amount of funds? If they are charging a fee for services provided is that something Ashland should explore, although philosophically I would hate someone to avoid calling for help because they don't have money to pay for it.**

<u>Response</u>

A fee-per-use basis system for billing means a bill is sent for services provided. The fees are determined from a base rate and mileage, which are approved by the Jackson County Commissioners for each Ambulance Service Area provider.

<u>Our Process</u>

Initially, we bill any and all insurances including commercial insurers, Medicare, Medicaid, Veteran's Administration, auto insurances and others for any transports we provide.

Next, if we cannot collect from the insurance company after multiple attempts and strategies, we work with the patient to get the most out of the insurance coverage to ensure the patient pays the least amount possible. The patient can make payments, if needed. We do not engage in "hard" collection practices like seizing property; we always follow the Fair Debt Collections Act, and we have a financial hardship policy for anyone who truly cannot afford to pay. If the patient is a Mercy Flights' Member, and their insurance pays any amount of the bill, the remaining balance of their bill is considered paid in full. If insurance does not pay any part of the bill, the patient is only responsible to pay 50% of their bill.

There are different types of non-transports; the fee is determined by the services provided. If a 9-1-1 call is cancelled, there is no charge. If we arrive and assist the patient with medical services, we bill for time and service provided, but the charge is minor compared to an actual transport. In these non-transport cases, the charges range between $350 and $422. With a Mercy Flights' Membership, the member receives one free non-transport and 50% off any other non-transport charges.

We are financially sustainable from all of our payment sources with the majority of funds paid by commercial and governmental insurers. A resident or visitor should always receive emergency care when needed.

4. Please provide detailed statistics on your turnover for the last five years.

Response

Per the American Ambulance Association, the average turnover rate in the U.S. EMS industry is 26%. To date, in 2019 the Mercy Flights turnover is 12%. Our average turnover rate over the past 5 years is 17%, and the last 3 years is 13%, both significantly lower than the national average.

In addition, over the past 5 years, leadership made a concerted effort to develop a culture of value and respect for all employees throughout all departments. We have refined our onboarding processes, enhanced performance management techniques, with an overarching goal to put our people first. We have invested significantly in leadership development, training and education. Please see our "Culture Statement" attached.

All of these efforts can be represented by our improved turnover rate as well as our employee engagement surveys. Our employee engagement surveys are conducted by a third party company.

Report on Residential Fireground Field Experiments

NIST Technical Note 1661

Jason D. Averill
Lori Moore-Merrell
Adam Barowy
Robert Santos
Richard Peacock
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U.S. Department of Commerce
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**National Institute of Standards and Technology Technical Note 1661,
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NIST
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U.S. Department of Commerce

Table of Contents

Abstract

Service expectations placed on the fire service, including Emergency Medical Services (EMS), response to natural disasters, hazardous materials incidents, and acts of terrorism, have steadily increased. However, local decision-makers are challenged to balance these community service expectations with finite resources without a solid technical foundation for evaluating the impact of staffing and deployment decisions on the safety of the public and firefighters.

For the first time, this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion, and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical experts involved. Additionally, the structure used in the field experiments included customized instrumentation; all related industry standards were followed; and robust research methods were used. The results and conclusions will directly inform the NPFA 1710 Technical Committee, who is responsible for developing consensus industry deployment standards.

This report presents the results of more than 60 laboratory and residential fireground experiments designed to quantify the effects of various fire department deployment configurations on the most common type of fire — a low hazard residential structure fire. For the fireground experiments, a 2,000 sq ft (186 m^2), two-story residential structure was designed and built at the Montgomery County Public Safety Training Academy in Rockville, MD. Fire crews from Montgomery County, MD and Fairfax County, VA were deployed in response to live fires within this facility. In addition to systematically controlling for the arrival times of the first and subsequent fire apparatus, crew size was varied to consider two-, three-, four-, and five-person staffing. Each deployment performed a series of 22 tasks that were timed, while the thermal and toxic environment inside the structure was measured. Additional experiments with larger fuel loads as well as fire modeling produced additional insight. Report results quantify the effectiveness of crew size, first-due engine arrival time, and apparatus arrival stagger on the duration and time to completion of the key 22 fireground tasks and the effect on occupant and firefighter safety.

Executive Summary

Both the increasing demands on the fire service - such as the growing number of Emergency Medical Services (EMS) responses, challenges from natural disasters, hazardous materials incidents, and acts of terrorism — and previous research point to the need for scientifically based studies of the effect of different crew sizes and firefighter arrival times on the effectiveness of the fire service to protect lives and property. To meet this need, a research partnership of the Commission on Fire Accreditation International (CFAI), International Association of Fire Chiefs (IAFC), International Association of Firefighters (IAFF), National Institute of Standards and Technology (NIST), and Worcester Polytechnic Institute (WPI) was formed to conduct a multiphase study of the deployment of resources as it affects firefighter and occupant safety. Starting in FY 2005, funding was provided through the Department of Homeland Security (DHS) / Federal Emergency Management Agency (FEMA) Grant Program Directorate for Assistance to Firefighters Grant Program — Fire Prevention and Safety Grants. In addition to the low-hazard residential fireground experiments described in this report, the multiple phases of the overall research effort include development of a conceptual model for community risk assessment and deployment of resources, implementation of a generalizable department incident survey, and delivery of a software tool to quantify the effects of deployment decisions on resultant firefighter and civilian injuries and on property losses.

The first phase of the project was an extensive survey of more than 400 career and combination (both career and volunteer) fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project. The survey results will constitute significant input into the development of a future software tool to quantify the effects of community risks and associated deployment decisions on resultant firefighter and civilian injuries and property losses.

The following research questions guided the experimental design of the low-hazard residential fireground experiments documented in this report:

1. How do crew size and stagger affect overall start-to-completion response timing?

2. How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the 22 critical fireground tasks?

3. How does crew size affect elapsed times to achieve three critical events that are known to change fire behavior or tenability within the structure:
   a. Entry into structure?
   b. Water on fire?
   c. Ventilation through windows (three upstairs and one back downstairs window and the burn room window).

4. How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene vary between crew sizes of four and five?

In order to address the primary research questions, the research was divided into four distinct, yet interconnected parts:

- Part 1 — Laboratory experiments to design appropriate fuel load
- Part 2 — Experiments to measure the time for various crew sizes and apparatus stagger (interval between arrival of various apparatus) to accomplish key tasks in rescuing occupants, extinguishing a fire, and protecting property
- Part 3 — Additional experiments with enhanced fuel load that prohibited firefighter entry into the burn prop – a building constructed for the fire experiments
- Part 4 — Fire modeling to correlate time-to-task completion by crew size and stagger to the increase in toxicity of the atmosphere in the burn prop for a range of fire growth rates.

The experiments were conducted in a burn prop designed to simulate a low-hazard[1] fire in a residential structure described as typical in NFPA 1710® *Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments*. NFPA 1710 is the consensus standard for career firefighter deployment, including requirements for fire department arrival time, staffing levels, and fireground responsibilities.

Limitations of the study include firefighters' advance knowledge of the burn prop, invariable number of apparatus, and lack of experiments in elevated outdoor temperatures or at night. Further, the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

Primary Findings

Of the 22 fireground tasks measured during the experiments, results indicated that the following factors had the most significant impact on the success of fire fighting operations. All differential outcomes described below are statistically significant at the 95 % confidence level or better.

Overall Scene Time:

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crews. On the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the

1 A low-hazard occupancy is defined in the NFPA Handbook as a one-, two-, or three-family dwelling and some small businesses. Medium hazards occupancies include apartments, offices, mercantile and industrial occupancies not normally requiring extensive rescue or firefighting forces. High-hazard occupancies include schools, hospitals, nursing homes, explosive plants, refineries, high-rise buildings, and other highlife hazard or large fire potential occupancies.

benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and is recognized in industry standards.[2]

Time to Water on Fire:

There was a 10% difference in the "water on fire" time between the two- and three-person crews. There was an additional 6% difference in the "water on fire" time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two person crews). There was an additional 6% difference in the "water on fire" time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).

Ground Ladders and Ventilation:

The four-person crews operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 % faster than the two-person crews and 25 % faster than the three-person crews.

Primary Search:

The three-person crews started and completed a primary search and rescue 25 % faster than the two-person crews. The four- and five-person crews started and completed a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. A 10 % difference was equivalent to just over one minute.

Hose Stretch Time:

In comparing four-and five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to the two-person crews the differences are more distinct. Two-person crews took 57 seconds longer than three-person crews to stretch a line. Two-person crews took 87 seconds longer than four-person crews to complete the same tasks. Finally, the most notable comparison was between two-person crews and five-person crews — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:

As defined by NFPA 1710, the "industry standard achieved" time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.[3] An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. Based on the study protocols, modeled after a typical fire department apparatus deployment strategy, the total number of firefighters on scene in the two- and three-person crew scenarios never equaled 15 and therefore the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:

Three different "standard" fires were simulated using the Fire Dynamics Simulator (FDS) model. Characterized in the *Handbook of the Society of Fire Protection Engineers* as slow-, medium-, and fast-growth rate[4], the fires grew exponentially with time. The rescue scenario was based on a non-ambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by early-arriving crews had less exposure to combustion products than occupants rescued by late-arriving crews. The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting them to an increasingly toxic atmosphere. For a slow-growth rate fire with two-person crews, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the general population. For a fast-growth rate fire with two-person crews, the FED was well above the median level at which 50 % of the general population would be incapacitated. Larger crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

Conclusion:

More than 60 full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many other factors including geography, local risks and hazards, available resources, as well as community expectations. This report does not specifically address these other factors.

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results provide a quantitative basis for the effectiveness of four-person crews for low-hazard response in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance time-to-critical-task measures for low-hazard structure fires. Additionally, the results provide tenability measures associated with a range of modeled fires.

Future research should extend the findings of this report in order to quantify the effects of crew size and apparatus arrival times for moderate- and high-hazard events, such as fires in high-rise buildings, commercial properties, certain factories, or warehouse facilities, responses to large-scale non-fire incidents, or technical rescue operations.

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2 NFPA Standard 1710 - A.5.2.4.2.1 …Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.

3 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. Section 5.2.1 – Fire Suppression Capability and Section 5.2.2 Staffing.

4 As defined in the handbook, a fast fire grows exponentially to 1.0 MW in 150 seconds. A medium fire grows exponentially to 1 MW in 300 seconds. A slow fire grows exponentially to 1 MW in 600 seconds. A 1 MW fire can be thought-of as a typical upholstered chair burning at its peak. A large sofa might be 2 to 3 MWs.

Background

The fire service in the United States has a deservedly proud tradition of service to community and country dating back hundreds of years. As technology advances and the scope of service grows (e.g., more EMS obligations and growing response to natural disasters, hazardous materials incidents, and acts of terrorism), the fire service remains committed to a core mission of protecting lives and property from the effects of fire.

Firefighting is a dangerous business with substantial financial implications. In 2007, U.S. municipal fire departments responded to an estimated 1,557,500 fires. These fires killed 3,430 civilians (non-firefighters) and contributed to 17,675 reported civilian fire injuries. Direct property damage was estimated at $14.6 billion dollars (Karter, 2008). In spite of the vigorous nationwide efforts to promote firefighter safety, the number of firefighter deaths has consistently remained tragically high. In both 2007 and 2008, the U.S. Fire Administration reported 118 firefighter fatalities (USFA 2008).

Although not all firefighter deaths occur on the fireground — accidents in vehicles and training fatalities add to the numbers — every statistical analysis of the fire problem in the United States identifies residential structure fires as a key component in firefighter and civilian deaths, as well as direct property loss. Consequently, community planners and decision-makers need tools for optimally aligning resources with the service commitments needed for adequate protection of citizens.

Problem

Despite the magnitude of the fire problem in the United States, there are no scientifically based tools available to community and fire service leaders to assess the effects of prevention, fixed sprinkler systems, fire fighting equipment, or deployment and staffing decisions. Presently, community and fire service leaders have a qualitative understanding of the effect of certain resource allocation decisions. For example, a decision to double the number of firehouses, apparatus, and firefighters would likely result in a decrease in community fire losses, while cutting the number of firehouses, apparatus, and firefighters would likely yield an increase in the community fire losses, both human and property. However, decision-makers lack a sound basis for quantifying the total impact of enhanced fire resources on the number of firefighter and civilian lives saved and injuries prevented.

Studies on adequate deployment of resources are needed to enable fire departments, cities, counties, and fire districts to design an acceptable level of resource deployment based upon community risks and service provision commitment. These studies will assist with strategic planning and municipal and state budget processes. Additionally, as resource studies refine data collection methods and measures, both subsequent research and improvements to resource deployment models will have a sound scientific basis.

Review of Literature

Research to date has documented a consistent relationship between resources deployed and firefighter and civilian safety. Studies documenting engine and ladder crew performance in diverse simulated environments as well as actual responses show a basic relationship between apparatus staffing levels and a range of important performance variables and outcome measurements such as mean on-scene time, time-to-task completion, incidence of injury among fire service personnel, and costs incurred as a result of on-scene injuries (Cushman 1981, McManis 1984, Morrison 1990, Ontario 1991, Phoenix 1991, Roberts 1993).

Reports by fire service officials and consulting associates reviewing fire suppression and emergency response by fire crews in U.S. cities were the first publications to describe the relationship between adequate staffing levels and response time, time to completion of various fireground tasks, overall effectiveness of fire suppression, and estimated value of property loss for a wide range of real and simulated environments. In 1980, the Columbus Fire Division's report on firefighter effectiveness showed that for a predetermined number of personnel initially deployed to the scene of a fire, the proportion of incidents in which property loss exceeded $5,000 and horizontal fire spread of more than 25 sq ft (2.3 $m^{2)}$ was significantly greater for crews whose numbers fell below the set thresholds of 15 total fireground personnel at residential fires and 23 at large-risk fires (Backoff 1980). The following year, repeated live experiments at a one-family residential site using modern apparatus and equipment demonstrated that larger units performed tasks and accomplished knockdown more quickly, ultimately resulting in a lower percentage of loss attributable to factors controlled by the fire department. The authors of this article highlighted that the fire company is the fire department's basic working unit and further emphasized the importance of establishing accurate and up-to-date performance measurements to help collect data and develop conclusive strategies to improve staffing and equipment utilization (Gerard 1981).

Subsequent reports from the United States Fire Administration (USFA) and several consulting firms continued to provide evidence for the effects of staffing on fire crews' ability to complete tasks involved in fire suppression efficiently and effectively. Citing a series of tests conducted in 1977 by the Dallas Fire Department that measured the time it took three-, four-, and five-person teams to advance a line and put water on a simulated fire at the rear of the third floor of an old school, officials from the USFA underscored that time-to-task completion and final level of physical exhaustion for crews markedly improved not after any one threshold, but with the addition of each new team member. This report went on to outline the manner in which simulated tests exemplify a clear-cut means to record and analyze the resources initially deployed and finally utilized at fire scenes (NFA 1981). A later publication detailing more Dallas Fire Department simulations — ninety-one runs each for a private residential fire, high-rise office fire, and apartment house fire — showed again that increased staffing levels greatly enhanced the coordination and effectiveness of crews' fire suppression efforts during a finite time span (McManis Associates 1984). Numerous studies of local departments have supported this conclusion using a diverse collection of data, including a report by the National Fire Academy (NFA) on fire department staffing in smaller communities, which showed that a company crew staffed with four firefighters could perform rescue of potential victims approximately 80 % faster than a crew staffed with three firefighters (Morrison 1990).

During the same time period that the impact of staffing levels on fire operations was gaining attention, investigators began to question whether staffing levels could also be associated with the risk of firefighter injuries and the cost incurred as a result of such injuries at the fire scene. Initial results from the Columbus Fire Division showed that "firefighter injuries occurred more often when the total number of personnel on the fireground was less than 15 at residential fires and 23 at large-risk fires" (Backoff 1980), and mounting evidence has indicated that staffing levels are a fundamental health and safety issue for firefighters in addition to being a key determinant of immediate response capacity. One early analysis by the Seattle Fire Department for that city's Executive Board reviewed the average severity of injuries suffered by three-, four-, and five-person engine companies, with the finding that "the rate of firefighter injuries expressed as total hours of disability per hours of fireground exposure were 54 % greater for engine companies staffed with 3 personnel when compared to those staffed with 4 firefighters, while companies staffed with 5 personnel had an injury rate that was only one-third that associated with four-person companies" (Cushman 1981). A joint report from the International Association of Fire Fighters (IAFF) and Johns Hopkins University concluded, after a comprehensive analysis of the minimum staffing levels and firefighter injury rates in U.S. cities with populations of 150,000 or more, that jurisdictions operating with crews of less than four firefighters had injury rates nearly twice the percentage of jurisdictions operating with crews of four-person crews or more (IAFF, JHU 1991).

More recent studies have continued to support the finding that staffing per piece of apparatus integrally affects the efficacy and safety of fire department personnel during emergency response and fire suppression. Two studies in particular demonstrate the consistency of these conclusions and the increasing level of detail and accuracy present in the most recent literature, by looking closely at the discrete tasks that could be safely and effectively performed by three- and four-person fire companies. After testing drills comprised of a series of common fireground tasks at several fire simulation sites, investigators from the Austin Fire Department assessed the physiological impact and injury rates among the variably staffed fire crews. In these simulations, an increase from a three- to four-person crew resulted in marked improvements in time-to-task completion or efficiency for the two-story residential fire drill, aerial ladder evolution, and high-rise fire drill, leading the researchers to conclude that loss of life and property increases when a sufficient number of personnel are not available to conduct the required tasks efficiently, independent of firefighter experience, preparation, or training. Reviews of injury reports by the Austin Fire Department furthermore revealed that the injury rate for three-person companies in the four years preceding the study was nearly one-and-a-half that of crews staffed with four or more personnel (Roberts 1993). In a sequence of similar tests, the Office of the Fire Marshal of Ontario, Canada likewise found that three-person fire companies were unable to safely perform deployment of backup protection lines, interior suppression or rescue operations, ventilation operations that required access to the roof of the involved structure, use of large hand-held hose lines, or establish a water supply from a static source without additional assistance and within the time limits of the study. Following these data, Fire Marshal officials noted that three-person crews were also at increased risk for exhaustion due to insufficient relief at fire scenes and made recommendations for the minimum staffing levels per apparatus necessary for suppression and rescue related tasks (Office of the Fire Marshal of Ontario 1993).

The most comprehensive contemporary studies on the implications of fire crew staffing now include much more accurate performance measures for tasks at the fireground, in addition to the basic metric of response time. They include environmental measures of performance, such as total water supply, which expand the potential for assessing the cost-effectiveness of staffing not only in terms of fireground personnel injury rates but also comparative resource expenditure required for fire suppression. Several examples from the early 1990s show investigators and independent fire departments beginning to gather the kind of specific, comprehensive data on staffing and fireground tasks such as those suggested and outlined in concurrent local government publications that dealt with management of fire services (Coleman 1988). A report by the Phoenix Fire Department laid out clear protocols for responding to structure fires and response evaluation in terms of staffing, objectives, task breakdowns, and times in addition to outlining the responsibilities of responding fire department members and the order in which they should be accomplished for a full-scale simulation activity (Phoenix 1991). One attempt to devise a prediction model for the effectiveness of manual fire suppression similarly reached beyond response time benchmarks to describe fire operations and the step-by-step actions of firefighters at incident scenes by delineating the time-to-task breakdowns for size-up, water supply, equipment selection, entry, locating the fire, and advancing hose lines, while also comparing the predicted time-to-task values with the actual times and total resources (Menker 1994). Two separate studies of local fire department performance, one from Taoyuan County in Taiwan and another from the London Fire Brigade, have drawn ties between fire crews' staffing levels and total water demand as the consequence of both response time and fire severity. Field data from Taoyuan County for cases of fire in commercial, business, hospital, and educational properties showed that the type of land use as well as response time had a significant impact on the water volume necessary for fire suppression, with the notable quantitative finding that the water supply required on-scene doubled when the fire department response increased by ten minutes (Chang 2005).

Response time as a predictor of residential fire outcomes has received less study than the effect of crew size. A Rand Institute study demonstrated a relationship between the distance the responding companies traveled and the physical property damage. This study showed that the fire severity increased with response distance, and therefore the magnitude of loss increased proportionally (Rand 1978). Using records from 307 fires in nonresidential buildings over a three-year period, investigators in the United Kingdom correspondingly found response time to have a significant impact on final fire area, which in turn was proportional to total water demand (Sardqvist 2000).

Recent government and professional literature continues to demonstrate the need for more data that would quantify in depth and illustrate the required tasks, event sequences, and necessary response times for effective fire suppression in order to determine with accuracy the full effects of either a reduction or increase in fire company staffing (Karter 2008). A report prepared for National Institute of Standards and Technology (NIST) stressed the ongoing need to elucidate the relationship between staffing and personnel injury rates, stating that "a scientific study on the relationship between the number of firefighters per engine and the incidence of injuries would resolve a long-standing question concerning staffing and safety" (TriData 2005). While not addressing staffing levels as a central focus, an annual review of fire department calls and false alarms by the National Fire Protection Association (NFPA) exemplified the need to capture not only the number of personnel per apparatus for effective fire suppression but also to clarify the demands on individual fire departments with resolution at the station level (NFPA 2008).

In light of the existing literature, there remain unanswered questions about the relationships between fire service resource deployment levels and associated risks. For the first time this study investigates the effect of varying crew size, first apparatus arrival time, and response time on firefighter safety, overall task completion and interior residential tenability using realistic residential fires. This study is also unique because of the array of stakeholders and the caliber of technical advisors involved. Additionally, the structure used in the field experiments included customized instrumentation for the experiments; all related industry standards were followed; robust research methods were used; and the results and conclusions will directly inform the *NFPA 1710* Technical Committee, as well as public officials and fire chiefs. [5]

5 NFPA is a registered trademark of the National Fire Protection Association, Quincy, Massachusetts. NFPA 1710 defines minimum requirements relating to the organization and deployment of fire suppression operations, emergency medical operations, and special operations to the public by substantially all career fire departments. The requirements address functions and objectives of fire department emergency service delivery, response capabilities, and resources. The purpose of this standard is to specify the minimum criteria addressing the effectiveness and efficiency of the career public fire suppression operations, emergency medical service, and special operations delivery in protecting the citizens of the jurisdiction and the occupational safety and health of fire department employees. At the time of the experiments, the 2004 edition of NFPA 1710 was the current edition.

Purpose and Scope of the Study

This project systematically studies deployment of fire fighting resources and the subsequent effect on both firefighter safety and the ability to protect civilians and their property. It is intended to enable fire departments and city/county managers to make sound decisions regarding optimal resource allocation to meet service commitments using the results of scientifically based research. Specifically, the residential fireground experiments provide quantitative data on the effect of crew size, first-due engine arrival time, and subsequent apparatus stagger on time-to-task for critical steps in response and fire fighting.

The first phase of the multiphase project was an extensive survey of more than 400 career and combination fire departments in the United States with the objective of optimizing a fire service leader's capability to deploy resources to prevent or mitigate adverse events that occur in risk- and hazard-filled environments. The results of this survey are not documented in this report, which is limited to the experimental phase of the project, but they will constitute significant input into future applications of the data presented in this document.

This report describes the second phase of the project, divided into four parts:

- Part 1 — Laboratory experiments to design the appropriate fuel packages to be used in the burn facility specially constructed for the research project
- Part 2 — Field tests for critical time-to-task completion of key tasks in fire suppression
- Part 3 — Field tests with real furniture (room and contents experiments)
- Part 4 — Fire modeling to apply data gathered to slow-, medium-, and fast-growth rate fires

The scope of this study is limited to understanding the relative influence of deployment variables on low-hazard, residential structure fires, similar in magnitude to the hazards described in 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*. The standard uses as a typical residential structure a 2,000 sq ft (186 m^2) two-story, single-family dwelling with no basement and no exposures (nearby buildings or hazards such as stacked flammable material).

The limitations of the study, such as firefighters' advance knowledge of the facility constructed for this experiment, invariable number of apparatus, and lack of experiments in extreme temperatures or at night, will be discussed in the Limitations section of this report. It should be noted that the applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, and response to hazardous material incidents, acts of terrorism, and natural disasters or other technical responses has not been assessed and should not be extrapolated from this report.

A Brief Overview of the Fireground Operations

Regardless of the size of a structure on fire, firefighting crews identify four priorities: life safety of occupants and firefighters, confinement of the fire, property conservation, and reduction of adverse environmental impact. Interdependent and coordinated activities of all fire fighting personnel are required to meet the priority objectives.

NFPA 1710 specifies that the number of on-duty fire suppression personnel must be sufficient to carry out the necessary fire fighting operations given the expected fire fighting conditions. During each fireground experiment, the following were dispatched to the test fire building:

- three engine companies
- one truck company
- a command vehicle with a battalion chief and a command aide

Staffing numbers for the engine and truck crews and response times were varied for the purposes of the tests. Additional personnel available to ensure safety will be described later in this report.

The following narrative account describes the general sequence of activities in part 2 of the experiments (time-to-task), when the fuel load permitted firefighter entry:

> The first arriving engine company conducts a size-up or initial life safety assessment of the building to include signs of occupants in the home, construction features, and location of the original fire and any extension to other parts of the structure. This crew lays a supply line from a hydrant close to the building for a continuous water supply.
>
> The truck company usually arrives in close proximity to the first engine company. The truck company is responsible for gaining access or forcing entry into the building so that the engine company can advance the first hose line into the building to locate and extinguish the fire. Usually, they assist the engine company in finding the fire. The NFPA and OSHA 2 In/2 Out[6] crew is also assembled prior to anyone entering an atmosphere that is immediately dangerous to life or health (IDLH). This important safety requirement will have a large impact on availability of firefighters to enter the building when small crews are deployed.
>
> Once a door is opened, the engine crew advances a hose line (attack line) toward the location of the fire. At the same time, members from the truck crew accompany the engine crew and assist in ventilating the building to provide a more tenable atmosphere for occupants and firefighters. Ventilation also helps by improving visibility in an otherwise "pitch black" environment, but it must be coordinated with the attack line crew to ensure it helps control the fire and does not contribute to fire growth. The truck crew performs a systematic rapid search of the entire structure starting in the area where occupants would be in the most danger. The most dangerous area is proximate to the fire and the areas directly above the fire.
>
> Depending upon the travel distance, the battalion chief and command aide will have arrived on the scene and have taken command of the incident and established a command post. The role of the incident commander is to develop the action plan to mitigate the incident and see that those actions are carried out in a safe, efficient, and effective manner. The command aide is responsible for situational assessment and communications, including communications with crew officers to ensure personnel accountability.
>
> Depending on response time or station location, the second (engine 2) and possibly the third engine company (engine 3) arrive. The second arriving engine (engine 2) connects to the fire hydrant where the first engine (engine 1) laid their supply line. Engine 2 pumps water from the hydrant through the supply line to the first engine for fire fighting operations. According to *NFPA 1710*, water should be flowing from the supply line to the attack engine prior to the attack crew's entry into the structure.
>
> The crew from the second engine advances a second hand line as a backup line to protect firefighters operating on the inside and to prevent fire from spreading to other parts of the structure.
>
> The third engine crew is responsible for establishing a Rapid Intervention Team (RIT), a rescue team staged at or near the command post or as designated by the Incident Commander (in the front of the building) with all necessary equipment needed to locate and/or rescue firefighters that become trapped or incapacitated. The RIT plans entry/exit portals and removes hazards, if found, to assist interior crews.
>
> As the fire fighting, search and rescue, and ventilation operations are continuing, two members of the truck company are tasked with placing ground ladders to windows and the roof to provide a means of egress for occupants or firefighters. The truck crew is responsible for controlling interior utilities such as gas and electric after their ventilation, search, and rescue duties are completed.
>
> Once the fire is located and extinguished and occupants are

6 The "2 In/2 Out" policy is part of paragraph (g)(4) of OSHAs revised respiratory protection standard, 29 CFR 1910.134. This paragraph applies to private sector workers engaged in interior structural fire fighting and to Federal employees covered under Section 19 of the Occupational Safety and Health Act. States that have chosen to operate OSHA-approved occupational safety and health state plans are required to extend their jurisdiction to include employees of their state and local governments. These states are required to adopt a standard at least as effective as the Federal standard within six months.

OSHAs interpretation on requirements for the number of workers required to be present when conducting operations in atmospheres that are immediately dangerous to life and health (IDLH) covers the number of persons who must be on the scene before fire fighting personnel may initiate an attack on a structural fire. An interior structural fire (an advanced fire that has spread inside of the building where high temperatures, "heat" and dense smoke are normally occurring) would present an IDLH atmosphere and therefore, require the use of respirators. In those cases, at least two standby persons, in addition to the minimum of two persons inside needed to fight the fire, must be present before fire fighters may enter the building.
Letter to Thomas N. Cooper, Purdue University, from Paula O. White, Director of Federal-State Operations, U.S. Department of Labor, Occupational Safety & Health Administration, November 1, 1995.

removed, the incident commander reassesses the situation and provides direction to conduct a very thorough secondary search of the building to verify that the fire has not extended into void spaces and that it is fully extinguished. (In a nonexperimental fire situation, salvageable property would be covered or removed to minimize damage.)

Throughout the entire incident, each crew officer is responsible for the safety and accountability of his or her personnel along with air management. The location and wellness of crews is tracked by the command aide through a system of personal accountability checks conducted at 20-minute intervals.

Following extinguishment of the fire, an onsite review is conducted to identify actions for improvement. Crews are monitored, hydrated and rested before returning to work in the fire building.

The Relation of Time-to-Task Completion and Risk

Delayed response, particularly in conjunction with the deployment of inadequate resources, reduces the likelihood of controlling the fire in time to prevent major damage and possible loss of life and increases the danger to firefighters.

Figure 1 illustrates a hypothetical sequence of events for response to a structure fire. During fire growth, the temperature of a typical compartment fire can rise to over 1,000° F (538° C). When a fire in part of a compartment reaches flashover, the rapid transition between the growth and the fully developed fire stage, flame breaks out almost at once over the surface of all objects in the compartment, with results for occupants, even firefighters in full gear, that are frequently deadly.

Successful containment and control of a fire require the coordination of many separate tasks. Fire suppression must be coordinated with rescue operations, forcible entry, and utilities control. Ventilation typically occurs only after an attack line is in place and crews are ready to move in and attack the fire. The incident commander needs up-to- the-minute knowledge of crew activities and the status of task assignments which could result in a decision to change from an offensive to a defensive strategy.

Standards of Response Cover

Developing a standard of response cover— the policies and procedures that determine the distribution, concentration, and reliability of fixed and mobile resources for response to fire (as well as other kinds of technical response) — related to service commitments to the community is a complex task. Fire and rescue departments must evaluate existing (or proposed) resources against identified risk levels in the community and against the tasks necessary to conduct safe, efficient and effective fire suppression at structures identified in these various risk levels. Leaders must also evaluate geographic distribution and depth or concentration of resources deployed based on time parameters.

Recognition and reporting of a fire sets off a chain of events before firefighters arrive at the scene: call receipt and processing, dispatch of resources, donning protective gear, and travel to the scene. *NFPA 1710* defines the overall time from dispatch to scene arrival as the *total response time*. The standard divides total

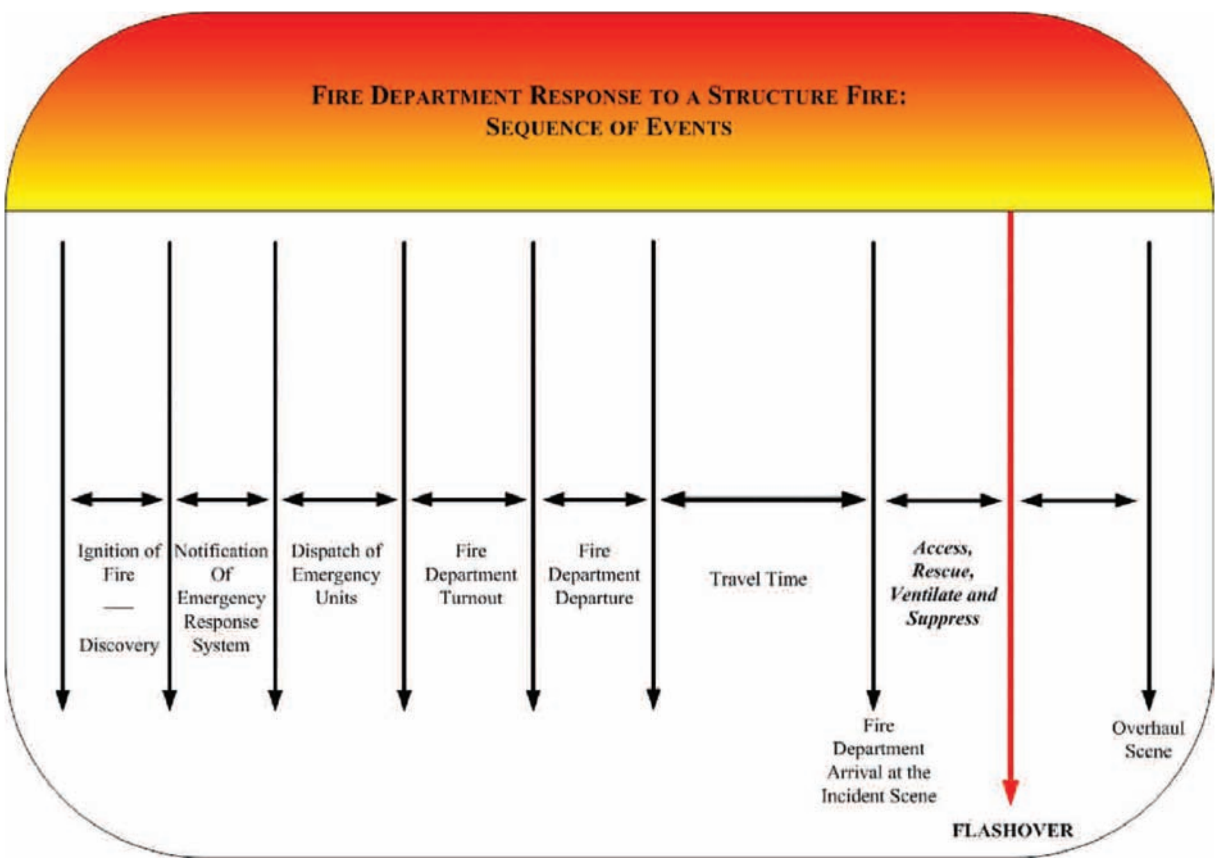


Figure 1: Hypothetical Timeline of Fire Department Response to Structure Fire

response time into a number of discrete segments, of which travel time — the time interval from the beginning of travel to the scene to the arrival at the scene — is particularly important for this study.

Arrival of a firefighting response force must be immediately followed by organization of the resources into a logical, properly phased sequence of tasks, some of which need to be performed simultaneously. Knowing the time it takes to accomplish each task with the allotted number of personnel and equipment is critical. Ideally crews should arrive and intervene in sufficient time to prevent flashover or spread beyond the room of origin.

Decision-making about staffing levels and geographic distribution of resources must consider those times when there will be simultaneous events requiring resource deployment. There should be sufficient redundancy or overlap in the system to allow for simultaneous calls and high volume of near simultaneous responses without compromising the safety of the public or firefighters.

Policy makers have long lacked studies that quantify changes in fireground performance based on apparatus staffing levels and on-scene arrival time intervals. These experiments were designed to observe the impact of apparatus staffing levels and apparatus arrival times on the time it takes to execute essential fireground tasks and on the tenability inside the burn prop for a full initial alarm assignment response. It is expected that the results of this study will be used to evaluate the related performance objectives in *NFPA 1710*.

Part 1: Planning for the Field Experiments

Laboratory Experiments

The purpose of the first segment, the laboratory experiments, was to characterize the burning behavior of the wood pallets as a function of:

- number of pallets and the subsequent peak heat release rate (HRR)
- compartment effects on burning of wood pallets
- effect of window ventilation on the fire
- effect on fire growth rate of the loading configuration of excelsior (slender wood shavings typically used as packing material)

Characterization of the fuel package was critical in order to ensure that the field experiments would not result in a flashover condition, one of the primary safety considerations in complying with the protocols in *NFPA 1403: Standard on Live fire Training Evolutions*.[7] Appendix A of this report contains the methods and full results for the laboratory experiments, which are summarized below. Figure 2 shows a test burn of pallets in the laboratory.

Figure 2: Test Burn of Pallets in Laboratory

Results of Laboratory Experiments

The objective of the laboratory experiments was to quantify the spread of heat and smoke throughout the planned burn prop in order to ensure that the fuel package would result in a fire large enough to generate heat and smoke consistent with a residential structure fire, yet not so large as to transition to flashover. The full results of the laboratory experiments and modeling are shown in Appendix A and Appendix B. To summarize briefly, a four-pallet configuration, which produced a peak of approximately 2 MW, was determined to be the largest fuel load the room could support without the threat of transitioning to flashover. The compartment produced a negligible effect on the heat release rate of the fire compared to open burning conditions. The presence of an open window in the burn room reduced the production of carbon monoxide and carbon dioxide gases, primarily through enhanced oxygen availability and dilution, respectively. The location and quantity of excelsior had a significant impact on the growth rate of fire. More excelsior located nearer the bottom of the pallets resulted in a more rapid achievement of peak burning.

The results of the fuel load experiments to inform the building and experimental design indicated development of untenable conditions in the field experiments between 5 min and 15 min, depending upon several factors: fire growth rate, ventilation conditions, the total leakage of heat into the building and through leakage paths, and manual fire suppression. This time frame allowed for differentiation of the effectiveness of various fire

7 NFPA 1403 contains the minimum requirements for training all fire suppression peronnel engaged in firefighting operations under live fire conditions.

Part 2: Field Experiment Methods

department response characteristics.

In part 2, fire experiments were conducted in a residential-scale burn prop at the Montgomery County Public Safety Training Academy in Rockville, MD.

Field Site

Montgomery County (MD) Fire and Rescue Department provided an open space to construct a temporary burn prop, with ready access to water and electrical utilities, at the Montgomery County Fire and Rescue Training Facility in Rockville, MD.

The burn prop was constructed as a two-story duplex with a common stairwell and movable walls between the sections to allow for multiple experiments daily. Symmetrically dividing the structure about the short axis allowed one side of the test structure to cool and dry out after a fire test with suppression. The burn prop contained two mirror-image, two-story units each totaling 2,000 ft^2 (186 m^2), without basement or nearby exposures — each therefore a typical model of a low-hazard single-family residence identified in *NFPA 1710*. An exterior view of the burn prop is shown in Figure 3. For each experiment there was a confirmed fire in the living room in the first floor rear of one unit of the structure.

Details and dimension are shown in the floor plan in Figure 4.

The black lines in Figure 4 indicate load-bearing reinforced concrete walls and red lines indicate the gypsum over steel stud partition walls. The ceiling height was 94 in (2.4 m) throughout the entire structure except in the burn compartments, where additional hardening was installed to protect against repeated exposure to fire during the experiments. This additional fire proofing slightly reduced the ceiling height. Complete details about the building construction are included in Appendix C.

Noncombustible furniture (angle iron and gypsum board construction) was fashioned to represent obstacles of realistic size and location for firefighters navigating the interior of the structure. The dimensions were typical of residential furnishings. Figure 5 shows an example of the noncombustible furniture used in the time-to-task experiments.

Figure 3: Exterior View of Burn Prop

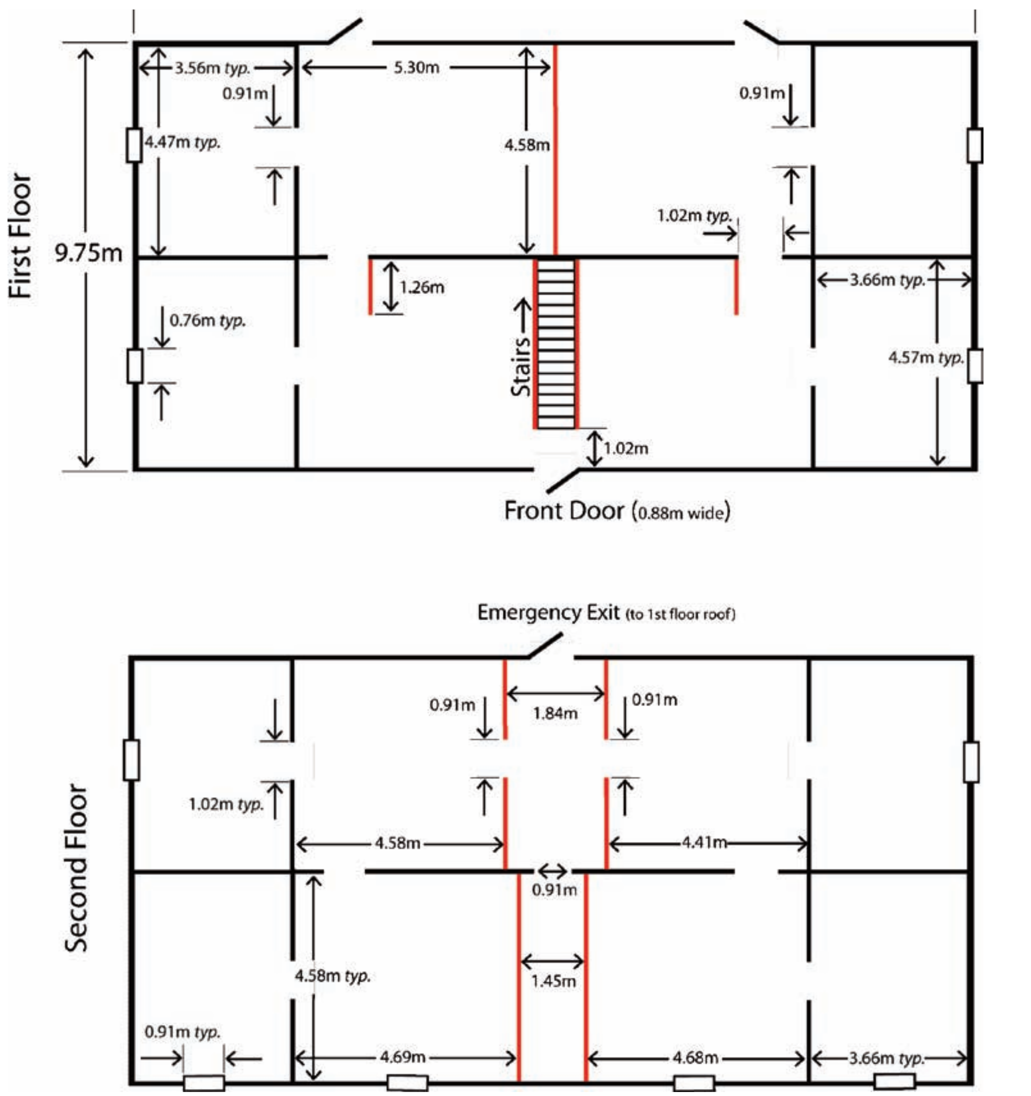


Figure 4: Dimensions of the Burn Prop Floor Plan

Overview of Field Experiments

In order to evaluate the performance representative of a *NFPA 1710*-compliant fire department, the field experiments consisted of two parts (the second and third parts of the four described in this report). In the first of the two parts of the field experiments, firefighter participants from Montgomery County (MD) and Fairfax County (VA) Fire Departments simulated an initial alarm assignment response to a structure described in *NFPA 1710* as a low-hazard residential structure to which firefighters respond on a regular basis. The staffing level of fire apparatus was varied incrementally from two to five personnel per piece. The interval between apparatus on-scene arrival times was varied at either 60 s or 120 s. Trained timing staff were used to record the start and completion times of 22 tasks deemed essential for mitigation of a residential fire incident by the study's technical experts. The pallet and excelsior configuration chosen from the laboratory experiments repeatably produced a consistent and realistic quantity of heat and smoke, similar to what firefighters encounter at a residential structure fire.

Although the fire source used in part 2 of the field experiments created a realistic amount of heat and smoke, the requirements of *NFPA 1403* prevented use of a fire source which could potentially reach flashover within the structure. Therefore, part 3 of the fire experiments was conducted in order to change the fuel package to be representative of realistic fuel loading that could be found in a living room in a residential structure (sleeper-sofa, upholstered chairs, end tables, etc). The intent of this part of the study was to determine how the times of firefighter interactions, averaged with respect to the staffing and arrival intervals, impacted the interior tenability conditions. Fire fighting tactics were performed in a manner which complied with *NFPA 1403*; ventilation was performed with proper personal protective equipment (PPE) and hand tools from the exterior of the burn prop. Suppression was performed with an interior remote suppression device operated from the exterior of the burn prop.

Instrumentation

Instrumentation to measure gas temperature, gas concentrations, heat flux, visual obscuration, video, and time during the experiments was installed throughout the burn prop. The data were recorded at 1-second intervals on a computer-based data acquisition system. Figure 6 presents a schematic plan view of the instrumentation. All instruments were wired to a centralized data collection room attached as a separate space on the west side of the building, which is described later in this report ensuring physical separation for the data collection personnel from the effects of the fire, while minimizing the wire and tube lengths to the data logging equipment. See Appendix C for additional details about the instrumentation.

Figure 5: Noncombustible Furniture Used in the Time-to-Task Experiments

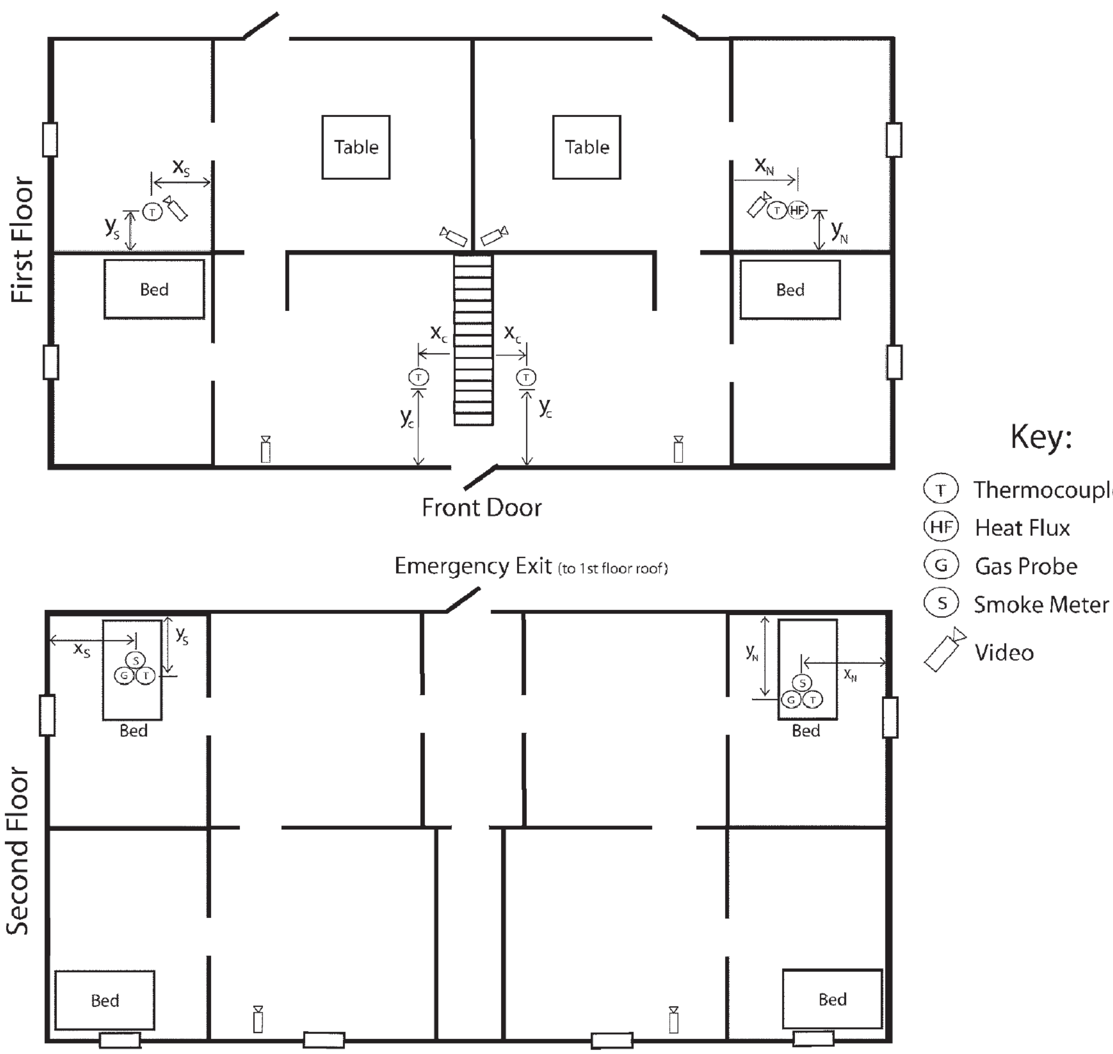


Figure 6: Instrumentation and Furniture Prop Layout

Figure 7: Fireground Safety Officer

Safety Protocols

Firefighter safety was always a primary concern in conducting the research. Participants were drawn from two departments — Fairfax County, VA and Montgomery County, MD — that regularly conduct NFPA 1403 compliant live fire training for their staff and recruits.

A safety officer was assigned to the experiments by the Montgomery County Fire and Rescue Department to assure compliance with *NFPA 1403*. The safety officer (Figure 7) participated in all orientation activities, daily briefings, and firefighter gear checks and was always actively involved in overseeing all experiments. The safety officer had full authority to terminate any operation if any safety violation was observed. In addition to the safety officer, a rapid intervention team (RIT), assigned from dedicated crews not in the actual experiment, was in place for each experiment, and a staffed ambulance was on standby at the site. Radio communication was always available during the experiments should a "mayday" emergency arise.

Experiments were stopped for any action considered to be a protocol breach or safety concern. For example, all ladders — 24 ft (7.3 m) or 28 ft (8.5 m) — were to be raised by two firefighters. As crew sizes were reduced, some firefighters attempted to place ladders single-handedly in an effort to complete the task more quickly. This procedure, while vividly illustrating how firefighters try to do more with less in the field, is unsafe and could potentially result in strain or impact injuries.

Additional safety features were built in to the field structure. A deluge sprinkler system oriented to the known location of the fuel package could be remotely activated for rapid fire suppression. All first floor rooms had direct access to the exterior of the building through either doors or windows. The second story had an emergency exit to the roof of the attached instrumentation room.

A closely related concern to ensure firefighter safety and readiness to repeat experiments with equivalent performance was adequate rehabilitation (see Figure 8). At the beginning and end of each day, crews completed a health and safety check. The importance of staying well-hydrated before and during experiments was especially emphasized.

Figure 8: Crew Rehabilitation

Time-to-Task Experiments

On-Scene Fire Department Tasks

The on-scene fire department task part of the study focused on the tasks firefighters perform after they arrive on the scene of a low-hazard residential structure fire. A number of nationally recognized fire service experts were consulted during the development of the on-scene fire department tasks in order to ensure a broad applicability and appropriateness of the task distribution.[8] The experiments compared crew performance and workload for a typical fire fighting scenario using two-, three-, four-, and five-person crews. 24 total experiments were conducted to assess the time it took various crew sizes to complete the same tasks on technically similar fires in the same structure. In addition to crew sizes, the experiments assessed the effects of stagger between the arriving companies. Close stagger was defined as a 1-minute time difference in the arrival of each responding company. Far stagger was defined as a 2-minute time difference in the arrival of each responding company. One-minute and two-minute arrival stagger times were determined from analysis of deployment data from more than 300 U.S. fire departments responding to a survey of fire department operations conducted by the International Association of Fire Chiefs (IAFC) and the International Association of Fire Fighters (IAFF). Considering both crew size and company stagger there were eight experiments conducted in triplicate totaling twenty-four tests, as shown in the full replicate block in Table 1. A full replicate was completed in a randomized order (determined by randomization software) before a test configuration was repeated.

Crew Size	Apparatus Stagger
2 Person	Close Stagger (One minute)
3 Person	Close Stagger (One minute)
4 Person	Close Stagger (One minute)
5 Person	Close Stagger (One minute)
2 Person	Far Stagger (Two minutes)
3 Person	Far Stagger (Two minutes)
4 Person	Far Stagger (Two minutes)
5 Person	Far Stagger (Two minutes)

Table 1: Primary Variables for Time-to-Task Experiments

Crew Size

For each experiment, three engines, a ladder-truck and a battalion chief and an aide were dispatched to the scene of the residential structure fire. The crew sizes studied included two-, three-, four-, and five-person crews assigned to each engine and truck dispatched. Resultant on-scene staffing totals for each experiment follow: (FF = firefighter)

- Two Person crews = 8 FFs + Chief and Aide = 10 total on-scene
- Three Person crews = 12 FFs + Chief and Aide= 14 total on-scene
- Four Person crews = 16 FFs + Chief and Aide = 18 total on-scene
- Five Person crews = 20 FFs + Chief and Aide = 22 total on-scene[9]

Department Participation

The experiments were conducted in Montgomery County, MD at the Montgomery County Fire Rescue Training Academy during the months of January and February 2009. All experiments took place in daylight between 0800 hours and 1500 hours. Experiments were postponed for heavy rain, ice, or snow and rescheduled for a later date following other scheduled experiments.

Montgomery County (MD) and Fairfax County (VA) firefighters participated in the field experiments. Each day both departments committed three engines, a ladder truck and associated crews, as well as a battalion chief to the experiments. The two battalion chiefs, alternated between the roles of battalion chief and aide. Firefighters and officers were identified by participating departments and oriented to the experiments. Each experiment included engine crews, truck crews and command officers from each participating department. Participants varied with regard to age and experience. Crews that normally operated together as a company were kept intact for the experiments to assure typical operation for the crew during the scenarios. However, in all experiments crews were used from both departments, including engine crews, truck crews, and officers.

This allocation of resources made it possible to conduct back-to-back experiments by rotating firefighters between field work and rehabilitation areas.

Crew Orientation

All study participants were required to attend an orientation prior to the beginning of the experiments (see Figure 9, page 25). The orientations were used to explain experiment procedures, task flows, division of labor between crews, and milestone events in the scenario.

Daily orientations were conducted for all shifts to assure every participant attended. Orientations included a description of the overall study objectives as well as the actual experiments in which they would be involved. Per the requirements of *NFPA 1403*, full disclosure regarding the structure, the fire, and the tasks to be completed were provided. Crews were also oriented to the fireground props, instrumentation used for data collection, and the specific scenarios to be conducted. Every crew member was provided a walkthrough of the structure during the orientation and each day prior to the start of the experiments.

8 Technical experts included Dennis Compton, Russell Sanders, William "Shorty" Bryson, Vincent Dunn, David Rohr, Richard Bowers, Michael Clemens, James Walsh, Larry Jenkins and Doug Hinkle. More information about the experts is presented in the Acknowledgments later in this report.

9 Note that the on-scene totals account for only the personnel assigned to "work" the fire. Additional personnel were provided for an RIT team, a staffed ambulance on site, and a safety officer specific to the experiments. The additional personnel are not included in thee staffing described above.

Tasks

Twenty-two fireground tasks were completed in each experiment. Meticulous procedures gathered data to measure key areas of focus, such as individual task start times, task completion times, and overall scenario performance times. Each task was assigned a standardized start and end marker, such as crossing the threshold to enter the building with a hose line or touching a ladder to raise it to a second story window. The 22 tasks, with the events for measuring start and stop times, are shown in Table 2 (page26). Figures 10 — 19 illustrate firefighter activity in a number of the tasks to complete experiments or prepare for the next experiment.

For reasons of both safety and cost efficiency, two tasks — forcible entry of the front door and ventilation of the windows on the first and second stories — required special procedures. The study could not accommodate replacing the doors and windows daily for the fire suppression experiments. Before the start of experiments with the full sequence of tasks, these two tasks were measured in a realistic manner using training props constructed at the site of the fireground experiments. As with the overall experiments, these two tasks were repeated in triplicate and the times averaged. The average time to complete the tasks was then used in the larger scale experiment. As firefighters came to the point of breaching the door or windows, the timers would hold them for the time designated by the earlier experiments and then give them the approval to open the door or windows. The start and end times were then recorded just as other tasks were.

Figure 9: Crew Orientation and Walkthrough

Figure 10: Ground Ladders

Figure 11: Ventilation

Figure 12: Ground Level Window Breakage Prop

Figure 13: Second Story Window Breakage Prop

Figure 14: Door Forcible Entry Prop

Figure 15: Crew Preparation and Cue Cards

Table 2: Tasks and Measurement Parameters

Tasks	Measurement Parameters
1. Stop at Hydrant, Wrap Hose	START - Engine stopped at hydrant STOP - Firefighter back on engine and wheels rolling
2. Position Engine 1	START - Wheels rolling from hydrant STOP - Wheels stopped at structure
3. Conduct Size-up (360-degree lap), transmit report, establish command	START - Officer off engine STOP - Completes radio transmission of report
4. Engage Pump	START - Driver off engine STOP - Driver throttles up pump
5. Position Attack Line (Forward Lay)	START - Firefighter touches hose to pull it from engine STOP - Flake, charge and bleed complete (hose at front door prepared to advance)
6. Establish 2 In/2 Out	Company officer announces – "2 In/2 Out established" (4 persons assembled on scene OR at the call of the Battalion Chief/Company Officer)
7. Supply Attack Engine	START - Firefighter touches hydrant to attach line STOP - Water supply to attack engine
8. Establish RIT **9. Gain/Force Entry**	Time that Company Officer announces RIT is established START - Action started (HOLD time= 10 seconds)
10. Advance Attack Line	STOP - Door opened for entry START – Firefighter touches hose STOP – Water on fire
11. Advance Backup Line (stop time at front door)	START - Firefighter touches hose to pull from engine bed STOP - Backup line charged to nozzle
12. Advance Backup Line/Protect Stairwell	START - Firefighter crosses threshold STOP - Position line for attack at stairwell
13. Conduct Primary Search	START - Firefighters enter front door STOP - Firefighters transmit "search complete"
14. Ground Ladders in Place	START - Firefighter touches ladder to pull it from truck STOP - 4 Ladders thrown: 3 ladders on the 2^{nd}-story windows and 1 to the roof
15. Horizontal Ventilation (Ground)	START- Firefighter at 1^{st} window to begin ventilation (HOLD for 8 seconds) STOP - Hold time complete - window open
16. Horizontal Ventilation (2^{nd} Story)	START - Firefighter grabs ladder for climb. (Firefighter must leg lock for ventilation. HOLD time at each window is 10 seconds) STOP - All 2^{nd}-story windows open - descend ladder - feet on ground.
17. Control Utilities (Interior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
18. Control Utilities (Exterior)	START - Radio transmission to control utilities STOP - When firefighter completes the task at the prop
19. Conduct Secondary Search	START - Firefighters enter front door STOP - Firefighters transmit "secondary search complete"
20. Check for Fire Extension (walls)	START- Firefighters pick up check-for-extension prop STOP- Completion of 4 sets total (1 set = 4 in and 4 out) This task may be done by more than one person.
21. Check for Fire Extension (ceilings)	START - Firefighters pick up check-for-extension prop STOP - Completion of 4 sets total (1 set = 3 up and 5 down) This task may be done by more than one person.
22. Mechanical Ventilation	START - Firefighters touch fans to remove from truck STOP - Fans in place at front door and started

Data Collection: Standardized Control Measures

Several control measures were used to collect data, including crew cue cards, radio communications, task timers, and video recording. Performance was timed for each task in each scenario including selected milestone tasks such as door breach, water-on-fire, and individual window ventilation. Data were collected for crew performance on each task, and individual firefighter performance was not considered.

Task Flow Charts and Crew Cue Cards

Task procedures were standardized for each experiment/scenario. Technical experts worked with study investigators to break down crew tasks into individual tasks based on crew size. Task flow charts were created and then customized for the various crew sizes. The carefully designed task flow ensured that the same overall workload was maintained in each experiment, but was redistributed based on the number of personnel available for the work. See Appendix D for additional details.

All tasks were included in each scenario and cue cards were developed for each individual participant in each scenario. For example, a four-person crew would have a cue card for each person on the crew including the officer, the driver, and the two firefighters. Cards were color coded by crew size to assure proper use in each scenario.

Figure 16: Connecting to the Hydrant

Figure 17: Crews Responding

Figure 18: Ceiling Breach/Molitor Machine

Figure 19: Incident Command

Figure 20: Task Timers

Figure 21: Video Recording for Quality Control

Radio communications

Interoperability of radio equipment used by both participating departments made it possible to use regular duty radios for communication during the experiments. Company officers were instructed to use radios as they would in an actual incident. Montgomery County Fire and Rescue Communications recorded all radio interaction as a means of data backup. Once all data quality control measure were complete, the records were then overwritten as a routine procedure.

Task Timers

Ten observers/timers, trained in the use of a standard stop watch with split-time feature, recorded time-to-task data for each field experiment. To assure understanding of the observed tasks, firefighters were used as timers, each assigned specific tasks to observe and to record the start and end times.

To enhance accuracy and consistency in recording times, the data recording sheets used several different colors for the tasks (see Appendix D). Each timer was assigned tasks that were coded in the same color as on the recording sheet. All timers wore high-visibility safety gear on the fireground (see Figure 20).

Video records

In addition to the timers, video documentation provided a backup for timed tasks and for quality control (see Figure 21). No less than six cameras were used to record fireground activity from varied vantage points. Observer/timer data were compared to video records as part of the quality control process.

Crew Assignment

Crews from each department that regularly operated together were assigned to work as either engine or truck companies in each scenario. Both Fairfax County and Montgomery County crews participated in each experiment.

Crews assigned to each responding company position in one scenario were assigned to another responding company position in subsequent scenarios, with the objective of minimizing learning from one experiment to another. For example, crews in the role of engine 1 in a morning scenario might be assigned to the engine 3 position in the afternoon, thus eliminating learning from exact repetition of a task as a factor in time to completion. Additionally, participating crews from both Montgomery County and Fairfax County were from three different shifts, further reducing opportunities for participant repetition in any one position.

Response Time Assumptions

Response time assumptions were made based on time objectives set forth in the *NFPA 1710*. Time stagger allocations were set by the project technical advisors in order to assess the impact of arriving unit time separation on task start and completion times, as well as the overall scene time.

Below are the values assigned to the various time segments in the overall response time. The total of the response time segments may also be referred to as the total reflex time.

1. Fire ignition = time zero
2. 60 s for recognition (detection of fire) and call to 9-1-1
3. 60 s for call processing/dispatch
4. 60 s for turnout[10]
5. Close Stagger = 240 s travel time FIRST engine with 60 s ladder-truck lag and 90 s lag for each subsequent engine
   a. Truck arrives at 300 s from notification
   b. Second engine at 330 s from notification
   c. Third engine at 420 seconds from notification
6. Far Stagger = 240 s travel time FIRST engine with 120 s ladder-truck lag and 150 s lag for each subsequent engine
   a. Truck arrives at 360 s from notification
   b. Second engine arrives at 390 s from notification
   c. Third engine arrives at 540 s from notification.

The design of this part of the experiments allowed firefighter entry into the burn building. The next part of the experiments required a modified methodology.

10 After the experiments were complete, the NFPA 1710 technical committee released a new edition of the standard that prescribes 80 seconds for turnout time.

Part 3: Room and Contents Fires

The Tornado Remote Controlled Monitor is Produced by Task Force Tips, Valparaiso, Indiana, USA. Permission to publish courtesy of Task Force Tips

Figure 22: Remotely Controlled Fire Suppression Nozzle for Room and Contents Fires

As previously discussed, *NFPA 1403* prohibits firefighters in a training exercise from entering a structure with sufficient fuel load to result in room flashover. But the value of the data from the time-to-task experiments lies not just in the duration and time-of-completion statistics for tasks, but also in measuring the tenability of the atmosphere for occupants urgently needing firefighter assistance. Therefore Part 3 of the experiments (room and contents fires) used a larger fuel load to focus on the seven of the 22 tasks that cause a change in the fire behavior through ventilation or active suppression:

1. Forced entry of the front door
2. Water on fire
3. Second floor window #1 ventilated (burn room window)
4. Second floor window #2 ventilated (front window, near corner)
5. Second floor window #3 ventilated (front window, near front door)
6. First floor window #1 ventilated (window beside the fire room)
7. First floor window #2 ventilated (self-ventilated at flashover)

Because the fuel load was sufficient for flashover, all firefighter activity was conducted outside the building. Tasks that in Part 3 required entry into the building, such as search or interior utility control, were factored into this part by delaying the next task for the average duration of the task from Part 2. Firefighters in full gear opened the door with a gloved hand or opened windows from the ground with a tool such as a pike pole or angle iron, again at the time specified by the averages from Part 2. Averages were derived from the three iterations of each scenario. The different number of iterations in Part 3 will be explained later in this report.

Because firefighters could not enter the building, a nozzle controlled from the instrumentation room was installed. The nozzle was placed in the room directly outside the burn room and oriented toward the burn room near the doorway in order to best emulate the nozzle location of live firefighter suppression (see Figure 22). The nozzle was encased with mineral wool and heavy-duty aluminum foil (bottom picture in Figure 22) to protect the electronics and wiring from the intense radiation energy emitted by the fire. Blocks were used to anchor the nozzle against the lateral forces exerted by the momentum of the water supply. The activation time for suppression was determined by the data from the time-to-task test results.

A 15° spray pattern was directed toward the seat of the fire and swept horizontally from side to side. While the remotely controlled hose line knocked down the majority of the fire, it was not as effective as a live firefighter with a better view into the room of origin. Therefore, after the fire was diminished, a supplemental stream was applied through the burn room window in order to control the fire (see Figure 23). All personnel on the hose line were in full turnout gear and self-contained breathing apparatus during the exterior application of water.

Fuel Packages for the Room and Contents Fires

In order to maximize the repeatability of the fire development, nominally identical rooms of furniture of identical manufacturer, style, and age were used for each test. A plan-view schematic of the furniture is shown in Figure 24 and pictures of the burn room prior to testing are shown in Figure 25. Key dimensions, mass, and materials for combustible furnishings are detailed in Appendix C.

Figure 23: Supplemental Suppression Applied for Room and Contents Tests

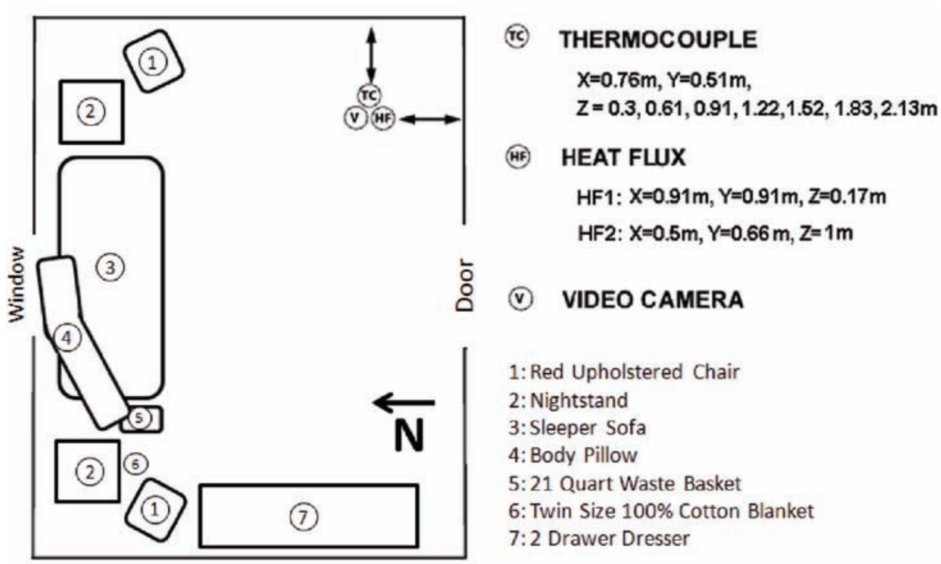


Figure 24: Configuration of Furnishings in Burn Room (Room and Contents Fires)

Figure 25: Pictures of the Room and Contents Furnishings

The ignition source consisted of a cardboard book of 20 matches that was ignited by an electrically heated wire, often referred to as an electric match. The electric match was placed near the bottom of a 21 qt (19.9 L) polypropylene waste container. The height of the waste container was 15.5 in (394 mm) with interior dimensions at the top opening of 14.5 in (368 mm) by 11.3 in (287 mm). Approximately 0.7 lbs (0.3 kg) of dry newspaper was added to the waste container. The majority of the newspaper was folded flat, and placed on edge along the sides of the waste container. Four sheets of newspaper, 22 in (559 mm) by 25 in (635 mm) were crumpled into "balls" approximately 3.9 in (100 mm) diameter and placed on top of the electric match in the center of the waste container.

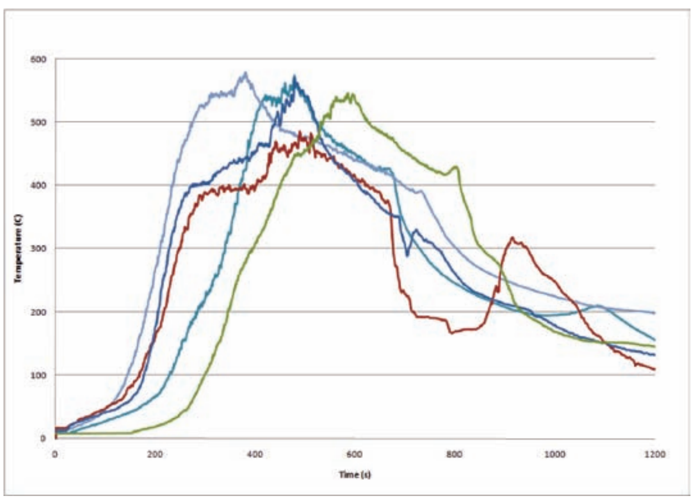
Experimental Matrix for Room and Contents Fires

Sufficient amounts of furniture for 16 rooms were available for the room and contents fires, so eight experiment scenerios were conducted — each with a replicate. Because the time to untenable conditions was a primary variable of interest in the room and contents fires, the arrival time of the first due engine was a paramount consideration. Because the effects of the subsequent apparatus stagger were explored in the time-to-task tests, the stagger was fixed at the "close arrival" time. Additionally, a baseline measurement was required to compare the effectiveness of response to the absence of a fire department response. Therefore, a five-person, later arrival combination was eliminated in favor of a no-response scenario (with replicate). Table 3 summarizes the 16 tests conducted.

The first due engine arrival times were determined using the following assumptions: ignition of the fire occurs at time zero. Smoke detector activation and a call to 9-1-1 occurs at 60 seconds after the fire starts. Call intake and processing requires an additional 90 seconds. The firefighters take 60 seconds to complete their turnout at the station and begin travel to the scene. Thus travel time begins 3.5 minutes into experiment. The two levels of arrival time are then determined by two different travel times: early arrival assumes a three-minute travel time, while later arrival assumes a five-minute travel time. For all scenarios in the room and contents experiments, the close stagger (60 seconds) between subsequent apparatus times was used.

Crew Size	First Due Arrival Time
2-Person	Early Arrival of First Engine (6.5 min) – close stagger
3-Person	Early Arrival of First Engine (6.5 min) – close stagger
4-Person	Early Arrival of First Engine (6.5 min) – close stagger
5-Person	Early Arrival of First Engine (6.5 min) – close stagger
2-Person	Later Arrival of First Engine (8.5 min) – close stagger
3-Person	Later Arrival of First Engine (8.5 min) – close stagger
4-Person	Later Arrival of First Engine (8.5 min) – close stagger
No Response (Baseline)	N/A

Table 3: Experimental Matrix for Room and Contents Tests (Each Conducted in Replicate)



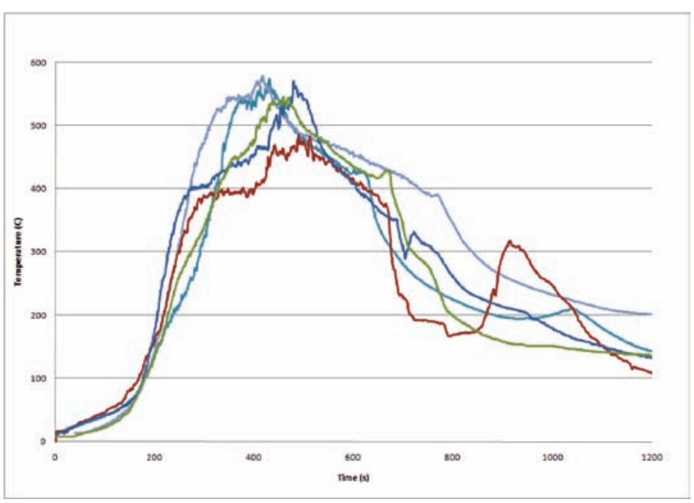


Figure 26: Direct Comparison of Temperatures, Before (Top) and After Adjustment (Bottom)

Procedure for Minimizing the Effect of Variance in Fire Growth Rate

Fires involving furnishings have inherent variance in burning behaviors. Factors such as humidity and minor variations in materials (particularly worn furnishings that may have different foam compression or fabric wear patterns), can result in uncertainty of 20 % or more, despite significant efforts to enhance repeatability. The early growth period of fire development is often associated with the greatest variance, since minor factors (as discussed above) can influence the thermal environment more easily when the fire is small. Therefore, the room and contents fires were normalized to the 212 °F (100 °C) temperature near the ceiling in the burn room in order to minimize the variance of the room and contents fires. The time at which the burn room reached this temperature (usually in approximately 180 seconds) rather than the actual ignition time, was designated as the "zero time."

Figure 26 shows the time-temperature curves before and after normalizing at 100°C. This approach was implemented during the experiments by watching the time temperature data in real-time from the instrumentation room and announcing the "zero-time" over the fireground radio system. The normalization procedure did not negatively affect tenability measurements in the target room because when the fire is small, products of combustion do not reach the room because of lack of momentum. Therefore, adjusting all room and contents tests to the same upper layer temperature was an appropriate way to minimize variance.

Milestone Times for Critical Tasks

As stated earlier, firefighters could not enter the burn building during the room and contents experiments because of the danger for potential flashover in an experimental scenario. Therefore, prescribed tasks were performed at specified times based on data from part 2. In this section we report on significant data gathered from instrumentation and describe an additional part of the experiments designed to extend our understanding of the effect of crew size and stagger on the tenability of the atmosphere in a burning structure.

Table 4 (page 32) identifies significant tasks selected as key milestones because of the way they affect fire behavior and atmospheric tenability inside the structure.

Milestone Tasks	2-Person Close Stagger
	Time from ignition (min : s)
Breached Door	8:44
Water On Fire	9:56
Upper Fire Window	13:01
Ground Non-fire Window	14:51
Upper Corner Window	17:55
Upper Front Door Window	19:55
Ground Fire Window	4:30
Milestone Tasks	**3-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:48
Water On Fire	8:54
Upper Fire Window	11:26
Ground Non-fire Window	13:31
Upper Corner Window	15:54
Upper Front Door Window	17:58
Ground Fire Window	4:30
Milestone Tasks	**4-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:46
Water On Fire	8:41
Upper Fire Window	9:23
Ground Non-fire Window	10:32
Upper Corner Window	11:46
Upper Front Door Window	13:45
Ground Fire Window	4:30
Milestone Tasks	**5-Person Close Stagger**
	Time from ignition (min : s)
Breached Door	7:35
Water On Fire	8:03
Upper Fire Window	10:11
Ground Non-fire Window	10:54
Upper Corner Window	12:31
Upper Front Door Window	12:47
Ground Fire Window	04:30

Table 4: Tasks That Affect Fire Behavior and Atmospheric Tenability

Analysis of Experimental Results

This section describes the analytic approaches used to address the research objectives of the study. First the statistical methods used to analyze the fireground time-to-task observations are presented. Then the time-to-task data and the room and contents data were combined to assess crew performance in relation to tenability within the structure.

Time-to-Task Analysis

Time-to-task data were compiled into a database and assessed for outliers and missing entries. Because all time-to-task experiments were conducted in triplicate, missing data were apparent and were reviewed via video and radio tapes. Missing data attributable to timer error were replaced by a time observed in the video. Where video and/or radio documentation was not adequate, missing data were recoded to the mean of the task times from the other two experiments.

Data Queries

The statistical methods used to analyze the time-to-task data were driven by a principal goal of this research project — to assess the effect of crew size, first-due engine arrival time, and subsequent apparatus stagger on time-to-task for critical steps in response and fire fighting. This research goal motivated the development of four specific research questions (see Figure 27) that in turn pointed to specific statistical analyses for generating inference and insight.

Statistical Methods – Time-to-Task

The analysis of the time-to-task data involved a sequence of multiple linear regressions using Ordinary Least Squares to generate and test the effects of staffing and stagger on timings. The regressions were of the form:

$$y_i = \beta_0 + \beta_1 x_{i1} + \beta_2 x_{i2} + \ldots + \beta_k x_{ik} + \varepsilon_i$$

where the x_{ik} reflect factors such as stagger and crew size, and the y represents our dependent/outcome variable.

Time-related outcomes (i.e., the dependent variables in the regression equations) could include task duration, elapsed time to start the task, and elapsed time until task completion, all measured in seconds. Table 5 (page 34) lists the time-related outcomes used to test the effect of crew size and stagger for the tasks in the field experiments.

The effects of crew size and stagger were explored using indicator variables in the regression analyses. The coefficient for a given indicator (for example, crew size of four relative to a crew size of two) indicated the number of seconds the larger crew size added or reduce the timing outcome of a task. Crew sizes were collapsed in some regressions to test whether the timings of "larger" crew sizes of four and five were significantly different than "smaller" crew sizes of two and three. Interaction terms were not assessed in these regression analyses because of the small number of experiments available for analysis.

Standard t-tests examined statistical significance (i.e., to see if the hypothesis of "no impact" could be rejected) to estimate the impact of several specific configurations:

- crew sizes of three versus two
- crew sizes of four versus three
- crew sizes of five versus four
- (occasionally) five versus two, and four versus two
- larger (four & five combined) versus smaller (two & three combined) and
- stagger

The specific tests for each task (regression analysis) are shown in the Appendix E. The actual coefficients of each regression and their corresponding standard errors are presented in Appendix F. To infer impact, significant tests were conducted at the 0.05 significance level. Only statistically significant contrasts of crew size and/or stagger are included in this section of the report. Graphic expositions of relevant time/task related findings are then presented as well. Where stagger was statistically significant, the effects are graphed separately. Where stagger was not statistically significant, the data for crew size were combined.

Time-to-Task Research Questions

1) How do crew size and stagger (i.e., timing of between first engine and subsequent apparatuses) affect overall (i.e., start to completion) response timing?

   a. To what extent do variations in crew size affect overall response timing?

   b. To what extent do variations in both crew size and stagger affect overall response timing?

2) How do crew size and stagger affect the timings of task initiation, task duration, and task completion for each of the tasks comprising the suite of 22 tasks?

   a. To what extent do variations in crew size affect timings across the suite of tasks?

   b. To what extent do variations in both crew size and stagger affect response timings across the suite of tasks?

3) How does crew size affect elapsed times to achieve three critical events known to change fire behavior or atmospheric tenability for occupants?

   a. Entry into structure

   b. Water on fire

   c. Ventilation of each window (three upstairs and one downstairs window and the burn room window)

4) How does the elapsed time to achieve the national standard of assembling 15 firefighters at the scene (measured using "at hydrant" as the start time) vary by crew sizes of 4 and 5?

Figure 27: Research Questions for Time-to-Task Experiments

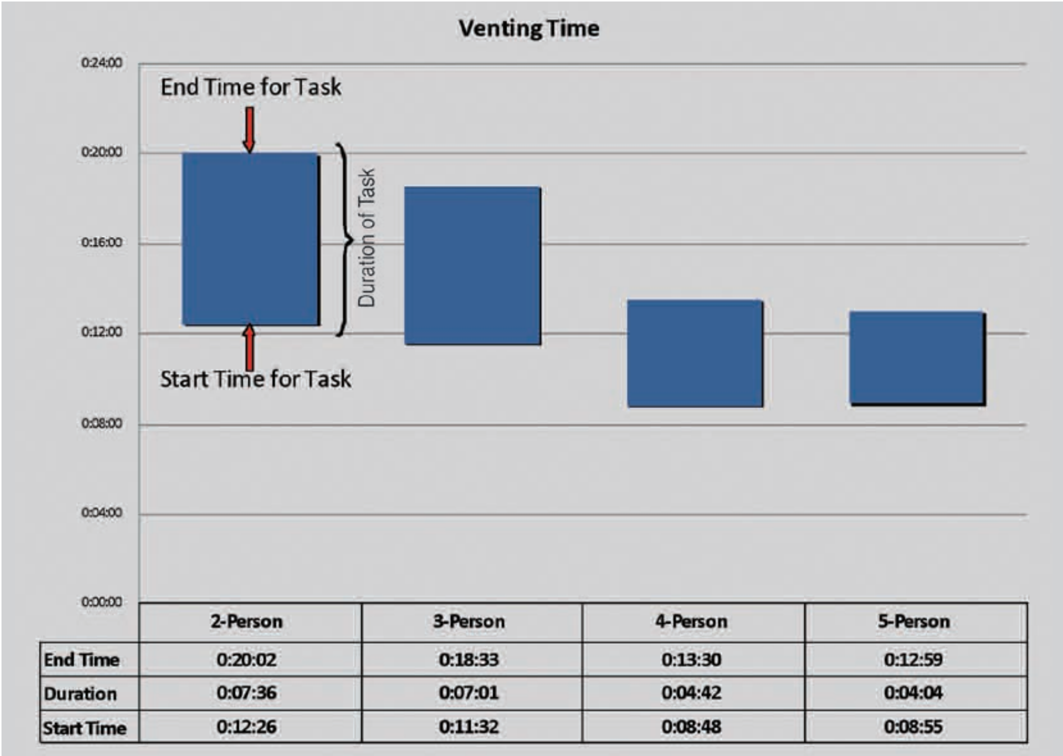


Figure 28: Example Time-to-Task Graph

Task:	Time-to-Task Outcome Measures: *Elapsed Time Until Start**	*Elapsed Time for Task Completion**	*Duration**
Conduct size-up	X	X	X
Position attack line	X		X
Establish 2 in - 2 out		X	
Establish RIT		X	
Gain forced entry	X		
Advance line	X		
Advance line		X	
Advance backup line to door	X	X	
Advance backup line to stairwell	X		
Advance backup line 2		X	
Conduct primary search 1	X		
Ground ladders in place		X	X
Horizontal ventilation, second story, window 3	X	X	
Horizontal ventilation, second story, window 2	X	X	
Horizontal ventilation, second story, window 1	X	X	
Horizontal ventilation, first story, window 2	X	X	
Control utilities interior	X		
Control utilities exterior	X		
Conduct secondary search	X		
Check for fire extension walls	X		
Check for fire extension ceiling	X		

* The columns of this table show the dependent variables, and the rows indicate the Tasks; an 'X' in a cell indicates that a separate regression analysis was conducted for a given dependent variable.

Table 5: Dependent Variables Used in a Regression Analysis of the Effect of Crew Size and Stagger on Time-to-Task Outcomes

Regression analyses

Appendix F presents the regression results for each task and relevant outcome, along with their corresponding standard errors. The results of conducting significance tests at the 0.05 level of significance are shown in Appendix E. Rather than detailing each of the lengthy lists of coefficients found to be significant, only the answers to the primary research questions are presented for each task.

Measurement Uncertainty

The measurements of length, temperature, mass, moisture content, smoke obscuration, and stopwatch timing taken in these experiments have unique components of uncertainty that must be evaluated in order to determine the fidelity of the data. Appendix G summarizes the uncertainty of key measurements taken during the experiments. Importantly, the magnitudes of uncertainties associated with these measurements have no impact on the statistical inferences presented in this report.

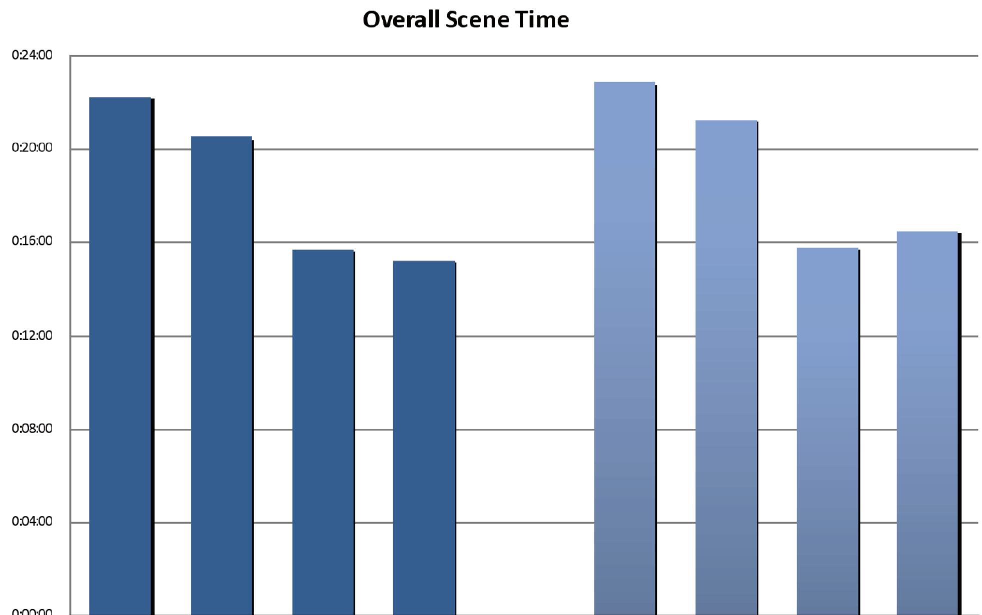
How to Interpret Time-to-Task Graphs

Figure 28 presents a sample time-to-task analysis, in this case results for venting time. Each crew size has a column graphic showing the start time and completion time for the task. Visually, columns starting lower on the graph depict deployment configurations that resulted in earlier start times. The height of the column graphic is a visualization of the duration of the task, taller columns indicating longer times to task completion. Time data are also shown in a table below the graph. Where stagger was statistically significant, the effects are graphed separately. Where stagger was *not* statistically significant, as in the illustration, the data for crew size were combined.

Time-to-Task Graphs

Overall Scene Time (Time to Complete All 22 Tasks)

The four-person crews operating on a low-hazard structure fire completed the same number of tasks on the fireground (on average) 7 minutes faster than the two-person crews (see Figure 29). The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster than the three-person crew. The four-person crews were able to complete necessary fireground tasks on a low-hazard residential structure fire nearly 30 % faster than the two-person crews and nearly 25 % faster than the three-person crews. Although on the low-hazard residential structure fire, adding a fifth person to the crews did not show any additional decrease in fireground task times, the benefits of a five-person vs. a four-person crew are significant in other measurements, particularly the "water-on-fire" time. Additionally, the greater need for five-person crews for medium- and high-hazard structures, particularly in urban settings, has been documented in other studies (Backoff et al., 1980; Cushman, 1982; McManis Associates et al., 1984) and five-person crews are required for areas that contain medium and high-hazard structures in fire protection consensus standards.[11]



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:22:16	0:20:30	0:15:44	0:15:13		0:22:52	0:21:17	0:15:48	0:16:31
Start Time	0:00:00	0:00:00	0:00:00	0:00:00		0:00:00	0:00:00	0:00:00	0:00:00

Figure 29: Overall Scene Time

11 NFPA 1710, Section 5.2.3.1.2 and Section 5.2.3.2.2: In jurisdictions with tactical hazards, high-hazard occupancies, high incident frequencies, geographical restrictions, or other pertinent factors as identified by the AHJ, these companies shall be staffed with a minimum of five or six on duty members.

Overall Scene Time and Crew Sizes

The graphs in Figure 30 show average times for each task by crew size.

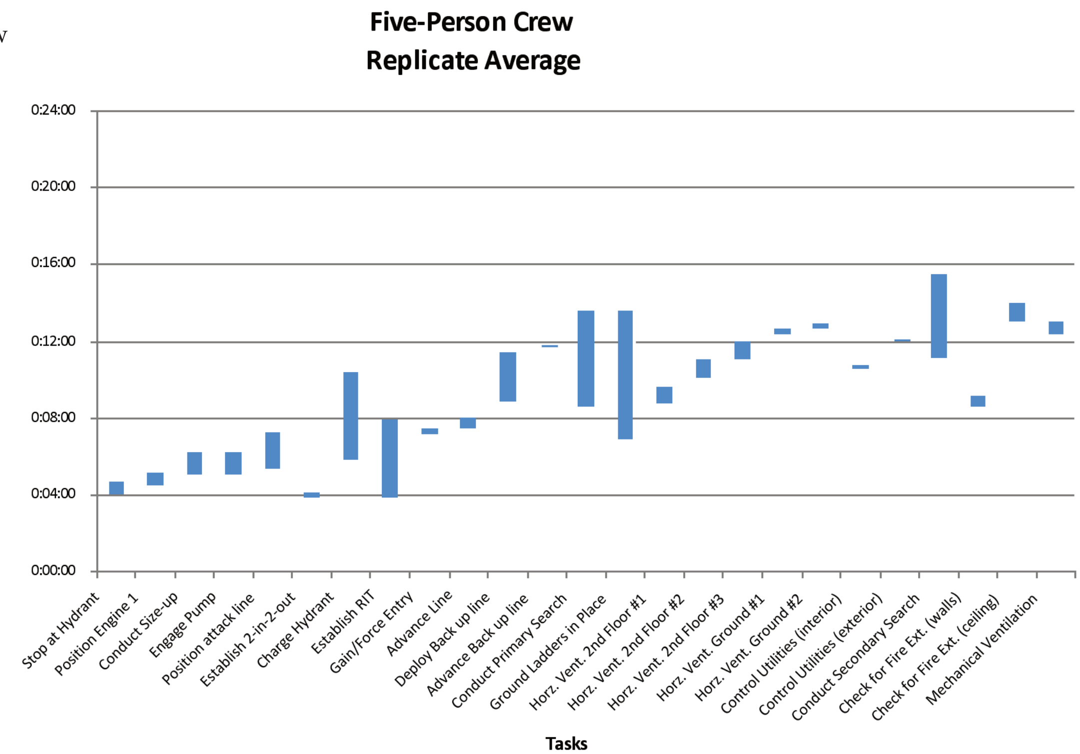


Figure 30 a: Overall Scene Time-FIve Person Crew

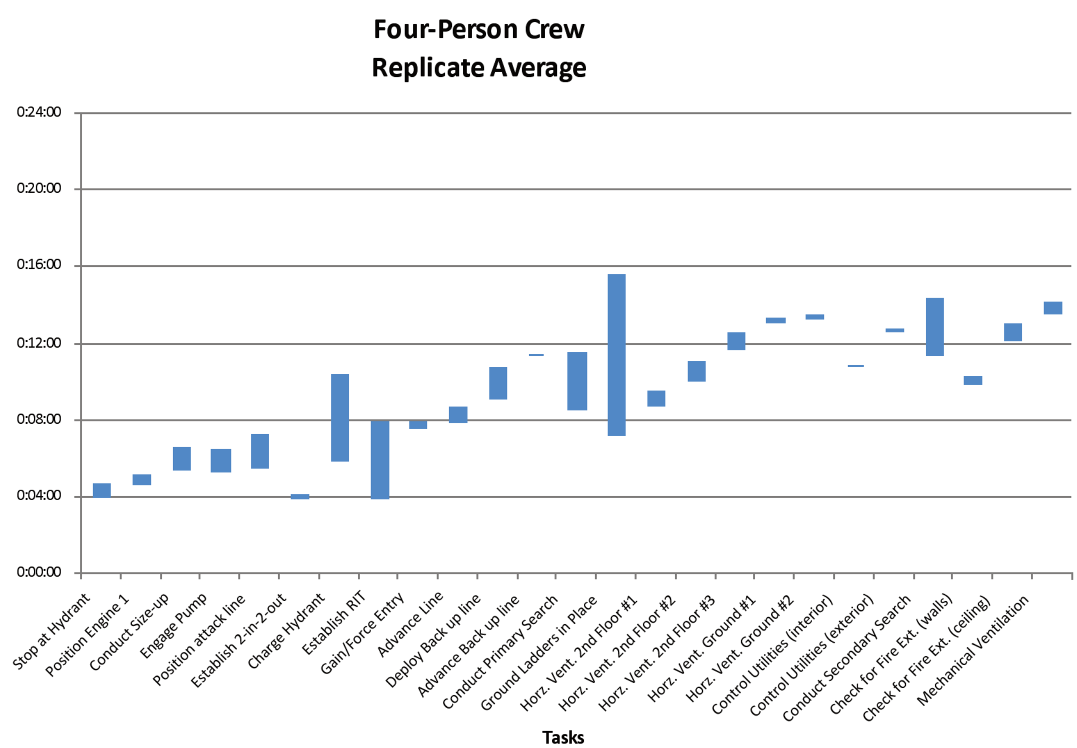


Figure 30 b: Overall Scene Time-Four Person Crew

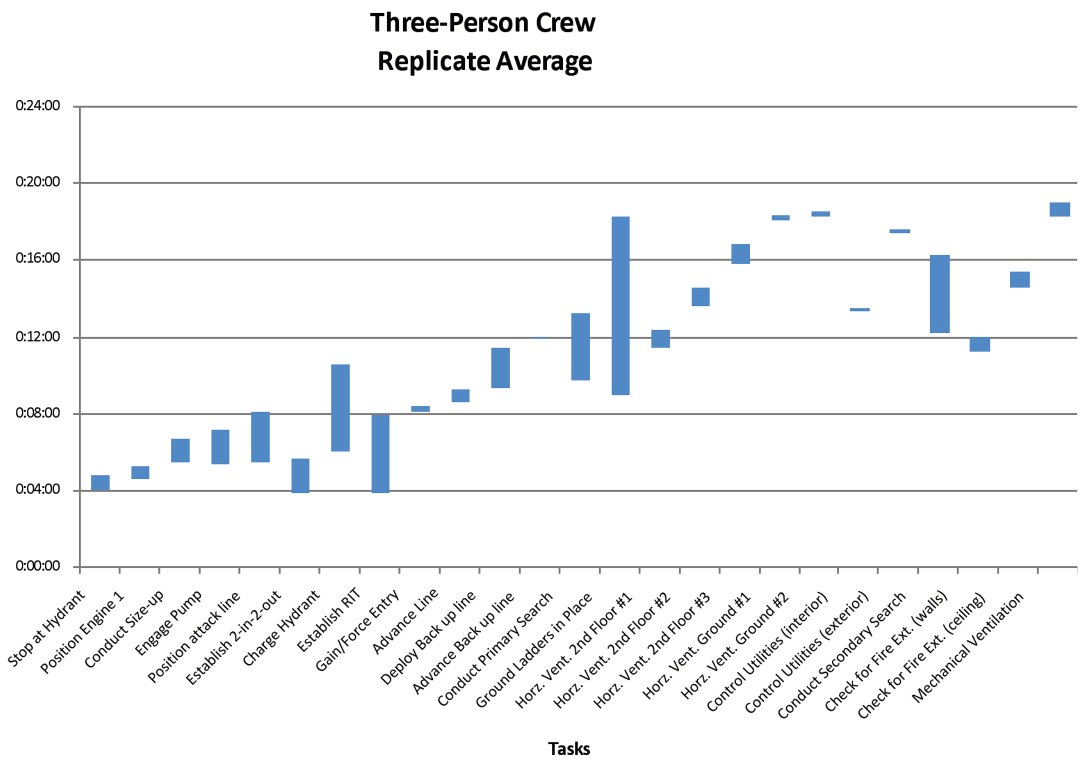


Figure 30 c: Overall Scene Time-Three Person Crew

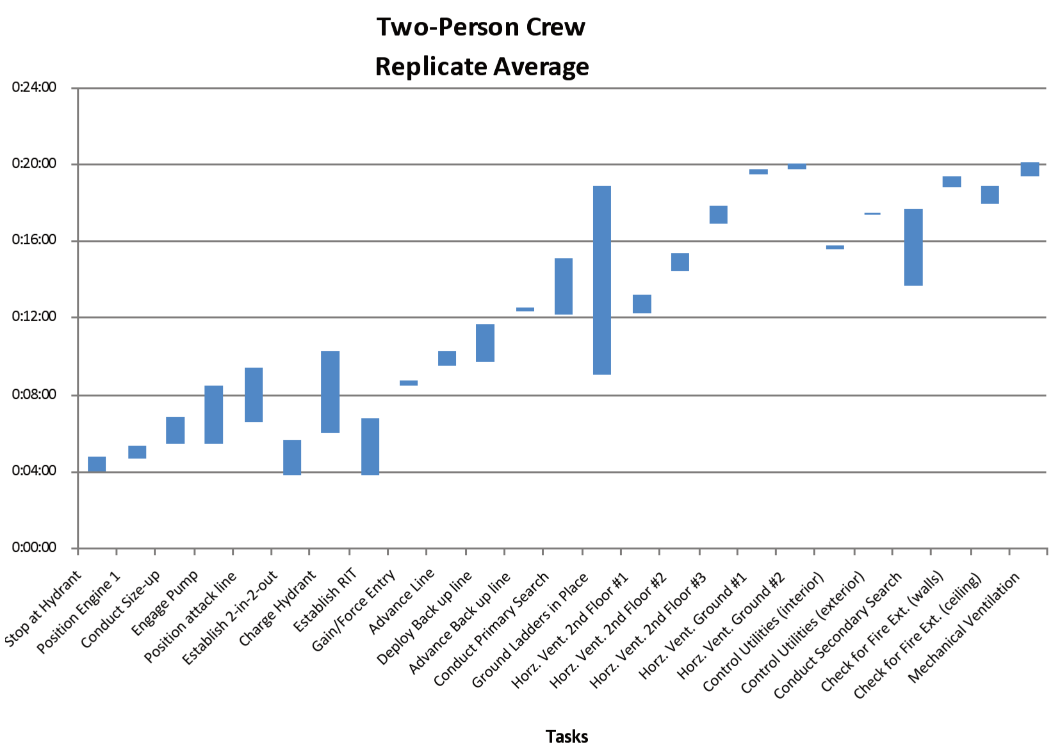
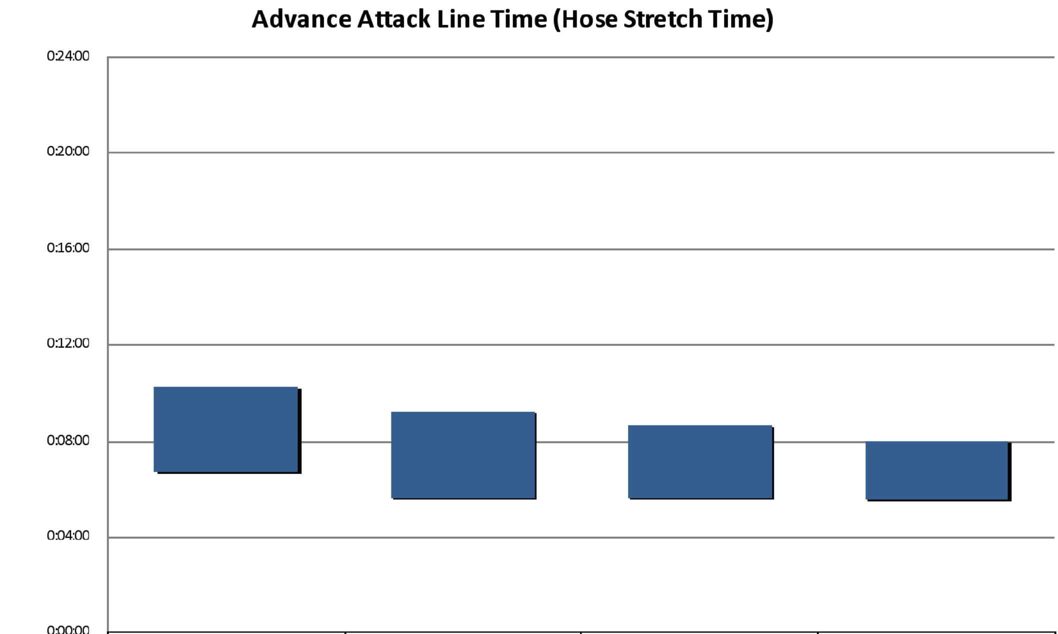


Figure 30 d: Overall Scene Time-Two Person Crew

Advance Attack Line Time (Hose Stretch Time)

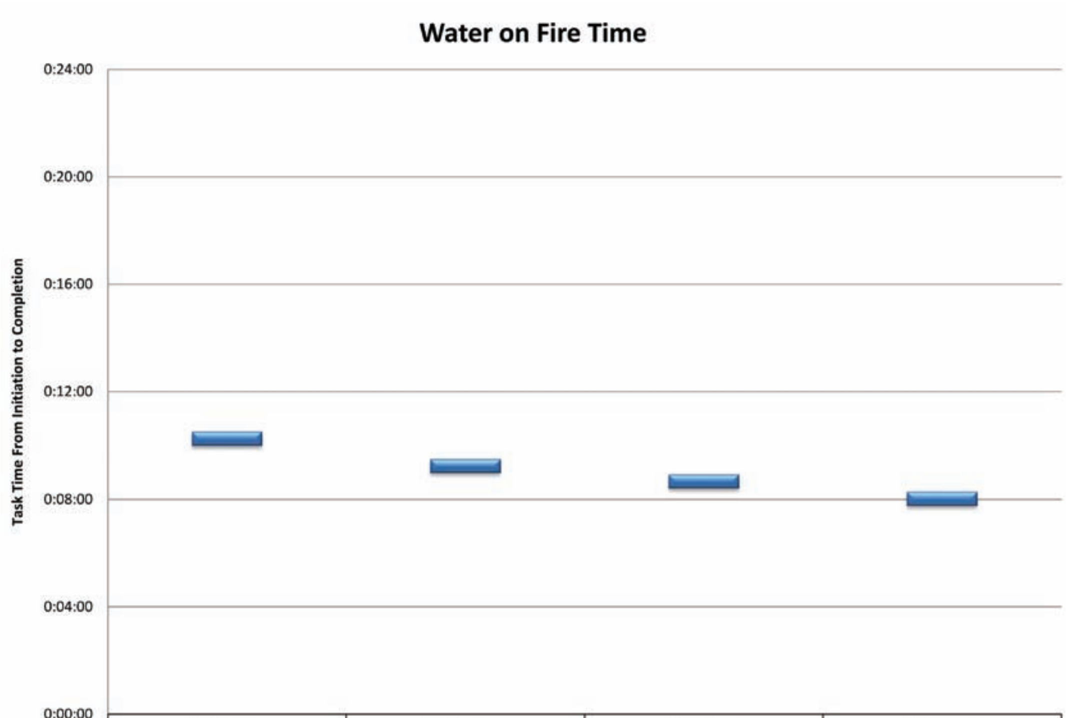
Figure 31 measures the interval from the start of the task "Position Attack Line" to the end of the task "Advance Attack Line." In comparing four- and five-person crews to two and three-person crews collectively, the time difference for this measure was statistically significant at 76 seconds (1 minute 16 seconds). In conducting more specific analysis comparing all crew sizes to a two-person crew the differences are more distinct. A two-person crew took 57 seconds longer than a three-person crew to stretch a line. A two-person crew took 87 seconds longer than a four-person crew to complete the same task. Finally, the most notable comparison was between a two-person crew and a five-person crew, with a 122-second difference in task completion time.[12, 13]



	2-Person	3-Person	4-Person	5-Person
End Time	0:10:16	0:09:15	0:08:41	0:08:01
Duration	0:03:34	0:03:36	0:03:02	0:02:29
Start Time	0:06:43	0:05:39	0:05:39	0:05:33

Figure 31: Advance Line Time (Hose Stretch Time) by Crew Size

12 Apparatus stagger was not statistically significant, so the data for crew size were combined.
13 Where subtracting the start time from the end time yields a result that differs from the duration noted in the chart by one second, it is the result of rounding fractional seconds to the nearest whole second.

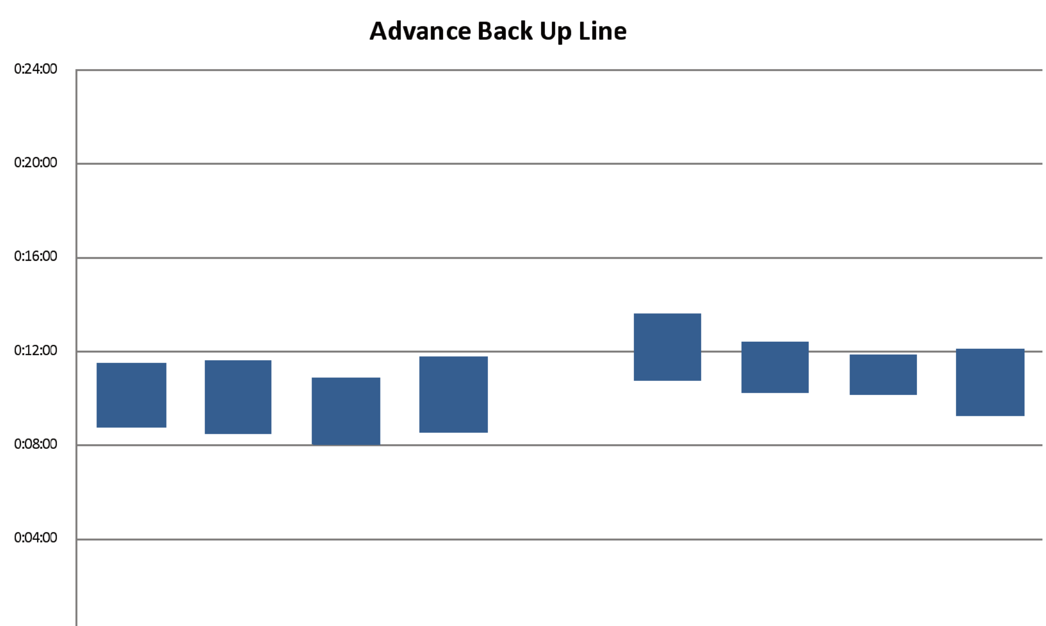


	2-Person	3-Person	4-Person	5-Person
End Time	0:10:16	0:09:15	0:08:41	0:08:01

Figure 32: Water on Fire Time by Crew Size and Stagger

Time to Water on Fire

There was a 10% difference in the "water on fire" time between the two- and three-person crews. There was an additional 6% difference in the "water on fire" time between the three- and four-person crews. (i.e., four-person crews put water on the fire 16% faster than two person crews). There was an additional 6% difference in the "water on fire" time between the four- and five-person crews (i.e. five-person crews put water on the fire 22% faster than two-person crews).



	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:11:28	0:11:33	0:10:55	0:11:48		0:13:37	0:12:23	0:11:54	0:12:04
Duration	0:02:34	0:02:58	0:02:46	0:03:09		0:02:45	0:02:04	0:01:41	0:02:44
Start Time	0:08:54	0:08:35	0:08:08	0:08:39		0:10:52	0:10:19	0:10:13	0:09:20

Figure 33: Times to Advance Backup Line by Crew Size and Stagger

Advancing a Backup Line

Advancing a backup line to the door and stairwell was started 16 % faster and completed 9 % for replicates with shorter staggers between company arrivals. Advancing a backup line is typically a task completed by the third arriving engine on a full alarm assignment and is critical to the safety of firefighters already in the building on the initial attack line. For this task, stagger of arrival was statistically significant and is an important consideration for overall station location and full alarm response capability. The differences can be seen in Figure 33, which shows the time from the start for the task "Deploy Backup Line" to the end of the task "Advance Backup Line."

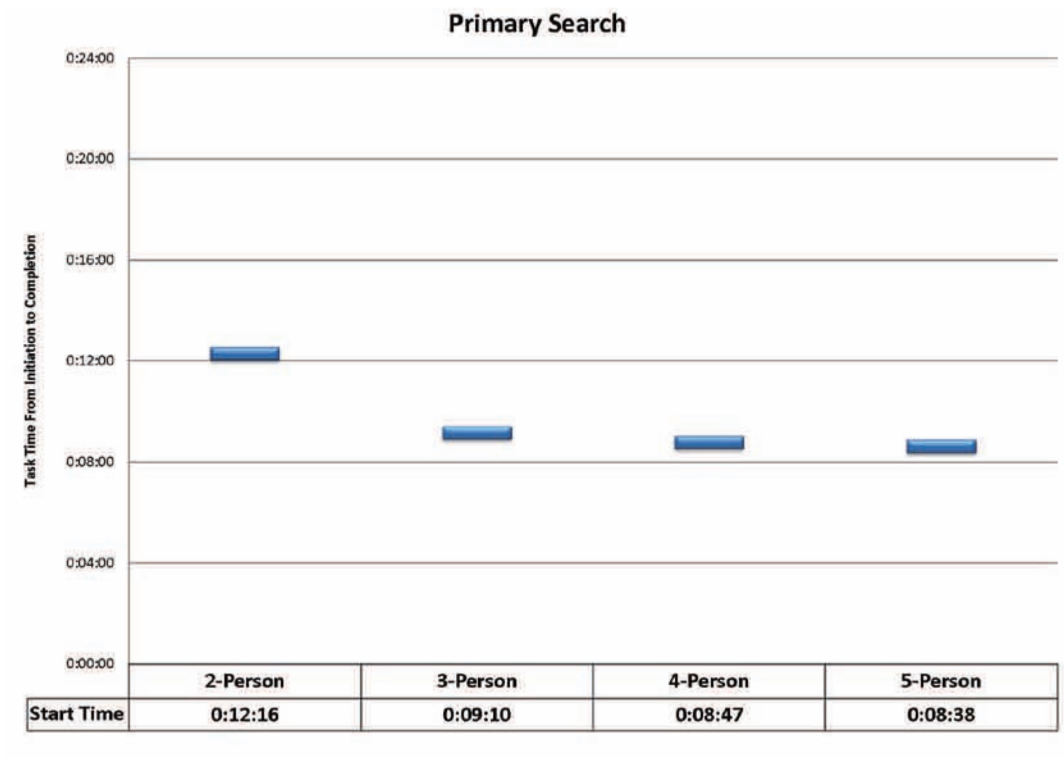
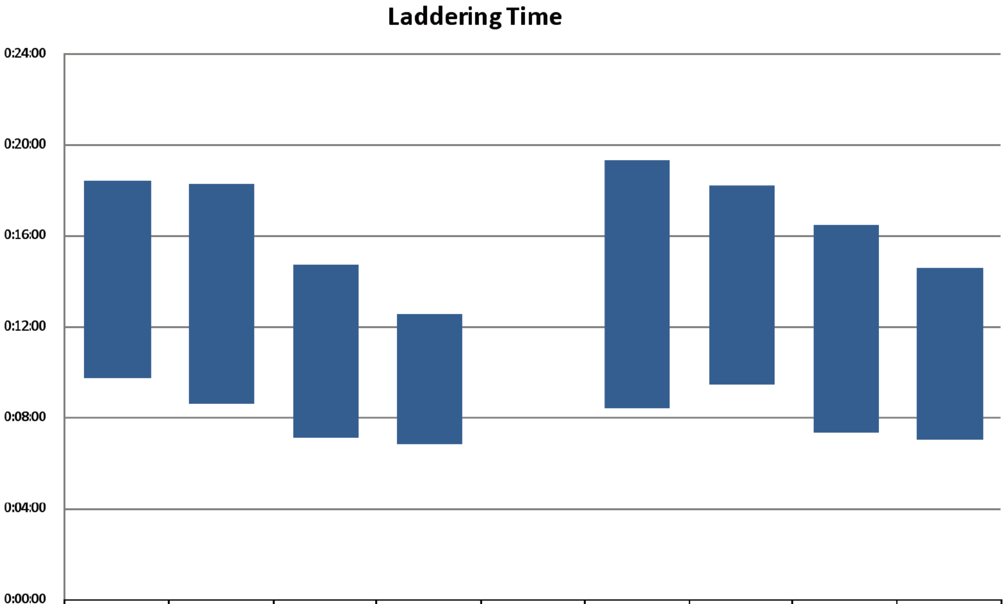


Figure 34: Times to Conduct Primary Search by Crew Size

14 Stagger was not significant, so data from close and far were combined to increase statistical power.

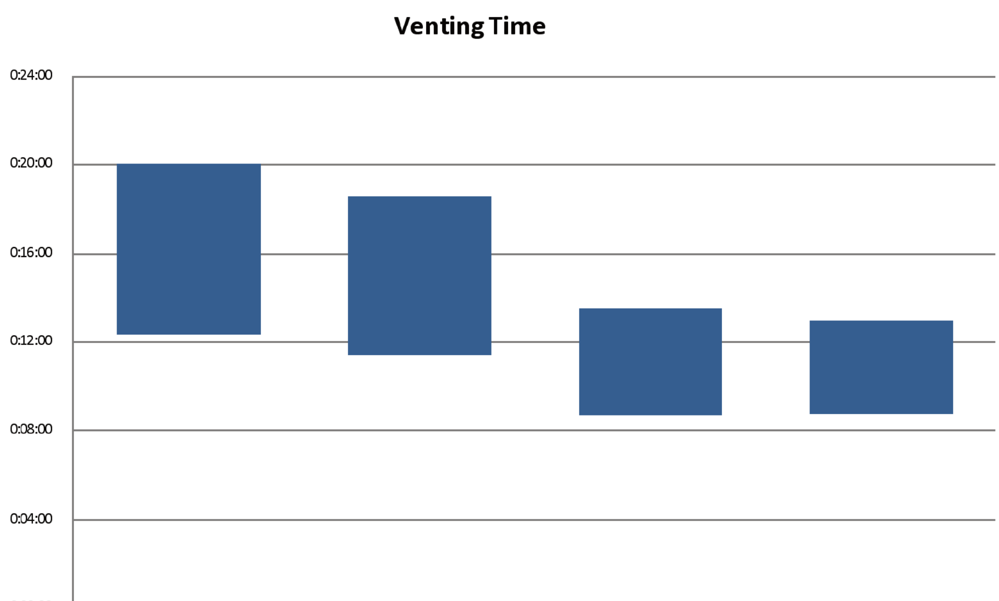


	2-Person Close	3-Person Close	4-Person Close	5-Person Close		2-Person Far	3-Person Far	4-Person Far	5-Person Far
End Time	0:18:24	0:18:19	0:14:45	0:12:34		0:19:23	0:18:12	0:16:29	0:14:38
Duration	0:08:31	0:09:35	0:07:31	0:05:40		0:10:51	0:08:40	0:09:03	0:07:31
Start Time	0:09:54	0:08:44	0:07:14	0:06:54		0:08:31	0:09:32	0:07:26	0:07:07

Figure 35: Laddering Time by Crew Size

Primary Search

Figure 34 summarizes the times that crews took to start the primary search. On the low-hazard, two-story single-family dwelling 2,000 sq ft (186 m^2) , the three-person crew started a primary search/rescue more than 25 % faster than the two-person crew. In the same structure, the four- and five-person crews started a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. Note that there is no end time included in this figure. Primary search end times were reliant upon radio communication by firefighters inside the structure. On occasion this communication did not occur or was delayed. Therefore data reliability was insufficient for analysis of task duration and end time.[14]



	2-Person	3-Person	4-Person	5-Person
End Time	0:20:02	0:18:33	0:13:30	0:12:59
Duration	0:07:36	0:07:01	0:04:42	0:04:04
Start Time	0:12:26	0:11:32	0:08:48	0:08:55

Figure 36: Ventilation Times by Crew Size[15]

Laddering and Venting Time

A four-person crew operating on a low-hazard structure fire completed laddering and ventilation (for life safety and rescue) 30 % faster than a two-person crew and 25 % faster than a three-person crew.

Ground laddering time started with the removal of the first ladder from the truck and stopped at end time of the last ladder put in place. A total of four ladders were raised on each experiment.

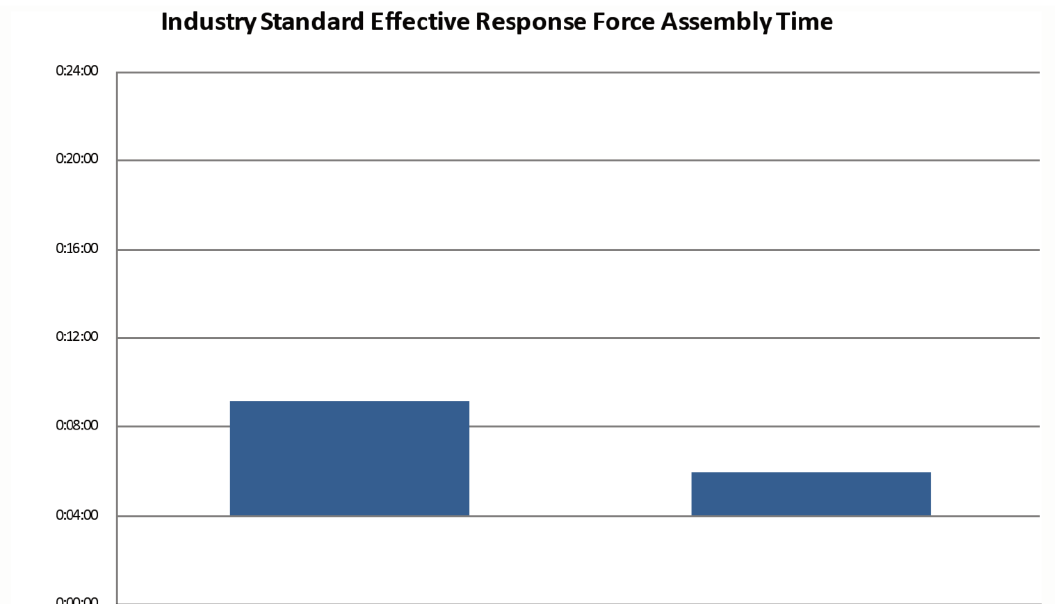
Truck operations ventilation time is the time from the start time of ventilation of the first window until the last window ventilation was complete.

The differences in start times and duration of the tasks can be seen in Figure 35 and Figure 36.

15 Stagger was not statistically significant, so the data for crew size were combined.

Industry Standard Effective Response Force Assembly Time

NFPA 1710 requires that a fire department have the capability to deploy an initial full-alarm assignment to a scene within eight-minutes (480 seconds). The number of people required falls between 15 and 17, depending on whether an aerial apparatus is used, and/or if two engines are being used to provide a continuous water supply. In these experiments, the measurement for an effective response force assembly time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene. Figure 37 reveals the differences in assembly times between the four and five-person crews. An effective response force was assembled by the five-person crews a full three minutes faster than the four-person crews. It is important to note that (by definition), the two-and three-person crews were unable to meet this standard at any time during the experiments.[16]



	4-Person	5-Person
End Time	0:09:10	0:05:57
Duration	0:05:02	0:01:48
Start Time	0:04:09	0:04:09

Figure 37: Industry Standard Effective Response Force Assembly Time

16 Stagger was not statistically significant, so the data for far and near stagger were combined.

Part 4: Fire Modeling

In the room and contents experiments conducted in Part 3 of the study, instrumentation measured oxygen, carbon dioxide, and carbon monoxide concentrations. Data were grouped by the type of experiment conducted with respect to crew size and first due engine arrival time. As previously shown in the experimental matrix, each group contained two replicate tests. In each group of data the results of the replicates were averaged to simplify the data for further comparison. Figure 38 and Figure 39 show the typical concentration curves for the experiments.

These two graphs show the ranges representative of those found in the experiments. Charts of gas curves for the remainder of the experiments — for both the burn room and the target room — can be found in Appendix H.

Fire Modeling Methods

A primary goal of fire department response is to prevent civilian injuries and deaths. Because the significant majority of fire deaths in the United States occur in residences, a rapid fire service response provides the last line-of-defense against civilian fire deaths. Further, because the fire service is less likely to rescue occupants intimate with the fire (i.e., inside the room of origin where conditions deteriorate rapidly), tenability measurements were taken in a remote bedroom on the second floor of the residential burn structure. The gas and temperature measurements were taken at the 5 ft (1.5 m) height above the floor, 3 ft (0.9 m) from the west wall in order to simulate a nonambulatory occupant (e.g, someone asleep, under the influence of alcohol or drugs, or otherwise mobility impaired).

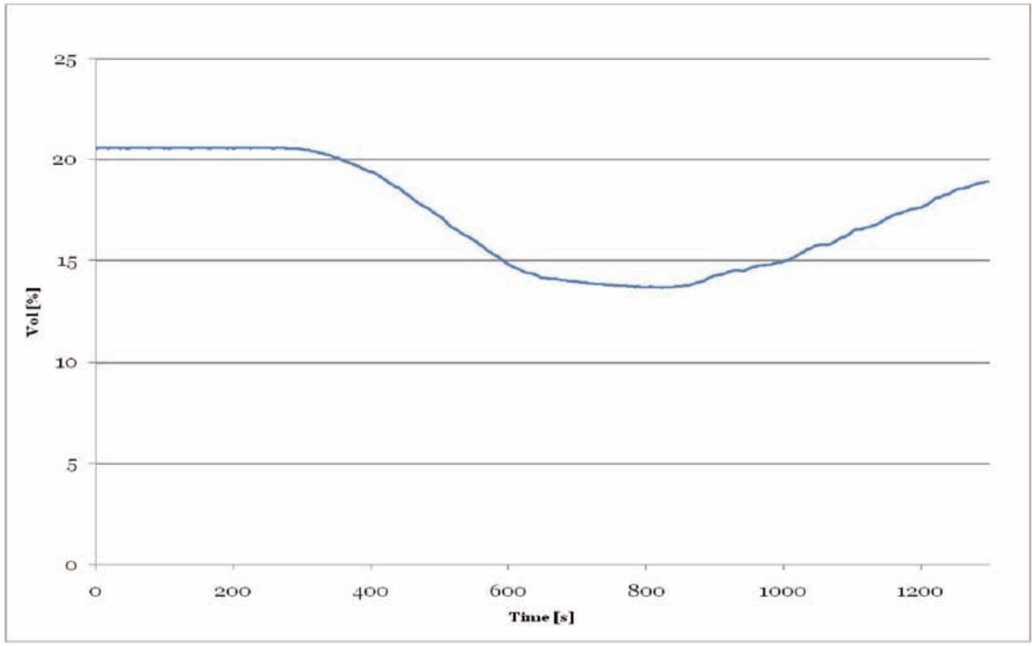


Figure 38: Representative Oxygen Concentration

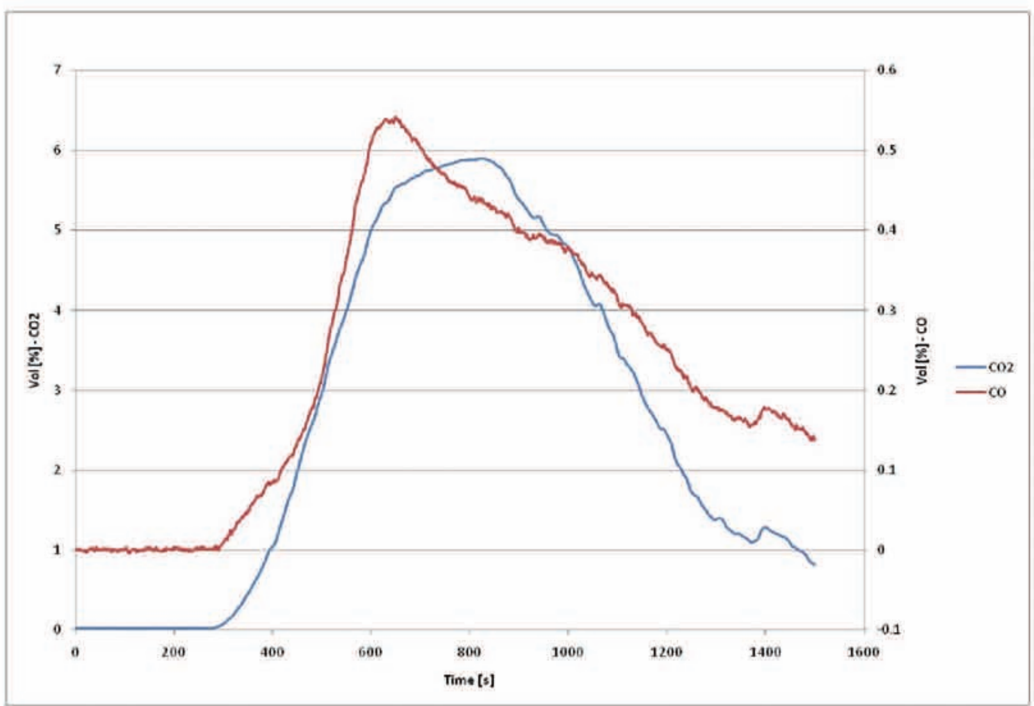


Figure 39: Representative Carbon Monoxide and Carbon Dioxide Concentrations

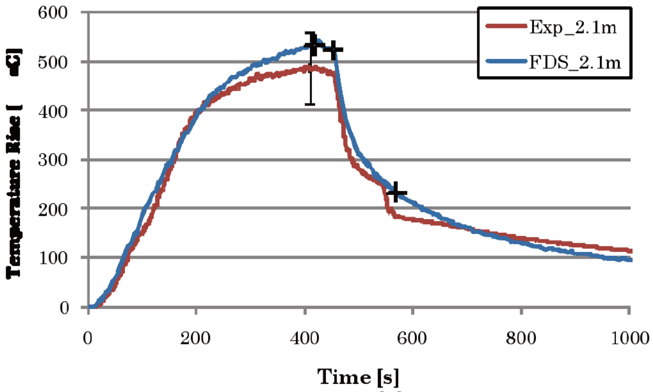


Figure 40: Measured vs. Predicted Temperature at the 2.1 m (6.9 ft) Thermocouple Location in the Burn Compartment

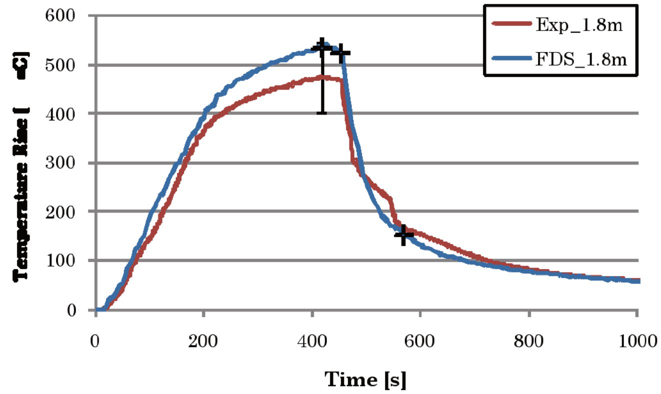


Figure 41: Measured vs. Predicted Temperature at the 1.8 m (5.9 ft) Thermocouple Location in the Burn Compartment

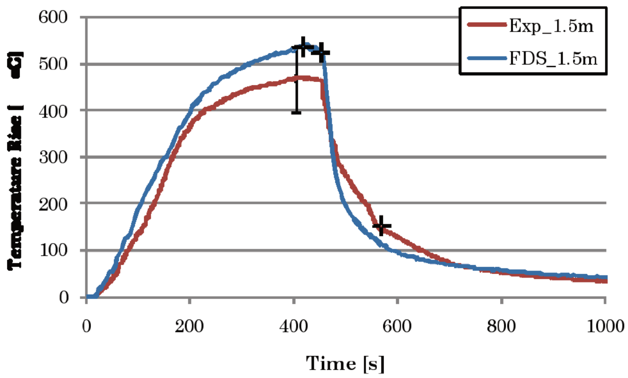


Figure 42: Measured vs. Predicted Temperature at the 1.5 m (4.9 ft) Thermocouple Location in the Burn Compartment

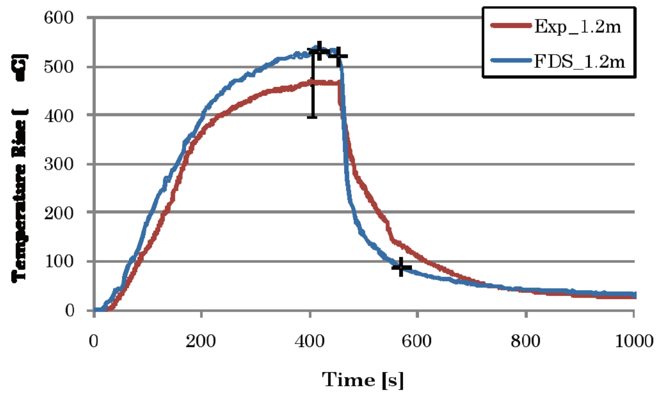


Figure 43: Measured vs. Predicted Temperature at the 1.2 m (3.9 ft) Thermocouple Location in the Burn Compartment

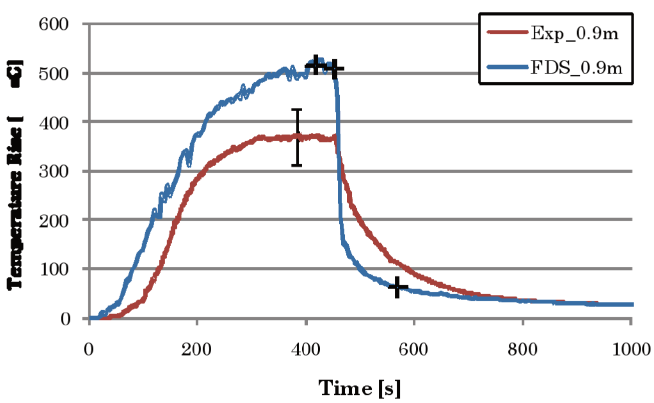


Figure 44: Measured vs. Predicted Temperature at the 0.9 m (2.9 ft) Thermocouple Location in the Burn Compartment

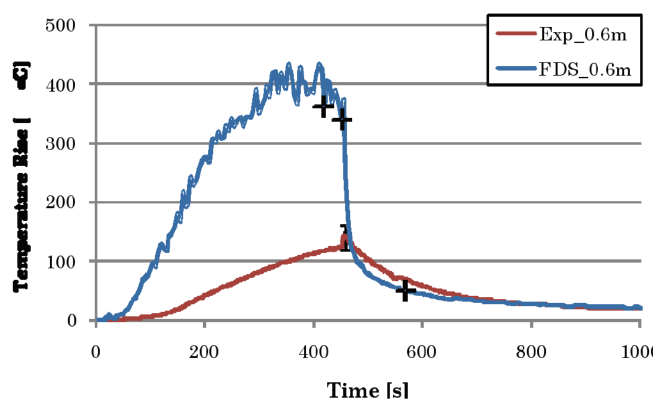


Figure 45: Measured vs. Predicted Temperature at the 0.6 m (1.9 ft) Thermocouple Location in the Burn Compartment

Computational fire models used the average suppression timings obtained from the time-to-task experiments under specific deployment configurations as inputs to the model. This quantitative approach eliminated the experimental variance of the fire. The resulting "computational" fire is repeatable, and therefore, any differences in occupant exposure to toxic gases will be due to the intervention times associated with a specific deployment configuration rather than the random variation that naturally occurs from fire to fire.

Fire simulations were completed using the NIST Fire Dynamics Simulator (FDS). FDS is a computational fluid dynamics model of fire-driven fluid flow. The first version of the FDS was released in 2000. FDS has been extensively verified and validated (USNRC 2007). Since the initial release, numerous improvements have been made and new features added. This study used FDS version 5.4.2 (Sub-version #4957), which was released on October 19, 2009. In order to calibrate the model, simulations were performed to replicate the experimental results observed in the room-and-contents fires. Once the ability of the model to replicate experimental results was established, the different fire growth rates and deployment configurations were simulated to characterize the effectiveness of different responses relative to different fire growth rates.

The occupant exposure to toxic gases was assumed to occur until the occupant is rescued by the truck crew (start time of primary search plus one minute). Table 6 shows the "rescue time" for the various crew sizes that correspond to the test matrix for the room and contents experiments.

Part 4 of the experiments used fire modeling to correlate response times to atmospheric tenability in a burning structure. In order to calibrate the computer fire model, simulations were performed to replicate the experimental results observed in the room-and-contents fires. Model inputs include building geometry and material properties, ventilation paths (doors, windows, leakage paths), and heat release rate of the fuel package. While the building geometry is easily measured and material properties (such as the thermal properties of drywall and concrete) are readily estimated, the heat release rate was not directly measured during the experiments. The heat release rate of the fuel package is the primary determinant of the production rate of heat, smoke, and gas species (e.g., carbon dioxide, carbon monoxide).

Figures 40 through 45 compare the experimental and simulated burn room temperatures using the burn room thermocouple tree. The tree contained thermocouples located at 0.6 m (1.9 ft), 0.9 m (2.9 ft), 1.2 m (3.9 ft), 1.5 m (4.9 ft), 1.8 m (5.9 ft), and 2.1 m (6.9 ft) above the floor. For additional information about the instrumentation type location, see Appendix C. The results for thermocouples located in the hot gas layer show excellent agreement. The temperature at the lower two thermocouples show an overprediction of the hot gas layer depth in the computer simulation. A small difference in the location of the interface height (the steep temperature gradient between the relatively cool lower gas layer and the hot upper gas layer), can result in significant predicted temperature differences with relatively little effect on the bulk heat and mass transport accuracy. This explanation is supported by the agreement of the temperatures in the remote bedroom.

Figure 46 compares the experimental and predicted oxygen concentration levels in the upstairs bedroom (measured at 5 ft (1.5 m) above the floor, centered above the bed). Figures 47 through 52 compare the experimental and simulated temperatures in the upstairs (target room) bedroom. As expected, the temperatures are moderated by mixing (cool ambient air mixes with hot combustion gases during transport between the burn room and the target room) and by thermal losses to the (cooler) surfaces between the two rooms.

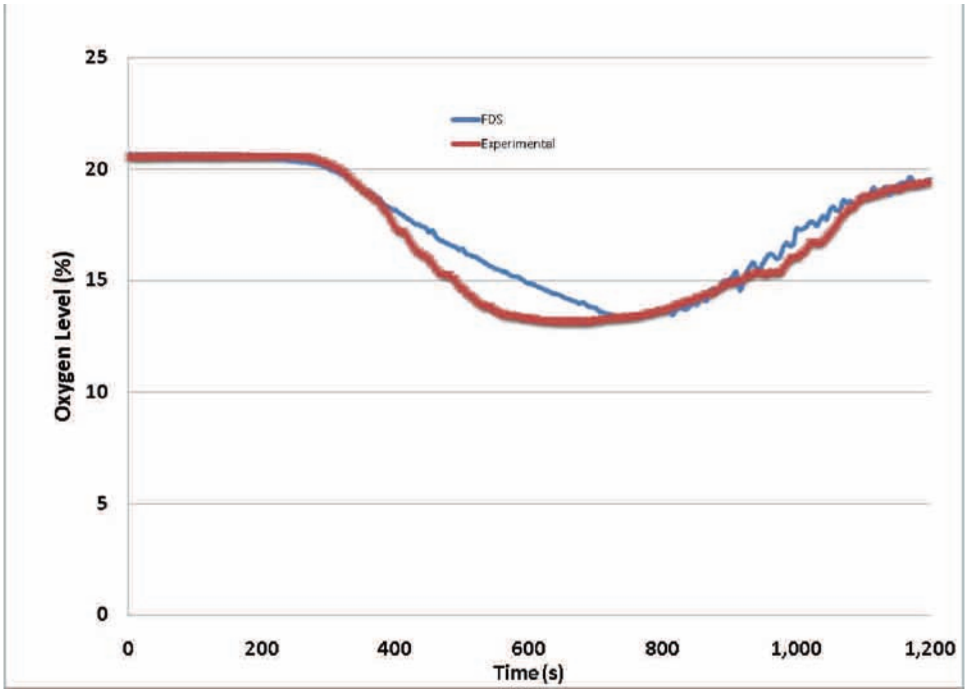


Figure 46: Measured Versus Predicted Oxygen Levels in the Upstairs Bedroom at 5 ft (1.5 m)

Once the model inputs were determined to agree with the experimental results, the input heat release rate was changed to represent three fire growth rates representative of a range of fire hazard development – slow, medium, and fast, which are described in greater detail in the following sections.

Time to Untenable Conditions: Research Questions

In the real world, fires grow at many different rates – from very slow, smoldering fires all the way to ultra-fast, liquid fuel or spray fires. In order to extend the applicability of the findings of this report beyond the one fire growth rate observed in part 3 of this report (residential room and contents fires), computer fire modeling was used to quantify the effectiveness of fire department operations in response to an idealized range of fire growth rates (characterized as slow, medium, and fast). Based on the research questions shown in Figure 53, fire modeling methods were then selected to maximize the applicability of the times to task results.

1) How do performance times relate to fire growth as projected by standard fire time/temperature curves?

2) How do these performance times vary by crew size, first due arrival time, and stagger?

3) How do crew size, stagger, and arrival time affect occupant tenability within the structure?

Figure 53: Research Questions for Time to Untenable Conditions

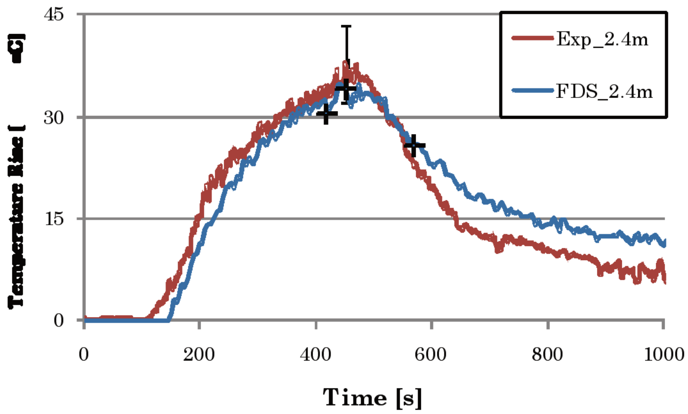


Figure 47: Measured vs. Predicted Temperature at the 2.4 m (7.8 ft) Thermocouple Location in the Bedroom

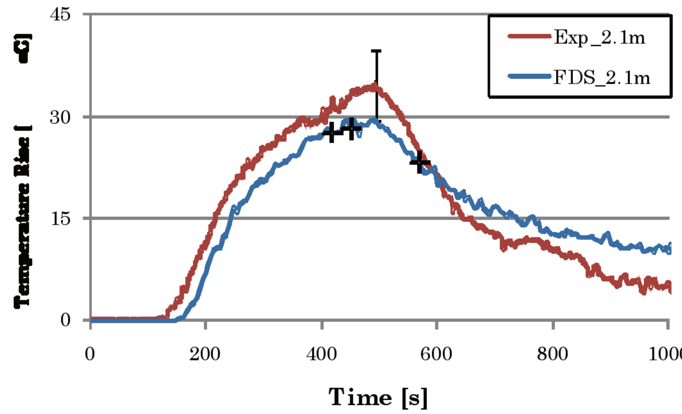


Figure 48: Measured vs. Predicted Temperature at the 2.1 m (6.8 ft) Thermocouple Location in the Bedroom

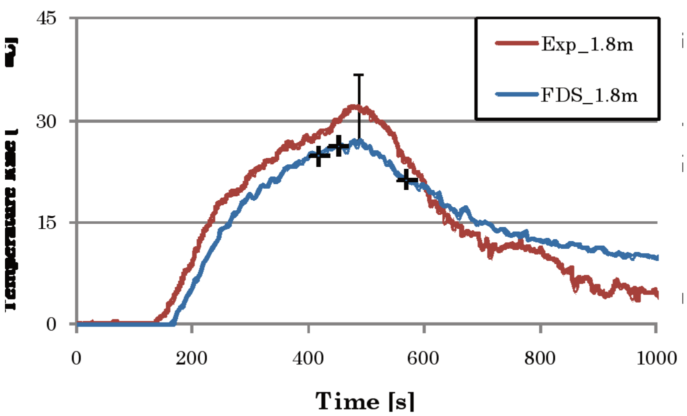


Figure 49: Measured vs. Predicted Temperature at the 1.8 m (5.9 ft) Thermocouple Location in the Bedroom

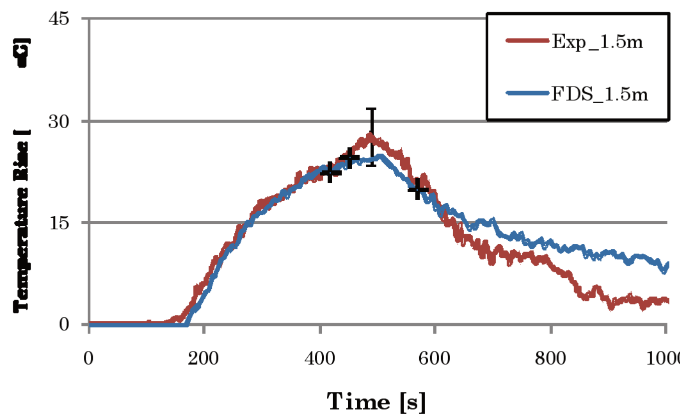


Figure 50: Measured vs. Predicted Temperature at the 1.5 m (4.9 ft) Thermocouple Location in the Bedroom

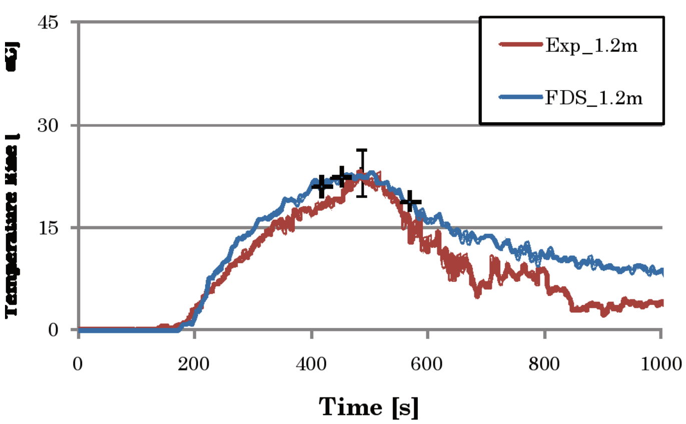


Figure 51: Measured vs. Predicted Temperature at the 1.2 m (3.9 ft) Thermocouple Location in the Bedroom

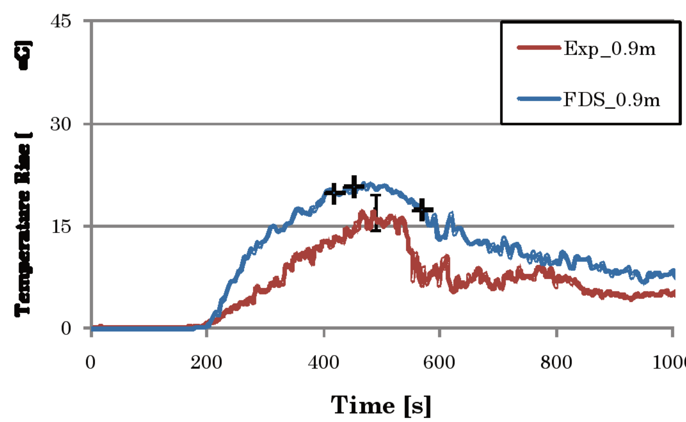


Figure 52: Measured vs. Predicted Temperature at the 0.9 m (2.9 ft) Thermocouple Location in the Bedroom

Fire Growth Rates

Three fire growth rates were used in the computer fire modeling to assess the effectiveness of different fire department deployment configurations in response to fires that were similar to, faster growing, and slower growing than the fires observed in the room-and-contents fires. The slow, medium, and fast fire growth rates are defined by the Society of Fire Protection Engineers according to the time at which they reach 1 megawatt (MW). A typical upholstered chair burning at its peak would produce a 1-MW fire, while a large sofa at its burning peak would produce roughly a 2-MW fire.

The growth rate of fires is often approximated by simple correlation of heat release rate to the square of time. If a fire is not suppressed before full-room involvement, the probability of spread beyond the room of origin increases dramatically if there is nearby fuel load to support fire spread. If a nearby fuel load is available, the 12 ft (3.7 m) by 16 ft (4.9 m) compartment used in the fire experiments would become fully involved at approximately 2 MW. Table 7 shows the time in seconds at which 1-MW and 2-MW (fully involved) fires in this compartment would be reached in the absence of suppression.

Fire Growth Rate	Time in Seconds Reach 1 MW	Time in Seconds to Reach to 2 MW
Slow	600	848
Medium	300	424
Fast	150	212

Table 7: Time to Reach 1 MW and 2 MW by Fire Growth Rate In the Absence of Suppression

A fire department rescue operation is a race between the deteriorating interior conditions inside the structure and the rescue and suppression activities of the fire department. Each fire growth rate was used as a baseline heat release rate for the simulation. Intervention times (window and door opening times and suppression time) from the time-to-task tests were systematically input into the model to evaluate the effects on interior tenability conditions. The interior tenability conditions were calculated in a remote upstairs bedroom (above the room of fire origin on the first floor) in order to maximize the opportunity for differentiation among different crew configurations.

Fractional Effective Dose (FED)

In order to convert instantaneous measurements of local gas conditions, the fractional effective dose (FED) formulation published by the International Standards Organization (ISO) in document 13571 *Life-threatening Components of Fire – Guidelines for the Estimation of Time Available for Escape Using Fire Data* (ISO 2007) were used. FED is a probabilistic estimate of the effects of toxic gases on humans exposed to fire effluent. The formulation used in the simulations accounts for carbon monoxide (CO), carbon dioxide (CO_2), and oxygen (O_2) depletion. Other gases, including hydrogen cyanide (HCN) and hydrogen chloride (HCl), were not accounted for in this analysis and may alter FED for an actual occupant.

$$FED = \sum_{i=1}^{n} \frac{C_i}{(C_t)_i} \Delta t \quad \text{Eq.1}$$

Where C_i is the concentration of the ith gas and $(C_t)_i$ is the toxic concentration of ith gas and Δt is the time increment.

There are three FED thresholds generally representative of different exposure sensitivities of the general population. An FED value of 0.3 indicates the potential for certain sensitive populations to become incapacitated as a result of exposure to toxic combustion products. Sensitive populations may include elderly, young, or individuals with compromised immune systems. Incapacitation is the point at which occupants can no longer effect their own escape. An FED value of 1.0 represents the median incapacitating exposure. In other words, 50 % of the general population will be incapacitated at that exposure level. Finally, an FED value of 3.0 represents the value where occupants who are particularly tolerant of combustion gas exposure (extremely fit persons, for example) are likely to become incapacitated.

These thresholds are statistical probabilities, not exact measurements. There is variability in the way individuals respond to toxic atmospheric conditions. FED values above 2.0 are often fatal doses for so-called typical occupants. There is no threshold so low that it can be said to be safe for every exposed occupant.[17]

Deployment Configuration (All times with close stagger adjusted for early and late arrival of first due engine)	Rescue Time for Deployment Configuration (Min : Sec)
2-Person Early	12:47
3-Person Early	9:03
4-Person Early	9:10
5-Person Early	8:57
2-Person Late	14:47
3-Person Late	11:03
4-Person Late	11:10

Table 6: Rescue Time for Different Deployment Configurations

17 See the following sections of ISO Document 13571:
5.2 Given the scope of this Technical Specification, FED and/or FEC values of 1,0 are associated, by definition, with sublethal effects that would render occupants of average susceptibility incapable of effecting their own escape. The variability of human responses to toxicological insults is best represented by a distribution that takes into account varying susceptibility to the insult. Some people are more sensitive than the average, while others may be more resistant (see Annex A.1.5). The traditional approach in toxicology is to employ a safety factor to take into consideration the variability among humans, serving to protect the more susceptible subpopulations.
5.2.1 As an example, within the context of reasonable fire scenarios FED and/or FEC threshold criteria of 0,3 could be used for most general occupancies in order to provide for escape by the more sensitive subpopulations. However, the user of this Technical Specification has the flexibility to choose other FED and/or FEC threshold criteria as may be appropriate for chosen fire safety objectives. More conservative FED and/or FEC threshold criteria may be employed for those occupancies that are intended for use by especially susceptible subpopulations. By whatever rationale FED and FEC threshold criteria are chosen, a single value for both FED and FEC must be used in a given calculation of the time available for escape.

Results from Modeling Methods

Table 8 shows the FED for slow-, medium-, and fast-growth rate fires correlated to rescue times based on crew size and arrival time in the study. As with the room-and-contents fire in part 3, results in Table 8 included only the close-stagger rescue time data. The effect of far-stagger rescue times on occupant tenability should be investigated in future studies. Values above 0.3 are shown in yellow, and those above the median incapacitating exposure of 1.0 are shown in red.

Figure 54 shows that with slow-growth fires in the experimental residential structure, all crew configurations could achieve rescue time before FED reached incapacitating levels. Figure 55 illustrates the greater danger of medium-growth fires, where the FED at rescue time for two-person crews is well above the 0.3 level, and almost to that level for the other crews.

Figure 56 (page 49) vividly illustrates the extreme danger of fast-growth fires. By the time a two-person crew is able to facilitate a rescue, the FED has far exceeded the median 1.0 level. For other crew sizes, the FED has exceeded 0.3, which is a threshold level for vulnerable populations.

Crew Configuration	Rescue Time	Fire Growth Rates		
		Slow	Medium	Fast
2 Early	12:47	.12	.72	1.49
2 Late	14:47	.35	1.37	2.56
3 Early	9:03	.01	.11	.40
3 Late	11:03	.04	.36	.84
4 Early	9:10	.01	.11	.42
4 Late	11:10	.05	.38	.91
5 Early	8:57	.01	.10	.38

KEY	
White	89% or more of population may be capable of effecting their own escape if they are able.
Yellow	Potential for certain sensitive populations (such as children and the elderly) to become incapacitated.
Red	More than 50% of the population would be incapable of effecting their own escape.

Table 8: FED as a Function of Deployment Configuration and Fire Growth Rate

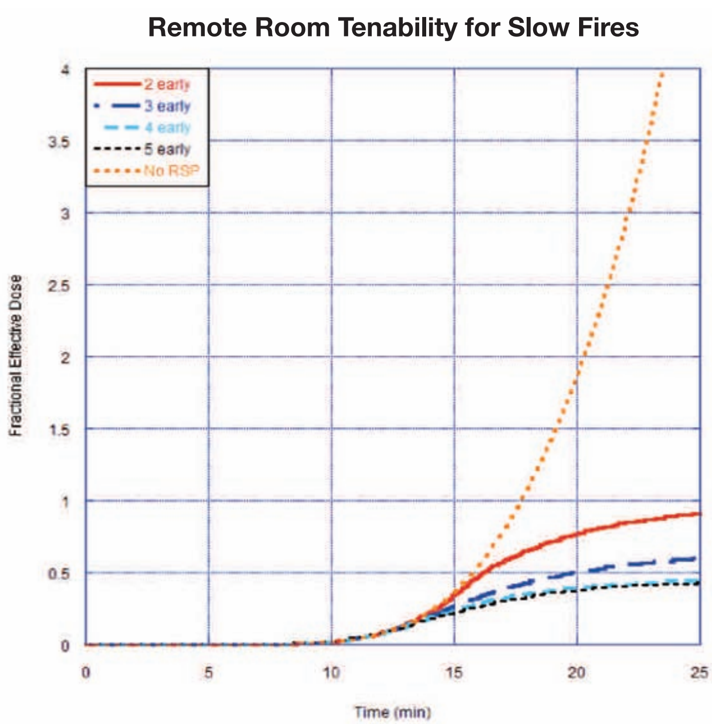


Figure 54: FED Curves for Early Arrival for All Crew Sizes at Slow-Growth Fires

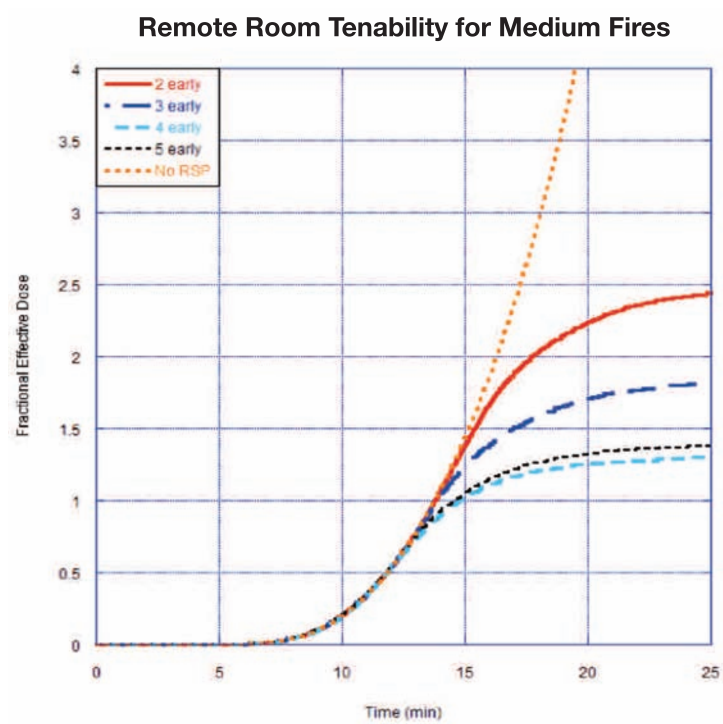


Figure 55: Average FED Curves for Early Arrival for All Crew Sizes at Medium-Growth Fires

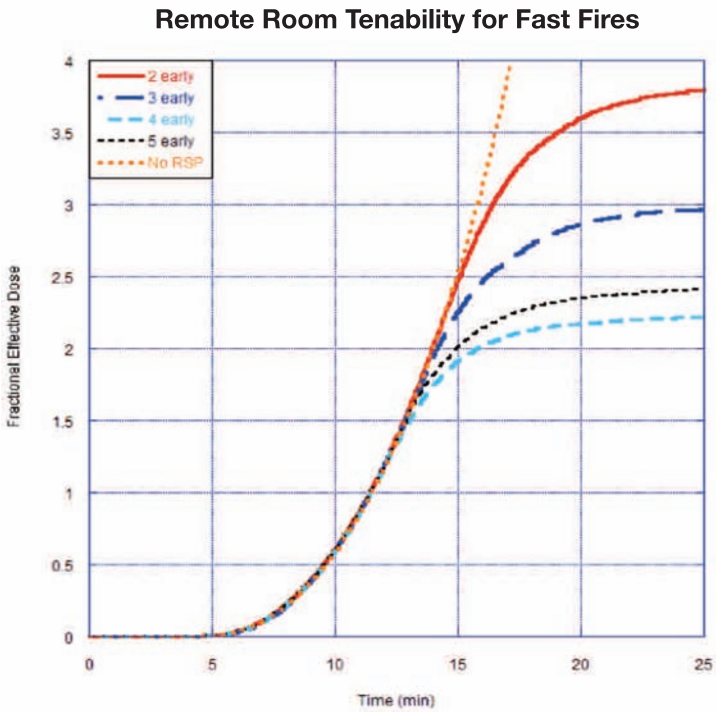


Figure 56: Average FED Curves for Early Arrival for All Crew Sizes at Fast-Growth Fires

Interior Firefighting Conditions and Deployment Configuration

The available time to control a fire can be quite small. Risks to firefighters are lower for smaller fires than larger fires because smaller fires are easier to suppress and produce less heat and fewer toxic gases. Therefore, firefighter deployment configurations that can attack fires earlier in the fire development process present lower risk to firefighters. The longer the duration of the fire development process without intervention, the greater the increase in risk for occupants and responding firefighters. Therefore, time is critical.

Stopping the escalation of the event involves firefighter intervention via critical tasks performed on the fireground. Critical tasks, as described previously, include those tasks that directly affect the spread of fire as well as the associated structural tenability.

There are windows of opportunity to complete critical tasks. A fire in a structure with a typical residential fuel load at six minutes post-ignition is very different from the same fire at eight minutes or at ten minutes post-ignition. Some tasks that are deemed "important" (e.g., scene size-up) for a fire in early stages of growth become critical if intervention tasks are delayed. Time can take away opportunities. If too much time passes, then the window of opportunity to affect successful outcomes (e.g., rescue victim or stop fire spread) closes.

For a typical structure fire event involving a fire department response, there is an incident commander on the scene who determines both the strategy and tactics that will be employed to stop the spread of the fire, rescue occupants, ventilate the structure, and ultimately extinguish the fire. Incident commanders must deal with the fire in the present and make intelligent command decisions based on the circumstances at hand upon arrival. Additionally, arrival time and crew size are factors that contribute to the incident commander's decisions and affect the capability of the firefighters to accomplish necessary tasks on scene in a safe, efficient, and effective manner.

Table 9 illustrates vividly the more dangerous conditions small crews face because of the extra time it takes to begin and complete critical tasks (particularly fire suppression). In the two minutes more it took for the two-person crew (early arrival) than the five-person crew (early arrival) to get water on the fire, a slow growth rate fire would have increased from 1.1 MW to 1.5 MW. This growth would have been even more extreme for a medium-or fast-growth rate fire. The difference is even more substantial for the two-person crew with late arrival as the fire almost doubled in size in the time difference between this crew and the five-person crew.

Based on fire modeling for the low hazard structure studied with a typical residential fuel load, it is likely that medium- and fast-growth rate fires will move beyond the room of origin prior to the arrival of firefighters for all crew sizes. Note that results in Table 8 included only the close-stagger rescue time data. The effect of far-stagger rescue times on occupant tenability should be investigated in future studies. Therefore, the risk level of the event upon arrival will be higher for all crews which must be considered by the incident commander when assigning firefighters to on-scene tasks.

Deployment Configuration	Time to Water on Fire (Min : Sec)	Fire Size at Time of Suppression for Slow-Growth Fires
2-Person, Late Arrival	14:26	2.1 MW
2-Person, Early Arrival	12:26	1.5 MW
3-Person, Late Arrival	13:24	1.8 MW
3-Person, Early Arrival	11:24	1.3 MW
4-Person, Late Arrival	13:11	1.7 MW
4-Person, Early Arrival	11:11	1.3 MW
5-Person, Late Arrival	12:33	1.6 MW
5-Person, Early Arrival	10:33	1.1 MW

Table 9: Fire Size at Time of Fire Suppression

Physiological Effects of Crew Size on Firefighters

Reports on firefighter fatalities consistently document overexertion/overstrain as the leading cause of line-of-duty fatalities. There is strong epidemiological evidence that heavy physical exertion can trigger sudden cardiac events (Mittleman et al. 1993; Albert et al. 2000). Therefore, information about the effect of crew size on physiological strain is very valuable.

During the planning of the fireground experiments, investigators at Skidmore College recognized the opportunity to conduct an independent study on the relationship between firefighter deployment configurations and firefighter heart rates. With the approval of the Institutional Review Board of Skidmore College, they were able to leverage the resources of the field experiments to conduct a separate analysis of the cardiac strain on fire fighters on the fireground.

For details, consult the complete report (Smith 2009). Two important conclusions from the report reinforce the importance of crew size:

- Average heart rates were higher for members of small crews, particularly two-person crews.
- Danger is increased for small crews because the stress of fire fighting keeps heart rates elevated beyond the maximum heart rate for the duration of a fire response, and so the higher heart rates were maintained for sustained time intervals.

Study Limitations

The scope of this study is limited to understanding the relative influence of deployment variables to low-hazard, residential structure fires, similar in magnitude to the hazards described in *NFPA 1710*. The applicability of the conclusions from this report to commercial structure fires, high-rise fires, outside fires, terrorism/natural disaster response, HAZMAT or other technical responses has not been assessed and should not be extrapolated from this report.

Every attempt was made to ensure the highest possible degree of realism in the experiments while complying with the requirements of *NFPA 1403*, but the dynamic environment on the fireground cannot be fully reproduced in a controlled experiment. For example, *NFPA 1403* required a daily walkthrough of the burn prop (including identifying the location of the fire) before ignition of a fire that would produce an Immediately Dangerous to Life and Health (IDLH) atmosphere, a precaution not available to responders dispatched to a live fire.

The number of responding apparatus for each fireground response was held constant (three engines and one truck, plus the battalion chief and aide) for all crew size configurations. The effect of deploying either more or fewer apparatus to the scene was not evaluated.

The fire crews who participated in the experiments typically operate using three-person and four-person staffing. Therefore, the effectiveness of the two-person and five-person operations may have been influenced by a lack of experience in operating at those staffing levels. Standardizing assigned tasks on the fireground was intended to minimize the impact of this factor, which has an unknown influence on the results.

The design of the experiments controlled for variance in performance of the incident commander. In other words, a more-or less-effective incident commander may have a significant influence on the outcome of a residential structure fire.

Although efforts were made to minimize the effect of learning across experiments, some participants took part in more than one experiment, and others did not.

The weather conditions for the experiments were moderate to cold. Frozen equipment such as hydrants and pumps was not a factor. However, the effect of very hot weather conditions on firefighter performance was not measured.

All experiments were conducted during the daylight hours. Nighttime operations could pose additional challenges.

Fire spread beyond the room of origin was not considered in the room and contents tests or in the fire modeling. Therefore, the size of the fire and the risk to the firefighter may be somewhat underestimated for fast-growing fires or slower-response configurations.

There is more than one effective way to perform many of the required tasks on the fireground. Attempts to generalize the results from these experiments to individual departments must take into account tactics and equipment that vary from those used in the experiments.

Conclusions

More than 60 laboratory and full-scale fire experiments were conducted to determine the impact of crew size, first-due engine arrival time, and subsequent apparatus arrival times on firefighter safety and effectiveness at a low-hazard residential structure fire. This report quantifies the effects of changes to staffing and arrival times for low-hazard residential firefighting operations. While resource deployment is addressed in the context of a single structure type and risk level, it is recognized that public policy decisions regarding the cost-benefit of specific deployment decisions are a function of many factors including geography, available resources, community expectations, as well as all local hazards and risks. Though this report contributes significant knowledge to community and fire service leaders in regard to effective resource deployment for fire suppression, other factors contributing to policy decisions are not addressed.

The objective of the experiments was to determine the relative effects of crew size, first-due engine arrival time, and stagger time for subsequent apparatus on the effectiveness of the firefighting crews relative to intervention times and the likelihood of occupant rescue using a parametric design. Therefore, the experimental results for each of these factors are discussed below.

Of the 22 fireground tasks measured during the experiments, the following were determined to have especially significant impact on the success of fire fighting operations. Their differential outcomes based on variation of crew size and/or apparatus arrival times are statistically significant at the 95 % confidence level or better.

Overall Scene Time:

The four-person crews operating on a low-hazard structure fire completed all the tasks on the fireground (on average) seven minutes faster — nearly 30 % — than the two-person crews. The four-person crews completed the same number of fireground tasks (on average) 5.1 minutes faster — nearly 25 % — than the three-person crew. For the low-hazard residential structure fire, adding a fifth person to the crews did not decrease overall fireground task times. However, it should be noted that the benefit of five-person crews has been documented in other evaluations to be significant for medium- and high-hazard structures, particularly in urban settings, and should be addressed according to industry standards.[18]

Time to Water on Fire:

There was a nearly 10 % difference in the "water on fire time" between the two and three-person crews and an additional 6 % difference in the "water on fire time" between the three- and four-person crews (i.e., 16 % difference between the four and two-person crews). There was an additional 6 % difference in the "water on fire'" time between the four- and five-person crews (i.e., 22 % difference between the five and two-person crews).

Ground Ladders and Ventilation:

The four-person crew operating on a low-hazard structure fire can complete laddering and ventilation (for life safety and rescue) 30 % faster than the two-person crew and 25 % faster than the three-person crew.

Primary Search:

The three-person crew started and completed a primary search and rescue 25 % faster than the two-person crew. In the same structure, the four- and five-person crews started and completed a primary search 6 % faster than the three-person crews and 30 % faster than the two-person crew. A 10 % difference was equivalent to just over one minute.

Hose Stretch Time:

In comparing four-and five-person crews to two-and three-person crews collectively, the time difference to stretch a line was 76 seconds. In conducting more specific analysis comparing all crew sizes to a two-person crew the differences are more distinct. A two-person crew took 57 seconds longer than a three-person crew to stretch a line. A two-person crew took 87 seconds longer than a four-person crew to complete the same tasks. Finally, the most notable comparison was between a two-person crew and a five-person crew — more than 2 minutes (122 seconds) difference in task completion time.

Industry Standard Achieved:

The "industry standard achieved" time started from the first engine arrival at the hydrant and ended when 15 firefighters were assembled on scene.[19] An effective response force was assembled by the five-person crews three minutes faster than the four-person crews. According to study deployment protocal, the two- and three-person crews were unable to assemble enough personnel to meet this standard.

Occupant Rescue:

Three different "standard" fires (slow-, medium-, and fast-growth rate) were simulated using the Fire Dynamics Simulator (FDS) model. The fires grew exponentially with time. The fire modeling simulations demonstrated that two-person, late arriving crews can face a fire that is twice the intensity of the fire faced by five-person, early arriving crews. The rescue scenario was based on a nonambulatory occupant in an upstairs bedroom with the bedroom door open.

Independent of fire size, there was a significant difference between the toxicity, expressed as fractional effective dose (FED), for occupants at the time of rescue depending on arrival times for all crew sizes. Occupants rescued by crews starting tasks two minutes earlier had lesser exposure to combustion products.

The fire modeling showed clearly that two-person crews cannot complete essential fireground tasks in time to rescue occupants without subjecting either firefighters or occupants to an increasingly hazardous atmosphere. Even for a slow-growth rate fire, the FED was approaching the level at which sensitive populations, such as children and the elderly are threatened. For a medium-growth rate fire with two-person crews, the FED was far above that threshold and approached the level affecting the median sensitivity in general population. For a fast-growth rate fire, the FED was well above the median level at which 50 % of the general population would be incapacitated. Larger crews responding to slow-growth rate fires can rescue most occupants prior to incapacitation along with early-arriving larger crews responding to medium-growth rate fires. The result for late-arriving (two minutes later than early-arriving) larger crews may result in a threat to sensitive populations for medium-growth rate fires." The new sentence is consistent with our previous description for two-person crews where we identify a threat to sensitive populations.. Statistical averages should not, however, mask the fact that there is no FED level so low that every occupant in every situation is safe.

18 NFPA Standard 1710 - A.5.2.4.2.1 …Other occupancies and structures in the community that present greater hazards should be addressed by additional fire fighter functions and additional responding personnel on the initial full alarm assignment.

19 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. Section 5.2.1 – Fire Suppression Capability and Section 5.2.2 Staffing.

Summary:

The results of these field experiments contribute significant knowledge to the fire service industry. First, the results establish a technical basis for the effectiveness of company crew size and arrival time in *NFPA 1710*. The results also provide valid measures of total effective response force assembly on scene for fireground operations, as well as the expected performance of time-to-critical-task measures for a low-hazard structure fires. Additionally, the results provide tenability measures associated with the occupant exposure rates to the range of fires considered by the fire model.

Future Research

In order to realize a significant reduction in firefighter line-of-duty death (LODD) and injury, fire service leaders must focus directly on resource allocation and the deployment of resources, both contributing factors to LODD and injury. Future research should use similar methods to evaluate firefighter resource deployment to fires in medium- and high-hazard structures, including multiple-family residences and commercial properties. Additionally, resource deployment to multiple-casualty disasters or terrorism events should be studied to provide insight into levels of risks specific to individual communities and to recommend resource deployment proportionate to such risk. Future studies should continue to investigate the effects of resource deployment on the safety of both firefighters and the civilian population to better inform public policy.

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APPENDIX A: Laboratory Experiments

The fire suppression and resource deployment experiments consisted of four distinct parts: laboratory experiments, time-to-task experiments, room and contents experiments and fire modeling. The purpose of the laboratory experiments was to assure a fire in the field experiments that would consistently meet *NFPA 1403* requirements for live fire training exercises. The laboratory experiments enabled investigators to characterize the burning behavior of the wood pallets as a function of:

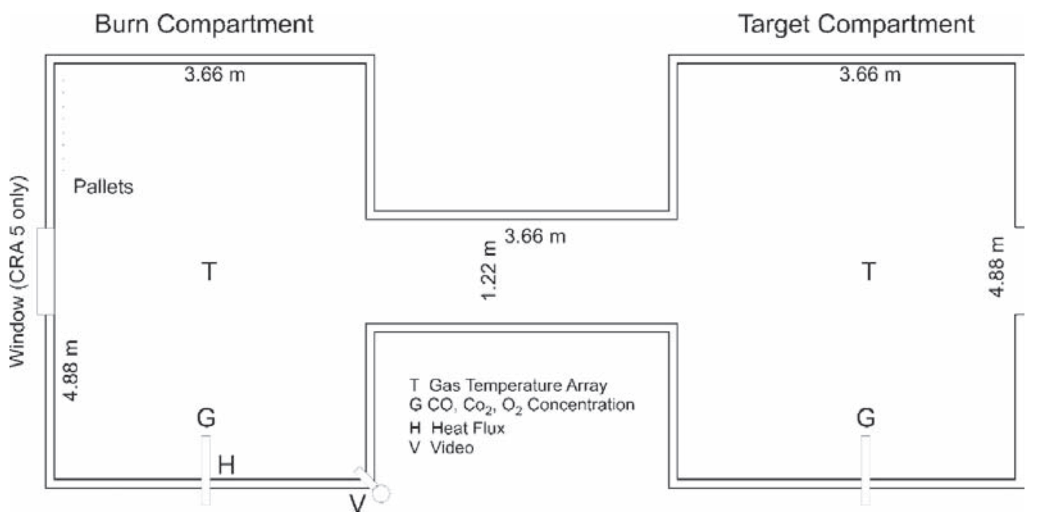


Figure A-1. Compartment Configuration and Instrumentation for Pallet Tests

- number of pallets and the subsequent peak heat release rate
- compartment effects on burning of wood pallets
- effect of window ventilation on the fire
- effect on fire growth rate of the loading configuration of excelsior (slender wood shavings typically used as packing material)

Design and Construction

Figure A-1 shows the experimental configuration for the compartment pallet burns. Two identically sized compartments (3.66 m x 4.88 m x 2.44 m) were connected by a hallway (4 m x 1 m x 2.4 m). At each end of the hallway, a single door connected the hallway to each of the compartments. In the burn compartment, a single window (3 m x 2 m) was covered with noncombustible board that was opened for some experiments and closed for others. At the end of test, it was opened to extinguish the remaining burning material and to remove any debris prior to the next test. In the second compartment, a single doorway connected the compartment to the rest of the test laboratory. It was kept open throughout the tests allowing the exhaust to flow into the main collection hood for measurement of heat release rate.

The structure was constructed of two layer of gypsum wallboard over steel studs. The floor of the structure was lined with two layers of gypsum wallboard directly over the concrete floor of the test facility. In the burn compartment, an additional lining of cement board was placed over the gypsum walls and ceiling surfaces near the fire source to minimize fire damage to the structure after multiple fire experiments. A doorway 0.91 m wide by 1.92 m tall connected the burn compartment to the hallway and an opening 1 m by 2 m connected the hallway to the target compartment. Ceiling height was 2.41 m throughout the structure, except for the slight variation in the burn room.

Fuel Source

The fuel source for all of the tests was recycled hardwood pallets constructed of several lengths of hardwood boards nominally 83 mm wide by 12.7 mm thick. Lengths of the individual boards ranged from nominally 1 m to 1.3 m. The finished size of a single pallet was approximately 1 m by 1.3 m by 0.11 m. **Figure A-2** shows the fuel source for one of the tests including six stacked pallets and excelsior ignition source. For an ignition source, excelsior was placed within the pallets, with the amount and location depending on the ignition scenario. Figure A-3 shows the pallets prior to a slow and a fast ignition scenario fire. Table A-1 details the total mass of pallets and excelsior for each of the free burn and compartment tests.

Experimental Conditions

The experiments were conducted in two series. In the first series, heat release measurements were made under free burn conditions beneath a 6 m by 6 m hood used to collect combustion gases and provide the heat release rate (HRR) measurement. A second series of tests was conducted with the fire in a compartmented structure to assess environmental conditions within the structure during the fires and determine the effect of the compartment enclosure on the fire growth. Table A-1 presents a summary of the tests conducted.

Figure A-2. Pallets and Excelsior Ignition Source Used as a Fuel Source

Table A-1. Tests Conducted and Ambient Conditions at Beginning of Each Test

Test	Test Type	Number of Pallets	Ignition Scenario	Total Pallet Mass (kg)	Excelsior Mass (kg)
PAL 1	Free burn	4	Fast	79.3	8.1
PAL 2	Free burn	6	Fast	118.8	15.1
PAL 3	Free burn	8	Fast	146.7	16.2
PAL 4	Free burn	4	Slow	51.0	1.65
PAL 5	Free burn	6	Slow	160.3	0.85
CRA 1	Compartment	6	Slow	114.0	0.83
CRA 2	Compartment	4	Slow	69.7	
CRA 3	Compartment	4	Fast	71.1	0.8
CRA 4	Compartment	4	Slow	73.9	0.83
CRA 5	Compartment	4	Slow	73.8	0.85

Notes: PAL stands for "pallet" and CRA ("Community Risk Assessment") is the designator for the configuration of pallets burned in the compartment. Efforts were made to use the same amount of excelsior mass for CRA 2 (~0.8 kg), but the value was not measured.

Figure A-3. Fuel and Excelsior Source for Slow (top) and Fast (bottom) Ignition Scenarios

Measurements Conducted

Heat release rate (HRR) was measured in all tests. HRR measurements were conducted under the 3 m by 3 m calorimeter at the NIST Large Fire Research Laboratory. The HRR measurement was based on the oxygen consumption calorimetry principle first proposed by Thornton (Thornton 1917) and developed further by Huggett (Huggett 1980) and Parker (Parker 1984). This method assumes that a known amount of heat is released for each gram of oxygen consumed by a fire. The measurement of exhaust flow velocity and gas volume fractions (O_2, CO_2 and CO) were used to determine the HRR based on the formulation derived by Parker (Parker 1984) and Janssens (Janssens 1981). The combined expanded relative uncertainty of the HRR measurements was estimated at ± 14 %, based on a propagation of uncertainty analysis (Bryant 2004).

For the compartment fire tests, gas temperature measurements were made in the burn compartment and in the target compartment connected by a hallway to the burn compartment using 24 gauge bare-bead chromel-alumel (type K) thermocouples positioned in vertical array. Thermocouples were located at the center of each compartment at locations 0.03 m, 0.30 m, 0.61 m, 0.91 m, 1.22 m, 1.52 m, 1.83 m, and 2.13 m from the ceiling. The expanded uncertainty associated with a type K thermocouple is approximately ± 4.4° C. (Omega 2004)

Gas species were continuously monitored in the burn compartment at a level 0.91 m from the ceiling at a location centered on the side wall of the compartment, 0.91 m from the wall. Oxygen was measured using paramagnetic analyzers. Carbon monoxide and carbon dioxide were measured using non-dispersive infrared (NDIR) analyzers. All analyzers were calibrated with nitrogen and a known concentration of gas prior to each test for a zero and span concentration calibration. The expanded relative uncertainty of each of the span gas molar fractions is estimated to be ± 1 %.

Total heat flux was measured on the side wall of the enclosure at a location centered on the side wall, 0.61 m from the ceiling level. The heat flux gauges were 6.4 mm diameter Schmidt-Boelter type, water cooled gauges with embedded type-K thermocouples (see Figure A-4). The manufacturer reports a ± 3 % expanded uncertainty in the response calibration (the slope in $kW/m^2/mV$). Calibrations at the NIST facility have varied within an additional ± 3 % of manufacturer's calibration. For this study, an uncertainty of ± 6 % is estimated.

Figure A-4: Heat Flux Gauge with Radiation Shielding

Test	Test Type	Number of Pallets	Ignition Scenario	Peak HRR (kW)	Time to Peak HRR (s)
PAL 1	Free burn	4	Fast	2144	205
PAL 2	Free burn	6	Fast	2961	320
PAL 3	Free burn	8	Fast	3551	301
PAL 4	Free burn	4	Slow	1889	385
PAL 5	Free burn	6	Slow	2410	986
CRA 1	Compartment	6	Slow	1705	1102
CRA 2	Compartment	4	Slow	1583	649
CRA 3	Compartment	4	Fast	1959	159
CRA 4	Compartment	4	Slow	1620	775
CRA 5	Compartment	4	Slow	1390	927

Table A-2. Peak Heat Release Rate During Several Pallet Tests in Free-burn and in a Compartment

Results

Table A-2 shows the peak HRR and time to peak HRR for the free burn tests and for the compartment tests. Figure A-5 includes images from the free burn experiments near the time of peak HRR for each of the experiments. Figure A-6 illustrates the progression of the fire from the exit doorway looking down the hallway to the burn compartment for one of the tests. Figure A-7 to Figure A-10 present graphs of the heat release rate for all of the tests. Figure A-11 through Figure A-15 shows the gas temperature, major gas species concentrations, and heat flux in the burn compartment and target compartment in the five compartment tests.

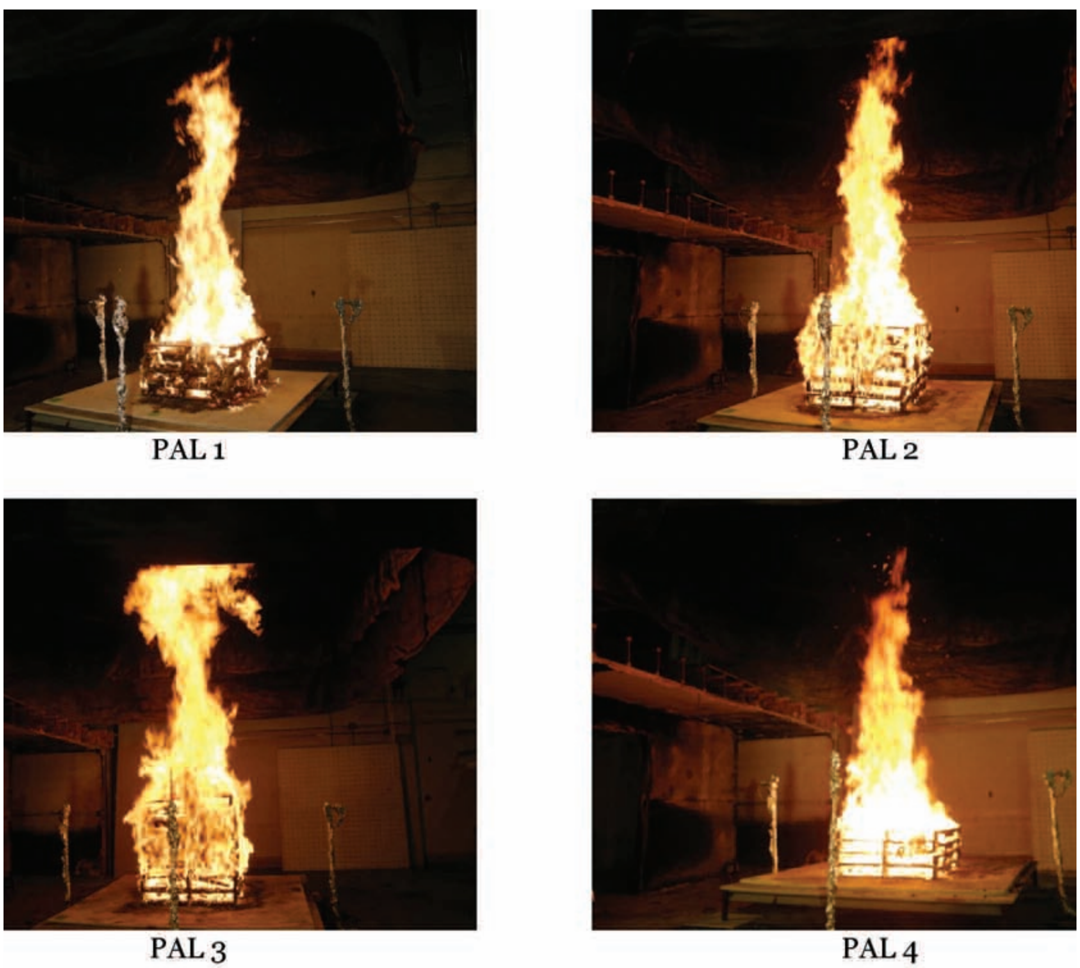


Figure A-5. Free-Burn Experiments Near Time of Peak Burning

Figure A-6. Example Fire Progression from Test CRA 1

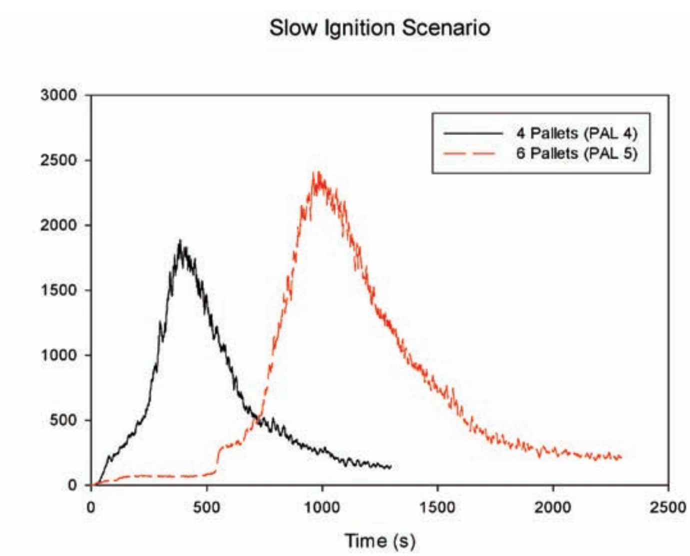


Figure A-7. HRR, Slow Ignition, Free Burn Scenario

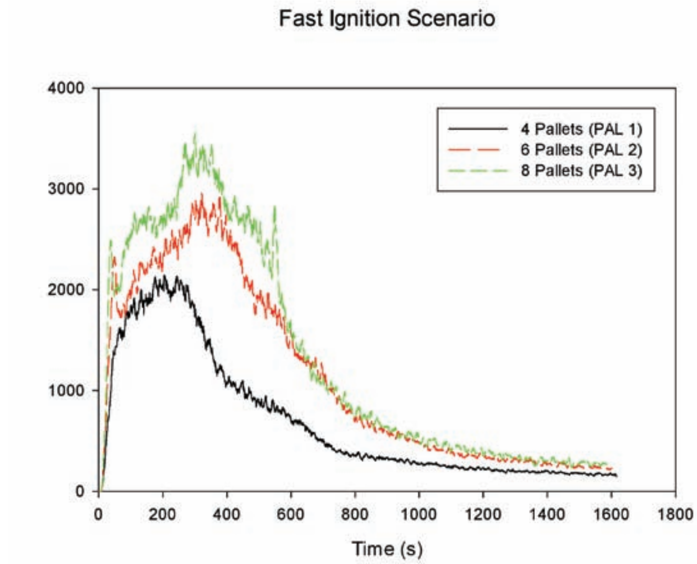


Figure A-8. HRR, Fast Igntion, Free Burn Scenario

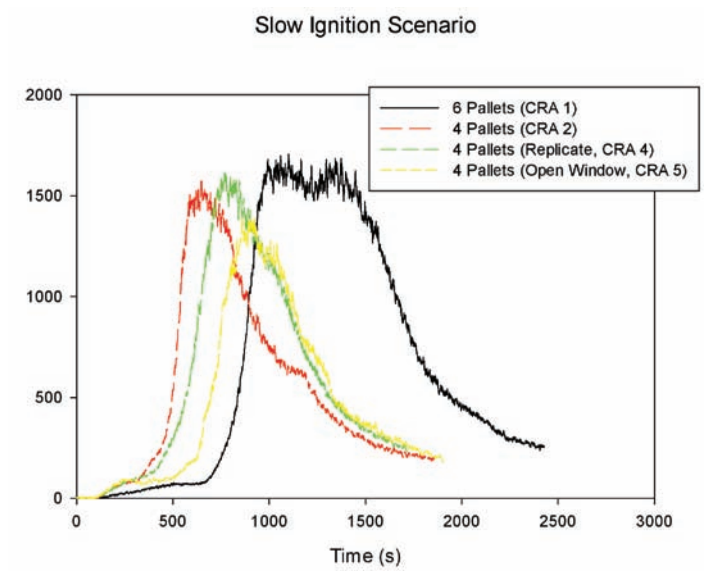


Figure A-9. HRR, Slow Ignition, Compartment Test

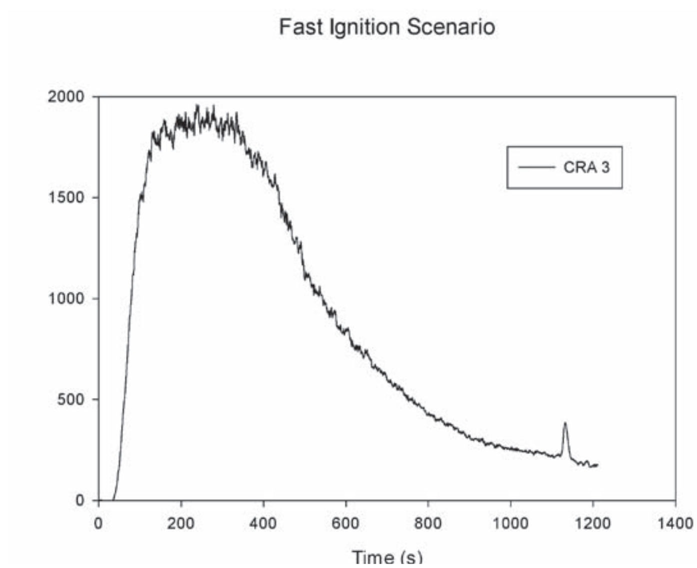
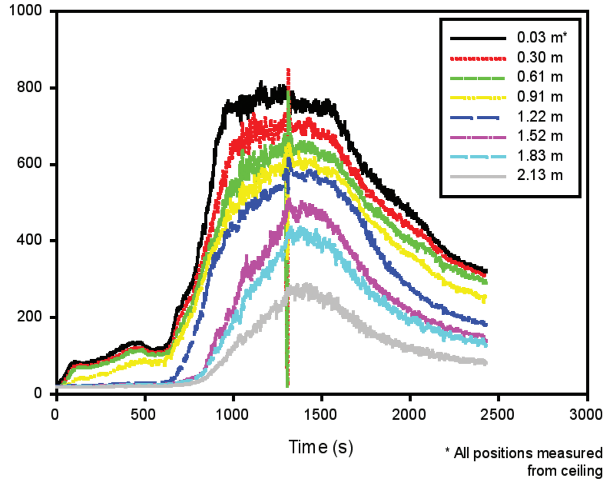
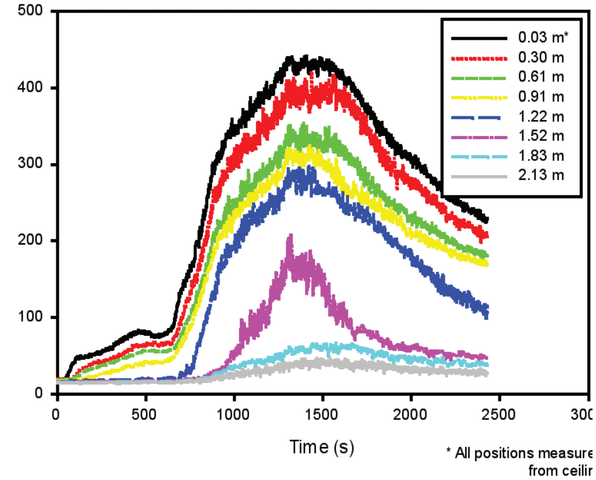


Figure A-10. HRR, Fast Ignition, Compartment Test

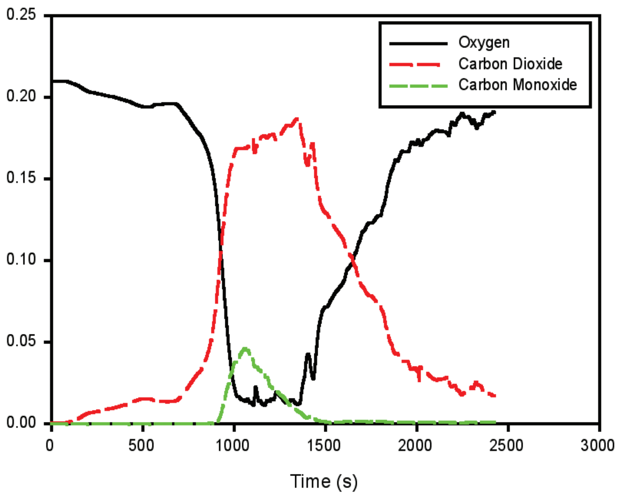
6 Pallets, Slow Ignition Scenario, Burn Room



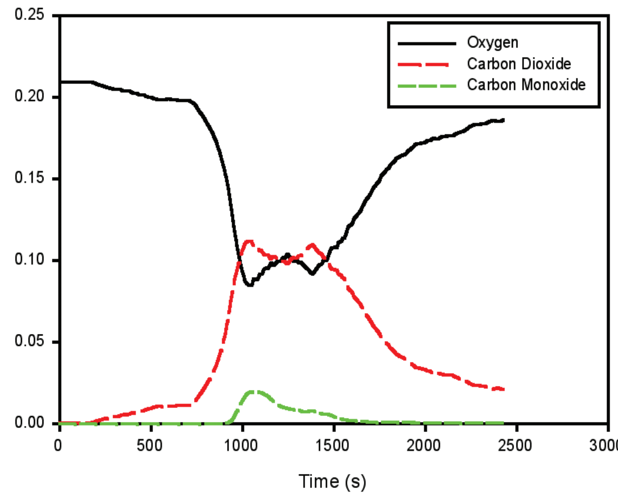
6 Pallets, Slow Ignition Scenario, Target Room



6 Pallets, Slow Ignition Scenario, Burn Room



6 Pallets, Slow Ignition Scenario, Target Room



6 Pallets, Slow Ignition Scenario, Burn Room

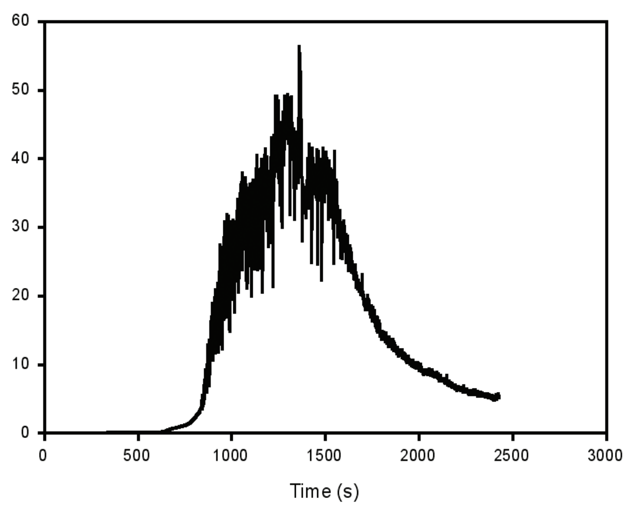
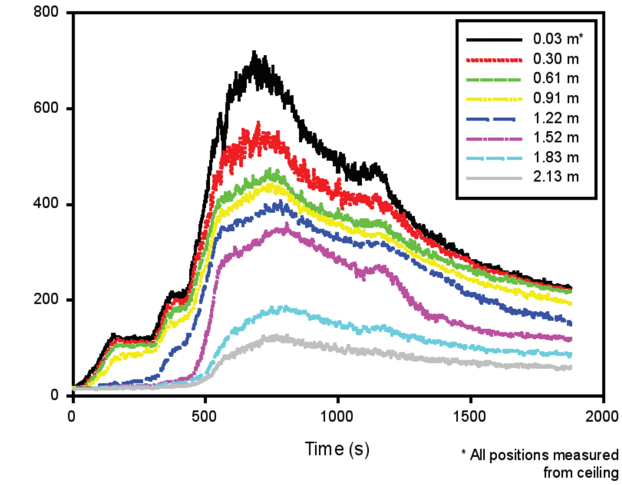
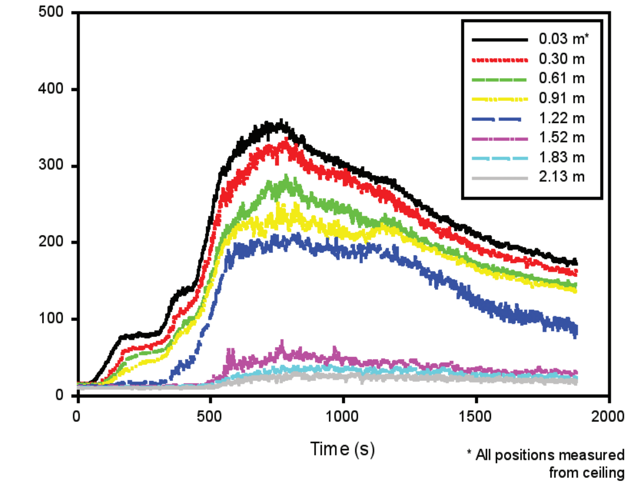


Figure A-11. Temperature, Gas Concentration, and Heat Flux During Test CRA 1, 6 Pallets, Slow Ignition Scenario

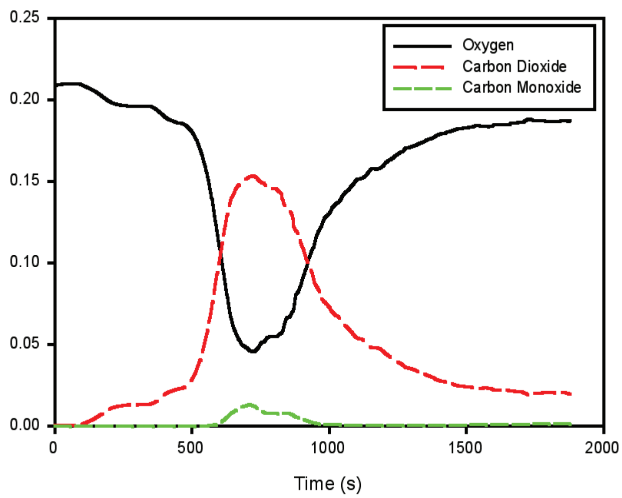
4 Pallets, Slow Ignition Scenario, Burn Room



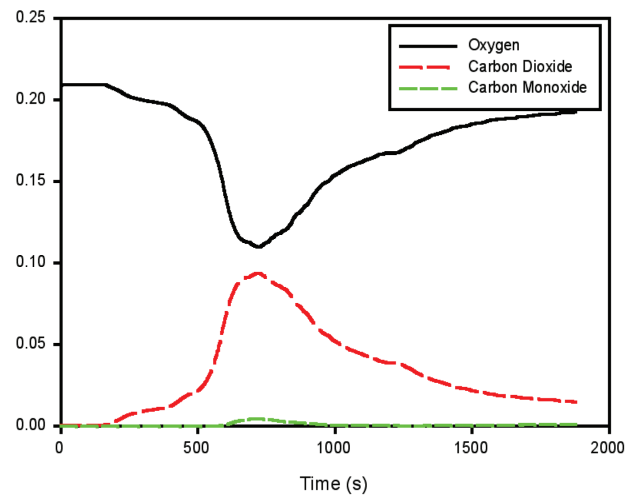
4 Pallets, Slow Ignition Scenario, Target Room



4 Pallets, Slow Ignition Scenario, Burn Room



4 Pallets, Slow Ignition Scenario, Target Room



4 Pallets, Slow Ignition Scenario, Burn Room

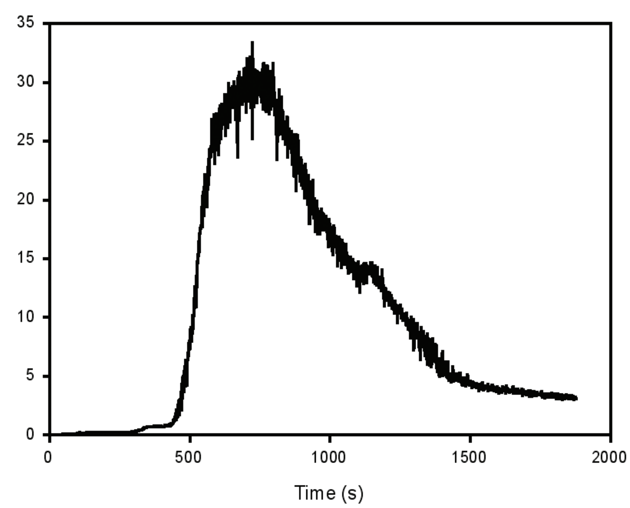


Figure A-12. Temperature, Gas Concentration, and Heat Flux During Test CRA 2, 4 Pallets, Slow Ignition Scenario

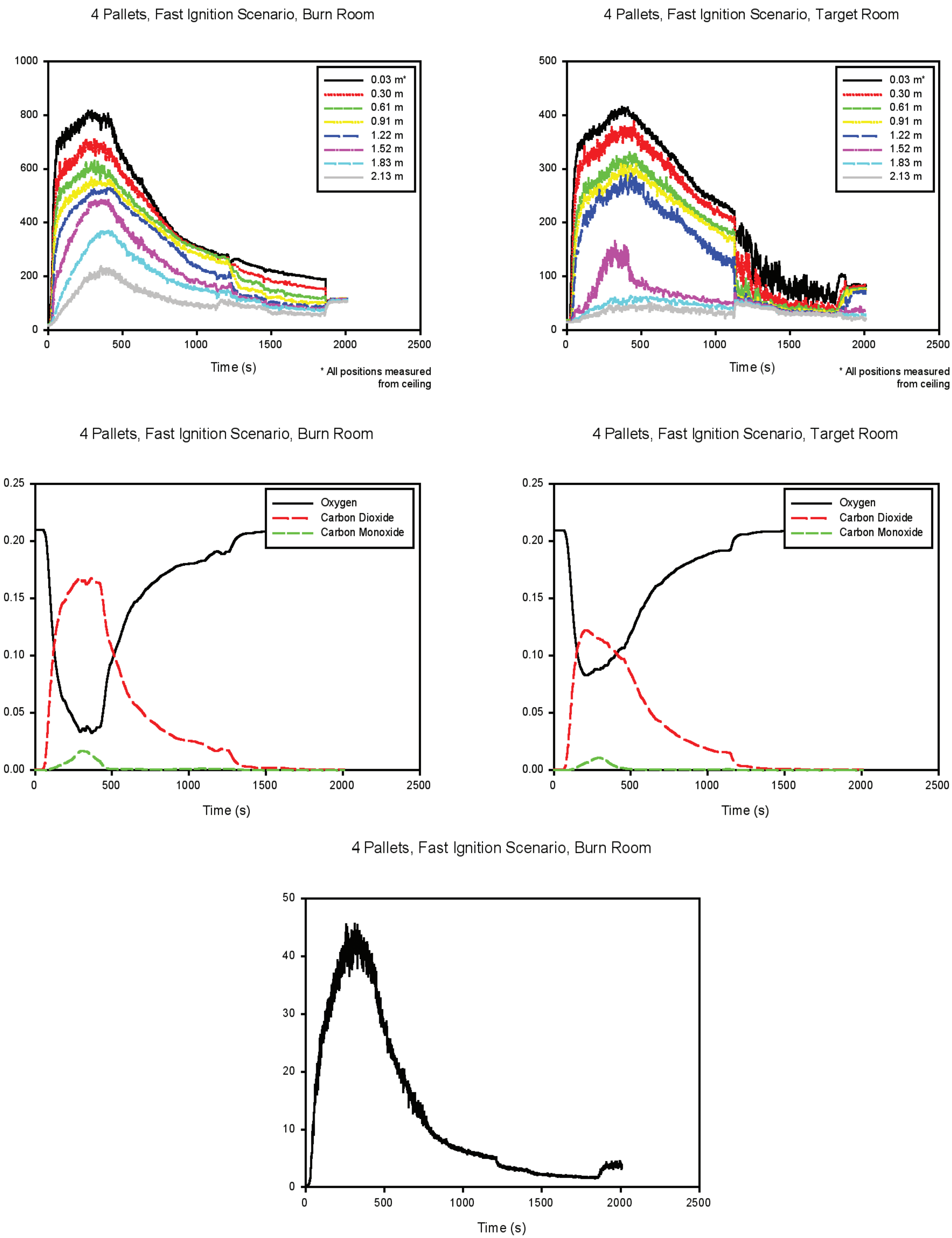
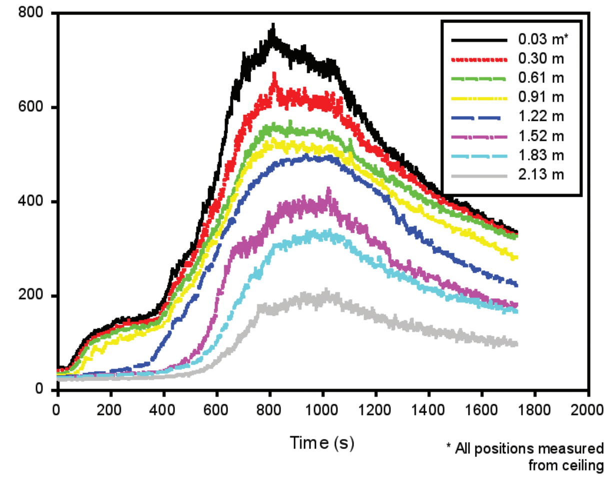
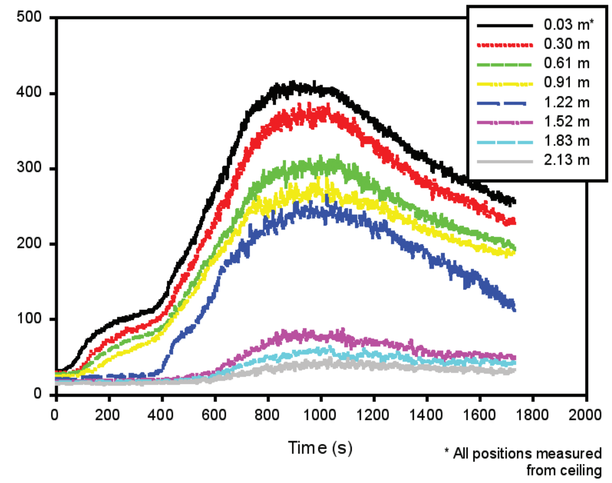


Figure A-13. Temperature, Gas Concentration, and Heat Flux During Test CRA 3, 4 Pallets, Fast Ignition Scenario

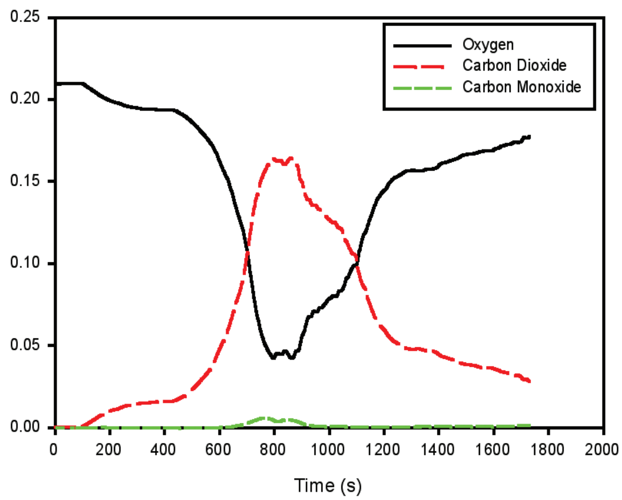
4 Pallets, Slow Ignition Scenario, Burn Room
(Replicate)



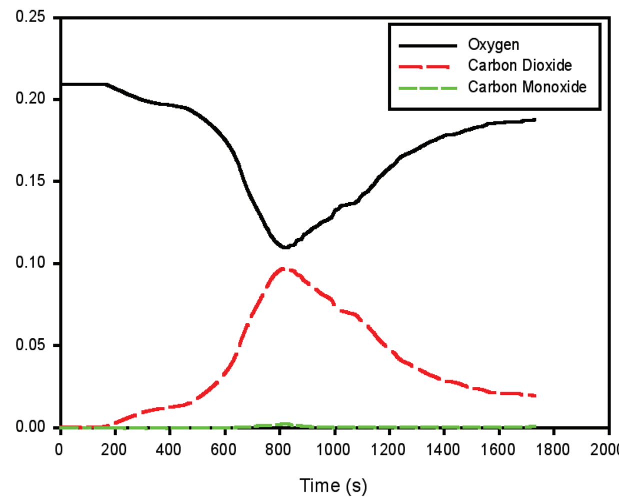
4 Pallets, Slow Ignition Scenario, Target Room
(Replicate)



4 Pallets, Slow Ignition Scenario, Burn Room
(Replicate)



4 Pallets, Slow Ignition Scenario, Target Room
(Replicate)



4 Pallets, Slow Ignition Scenario, Burn Room
(Replicate)

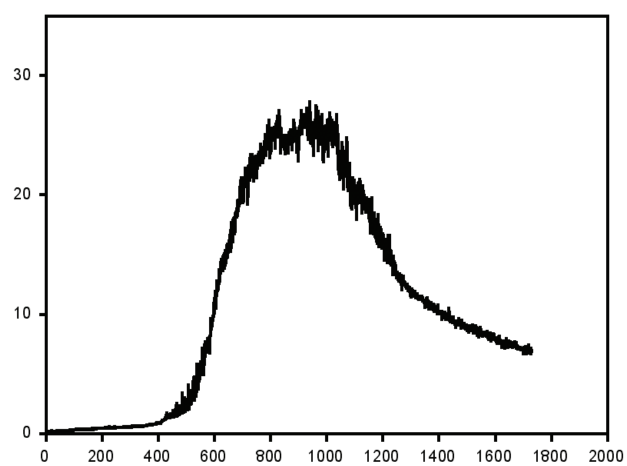


Figure A-14. Temperature, Gas Concentration, and Heat Flux During Test CRA 4, 4 Pallets, Slow Ignition Scenario (Replicate)

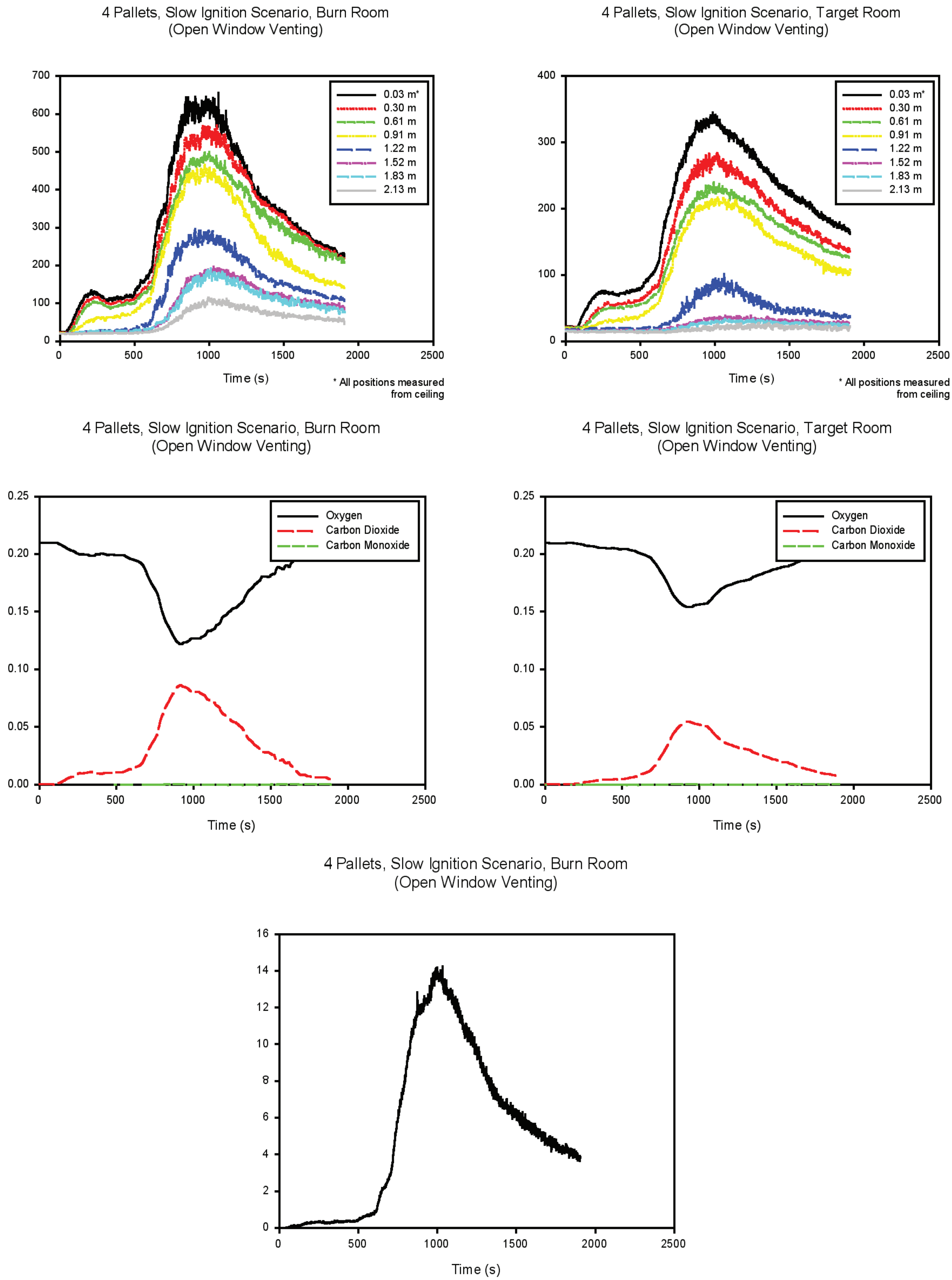


Figure A-15. Temperature, Gas Concentration, and Heat Flux During Test CRA 5, 4 Pallets, Slow Ignition Scenario (Open Window Venting)

APPENDIX B: Designing Fuel Packages for Field Experiments

Based upon the results of the laboratory experiments, the project team determined that four pallets would provide both a realistic fire scenario, as well as a repeatable and well-characterized fuel source. Varying the placement and quantity of excelsior provided significant variance in the rate of fire growth. Prior to finalization of the fuel package and construction specifications, modeling was used to ensure that the combination of fuel and residential geometry would result in untenable conditions throughout the structure without subjecting the firefighters to unsafe testing conditions. Therefore, CFAST (the consolidated fire and smoke transport model (Jones 2000)) and FDS (fire dynamics simulator model (McGrattan 2006)) were used to predict the temperatures and toxic species within the structure as a function of the experimentally determined heat release rates. The results summarized below confirmed that the building geometry and fuel package produced adequate variation in tenability conditions in the residential structure and ensured that the room of origin would not reach flashover conditions (a key provision of *NFPA 1403*). Meeting these conditions provided the foundation for experiments to meet the two primary objectives of fire department response: preservation of life and property.

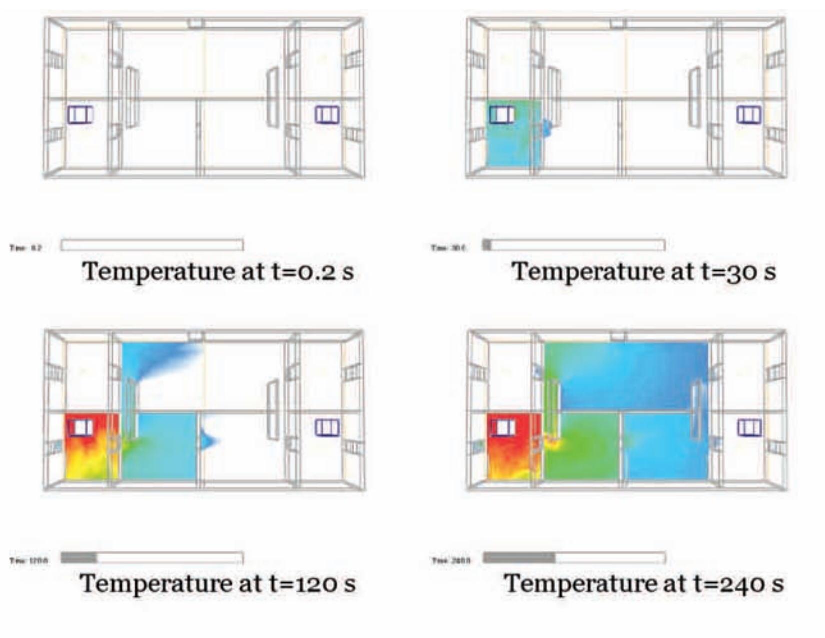


Figure B-1 and B-2 show the thermal and smoke conditions in the residential structure at different time periods using the fast growth, four pallet fuel package.

The results of the fire modeling indicated development of untenable conditions in the field experiments between 5 and 15 minutes, depending upon several factors: fire growth rate, ventilation conditions, the total leakage of heat into the building and through leakage paths, and firefighter intervention. This time frame allowed for differentiation of the effectiveness of various fire department deployment models.

Figure B-1: Time-dependent temperature contours in field structure with fast growth fire

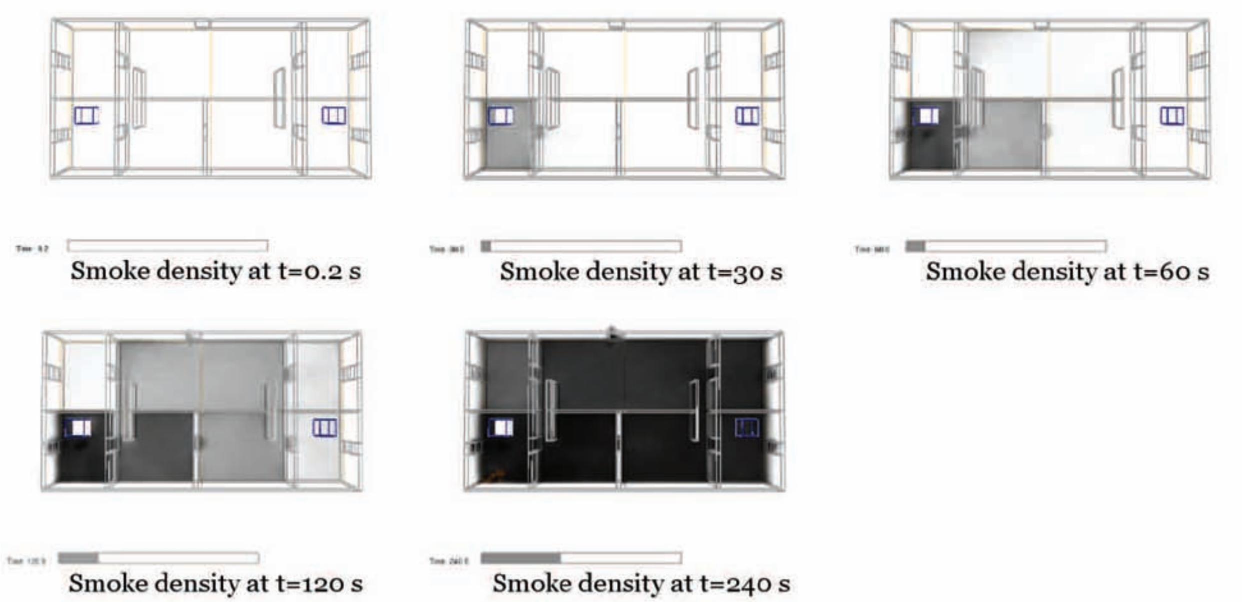


Figure B-2: Time-dependent smoke density contours in field structure with fast growth fire

APPENDIX C: Temporary Burn Prop Construction and Instrumentation

Through the generosity of the Montgomery County (MD), an open space was provided to construct a temporary burn prop at the Montgomery County Fire and Rescue Training Facility in Rockville, MD. The area had ready access to water and electrical utilities. A licensed general contractor was retained, including a structural engineer for the design of critical ceiling members, and the burn prop was constructed over a several month period in late 2008.

The burn prop consisted of two 2,000 ft.^{2} (186 m^2) floors totaling 4,000 ft.^{2} (372 m^2). An exterior view of two sides of the burn prop is shown in Figure C-1.

Additional partitions were installed by NIST staff to create a floor plan representative of a two-story, 186 m^2 (2,000 ft.^{2}) single family residence. Note that the structure does not have a basement and includes no exposures. The overall dimensions are consistent with the general specifications of a typical low hazard residential structure that many fire departments respond to on a regular basis, as described in *NFPA 1710*.

Further details about typical single family home designs are not provided in the standard. Therefore, a floor plan representative of a typical single family home was created by the project team. Details and floor plan dimensions are shown in Figure C-2.

Figure C-1: View of two sides of the burn prop

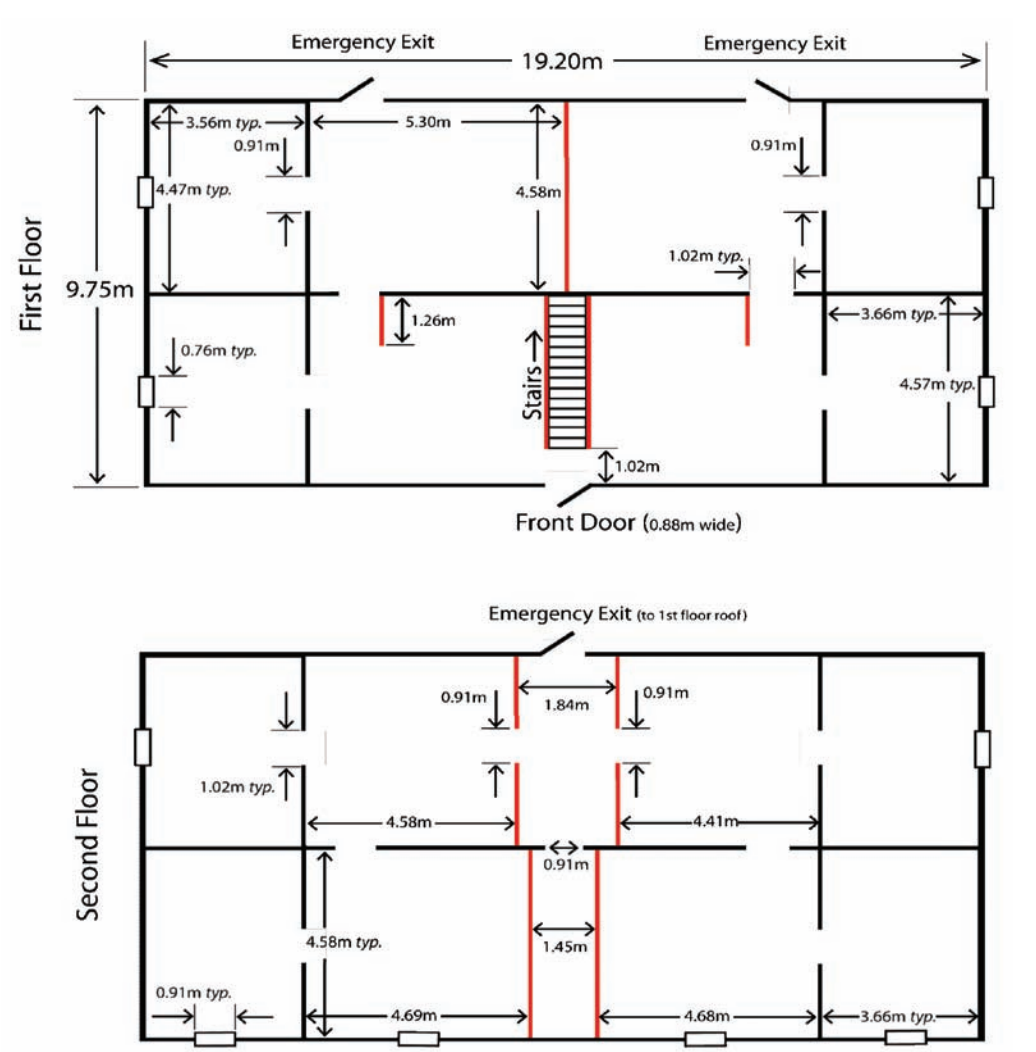


Figure C-2: Dimensions of the Burn Prop Floor Plan

The black lines indicate load-bearing reinforced concrete walls and red lines indicate the gypsum over steel stud partition walls. The ceiling height, not shown in Figure C-2, is 94 in. (2.4 m) throughout the entire structure except in the burn compartments, where the ceiling height is 93 in. (2.4 m). The purpose of the partition walls was to symmetrically divide the structure about the short axis in order to allow one side of the test structure to cool down and dry-out after a fire test with suppression while conducting experiments on the other side.

The concrete walls original to the burn prop were 8 in. (204 mm) thick steel reinforced poured concrete and the floors on the first level and second levels were 4 in. (102 mm) thick poured concrete. The support structure for the second floor and the roof consisted of corrugated metal pan welded to open web steel joists. The dimensions of the joists are shown in Figure C-3. The ceiling was constructed from ½ in. (13 mm) thick cement board fastened to the bottom chord of the steel joists. Partition walls were constructed from 5/8 in. (17 mm) thick gypsum panels attached to 20 gauge steel studs fastened to steel track, spaced 16 in. (407 mm) on center.

Additional construction was implemented in the burn compartments to address thermal loading and hose stream impingement concerns. Spray-on fireproofing was applied to the steel joists prior to fastening the ceiling, as shown in Figure C-4. The ceilings were constructed with three layers of ½ in. (13 mm) cement board, as opposed to one layer construction in the rest of the building. Each layer was fastened in a different direction so that seams of adjacent layers ran orthogonally. The difference in ceiling heights previously

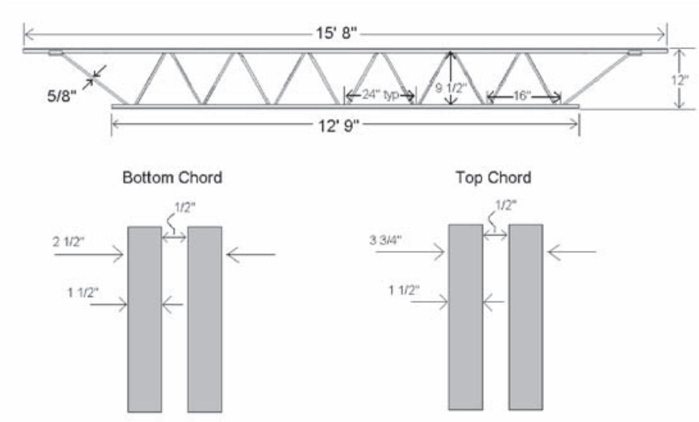


Figure C-3: Structural Steel Dimensions

mentioned is the result of the two additional sheets of cement board. The burn compartment walls were constructed from a single layer of ½ in. (13 mm) cement board over a single layer of 5/8 in. (16 mm) gypsum board, attached to 7/8 in. (22 mm) offset metal furring strips. Particular care was taken so that all ceiling and partition wall seams were filled with chemically-setting type joint compound to prevent leakage into the interstitial space between the ceiling and the floor above. After construction of the ceiling was complete, a dry-standpipe deluge system was installed with one head in each burn room to provide emergency suppression. During an experiment, a 2.5 in. (104 mm) ball valve fitting was attached and charged from a nearby hydrant. Figure C-5 was taken during the process of replacing "worn out" ceiling panels and shows the additional construction implemented in the burn room as well as the deluge sprinkler head.

Windows and exterior doors were constructed to be non-combustible. Windows were fabricated from 0.25 in. (10 mm) thick steel plate and the exterior doors were of prefabricated hollow-core steel design. The windows on the first floor were 30 in. (0.76 m) width x 36 in. (0.91 m) height and 36 in. (0.91 m) width x 40 in. (1.02 m) height on the second floor. Exterior doors were 35.8 in. (0.88 m) width x 80.5 in. (2.03 m) height. There were no doors attached to the doorways inside the structure. Figure C-6 shows the construction of the burn prop windows as well as the NFPA 1403-compliant latch mechanism. Figure C-7 is a picture of the interior of the burn prop taken just outside the burn compartment, showing the construction of the ceiling, interior doorway construction, gypsum wing wall and the joint compound used to seal seams in the ceiling and walls.

Instrumentation

After construction, the instrumentation to measure the propagation of products of combustion was installed throughout the burn prop. The instrumentation plan was designed to measure gas temperature, gas concentrations, heat flux, visual obscuration, video, and time during the experiments. The data were recorded at intervals of 1 s on a computer based data acquisition system. A schematic plan view of the instrumentation arrangement is shown in Figure C-8.

Table C-1 gives the locations of all of the instruments.

Figure C-4: Fireproofing added to structural steel

Figure C-5: Additional construction of burn room walls and ceiling and deluge sprinkler head.

Figure C-6: Window & Latch Construction

Figure C-7: Interior View of Burn Prop

Measurements taken prior to the compartment fire experiments were length, wood moisture content, fuel mass and weather conditions (relative humidity, temperature, wind speed and direction). Gas temperatures were measured with two different constructs of type K (Chromel-Alumel) thermocouples. All thermocouples outside the burn compartments were fabricated from 30 gauge glass-wrapped thermocouple wire. Vertical arrays of three thermocouples were placed near the front door on the north side and south sides of the stairwell on the first floor. On the second floor, vertical arrays of eight thermocouples were placed near the center of each target room. Inside the burn compartments, seven 3.2 mm (0.125 in.) exposed junction thermocouples and 0.76 m (30 in.) SUPER OMEGACLAD XL® sheathed thermocouple probes were arranged in a floor-to-ceiling array. Figure C-9 shows the vertical array in the burn

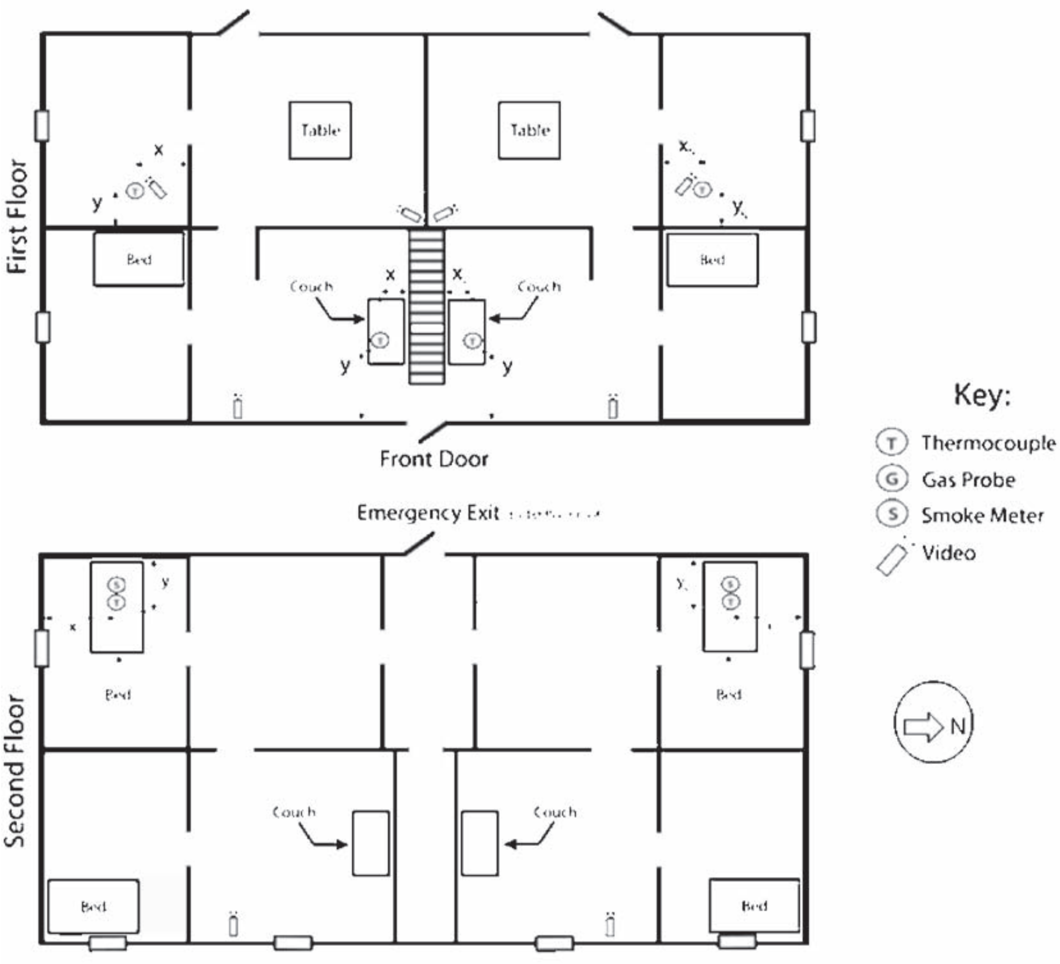


Figure C-8: Instrumentation & Furniture Prop Layout

compartment. Type K thermocouple probes were chosen because of their ability to withstand high temperature, moisture and physical abuse resulting from physical contact with hose streams and firefighters. To protect the extension wire and connectors from the effects of heat and water, through-holes were drilled in the burn compartment walls and the sheaths were passed through from the adjacent compartment. To prevent leakage through the holes, all void spaces were tightly packed with mineral wool. Inside the burn compartment the end of each probe was passed through an angle iron stand, and fastened to the floor and ceiling to provide additional protection from physical contact with firefighters and to ensure that the measurement location remained fixed throughout the experiments. In consideration of the risk associated with heating the open web steel joists, additional thermocouples were placed above each burn compartment to monitor the temperature of the interstitial space.

Table C-1: Detailed locations of instruments within respective rooms

Floor	Instrument	X_S [m]	Y_S [m]	Z_S [m]	X_N [m]	Y_N [m]	Z_N [m]	X_C [m]	Y_C [m]	Z_C [m]
1	**Thermocouple**	0.76	0.51	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13	0.76	0.51	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13	Find	Find	0.91, 1.52, 2.41
	HF Gauge 1		N/A		0.91	0.91	0.17			
	HF Gauge 2				0.5	0.66	1			
2	**Thermocouple**	1.83	0.91	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13, 2.41	1.83	0.91	0.3, 0.61, 0.91, 1.22, 1.52, 1.83, 2.13, 2.41		N/A	
	Smoke Meter	1.7	0.49	1.52	1.64	0.43	1.5			
	Gas Probe	1.83	0.91	1.7	1.83	0.91	1.52			

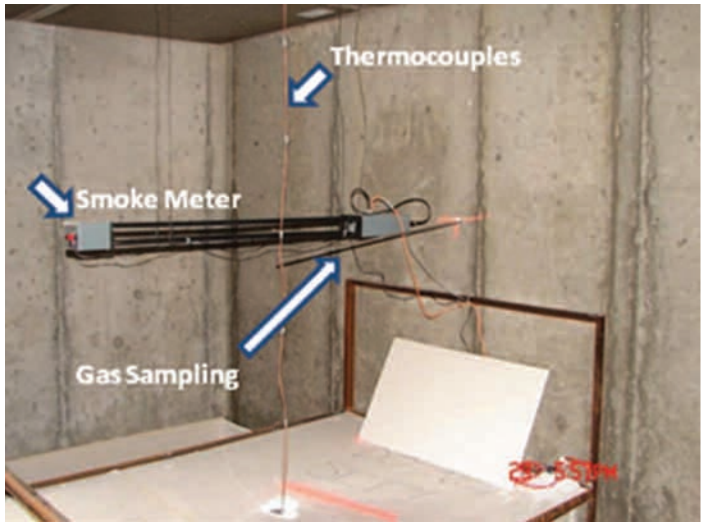


Figure C-9: Burn Room Thermocouple Array   Figure C-10: Target Room Instrument Cluster

Gas concentrations were sampled at the same location in each target room. Both gas probes were plumbed to the same analyzer and isolated using a switch valve; gas was only sampled at one location during any given test. The gas sampling points were located in the center of the West wall (C Side) of both rooms, 1.5 m (5 ft.) above the floor. The sampling tubes were connected to a diaphragm pump which pulled the gas samples through stainless steel probes into a sample conditioning system designed to eliminate moisture in the gas sample. The dry gas sample was then piped to the gas analyzer setup. In all of the experiments, oxygen was measured using a paramagnetic analyzer and carbon monoxide and carbon dioxide were measured using a non-dispersive infrared (NDIR) analyzer. One floor-to-ceiling thermocouple array was also co-located with each sample port inlet.

Schmidt-Boelter heat flux gauges were placed in the North burn room. One gauge was located 1.0 m (3.3 ft.) above the floor and was oriented towards the fire origin (waste basket). This heat flux gauge was placed to characterize the radiative heat flux at the face piece level that would be experienced by a firefighter inside the room. A second flux gauge was placed on the floor in order to characterize the radiative heat flux from the upper layer and to make an estimate of how close the room was to flashing over with respect to time from ignition (using the common criteria of flashover occurring at ~20kW/m^2 at the floor level). The heat flux gauges were co-located with the thermocouple probe array.

Figure C-11: Non-combustible "Prop" Table

All length measurements were made using a steel measuring tape. Wood moisture content measurements were taken using a non-insulated-pin type wood moisture meter. Fuel mass was measured prior to each experiment using a platform-style heavy duty industrial scale. Mass was not measured after each experiment because of the absorption of fire suppression water. Publicly accessible Davis Vantage Pro2 weather instrumentation (available via http://www.wunderground.com) located approximately two miles from the experimentation site was used to collect weather data in five minute intervals for the each day that the experiments were conducted. Figure C-10 is a photograph of the West wall of the North target room, showing the thermocouple array, the smoke obscuration meter, and a gas sampling probe used during the phase two experiments. The layout is identical to that in the South target room.

Non-combustible "prop" furniture was fabricated from angle iron stock and gypsum wallboard. The purpose of the furniture was twofold. The furniture was placed inside the burn prop to simulate realistic obstacles which obscure the search paths and hose stream advancement. The second use for the furniture was so that measurement instrumentation could be strategically placed within the frame of the furniture. This served to protect instrumentation from physical damage as a result of contact with firefighters and their tools. Figure C-11 shows an example of a table placed outside the burn room.

All instruments were wired to a centralized data collection room, shown in Figure C-12, which was attached as a separate space on one side of the building. This ensured physical separation for the data collection personnel from the effects of the fire, while minimizing the wire and tube lengths to the data logging equipment. Note that the roof of the instrument room was designed to serve as an additional means of escape for personnel from the second floor of the burn prop through a metal door. A railing was installed in order to minimize the fall risk in the event that the emergency exit was required.

Outside

Inside

Figure C-12: Instrumentation Room

Table C-2: Dimensions and Mass of Furniture for Room and Contents Tests					
Furniture	Width [m]	Depth [m]	Height [m]	Mass [kg]	Material
Couch	1.8	0.8	0.9	58.1	See D-3
Dresser	1.8	0.5	0.6	72.3	Laminated Particle Board
Nightstand	0.5	0.6	0.61	22.7	Laminated Particle Board
Chair	0.5	0.7	0.6	9.2	Wood, Fabric, and Polyurethane Foam
	Back cushion = 0.1m, Bottom cushion = 0.07m				
Blanket	1.8	-	2.4	1.3	100 % Cotton
Body Pillow	0.5	-	1.4	1.3	100 % cotton cover, polyester fill
Trash Can	0.4	0.3	0.4	1.3	Polypropylene
Towel	0.8	-	1.4	0.4	100 % Cotton
Wallboard	1.2	0.003	2.4	9.0	MDF

Table C-3: Materials in Couch	
Body:	Resinated dyed fiber (unknown material) 3 %
	PU foam pad 46%
	Waste fiber batting (unknown material) 26 %
	Polyester fiber batting 25 %
Cushions:	PU foam pad 86 %
	Polyester fiber batting 14 %

Time-to-Task Data Collection Chart

Date ______________ Start Time __________ End Time (all task complete) __________

Timer Name ____

Task	Start Time	Completion Time	Duration
Stop at Hydrant-- Wrap Hose			
Position Engine 1			
Conduct Size-up - 360^{o} lap - Transmit report - establish command			
Engage Pump			
Position attack line (stop time – at front door)			
Establish 2-in-2-out			
Charge Hydrant – supply attack Engine			
Establish RIT			
Gain/Force Entry			
Advance Line (stop time –water on fire)			
Deploy Back up line (stop time at front door)			
Advance Back up line/protect stairwell (start time at front door – Stop at stairwell)			
Conduct Primary Search			
Ground Ladders in Place			
Horizontal Ventilation (ground)			
Horizontal Ventilation (2nd story)			
Control Utilities (interior)			
Control Utilities (exterior)			
Conduct Secondary Search			
Check for Fire Extension (walls)			
Check for Fire Extension (ceiling)			
Mechanical Ventilation			

Company Protocols: Crew Size of 2

(10 total personnel on scene)

PLUS 4 RIC – 1403 = total 14 needed

Tasks/Company	Engine 1/2	Truck 1/2	Engine 2/2	Battalion Chief/ Aide	Engine 3/2
Arrive on Scene - Arrive/ stop at hydrant - Position engine ———————— - Layout report - On-scene report - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360º lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine	Driver/O Driver/O Driver/O	Position Truck	-Dry Lay – 2nd engine takes hydrant - Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - ---------------- - Advance	Officer – (Not interior—just front door) Officer	Officer			
Establish - 2 in – 2 out (Initial RIT)		O/D			
Establish RIT (Dedicated)		O/D (performs all RIT duties)			

Tasks/Company	Engine 1/2	Truck 1/2	Engine 2/2	Battalion Chief/ Aide	Engine 3/2
Gain/ Force Entry		O/D			
Advance Line - scan search fire room - suppression	Officer (if officer commits then he must pass command)		Officer		
Deploy Back-up Line and protect stairwell					O/D
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors					O/D
Ventilation (vent for fire or vent for life) - Horizontal - Ventilation		Driver/Officer			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver /Officer			
Control Utilities (Interior and exterior)					Driver/Officer
Conduct Secondary Search - Search Fire Floors - Search other Floors Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	Officer Officer		Officer Officer		O/D
Mechanical Ventilation		Driver/Officer			

Company Protocols: Crew Size of 3

(14 total personnel on scene)

PLUS 4 RIC – 1403 = total 18 needed

Tasks/Company	Engine 1/3	Truck 1/3	Engine 2/3	Battalion Chief/ Aide	Engine 3/2
Arrive on Scene - Arrive/ stop at hydrant - Position engine ______________ - Layout report - On-scene report - Conduct size-up – 360° lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	 Driver Officer -	-Arrive - 360 degree lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine	Driver Driver Driver	Position Truck	Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	D/RB				
Establish - 2 in – 2 out (Initial RIT)		O/RB			
Establish RIT (Dedicated)			O/RB— advance by foot to get to point of entry – performs all RIT duties		

Tasks/Company	Engine 1/3	Truck 1/3	Engine 2/3	Battalion Chief/ Aide	Engine 3/3
Gain/ Force Entry		O/RB			
Advance Line - scan search fire room - suppression	O/RB (if officer commits then he must pass command)				
Deploy Back-up Line and protect stairwell					O/RB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors		O/ RB -			
Ventilation (vent for fire or vent for life) - Horizontal - Ventilation		Driver			Driver
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver			Driver
Control Utilities (Interior and exterior)		Driver (exterior) O/RB (Interior)			Driver (exterior)
Conduct Secondary Search - Search Fire Floors - Search other Floors					O/RB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	O/RB	O/RB			
Mechanical Ventilation		Driver			Driver

Company Protocols: Crew Size of 4

Total on scene = 18

PLUS 4 RIC – 1403 = total 22 needed

Tasks/Company	Engine 1/4	Truck 1/4	Engine 2/4	Battalion Chief/ Aide	Engine 3/4
Arrive on Scene - Arrive/ stop at hydrant - Position engine ———————— - Layout report - On-scene report - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360 degree lap		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine (1 3/4")	Driver Driver Driver	Position Truck	-Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	RB/Nozzle LB/Flake Both advance line for fire attack				
Establish - 2 in – 2 out (Initial RIT)		D/LB			
Establish RIT (Dedicated)			O/LB/RB— advance by foot to get to point of entry – performs all RIT duties		

Tasks/Company	Engine 1/4	Truck 1/4		Battalion Chief/ Aide	Engine 3/4
Gain/ Force Entry		O/RB			
Advance Line - scan search fire room - suppression	RB/LB Officer – not on line (if officer commits then he must pass command)				
Deploy Back-up Line and protect stairwell					O/RB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor Search other Floors		Officer and RB -			
Ventilation - Horizontal - Ventilation		Driver and LB			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24'/28' and roof ladder in case of vertical vent.		Driver /LB			
Control Utilities (Interior and exterior) Conduct Secondary Search - Search Fire Floors - Search other Floors		Driver/LB (control exterior) O/RB (control interior)			D/LB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension - wall breech - ceiling breech	O/RB	O/RB			
Mechanical Ventilation		D/LB			

Company Protocols: Crew Size of 5

D/O/LB/RB/CB   Total on scene = 22

PLUS 4 RIC – 1403 = total 26 needed

Tasks/Company	Engine 1/5	Truck 1/5	Engine 2/5	Battalion Chief/ Aide	Engine 3/4
Arrive on Scene - Arrive/ stop at hydrant - Position engine ______________ - Layout report - On-scene report - Locate Fire - Conduct size-up – 360º lap – incident action plan – offensive – detail incident (situation report) - Transmit size-up to responding units - Transfer command to chief	Driver Officer -	-Arrive - 360 degree Size up.		- Arrives - Assumes Command - Evaluates Resources - Establishes Command post - Evaluates exposure problems - Directs hose positioning - Coordinates Units - Transmits Progress reports - Changes strategy - Orders, records, and transmits results of primary and secondary searches - Declares fire under control	
Establish Supply line - Hydrant-Drop line (wrap) - Position engine - Pump engaged - 4" straight lay - ---------------- - Supply attack engine (1 3/4")	Driver Driver Driver	Position Truck	-Dry Lay – 2nd engine takes hydrant Charged hydrant – Supply attack engine Driver		
Position attack line - Flake - Charge - Bleed - Advance	RB/Nozzle LB/Flake CB/ Control --------------- Advance line for fire attack ---------------- The Officer responsibility is to supervise hose stretch /monitor safety and continually survey the scene				
Establish - 2 in – 2 out (Initial RIT)		D/LB			

Tasks/Company	Engine 1/5	Truck 1/5	Engine 2/5	Battalion Chief/ Aide	Engine 3/5
Establish RIT (Dedicated)			O/LB/RB—advance by foot to get to point of entry – performs all RIT duties		
Gain/ Force Entry		O/RB/CB			
Advance Line - scan search fire room - suppression	RB/LB/CB Officer – not on line (if officer commits then he must pass command)				
Insures first line flowing water— Deploy Back-up Line and protect stairwell (1 ¾”)					O/RB/CB
Complete Primary Search (in combo with Fire Attack) Search Fire Floor – Search other floors-		Officer and RB/CB			
Ventilation (vent for fire or vent for life) - Horizontal - Vertical		Driver and LB			
Ground Laddering – 2nd story windows, front and side, for firefighter means of egress and for vertical ventilation – 24’/28’ and roof ladder in case of vertical vent.		Driver /LB			
Control Utilities after search, force entry, venting and fire extinguished (Interior and exterior)		Driver/LB (control exterior) O/RB/CB (control interior)			
Conduct Secondary Search -Fire Floor -Primary and secondary search of entire floor above		D/LB			D/LB O/RB/CB
Check for Fire Extension Open ceiling walls near fire on fire floor Check floor above for fire extension wall breech ceiling breech-	O/RB				O/RB/CB
Mechanical Ventilation					

Appendix E: Statistical Analysis of Time to Task Test Data

Identifying Statistically Significant Differences in Crew Size and Stagger on a Number of Task Timings Using Regression Analyses of Times (Start, End and Duration) on Crew Size and Stagger

	Crew Size			Stagger	Crew Size	Stagger
Task-Based Measure of Time	**3 vs. 2**	**4 vs. 3**	**5 vs. 4**		**5/4 vs. 3/2**	
Total time	X*	X			X	
Conduct size up (start)			X		X	
Conduct size up (end)					X	
Conduct size up (duration)						
Position attack line (start)	X				X	
Position attack line (duration)		X			X	
Establish 2 in 2 out (end)		X		X	X	X
Establish RIT (end)	na	na	na	na	na	na
Gain forced entry (start)		X			X	
Advance line (start)	X	X			X	
Advance line (end)	X		X		X	
Deploy backup line (start)					X	X
Deploy backup line (end)				X		X
Advance backup line (start)				X		X
Advance backup line (end)				X		X
Conduct primary search (start)	X	X			X	
Ground ladders in place (end)		X	x	X	X	o
Ground ladders in place (duration)			X	X	X	X
Horizontal ventilation Story 2 window 3 (Start)		X			X	
Horizontal ventilation Story 2 window 3 (End)		X			X	
Horizontal ventilation Story 2 window 2 (Start)		X			X	
Horizontal ventilation Story 2 window 2 (End)		X			X	
Horizontal ventilation Story 2 window 1 (Start)		X			X	
Horizontal ventilation Story 2 window 1 (End)		X			X	
Horizontal ventilation Story 1 window 2 (Start)	o	X			X	
Horizontal ventilation Story 1 window 2 (End)		X			X	
Control utilities (interior) (Start)	X	X			X	
Conduct Secondary Search (Start)	X				X	
Check for Fire Ext (walls) (Start)	X	X			X	
Check for Fire Ext (ceiling) (Start)		X				
Stretch time**	X		o		X	

* An '**X**' denotes statistical significance at the 0.05 level; a '**o**' denotes significance at the 0.10 level.

Appendix F: All Regression Coefficients

Regression Models of Time to Task (in Seconds) as a Function of Crew Size and Stagger (Standard Errors are in Parentheses underneath coefficients)

Measure of Task Time	Coefficients					
	Time measured	Crew size of 3	Crew size of 4	Crew size of 5	Close Stagger	Constant
Total time		-100.5	-408.33	-402.17	-40.83	1374.42
		(50.29)	(50.29)	(50.29)	(35.56)	(39.77)
Conduct size up	Start	2.5	-5.167	-18.17	-1.25	335
		(5.97)	(5.97)	(5.97)	(4.22)	(4.72)
Conduct size up	Complete	-5.167	-13.17	-38.33	-12	416
		(13.60)	(13.60)	(13.60)	(9.62)	(10.75)
Conduct size up	Duration	-7.667	-8	-20.17	-10.75	81.04
		(12.10)	(12.10)	(12.10)	(8.56)	(9.57)
Position attack line	Start	-63.5	-63.5	-69.67	-11.17	408.1
		(14.09)	(14.09)	(14.09)	(9.96)	(11.14)
Position attack line	Duration	-16	-63.67	-61.67	5.167	160.6
		(13.79)	(13.79)	(13.79)	(9.75)	(10.90)
Establish 2in - 2 out	Complete	-6.7E-15	-90	-90	-30	355
		(9.73)	(9.73)	(9.73)	(6.88)	(7.69)
Establish RIT	Complete	70	70	70	-60	435
		0.00	0.00	0.00	0.00	0.00
Gain forced entry	Start	-23.5	-54	-80.83	-20.83	528.6
		(19.66)	(19.66)	(19.66)	(13.90)	(15.54)
Advance line	Start	-54	-97.83	-123.5	-17.5	586.3
		(18.83)	(18.83)	(18.83)	(13.31)	(14.88)
Advance line	Complete	-61	-95.5	-134.7	-19.08	625.5
		(20.35)	(20.35)	(20.35)	(14.39)	(16.08)
Deploy backup line	Start	-26	-42.67	-53.5	-96.75	641.5
		(17.11)	(17.11)	(17.11)	(12.10)	(13.53)
Deploy backup line	Complete	-15.83	-56.17	-17.5	-53.75	728.9
		(33.49)	(33.49)	(33.49)	(23.68)	(26.48)
Advance backup line	Start	-33	-66.83	-34.83	-63	779.7
		(29.65)	(29.65)	(29.65)	(20.97)	(23.44)
advancebackupline2	Complete	-34.5	-68.17	-36.17	-63.75	784.4
		(29.73)	(29.73)	(29.73)	(21.02)	(23.50)
conductprimarysearch1	Start	-147	-215.8	-211.5	0.1667	736.1
		(25.08)	(25.08)	(25.08)	(17.74)	(19.83)
Ground ladders in place	Complete	-38	-196.5	-317.8	-69.83	1168
		(48.38)	(48.38)	(48.38)	(34.21)	(38.24)
Ground ladders in place	Duration	-33.83	-83.67	-185.7	-72.08	617
		(48.12)	(48.12)	(48.12)	(34.03)	(38.04)
Horizontal ventilation, second story, window 3	Start	-53.67	-217.8	-211	-26.59	759.1
		(30.75)	(30.75)	(30.75)	(21.75)	(24.31)
Horizontal ventilation, second story, window 3	Complete	-64.83	-316	-353	-33.58	1088
		(49.74)	(49.74)	(49.74)	(35.17)	(39.32)
Horizontal ventilation, second story, window 2	Start	-51.67	-265.8	-261.2	-18.83	885.1
		(37.20)	(37.20)	(37.20)	(26.30)	(29.41)

All Regression Coefficients (CONTINUED)

Regression Models of Time to Task (in Seconds) as a Function of Crew Size and Stagger (Standard Errors are in Parentheses underneath coefficients)

Horizontal ventilation, second story, window 2	Complete	**-53.5**	**-259.8**	**-262.3**	**-13.33**	**931.3**
		(39.97)	(39.97)	(39.97)	(28.26)	(31.60)
Horizontal ventilation, second story, window 1	Start	**-70**	**-316.3**	**-348.8**	**-31.08**	**1038**
		(48.37)	(48.37)	(48.37)	(34.20)	(38.24)
Horizontal ventilation, second story, window 1	Complete	**-51.83**	**-219**	**-214.8**	**-24**	**805.7**
		(33.71)	(33.71)	(33.71)	(23.83)	(26.65)
Horizontal ventilation, first story, window 2	Start	**-87.17**	**-386.3**	**-428.5**	**-44.67**	**1200**
		(45.13)	(45.13)	(45.13)	(31.91)	(35.68)
Horizontal ventilation, first story, window 2	Complete	**-88.5**	**-391.5**	**-423.3**	**-44.17**	**1224**
		(47.02)	(47.02)	(47.02)	(33.25)	(37.17)
Control utilities interior	Start	**-136.5**	**-287.8**	**-300**	**-6.333**	**946.3**
		(45.57)	(45.57)	(45.57)	(32.22)	(36.02)
Control utilities exterior	Start	**6.667**	**-281.8**	**-312.8**	**-38.17**	**1063**
		(70.21)	(70.21)	(70.21)	(49.65)	(55.51)
Conduct secondary search	Start	**-92.5**	**-143**	**-152.7**	**-28.25**	**846**
		(38.97)	(38.97)	(38.97)	(27.56)	(30.81)
Check for fire extension walls	Start	**-453.8**	**-535.3**	**-608.7**	**-38.25**	**1155**
		(38.28)	(38.28)	(38.28)	(27.07)	(30.26)
Check for fire extension ceiling	Start	**-206.3**	**-349.7**	**-292.7**	**-2.833**	**1086**
		(48.29)	(48.29)	(48.29)	(34.14)	(38.17)

Regression Models of Time to Task (in Seconds) as a Function of Combined Crew Size and Stagger (Standard Errors appear in Parentheses)

		Coefficients		
Measure of Task Time*	Time measured	Crew size of 4/5 vs. 3/2	Close Stagger	Constant
Total time		**-355** (37.23)	**-40.83** (37.23)	**1324.00** (32.24)
Conduct size up	Start	**-12.92** (4.50)	**-1.25** (4.50)	**336.2** (3.90)
Conduct size up	Complete	**-23.17** (9.97)	**-12** (9.97)	**413.4** (8.64)
Conduct size up	Duration	**-10.25** (8.44)	**-10.75** (8.44)	**77.21** (7.31)
Position attack line	Start	**-34.83** (13.66)	**-11.17** (13.66)	**376.3** (11.83)
Position attack line	Duration	**-54.67** (9.60)	**5.167** (9.60)	**152.6** (8.31)
Establish 2in - 2 out	Complete	**-90** (6.55)	**-30** (6.55)	**355** (5.67)
Establish RIT	Complete	**35** (10.80)	**-60** (10.80)	**470** (9.35)
Gain forced entry	Start	**-55.67** (14.32)	**-20.83** (14.32)	**516.8** (12.40)
Advance line	Start	**-83.67** (15.67)	**-17.5** (15.67)	**559.3** (13.57)
Advance line	Complete	**-84.58** (17.67)	**-19.08** (17.67)	**595** (15.31)
Deploy backup line	Start	**-35.08** (12.30)	**-96.75** (12.30)	**628.5** (10.65)
Deploy backup line	Complete	**-28.92** (23.43)	**-53.75** (23.43)	**721** (20.29)
Advance backup line	Start	**-34.33** (21.17)	**-63** (21.17)	**763.2** (18.33)
advancebackupline2	Complete	**-34.92** (21.27)	**-63.75** (21.27)	**767.1** (18.42)
conductprimarysearch1	Start	**-140.2** (28.28)	**0.1667** (28.28)	**662.6** (24.49)
Ground ladders in place	Complete	**-238.2** (37.99)	**-69.83** (37.99)	**1149** (32.90)
Ground ladders in place	Duration	**-117.7** (36.37)	**-72.08** (36.37)	**600.1** (31.49)
Horizontal ventilation, second story, window 3	Start	**-187.6** (22.31)	**-26.59** (22.31)	**732.3** (19.32)
Horizontal ventilation, second story, window 3	Complete	**-302.1** (35.38)	**-33.58** (35.38)	**1056** (30.64)

Regression Models of Time to Task (in Seconds) as a Function of Combined Crew Size and Stagger (CONTINUED) (Standard Errors appear in Parentheses)

Horizontal ventilation, second story, window 2	Start	**-237.7**	**-18.83**	**859.3**
		(26.27)	(26.27)	(22.75)
Horizontal ventilation, second story, window 2	Complete	**-234.3**	**-13.33**	**904.6**
		(28.12)	(28.12)	(24.36)
Horizontal ventilation, second story, window 1	Start	**-297.6**	**-31.08**	**1003**
		(34.64)	(34.64)	(30.00)
Horizontal ventilation, second story, window 1	Complete	**-191**	**-24**	**779.8**
		(24.05)	(24.05)	(20.83)
Horizontal ventilation, first story, window 2	Start	**-363.8**	**-44.67**	**1156**
		(33.83)	(33.83)	(29.30)
Horizontal ventilation, first story, window 2	Complete	**-363.2**	**-44.17**	**1180**
		(34.80)	(34.80)	(30.14)
Control utilities interior	Start	**-225.7**	**-6.333**	**878.1**
		(37.23)	(37.23)	(32.25)
Control utilities exterior	Start	**-300.7**	**-38.17**	**1066**
		(47.48)	(47.48)	(41.12)
Conduct secondary search	Start	**-101.6**	**-28.25**	**799.7**
		(29.88)	(29.88)	(25.88)
Check for fire extension walls	Start	**-345.1**	**-38.25**	**927.9**
		(75.46)	(75.46)	(65.35)
Check for fire extension ceiling	Start	**-218**	**-2.833**	**983.1**
		(46.32)	(46.32)	(40.12)
Stretch time = advance line minus position engine	Duration	**-75.7**	**-17.2**	**273.3**
		(16.68)	(16.68)	(14.44)

*** Standard errors are in parentheses below coefficient value**

		Crew size of 3	Crew size of 4	Crew size of 5	Close Stagger	Constant
Stretch time = advance line minus position engine	Duration	**-57.3**	**-86.7**	**-122.0**	**-17.2**	**301.9**
		(19.39)	(19.39)	(19.39)	(13.71)	(15.33)

APPENDIX G: Measurement Uncertainty

The measurements of length, temperature, mass, moisture content, smoke obscuration, and time taken in these experiments have unique components of uncertainty that must be evaluated in order to determine the fidelity of the data. These components of uncertainty can be grouped into two categories: Type A and Type B. Type A uncertainties are those evaluated by statistical methods, such as calculating the standard deviation of the mean of a set of measurements. Type B uncertainties are based on scientific judgment using all available and relevant information. Using relevant information, the upper and lower limits of the expected value are estimated so that the probability that the measurement falls within these limits is essentially 100 %. After all the component uncertainties of a measurement have been identified and evaluated it is necessary to use them to compute the combined standard uncertainty using the law of propagation of uncertainty (the "root sum of squares"). Although this expresses the uncertainty of a given measurement, it is more useful in a fire model validation exercise to define an interval for which the measurement will fall within a certain level of statistical confidence. This is known as the expanded uncertainty. The current international practice is to multiply the combined standard uncertainty by a factor of two (k=2), giving a confidence of 95 %.

Length measurements of room dimensions, openings and instrument locations were taken using a steel measuring tape with a resolution of 0.02 in (0.5 mm). However, measurement error due to uneven and unlevel surfaces results in an estimated uncertainty of ± 0.5 % for length measurements taken on the scale of room dimensions. The estimated total expanded uncertainty for length measurements is ± 1.0 %.

The standard uncertainty of the thermocouple wire itself is 1.1°C or 0.4 % of the measured value, whichever is greater (Omega 2004). The estimated total expanded uncertainty associated with type K thermocouples is approximately ± 15 %. Previous work done at NIST has shown that the uncertainty of the environment surrounding thermocouples in a full-scale fire experiment has a significantly greater uncertainty (Blevins 1999) than the uncertainty inherent with thermocouple design. Furthermore, while a vertical thermocouple array gives a good approximation of the temperature gradient with respect to height, temperatures cannot be expected to be uniform across a plane at any height because of the dynamic environment in a compartment fire. Inaccuracies of thermocouple measurements in a fire environment can be caused by:

- Radiative heating or cooling of the thermocouple bead
- Soot deposition on the thermocouple bead which change its mass, emissivity, and thermal conductivity
- Heat conduction along thermocouple wires
- Flow velocity over the thermocouple bead

To reduce these effects, particularly radiative heating and cooling, thermocouples with smaller diameter beads were chosen. This is particularly important for thermocouples below the interface because the radiative transfer between the surrounding room surfaces will be significantly less uniform than if the thermocouple were in the hot gas layer. It is suggested in [Pitts] that it may be possible to correct for radiative transfer given enough sufficient knowledge about thermocouple properties and the environment. However, measurements of local velocity and the radiative environment were not taken. Additionally, the probes were located away from the burn compartment walls in order to avoid the effects of walls and corners.

The gas measurement instruments and sampling system used in this series of experiments have been demonstrated to have an expanded (k = 2) relative uncertainty of ± 1 % when compared with span gas volume fractions (Matheson). Given the limited set of sampling points in these experiments, an estimated uncertainty of ± 10 % is being applied to the results.

The potential for soot deposition on the face of the water-cooled total heat flux gauges contributes significant uncertainty to the heat flux measurements. Calibration of heat flux gauges was completed at lower fluxes and then extrapolated to higher values and this resulted in a higher uncertainty in the flux measurement. Combining all of component uncertainties for total heat flux resulted in a total expanded uncertainty of -24 % to +13 % for the flux measurements.

Prior to experimentation, ten of the wooden pallets used in the fuel packages were randomly selected for measurement. Two measurements were taken, moisture content and mass. Moisture content was measured using a pin-type moisture meter with a moisture measurement range of 6 % to 40% and an accuracy of <0.5 % of the measured value between 6 % and 12 % moisture content. Mass measurements were made with an industrial bench scale having a range of 0kg to 100 kg, a resolution of 0.1 kg and an uncertainty of ± 0.1 kg.

All timing staff were equipped with the same model of digital stopwatch with a resolution of 0.01 seconds and an uncertainty of ± 3 seconds per 24 hours; the uncertainty of the timing mechanism in the stopwatches is small enough over the duration of an experiment that it can be neglected. There are three components of uncertainty when using people to time fire fighting tasks. First, timers may have a bias depending on whether they record the time in anticipation of, or reaction to an event. A second component exists because multiple timers were used to record all tasks. The third component is the mode of the stimulus to which the staff is reacting: audible (firefighters announcing task updates over the radio) or visual (timing staff sees a task start or stop).

Milestone events in these experiments were recorded both audibly and visually. A test series described in the *NIST Recommended Practice Guide for Stopwatch and Timer Calibrations* found the reaction times for the two modes of stimulus to be approximately the same, so this component can be neglected. Because of the lack of knowledge regarding the mean bias of the timers, a rectangular distribution was assumed and the worst case reaction time bias of 120 ms was used, giving a standard deviation of 69 ms. The standard deviation of the reaction time was assumed to be the worst case of 230 ms. The estimated total expanded uncertainty of task times measured in these experiments is 240 ms.

An additional component of uncertainty exists for the time measurement of the application of water on the fire. In order to measure this time, timing staff were required to listen for radio confirmation that suppressing water had been applied by the interior attack crew. This process required a member of the interior crew to find and manipulate their microphone, wait for the radio to access a repeater, and transmit the message. Because of the lack of knowledge about the distributions of time it takes for each part of this process, all parts are lumped into a single estimate of uncertainty and a rectangular distribution is assumed. This is most reasonably estimated to be 2.5 seconds with a standard deviation of ±2.89 seconds and an expanded uncertainty of ± 5.78 seconds.

Weather measurement uncertainty was referenced to the published user's manual for the instrumentation used. The weather instrumentation has calibration certificates that are traceable to NIST standards. A summary of experimental measurement uncertainty is given in Table G-1.

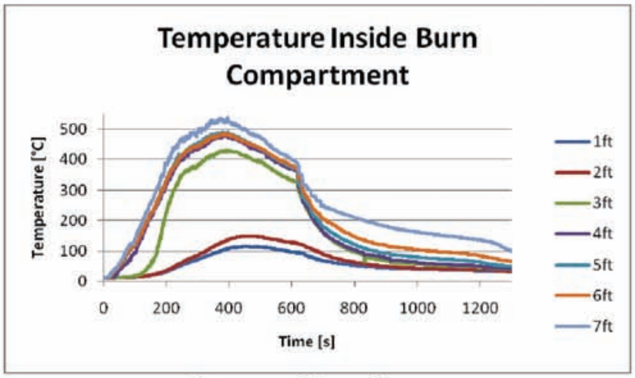
Table G-1: Summary of Measurement Uncertainty

Measurement	Component Standard Uncertainty	Combined Standard Uncertainty	Total Expanded Uncertainty
Length Measurements			
Instrumentation Locations	± 1 %	± 3 %	± 6 %
Building Dimensions	± 1 %		
Repeatability[1]	± 2 %		
Random[1]	± 2 %		
Gas Temperature – Lower Layer			
Calibration	± 1 %	± 8 %	± 15 %
Radiative Cooling	- 5 % to + 0 %		
Radiative Heating	0 % to + 5 %		
Repeatability [1]	± 5 %		
Random [1]	± 3 %		
Wood Moisture Content			
	± 0.5 %	± 0.5 %	± 1%
Wood Pallet Mass			
	± 0.2%	± 0.1%	± 0.1%
Weather			
Relative Humidity	± 3%		
Barometric Pressure	± 0.03" Hg		
Wind Speed	± 5%		
Wind Direction	± 5%		
Outside Temperature	±0.5°C		
Time			
Timer Bias	± 0.069s	± 2.90s	
Reaction Time	± 0.230s		± 5.80 s
Radio Operation	± 2.890s		
Notes: 1. Random and repeatability evaluated as Type A, other components as Type B.			

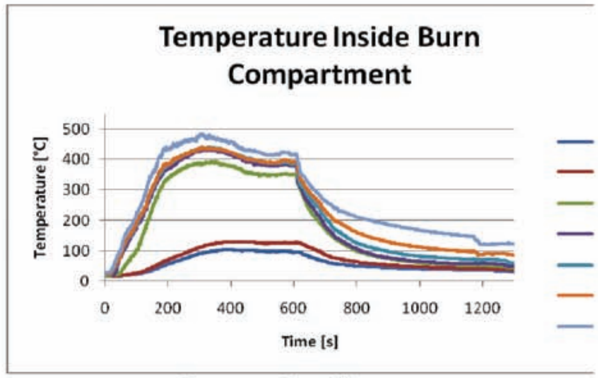
APPENDIX H: Charts of Gas and Temperature Data

Examples of Gas and Temperature Data for Time-to-Task Tests

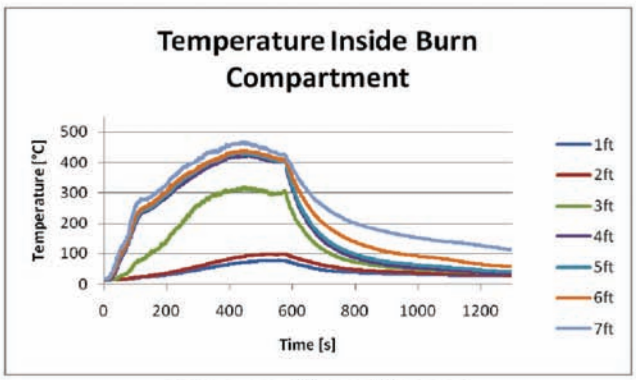
Burn Room Data



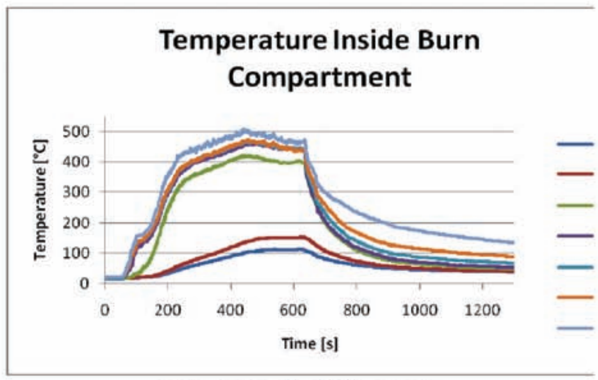
2 Person, Close Stagger



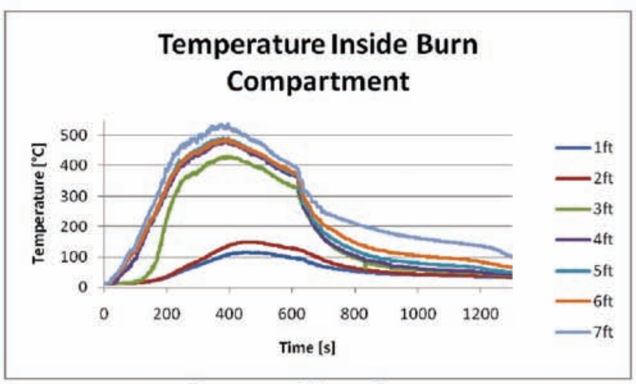
2 Person, Far Stagger



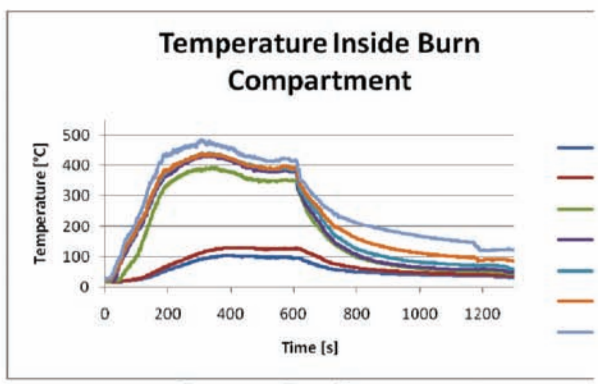
3 Person, Close Stagger



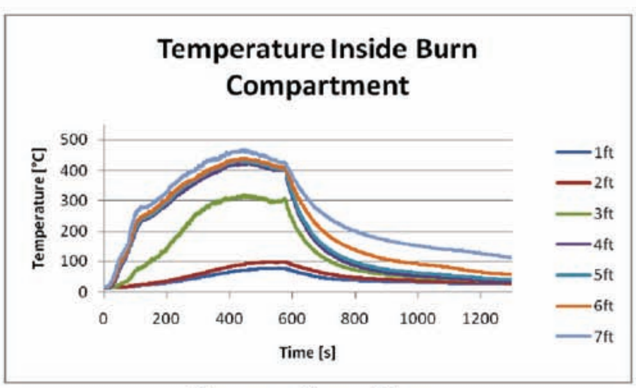
3 Person, Far Stagger



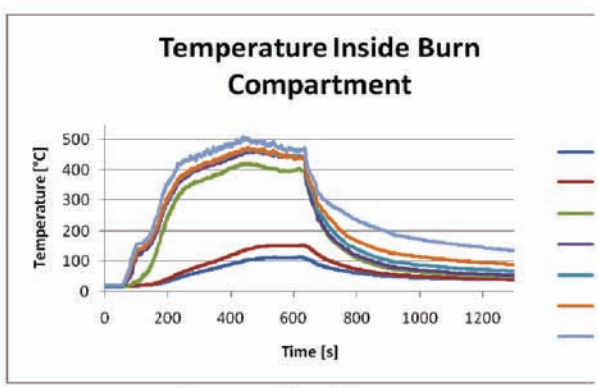
2 Person, Close Stagger



2 Person, Far Stagger

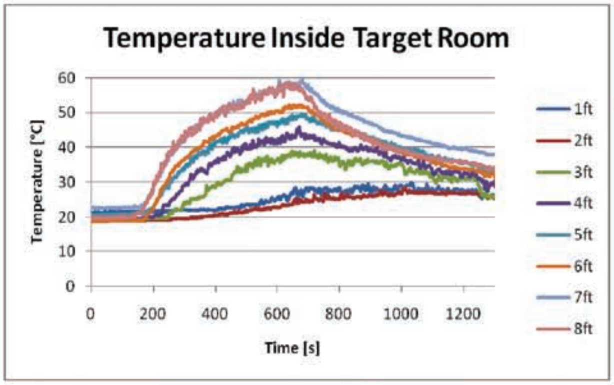


3 Person, Close Stagger

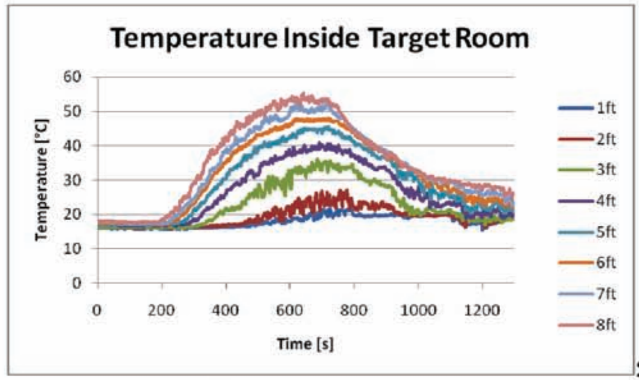


3 Person, Far Stagger

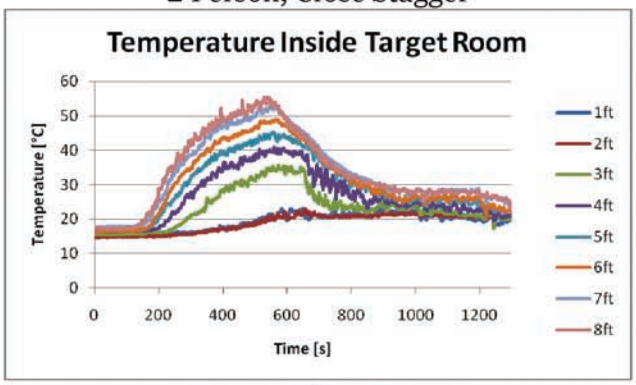
Target Room Data



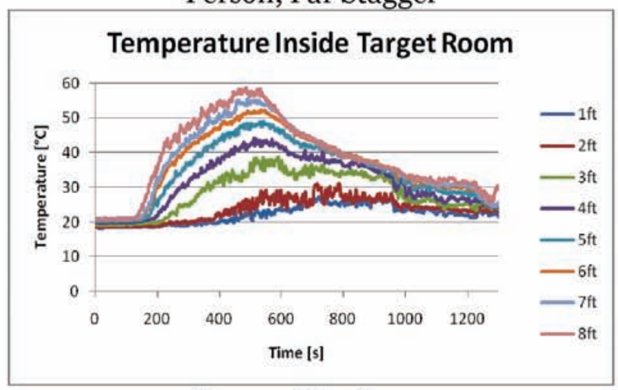
2 Person, Close Stagger



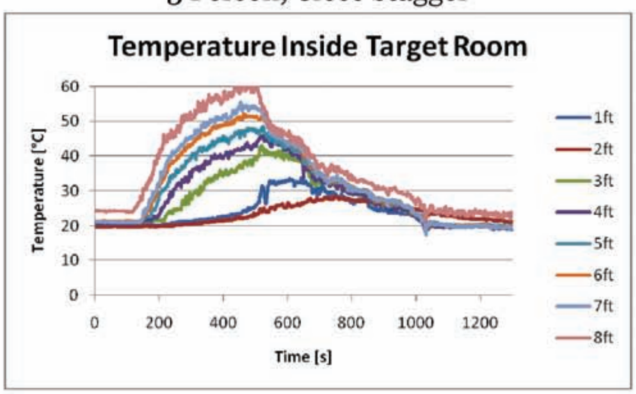
2 Person, Far Stagger

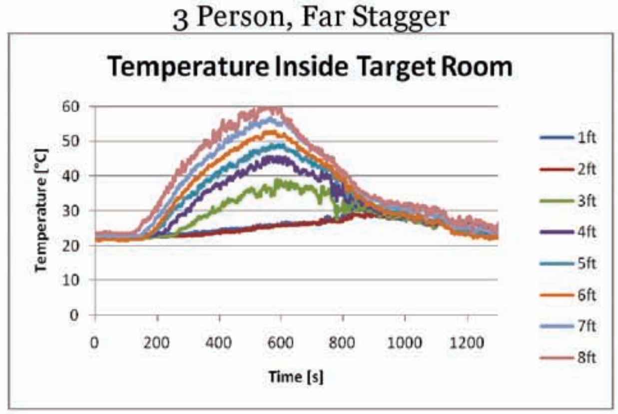


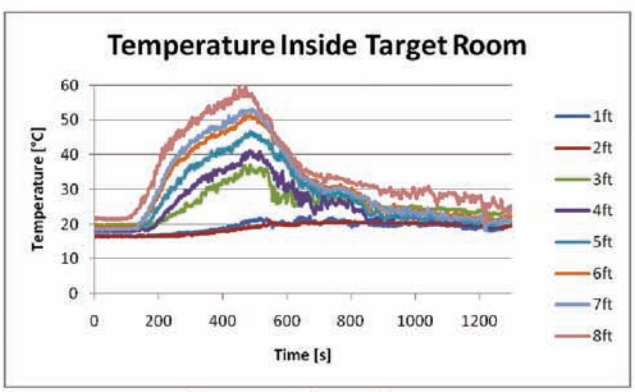
3 Person, Close Stagger



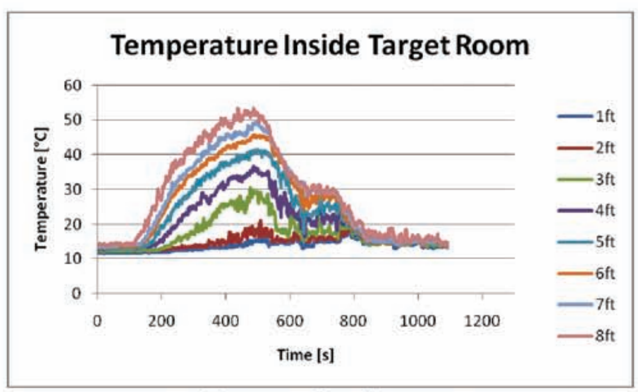
3 Person, Far Stagger





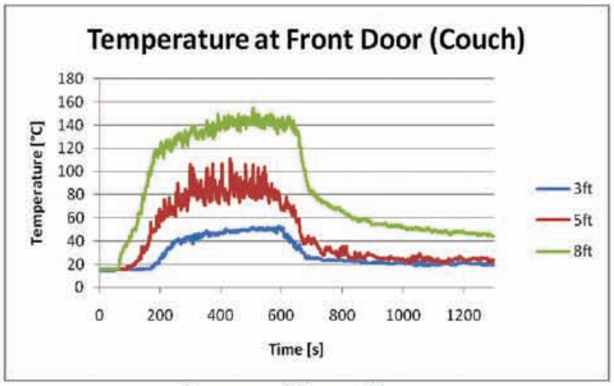


5 Person, Close Stagger

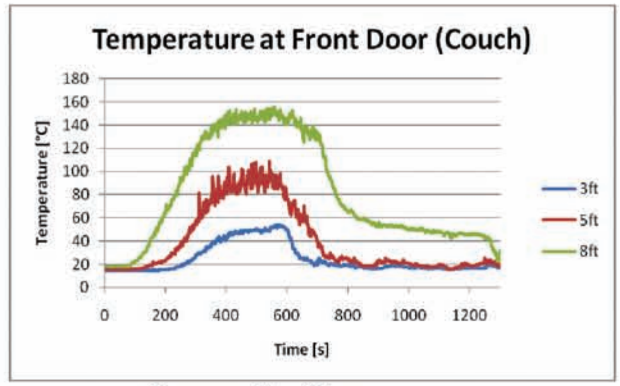


5 Person, Far Stagger

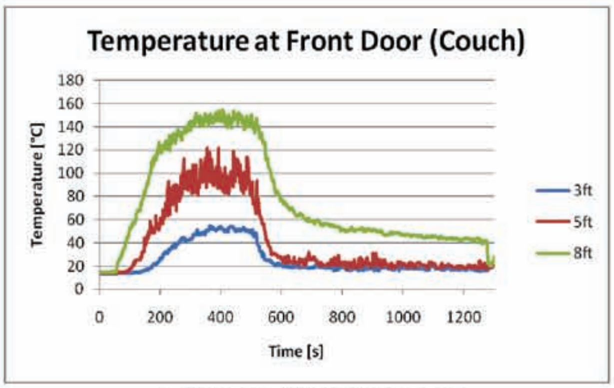
Temperature Near Front Door (Couch)



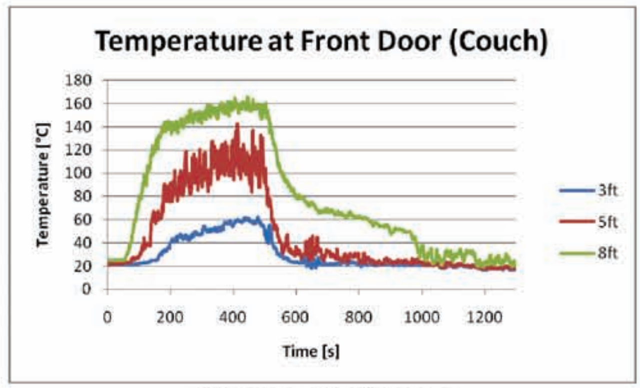
2 Person, Close Stagger



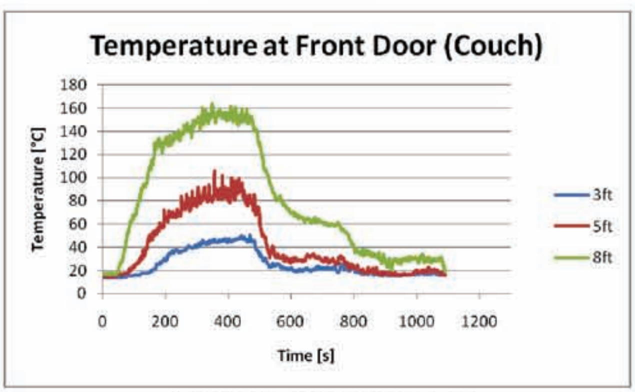
2 Person, Far Stagger



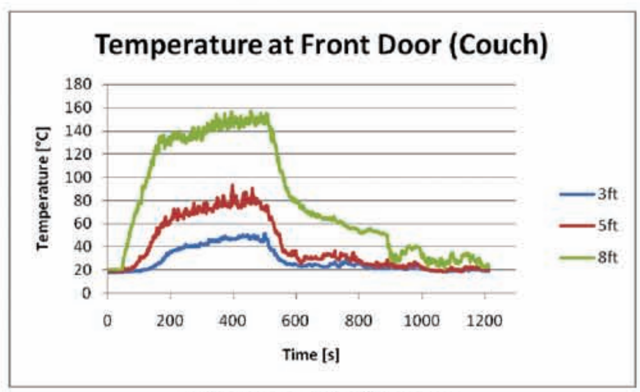
3 Person, Close Stagger



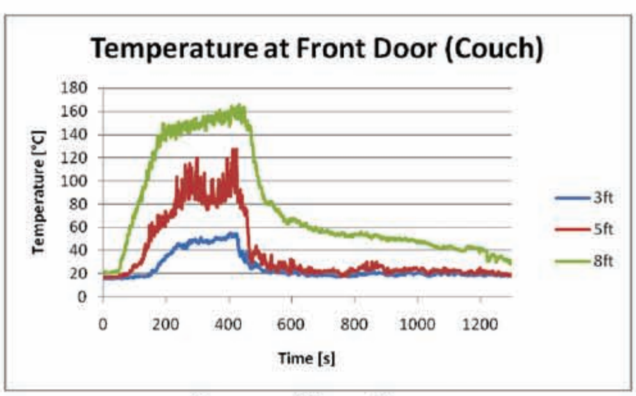
3 Person, Far Stagger



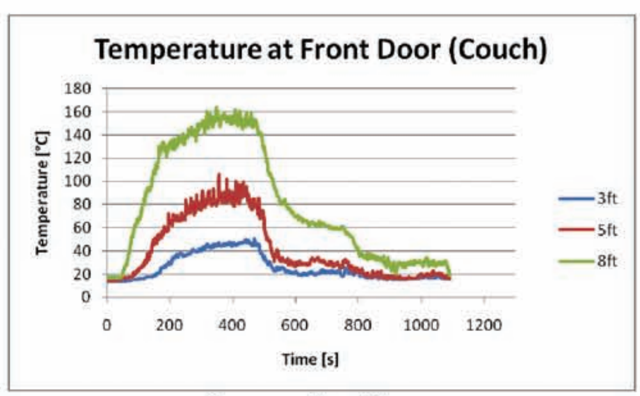
4 Person, Close Stagger



4 Person, Far Stagger



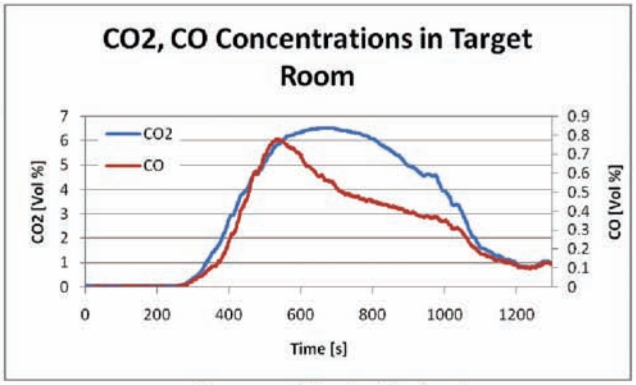
5 Person, Close Stagger



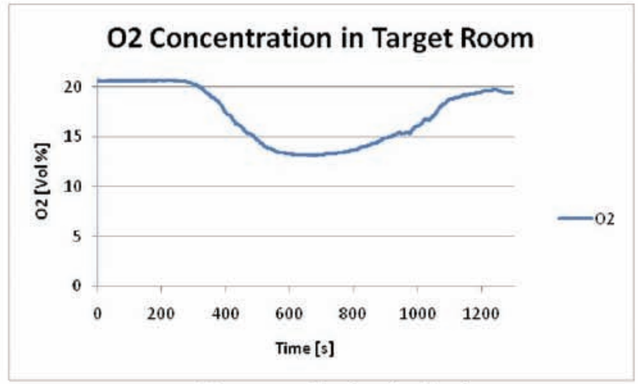
5 Person, Far Stagger

Gas and Temperature Data for Room and Contents Tests

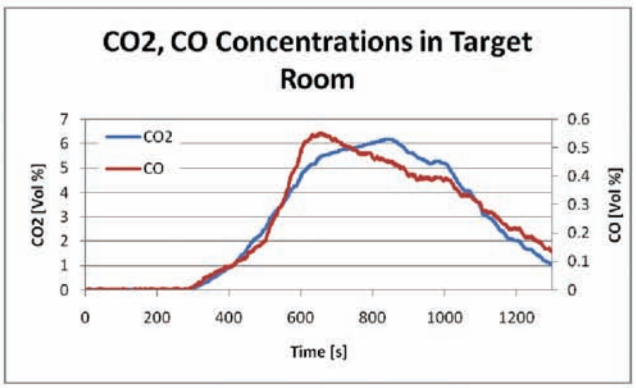
Examples of Gas Data in Target Room



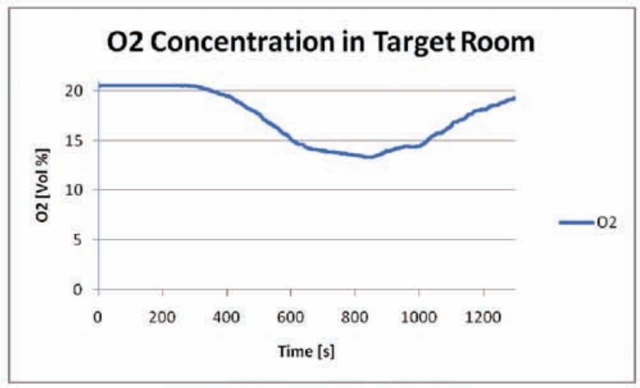
2-Person, Early Arrival



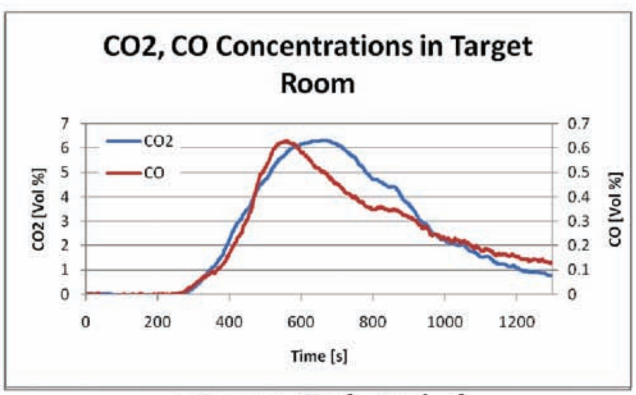
2-Person, Early Arrival



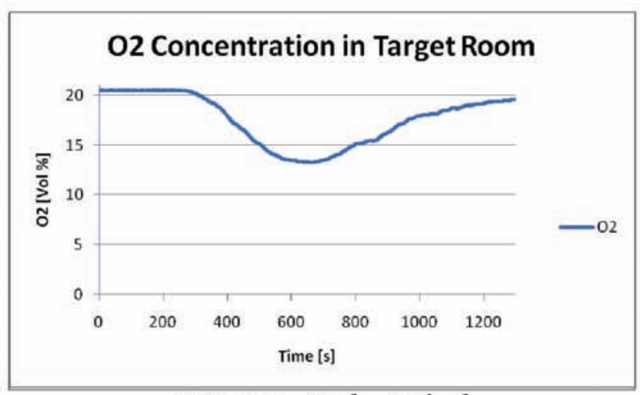
2-Person, Late Arrival



2-Person, Late Arrival



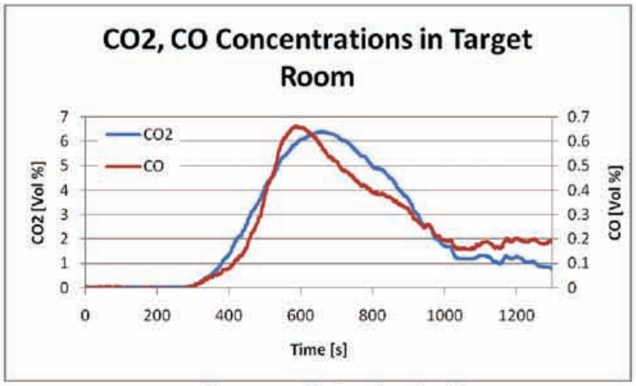
3-Person, Early Arrival



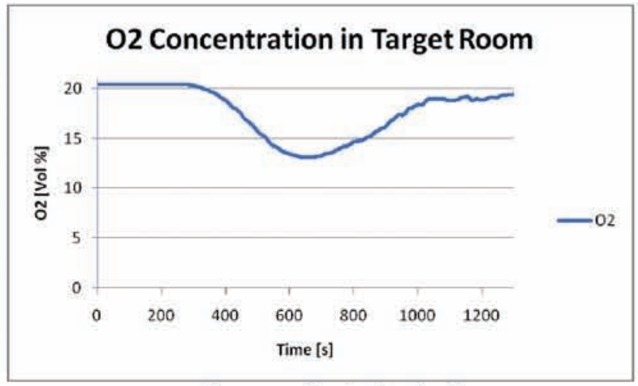
3-Person, Early Arrival

Gas and Temperature Data for Room and Contents Tests

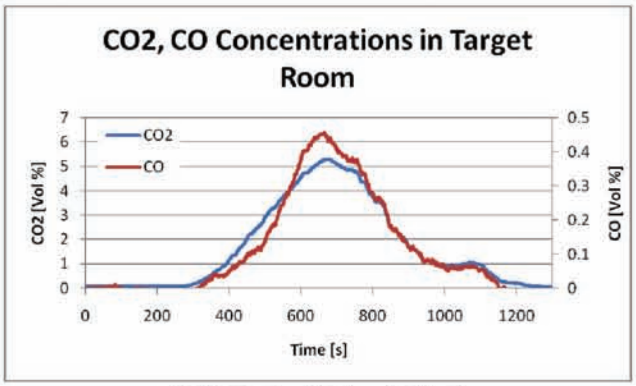
Examples of Gas Data in Target Room



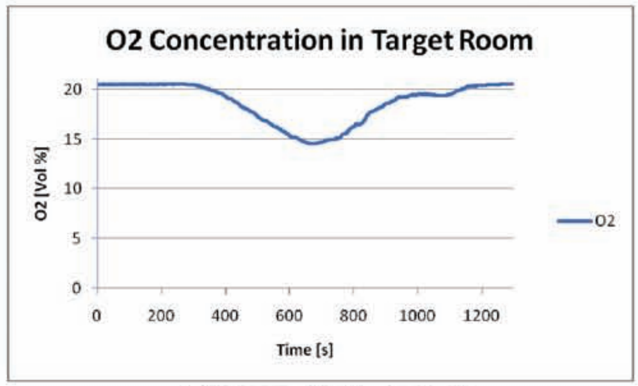
3-Person, Late Arrival



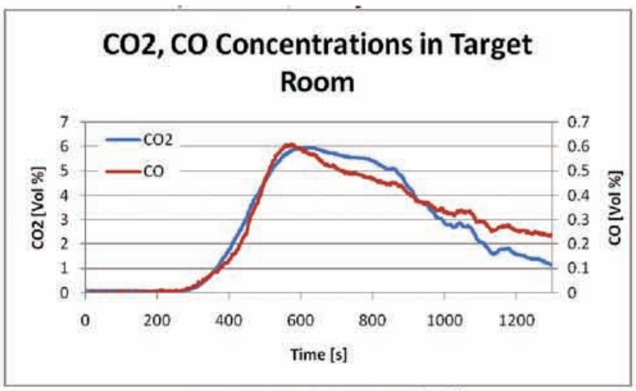
3-Person, Late Arrival



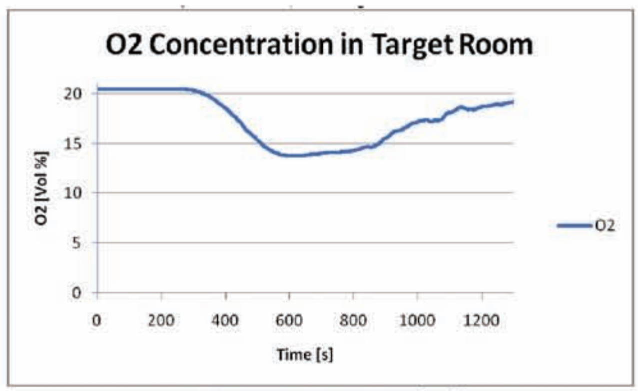
4-Person, Early Arrival



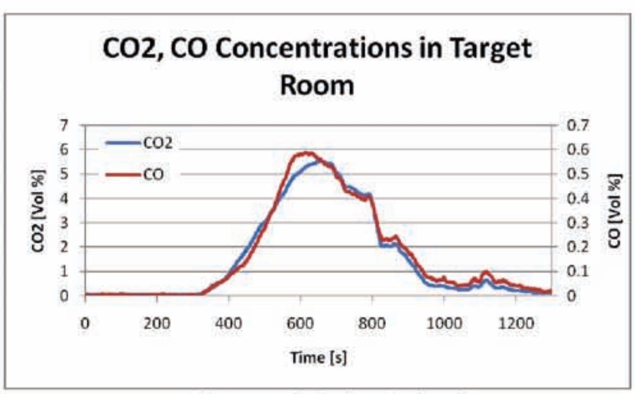
4-Person, Early Arrival



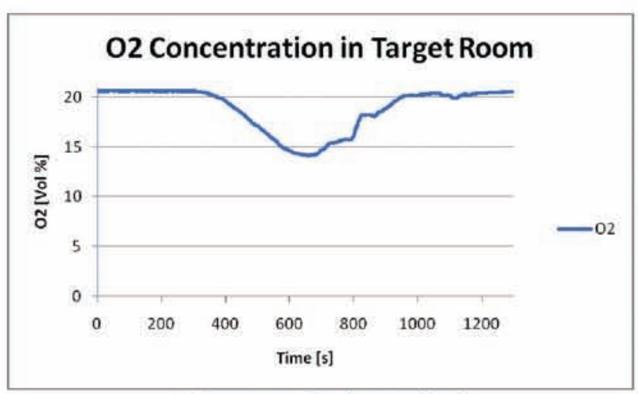
4-Person, Late Arrival



4-Person, Late Arrival

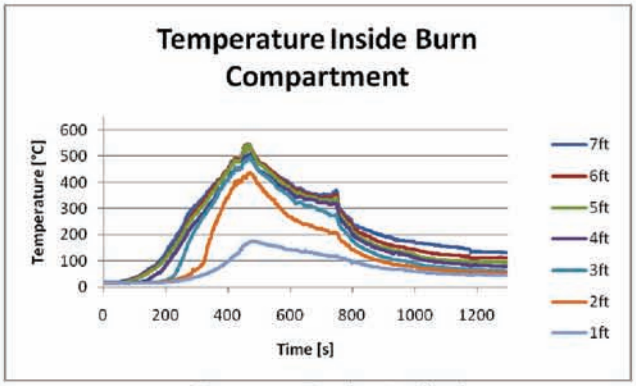


5-Person, Early Arrival

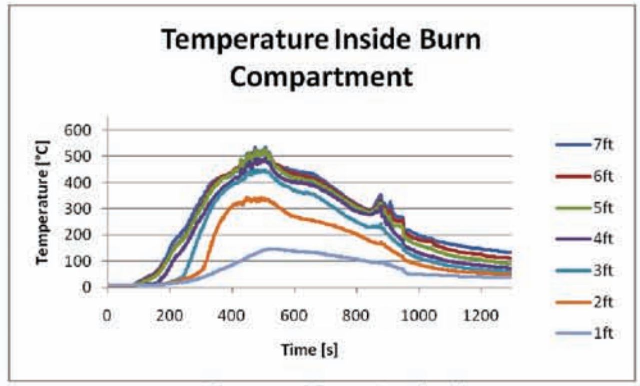


5-Person, Early Arrival

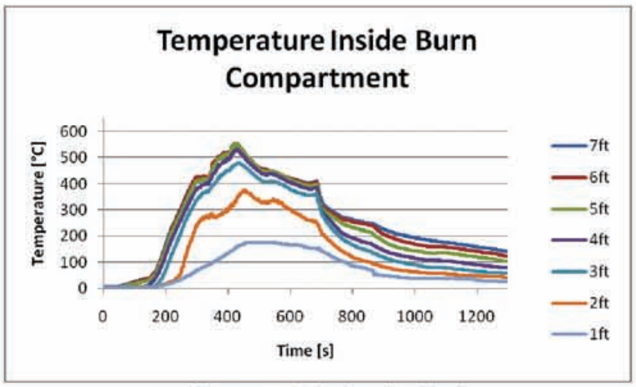
Temperatures in Burn Room



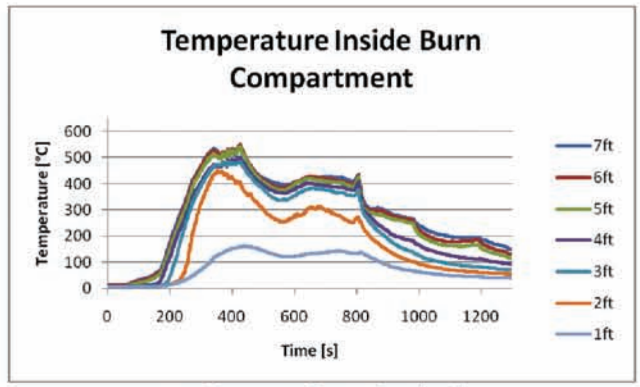
2-Person, Early Arrival



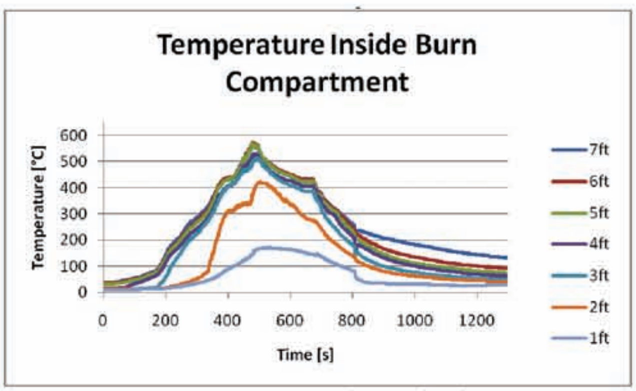
2-Person, Late Arrival



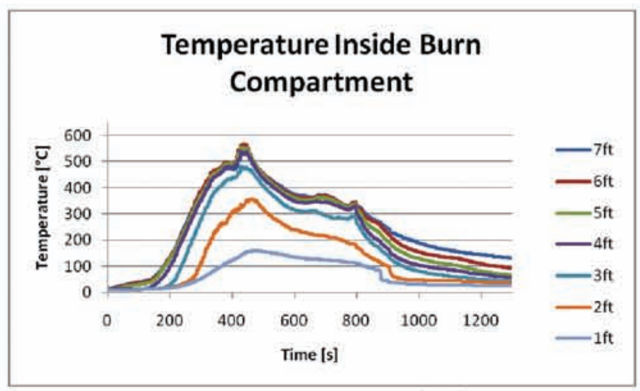
3-Person, Early Arrival



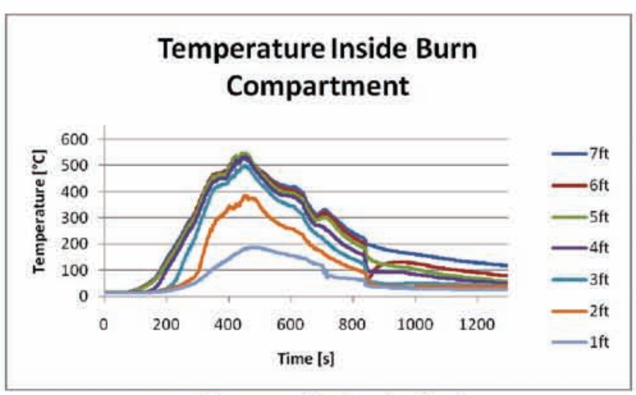
3-Person, Late Arrival



4-Person, Early Arrival

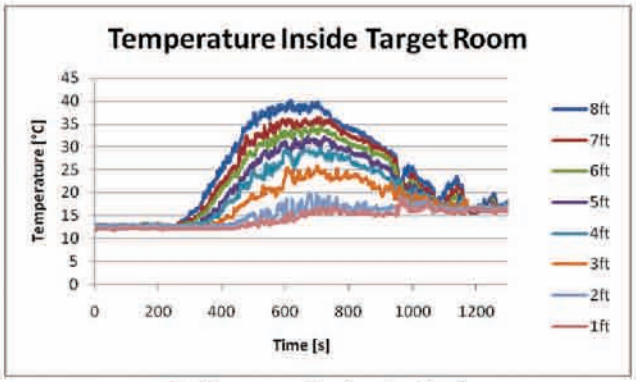


4-Person, Late Arrival

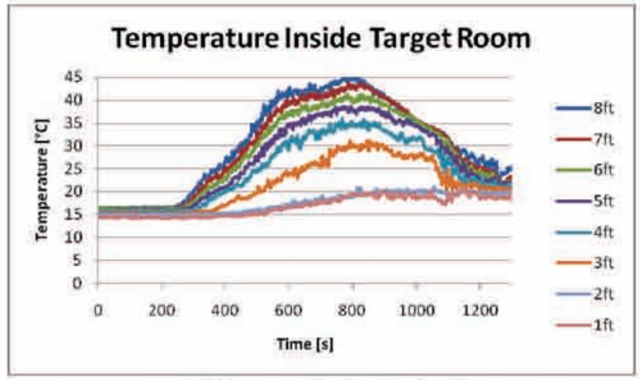


5-Person, Early Arrival

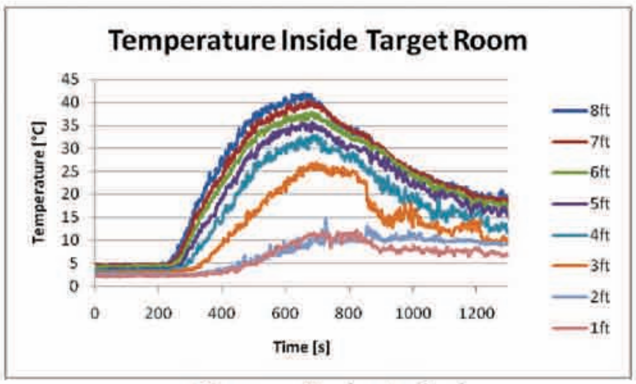
Temperatures in Target Room



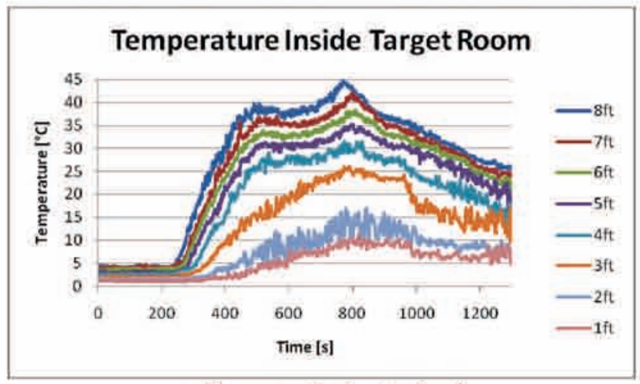
2-Person, Early Arrival



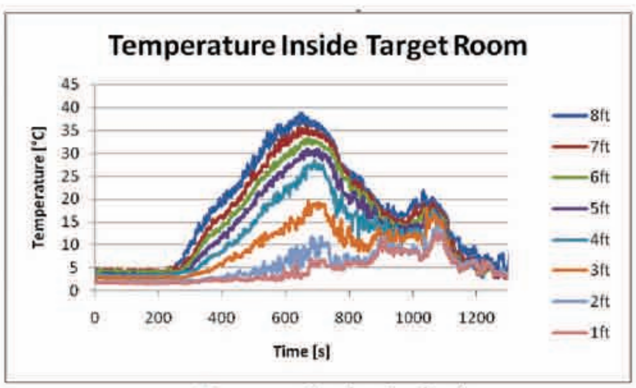
2-Person, Late Arrival



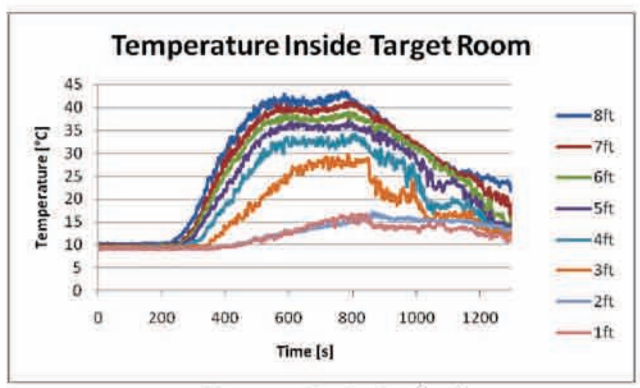
3-Person, Early Arrival



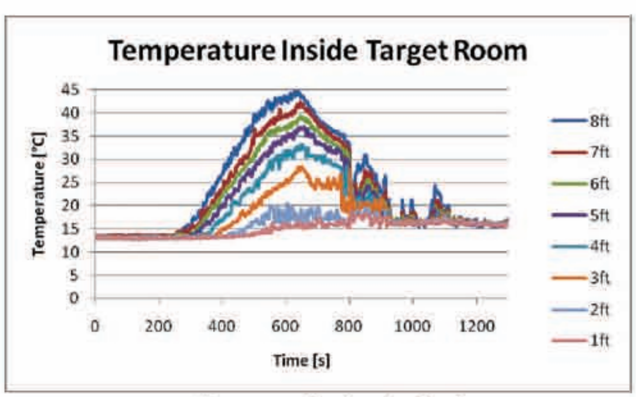
3-Person, Late Arrival



4-Person, Early Arrival

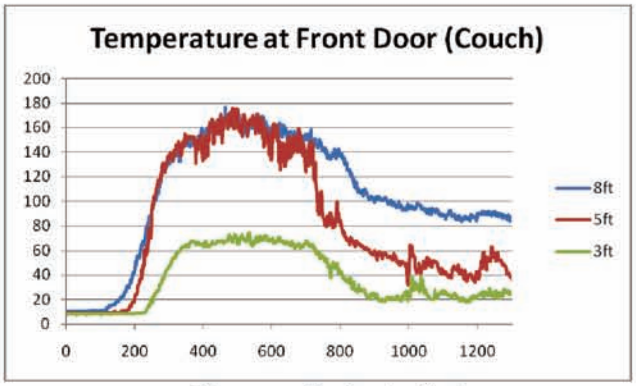


4-Person, Late Arrival

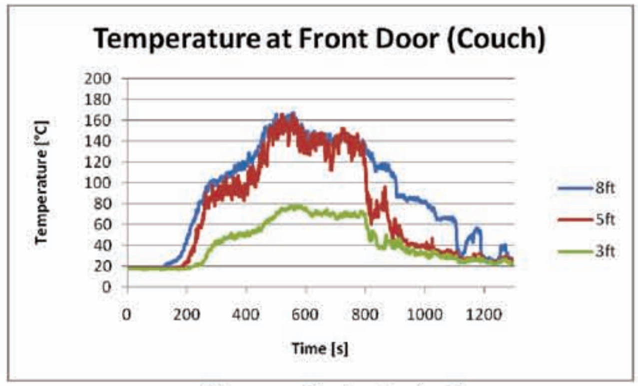


5-Person, Early Arrival

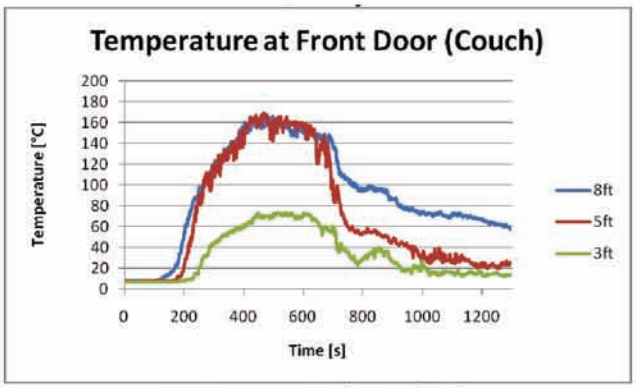
Temperatures Near Front Door (Couch)



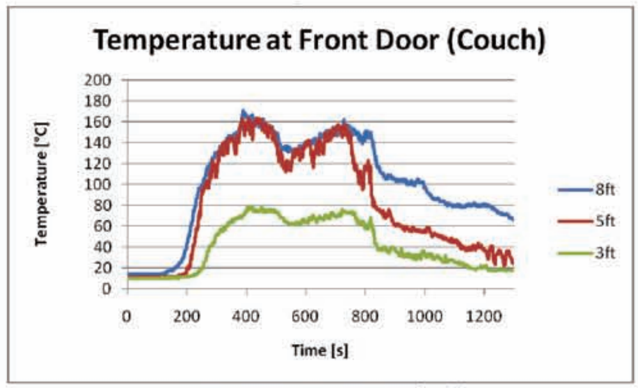
2-Person, Early Arrival



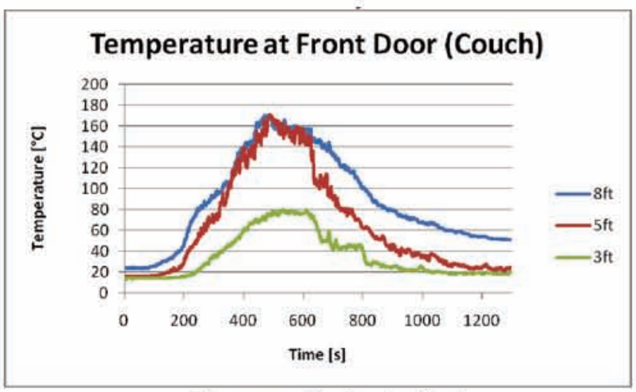
2-Person, Late Arrival



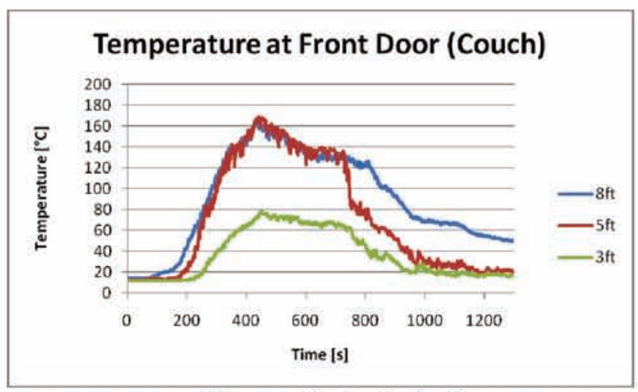
3-Person, Early Arrival



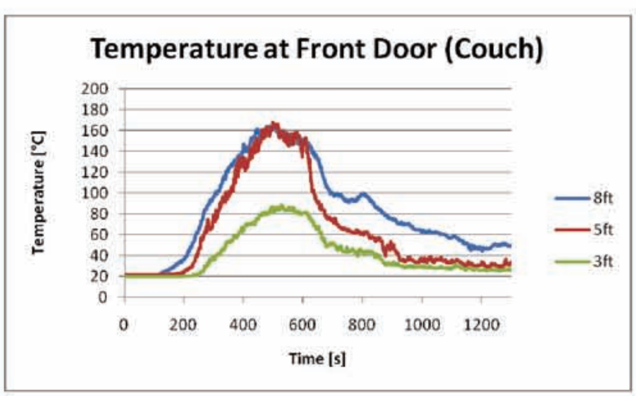
3-Person, Late Arrival



4-Person, Early Arrival



4-Person, Late Arrival



5-Person, Early Arrival

NOTES: