CENTER FOR PUBLIC SAFETY MANAGEMENT, LLC

FIRE OPERATIONAL & ADMINISTRATIVE ANALYSIS REPORT

Danville, Kentucky

Final Report

CPSM®

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ICMA

Exclusive Provider of Public Safety Technical Services for
International City/County Management Association

THE ASSOCIATION & THE COMPANY

The International City/County Management Association is a 103-year old, nonprofit professional association of local government administrators and managers, with approximately 13,000 members located in 32 countries.

Since its inception in 1914, ICMA has been dedicated to assisting local governments and their managers in providing services to its citizens in an efficient and effective manner. ICMA advances the knowledge of local government best practices with its website (www.icma.org), publications, research, professional development, and membership. The ICMA Center for Public Safety Management (ICMA/CPSM) was launched by ICMA to provide support to local governments in the areas of police, fire, and emergency medical services.

ICMA also represents local governments at the federal level and has been involved in numerous projects with the Department of Justice and the Department of Homeland Security.

In 2014, as part of a restructuring at ICMA, the Center for Public Safety Management (CPSM) was spun out as a separate company. It is now the exclusive provider of public safety technical assistance for ICMA. CPSM provides training and research for the Association's members and represents ICMA in its dealings with the federal government and other public safety professional associations such as CALEA, PERF, IACP, IFCA, IPMA-HR, DOJ, BJA, COPS, NFPA, and others.

The Center for Public Safety Management, LLC, maintains the same team of individuals performing the same level of service as when it was a component of ICMA. CPSM's local government technical assistance experience includes workload and deployment analysis using our unique methodology and subject matter experts to examine department organizational structure and culture, identify workload and staffing needs, and align department operations with industry best practices. We have conducted over 341 such studies in 42 states and provinces and 246 communities ranging in population from 8,000 (Boone, Iowa) to 800,000 (Indianapolis, Ind.).

Thomas Wieczorek is the Director of the Center for Public Safety Management. Leonard Matarese serves as the Director of Research & Program Development. Dr. Dov Chelst is the Director of Quantitative Analysis.

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SECTION 1. EXECUTIVE SUMMARY

The Center for Public Safety Management LLC (CPSM) was contracted by the City of Danville, Kentucky, to conduct an analysis of the city's fire department.

The Danville Fire Department (DFD) is responsible for providing services that include fire suppression; first response emergency medical services; community risk reduction, origin and cause; and special operations (technical rescue and mitigation of hazardous materials incidents). These services are provided from two stations. Response is made through two engine companies, a ladder company (cross-staffed with the engine crew at Station 2), and various other operational support vehicles.

The service demands of the community are numerous for the department and include EMS first response, fire suppression, technical rescue, hazardous materials, and transportation emergencies to include extensive rail traffic and vehicle, and other nonemergency responses. A significant component of this report is the completion of an All-Hazard Risk Assessment of the Community. The All-Hazard Risk Assessment of the Community contemplates many factors that cause, create, facilitate, extend, and enhance risk in and to a community.

The response time and staffing components discussion of this report are designed to examine the current level of service provided by the DFD compared to national best practices. As well, these components provide incident data and relevant information that the department can utilize for future planning and self-review of service levels for continued improvement designed to meet community expectations and mitigate emergencies effectively and efficiently.

Other significant components of this report are an analysis of the current deployment of resources and the performance of these resources in terms of response times and the two DFD fire management zones; current staffing levels and patterns; department resiliency (ability to handle more than one incident); critical tasking elements for specific incident responses; and assembling an effective response force. CPSM analyzed these items and is providing recommendations where applicable to improve service delivery and for future planning purposes.

A comprehensive risk assessment and review of deployable assets are critical aspects of a fire department's operation. First, these reviews will assist the DFD in quantifying the risks that it faces. Second, the DFD will be better equipped to determine if the current response resources are sufficiently staffed, equipped, trained, and positioned. The factors that drive the service needs are examined and then link directly to discussions regarding the assembling of an effective response force and the examination of the response capabilities needed to adequately address the existing risks, which encompasses the component of critical tasking.

This report also contains a series of observations and planning objectives and recommendations provided by CPSM that are intended to help the DFD deliver services more efficiently and effectively.

Recommendations and considerations for continuous improvement of services are presented here. CPSM recognizes there may be recommendations and considerations offered that first must be budgeted and/or bargained, or for which processes must be developed prior to implementation.

RECOMMENDATIONS

1. CPSM recommends the DFD adopt the 20-year fire apparatus replacement plan that includes age recommendations in accordance with NFPA 1901 standard, Standard for Automotive Fire Apparatus. Heavy fire apparatus planning objectives should include (Discussion pp. 11-13.)
   - First-line apparatus should not exceed 15 years of service on the front line, and once they reach this age, should be replaced with a new apparatus and then rotated to reserve status.
   - Apparatus in front-line or reserve status and which have not been properly maintained as evidenced by maintenance records, or that are not operationally or roadworthy as evidenced by maintenance records, should be placed out of service.
   - Apparatus in reserve status in excess of 20 years old should comply with NFPA 1901 and be upgraded in accordance with NFPA 1912 if the department plans to continue to use this apparatus.
   - Apparatus and major apparatus components such as the motor, fire pump, aerial ladder assembly and hydraulics, chassis and chassis components such as brakes, wheels, and steering equipment should be maintained in accordance with manufacturer and industry specifications and standards.
   - Fixed or portable apparatus components that require annualized testing, such as fire pumps, aerial ladder and aerial ladder assemblies, ground ladders, self-contained breathing apparatus to include personnel fit-testing, and fire hose, should be tested in accordance with manufacturer and industry specifications and standards.
2. CPSM recommends the city and the DFD develop a plan that includes short-, medium-, and long-range goals to address the deficiencies in the 2014 Public Protection Classification analysis conducted by ISO. The planning elements should address those FSRS features where the city is most deficient, as outlined in this report. Addressing other, less significant deficiencies, should also be included in this plan. (Discussion pp. 21-23.)
3. CPSM recommends the DFD address call processing time with the Emergency Communications Center and develop a plan that has a goal of reducing alarm processing time to a level that is within NFPA 1710 standards. CPSM further recommends the DFD address turnout time internally and develop a plan that has a goal of reducing turnout time to a level that is within NFPA 1710 standards. (Discussion pp. 42-50.)
4. CPSM recommends the DFD relocate the ladder apparatus from Station 2 to the Central Fire Station once the new facility is built and occupied, so that aerial ladder service/coverage is available to multilevel buildings in the city's core and the most densely populated built-upon areas of the city. (Discussion pp. 50-55.)
5. CPSM recommends the DFD identify and work with fire departments that can provide mutual and automatic aid assets, and then enter into agreements with these departments so that staffing and deployable assets to assemble an Effective Response Force for a fire or other incident where critical tasks outnumber available resources can be enhanced for not only Danville, but these jurisdictions as well. (Discussion pp. 55)
6. Maintain minimum staffing on each engine company at three each work shift and at each station. CPSM does not recommend any engine company drop to two personnel as this impacts the fire department's already strained ability to assemble an Effective Response Force to mitigate an emergency and complete critical tasks simultaneously rather than in

succession. CPSM recommends this be considered in the immediate term (current planning period). (Discussion pp. 56-73.)

7. Eliminate the cross-staffing of the ladder apparatus with engine company personnel and staff the ladder apparatus with three personnel (one lieutenant and two firefighters) each work shift. This would require the addition of nine personnel. CPSM recommends this be considered in the short term (two- to three-year planning period). (Discussion pp. 56-73.)
8. Continue the planning and funding/budget efforts for the construction, staffing, and equipping of Station 3, and the hiring of personnel (three per shift, nine total). CPSM further recommends this be considered over a mid-term time frame (five-year planning period). (Discussion pp. 56-73.)
9. Monitor development in the northeast section of the city. As this area experiences growth and as demand for service increases, CPSM recommends the city consider a fourth fire station staffed with one engine and three personnel per shift. CPSM further recommends this be considered over a long-term time frame (seven- to ten-year planning period). (Discussion pp. 56-73.)

SECTION 2. AGENCY OVERVIEW

DANVILLE FIRE DEPARTMENT

The Danville Fire Department (DFD) is responsible for providing services that include fire suppression; first response emergency medical services; fire prevention and education; technical rescue to include vehicle extrication and high-angle rope rescue; response to and mitigation of hazardous materials incidents; and response to disasters both natural and man-made. Emergency medical service (EMS) ground transportation is delivered by Boyle County EMS. Emergency communications (9-1-1) is provided by the Danville Police Department.

The Fire Chief is the head of the fire department. Assisting the chief is a Deputy Fire Chief and a Fire Marshal. An Executive Assistant provides administrative support to fire administration. The Fire Marshal conducts/oversees community risk reduction activities to include fire prevention inspections, fireworks and open burning regulatory activities, fire education activities, and fire cause and origin investigations.

The DFD operates out of two stations, staffing each station with one Lieutenant and two firefighters. The Lieutenant serves as the first-line or company supervisor. Operationally, each station primary response vehicle is an engine apparatus. Station 2 cross-staffs an aerial ladder apparatus and a rescue apparatus. Under this cross-staffing model at Station 2, the Lieutenant may choose for the crew to respond in the engine, ladder, or rescue apparatus dependent on the call type. There is one Battalion Chief on duty each shift who has overall administrative and operational command of both stations and personnel. The Battalion Chief responds out of Station 1. The department has 21 budgeted operational personnel assigned to field operations (seven per shift).

The DFD utilizes a three-platoon/shift system whereby operational personnel work 24 hours on, and are off for 48 hours. Under this schedule, operational personnel are scheduled for and work a 56-hour work week. Fair Labor Standards Act (FLSA)-29 USC §207(k) regulations exempt hourly personnel from overtime after 40 hours/week; however, under USC §207(k), any hours worked over 53 hours/week can be either flexed off during the selected pay cycle (7-28 days) or compensated. Firefighters, Lieutenants, and Battalion Chiefs are classified as non-exempt, that is, hourly employees, in Danville. The DFD is on a seven-day cycle and compensates non-exempt (hourly) employees for hours worked beyond 40 hours for the workweek. Due to the limited number of DFD non-exempt employees, this is deemed the best method for the city to meet the standards of USC §207(k).

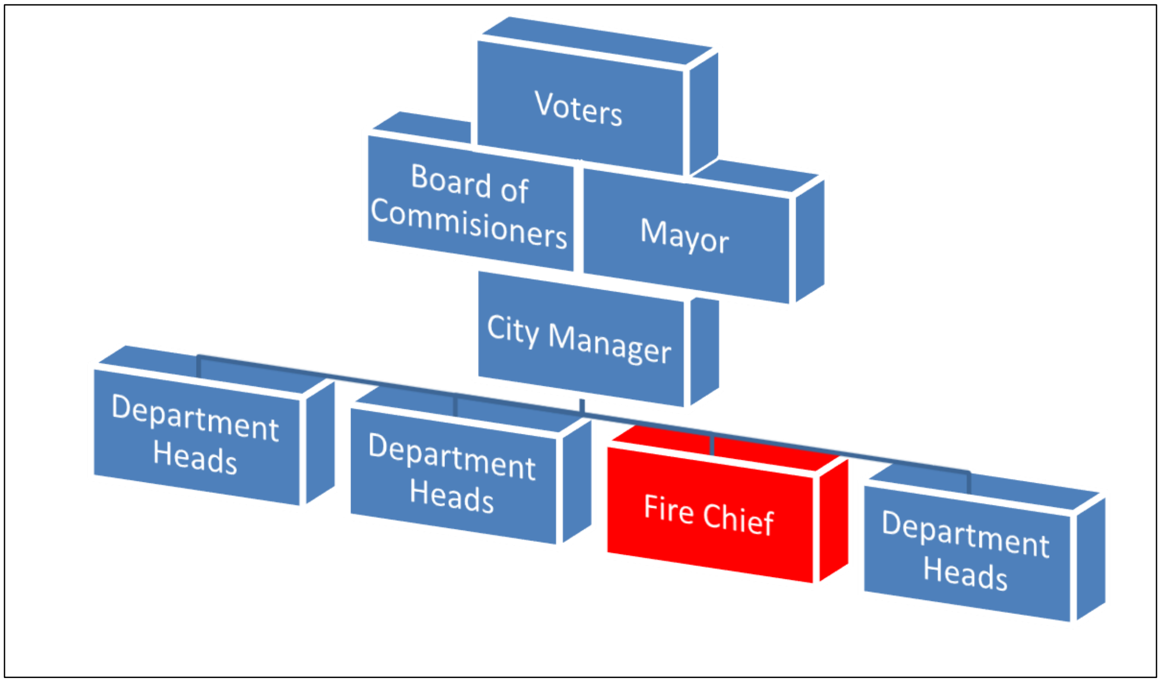
Personnel are trained to firefighting and officer standards as set forth by the Commonwealth of Kentucky. As well, operations personnel are trained to the level of Emergency Medical Technician-Basic (EMT-B), and Hazardous Materials–Operations level. The department operates a haz-mat unit and a rescue unit, which are vehicles equipped to mitigate specialty incident types.

Governance and Administration

The City of Danville operates under the city manager form of government pursuant to KRS 83A.150. Under this plan, the Board of Commissioners (BOC) are elected by the citizens of the city. All legislative and executive authority is vested with the BOC. The BOC is led by a Mayor, who presides over commission meetings and who works with other commissioners on legislative matters for the city. The BOC appoints a City Manager who is the chief administrative officer of the city, and carries out the duties and responsibilities as legislated by city ordinance, and those policy decisions legislated by the BOC. The Fire Chief reports to the City Manager.[1]

The following figure depicts the fire department's place in the organization.

FIGURE 2-1: City of Danville Organizational Chart



SERVICE AREA

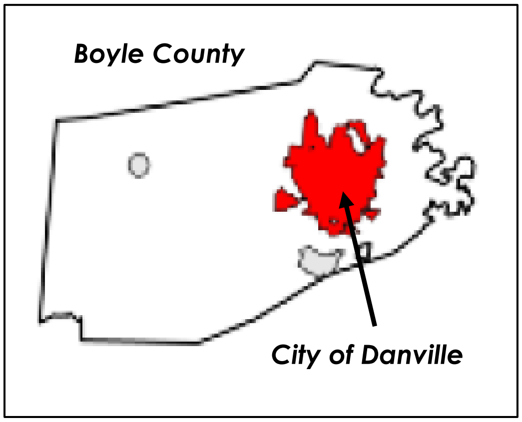
The DFD provides fire, EMS, and protective services within the municipal boundaries of the city. This includes, according to the US Census Bureau, an area of 15.82 square miles of which the majority is land mass (about 0.077 square miles is water). The DFD also responds to fire and EMS emergencies outside of the city boundaries on request through mutual aid agreements.

Danville is located in the western portion of Boyle County, and is the largest incorporated area of the county. Danville is not contiguous with any other incorporated town or city; rather, it is contiguous with unincorporated Boyle County on all city municipal borders. Danville serves as the county seat of Boyle County.

The next figure shows the location of Danville in Boyle County, while the subsequent figure illustrates the DFD's service area and the locations of the fire stations.

1. https://www.danvilleky.org/city-government/form-of-government

FIGURE 2-2: Danville Municipal Service Area in Boyle County



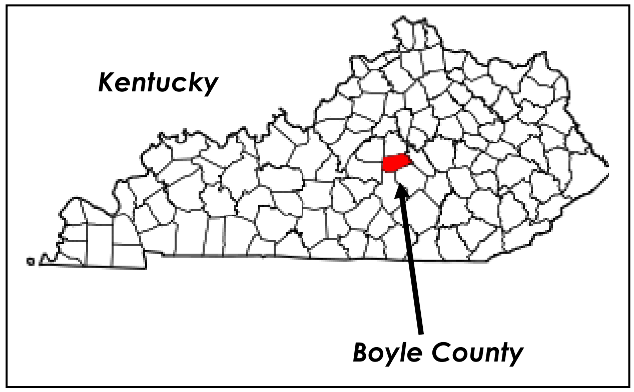
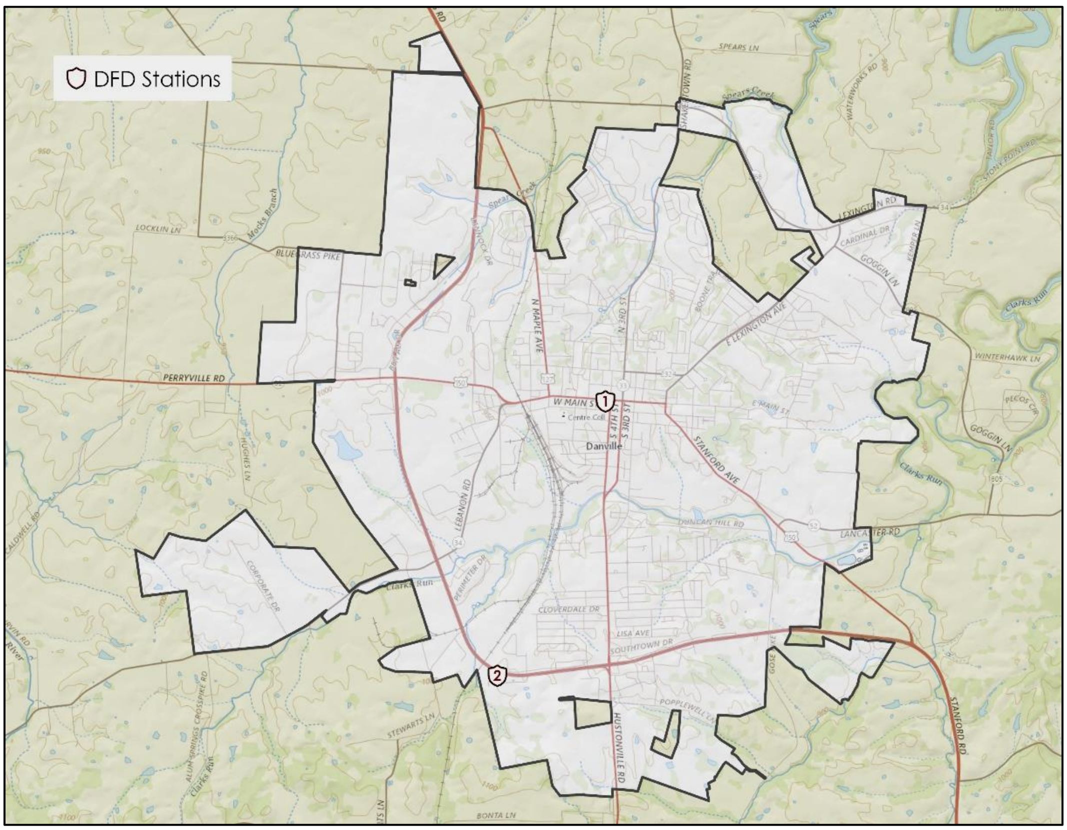


FIGURE 2-3: Danville Municipal Boundaries with Fire Stations



SECTION 3. AGENCY RESOURCES

RESOURCE DESCRIPTIONS

Budget

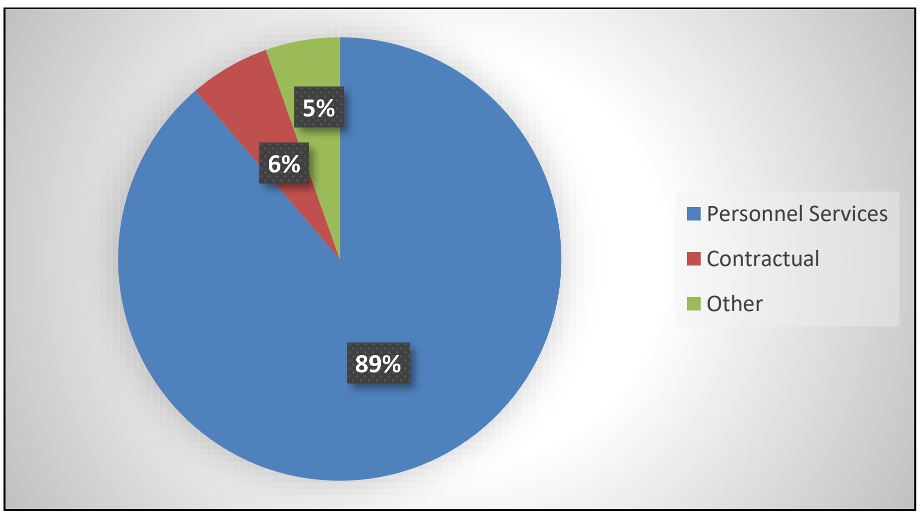
The City of Danville operates on a fiscal year budget from July 1 to June 30. The DFD's FY 20-21 budget is $3,080,869.82. The DFD budget is separated into three customary segments, which are: personnel services, contractual, and other (materials, tools, operating). The following table depicts how these segments are funded in the current fiscal year.

TABLE 3-1: DFD FY 2020–2021 Budget

Personnel Services	Contractual	Other
$2,733,219.82	$180,950.00	$166,700.00

The next figure shows how these budgeted funds are broken out by percentage. As is typical for fire departments, personnel services make up the majority of the DFD's budget.

FIGURE 3-1: DFD FY 2020–2021 Budget Share by Category



Facilities

Fire facilities must be designed and constructed to accommodate current and forecast trends in fire service vehicle type and manufactured dimensions. A facility must have sufficiently-sized bay doors, circulation space between garaged vehicles, departure and return aprons of adequate length and turn geometry to ensure safe response, and floor drains and oil separators to satisfy environmental concerns. Station vehicle bay areas should also consider future tactical vehicles that may need to be added to the fleet to address forecasted response challenges, even if this consideration merely incorporates civil design that ensures adequate parcel space for additional bays to be constructed in the future.

Personnel-oriented needs in fire facilities must permit performance of daily duties in support of response operations. For personnel, fire facilities must have provisions for vehicle maintenance and repair; storage areas for essential equipment and supplies; space and amenities for administrative work, training, physical fitness, laundering, meal preparation, and personal hygiene/comfort; and—where a fire department is committed to minimize "turnout time"—bunking facilities.

A fire department facility may serve as a de facto "safe haven" during local community emergencies, and also serve as likely command center for large-scale, protracted, campaign emergency incidents. Therefore, design details and construction materials and methods should embrace a goal of building a facility that can perform in an uninterrupted manner despite prevailing climatic conditions and/or disruption of utilities. Programmatic details, such as the provision of an emergency generator connected to automatic transfer switching, even going as far as providing tertiary redundancy of power supply via a "piggyback" roll-up generator with manual transfer (should the primary generator fail), provide effective safeguards that permit the fire department to function fully during local emergencies when response activity predictably peaks.

Personnel/occupant safety is a key element of effective station design. This begins with small details such as the quality of finish on bay floors and nonslip treads on stairwell steps to decrease tripping/fall hazards, or use of hands-free plumbing fixtures and easily disinfected surfaces/countertops to promote infection control. It continues with installation of specialized equipment such as an exhaust recovery system to capture and remove cancer-causing byproducts of diesel fuel exhaust emissions. A design should thoughtfully incorporate best practices for achieving a safe and hygienic work environment.

Ergonomic layout and corresponding space adjacencies in a fire station should seek to limit the travel distances between occupied crew areas to the apparatus bays. Likewise, design should carefully consider complementary adjacencies, such as lavatories/showers in proximity of bunk rooms, and desired segregations, such as break rooms or fitness areas that are remote from sleeping quarters. Furnishings, fixtures, and equipment selections should provide thoughtful consideration of the around-the-clock occupancy inherit to fire facilities. Durability is essential, given the accelerated wear and life cycle of systems and goods in facilities that are constantly occupied and operational.

Sound community fire-rescue protection requires the strategic distribution of fire station facilities to ensure that effective service area coverage is achieved, that predicted response travel times satisfy prevailing community goals and national best practices, and that the facilities are capable of supporting mission-critical personnel and vehicle-oriented requirements and needs. Additionally, depending on a fire-rescue department's scope of services, size, and complexity, other facilities may be necessary to support emergency communications, personnel training, fleet and essential equipment maintenance and repair, and supply storage and distribution.

National standards such as the National Fire Protection Association's (NFPA) 1500, *Standard on Fire Department Occupational Safety, Health, and Wellness Program*, outlines standards that transfer to facilities such as infection control, personnel and equipment decontamination, cancer prevention, storage of protective clothing, and employee fitness. NFPA 1851, *Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Firefighting and Proximity Fire Fighting*, further delineates laundering standards for protective clothing and station wear. Laundry areas in fire facilities continue to evolve and are being separated from living areas to reduce contamination. Factors such as wastewater removal and air flow need to be considered in a facility design.

FIGURE 3-2: Central Fire Station

Central Fire Station, which houses both operational response units and fire administration, is located at 420 W. Main St. A new Central Fire Station is currently under construction to replace the existing facility. This new station will be located just west of Danville City Hall, which is located at 445 W. Main St. The location of the new Central Fire Station will not affect response times and response areas compared to the current station.

TABLE 3-2: DFD Facility Summary

Station	Year Built	Apparatus Sq. Ft.	Apparatus Outside	Admin/Trng Sq. Ft.	Crew Sq. Ft.	Total Sq. Ft.	Total On-Duty Crew
Central Fire Station	1961	3,092	Yes	2,387	5,443	10,922	4
Station 2	2005	3,151	Yes	0	3,148	6,299	3

Due to its age (60 years), the current Central Fire station, is outdated and past its useful life. The new station, at almost 21,000 square feet, will accommodate more crew members should staffing be increased. It will also have more space for apparatus storage, administrative office, and training;, will have clean crew areas separated from apparatus bays and other carcinogens and potential exposures from operational responses; will include a basement for additional storage and crew member use; and will have other contemporary fire facility fittings and equipment such as vehicle exhaust removal, decontamination areas, and a modern kitchen facility that will be available for 24-hour use.

The following figure is an elevation rendition of this new facility, accompanied by projected square foot specifications.

§ § §

FIGURE 3-3: New Central Fire Station-Elevation Rendition[2]

VIEW LOOKING NORTHEAST

Apparatus Bay Space
5,479 sq. ft.

Administrative and Training
7,628 sq. ft.

Crew Space
7,842 sq. ft.

Total Sq. Ft.
20,949

FIGURE 3-4: Fire Station 2

Station 2 is located at 101 Fireside Dr. This station was originally constructed as a satellite station, and while adequate for the crew size assigned to this station, it lacks sufficient interior apparatus storage space, as well administrative, training areas, crew health and wellness area and equipment to function as an independent station. Crews assigned to this station travel to the Central Fire Station for many activities. Additionally, this station lacks vehicle exhaust systems for apparatus carbon emissions, commercial appliances, personal protective gear cleaning systems (extractor), and an air compressor to refill self-contained breathing apparatus cylinders. Structurally the station is sound minus the normal repairs. According to staff the roof is nearly due for replacement.

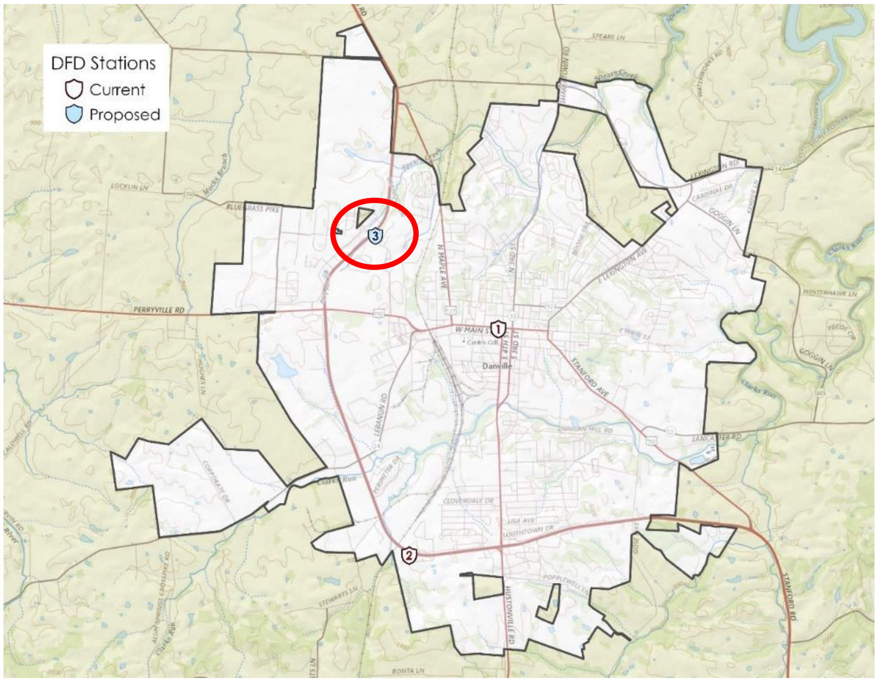
The city is considering a proposed Station 3, which would be located at the former fair grounds site and next to the Danville-Boyle County Humane Society. This location is in the northwest section of the city. The land for the station has been purchased but the construction has not yet been funded. The location was chosen due to availability of land, projected future development north and west of the Central Fire Station, proximity to the bypass (for north and south response movement), and by the reality that the city is bisected by a major rail line, with some streets subject to at-grade crossings that would hamper east-west response.

The purpose of this station is to reduce response times in the north and northwest areas of the city, and increase in all of the city the effective response force to emergency incidents such as structural fires where certain critical tasks must be performed simultaneously rather than in

2. https://www.amnews.com/2019/05/17/new-central-fire-station-design-released/

succession. This will be discussed more comprehensively later in this report. The next figure shows the future placement of fire stations in Danville.

FIGURE 3-5: Danville Fire Stations with Proposed Station 3



Fleet and Equipment

The provision of an operationally ready and strategically located fleet of mission-essential fire-rescue vehicles is fundamental to the ability of a fire-rescue department to deliver reliable and efficient public safety within a community.

The DFD currently operates a heavy fire apparatus fleet that includes:

- Three engine apparatus (two front line, two reserves).
  - Year purchased: 2000, 2010, 2014 (future purchase planned for 2022).
  - Engine apparatus replacement schedule: 20 years.
- One aerial ladder apparatus (Quint) that has aerial ladder, fire pump, hose, water tank, fire, and EMS equipment.
  - Year purchased: 2018.
  - Aerial ladder apparatus replacement schedule: 20 years.
- One rescue truck apparatus equipped with specialized technical rescue equipment for vehicle/machinery extrication, high angle rope rescue and rigging systems, structure collapse, and other light and heavy duty technical rescue responses.
  - Year purchased: 1991.
  - Rescue truck apparatus replacement schedule: 30+ years.

The DFD also has an assortment of command and light response vehicles to round out the response fleet.

The procurement, maintenance, and eventual replacement of response vehicles is one of the largest expenses incurred in sustaining a community's fire-rescue department. While it is the personnel of the DFD who provide emergency services within the community, the department's fleet of response vehicles is essential to operational success. Reliable vehicles are needed to deliver responders and the equipment/materials they employ to the scene of dispatched emergencies within the city.

Replacement of fire-rescue response vehicles is a necessary, albeit expensive, element of fire department budgeting that should reflect careful planning. A well-planned and documented emergency vehicle replacement plan ensures ongoing preservation of a safe, reliable, and operationally capable response fleet. A plan must also schedule future capital outlay in a manner that is affordable to the community.

NFPA 1901, *Standard for Automotive Fire Apparatus*, serves as a guide to the manufacturers that build fire apparatus and the fire departments that purchase them. The document is updated every five years, using input from the public/stakeholders through a formal review process. The committee membership is made up of representatives from the fire service, manufacturers, consultants, and special interest groups. The committee monitors various issues and problems that occur with fire apparatus and attempts to develop standards that address those issues. A primary interest of the committee over the past years has been improving firefighter safety and reducing fire apparatus crashes.

The Annex Material in NFPA 1901 (2016) contains recommendations and work sheets to assist in decision making in vehicle purchasing. With respect to recommended vehicle service life, the following excerpt is noteworthy:

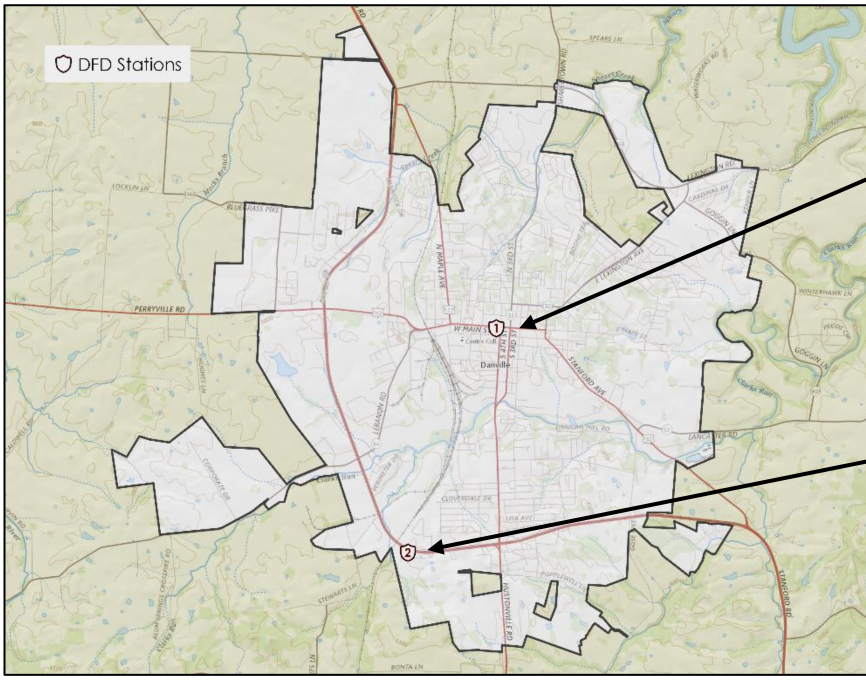
> *"It is recommended that apparatus greater than 15 years old that have been properly maintained and that are still in serviceable condition be placed in reserve status and upgraded in accordance with NFPA 1912, Standard for Fire Apparatus Refurbishing (2016), to incorporate as many features as possible of the current fire apparatus standard. This will ensure that, while the apparatus might not totally comply with the current edition of the automotive fire apparatus standards, many improvements and upgrades required by the recent versions of the standards are available to the firefighters who use the apparatus."*

The impetus for these recommended service life thresholds is continual advances in occupant safety. Despite good stewardship and maintenance of emergency vehicles in sound operating condition, there are many advances in occupant safety, such as fully enclosed cabs, enhanced rollover protection and air bags, three-point restraints, antilock brakes, higher visibility, cab noise abatement/hearing protection, and a host of other improvements as reflected in each revision of NFPA 1901. These improvements provide safer response vehicles for those providing emergency services within the community, as well those "sharing the road" with these responders.

The DFD does have a replacement plan for front-line heavy fire apparatus in-service program as noted above, which meets, in most cases, the NFPA 1901 standards for heavy fire apparatus (20-year replacement plan that follows a 15-year front-line and 5-year reserve service life). The current rescue truck apparatus is 30 years old, and well beyond the age considered by NFPA 1901 as front-line or reserve apparatus for the reasons stated herein.

The following figure illustrates DFD stations with apparatus assignments.

FIGURE 3-6: DFD Fire Stations with Assigned Apparatus



Station 1

Engine 12
Frontline-Staffed

Engine 17
Reserve

Battalion Chief
Frontline-Staffed

Station 2

Engine 18
Frontline-Staffed

Ladder 1
Frontline
Cross staffed

Rescue 1
Frontline
Cross staffed

Recommendations:

- CPSM recommends the DFD adopt the 20-year fire apparatus replacement plan that includes age recommendations in accordance with NFPA 1901 standard, Standard for Automotive Fire Apparatus. Heavy fire apparatus planning objectives should include (Recommendation No. 1):
  - First-line apparatus should not exceed 15 years of service on the front line, and once they reach this age, should be replaced with a new apparatus and then rotated to reserve status.
  - Apparatus in front-line or reserve status and which have not been properly maintained as evidenced by maintenance records, or that are not operationally or roadworthy as evidenced by maintenance records, should be placed out of service.
  - Apparatus in reserve status in excess of 20 years old should comply with NFPA 1901 and be upgraded in accordance with NFPA 1912 if the department plans to continue to use this apparatus.
  - Apparatus and major apparatus components such as the motor, fire pump, aerial ladder assembly and hydraulics, chassis and chassis components such as brakes, wheels, and steering equipment should be maintained in accordance with manufacturer and industry specifications and standards.
  - Fixed or portable apparatus components that require annualized testing, such as fire pumps, aerial ladder and aerial ladder assemblies, ground ladders, self-contained breathing apparatus to include personnel fit-testing, and fire hose, should be tested in accordance with manufacturer and industry specifications and standards.

SECTION 4. ALL-HAZARD RISK ASSESSMENT OF THE COMMUNITY

POPULATION AND DEMOGRAPHICS

The U.S. Census Bureau estimated the 2019 City of Danville population at 16,769. This is a 3.4 percent increase from the 2010 decennial population of 16,206. As the city is about 16 square miles in area, the population density based on the Census Bureau population data is 1,025/square mile; some areas of the city have a greater density than others.[3]

The age and socio-economic factors of the population can have an impact on requests for fire and EMS service. Evaluation of the number of seniors and children by fire management zones can provide insight into trends in service delivery and can quantitate the probability of future service requests. In a 2018 National Fire Protection Association (NFPA) report on residential fires, the following key findings were identified for the period 2011–2015:[4]

- Males were more likely to be killed or injured in home fires than females, and accounted for a larger percentages of the victims (57 percent of the deaths and 54 percent of the injuries).
- The largest number of deaths (19 percent) in a single age group was among people ages 55 to 64.
- Half (50 percent) of the victims of fatal home fires were between the ages of 25 and 64, as were three of every five (62 percent) of the non-fatally injured.
- One-third (33 percent) of the fatalities were age 65 or older; only 15 percent of the non-fatal injured were in that age group.
- Children under the age of 15 accounted for 12 percent of the home fire fatalities and 10 percent of the injuries. Children under the age of 5 accounted for 6 percent of the deaths and 4 percent of the injuries.
- Adults of all ages had higher rates of non-fatal fire injuries than children.
- While smoking materials were the leading cause of home fire deaths overall, this was true only for people in the 45 to 84 age group.
- For adults 85 and older, fire from cooking was the leading cause of fire death.

In Danville the following age and socioeconomic factors should be considered when determining risk for fire and EMS preparedness and response:

- Children under the age of five represent 5.4 percent of the population.
- Persons under the age of 18 represent 18.9 percent of the population.
- Persons over the age of 65 represent 18.7 percent of the population.
- Female persons represent 51.9 percent of the population.
- There are 2.31 persons per household in Danville.

3. https://www.census.gov/quickfacts/fact/table/danvillecitykentucky/PST045219
4. M. Ahrens, "Home Fire Victims by Age and Gender", Quincy, MA: NFPA, 2018.

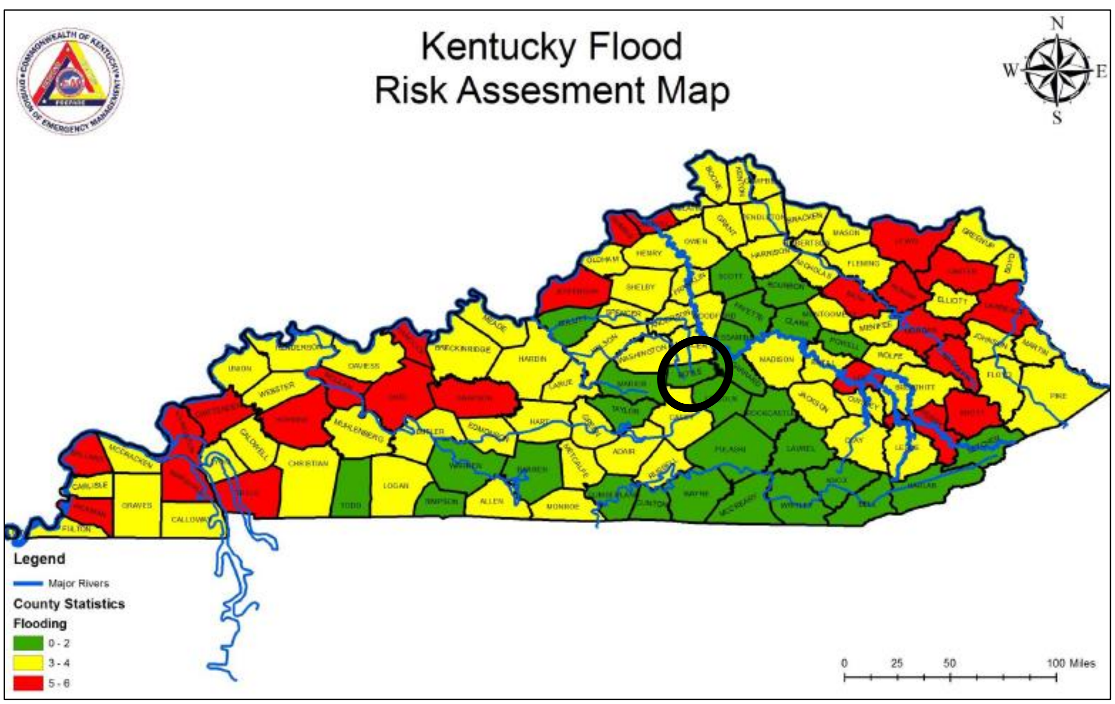
- The median household income in 2018 was $39,906.
- Persons in poverty amount to 18.6 percent of the population.
- White alone represents the highest percentage of race in Danville at 82.2 percent. The remaining population profile by race is: Black or African-American at 11.7 percent, American Indian or Alaska Native alone at 0.2 percent, Asian alone at 1.4 percent, two or more races at 2.8 percent, and Hispanic or Latino at 4.8 percent.

ENVIRONMENTAL FACTORS

The City of Danville, because of its location in central Kentucky, is prone to certain environmental factors that present the city with the following environmental risks:[5]

Flooding: The flooding risk is due to the city's proximity to the Salt (to the west) and Dix (to the east) rivers. Flooding may result from heavy rainfall either in and around the city or region, or from upstream, as rivers in Kentucky flow predominantly from north to south. Flooding can be predicted from heavy rainfall or significant weather events such as the remnants of tropical systems, or flash flooding of tributaries that feed the Salt and Dix rivers from sudden heavy rainfall. Flash floods cause roadways to be covered in water, rendering the roads impassable for extended periods of time, destroying property, and creating dangerous scenarios such as swift water in certain areas of the city. A 100-year floodplain has been identified in Danville along the area known as Clark's Run that is a tributary to Dix River.[6] The next figure illustrates the flooding risk assessment map for the state showing Boyle County at a low risk (0-2).

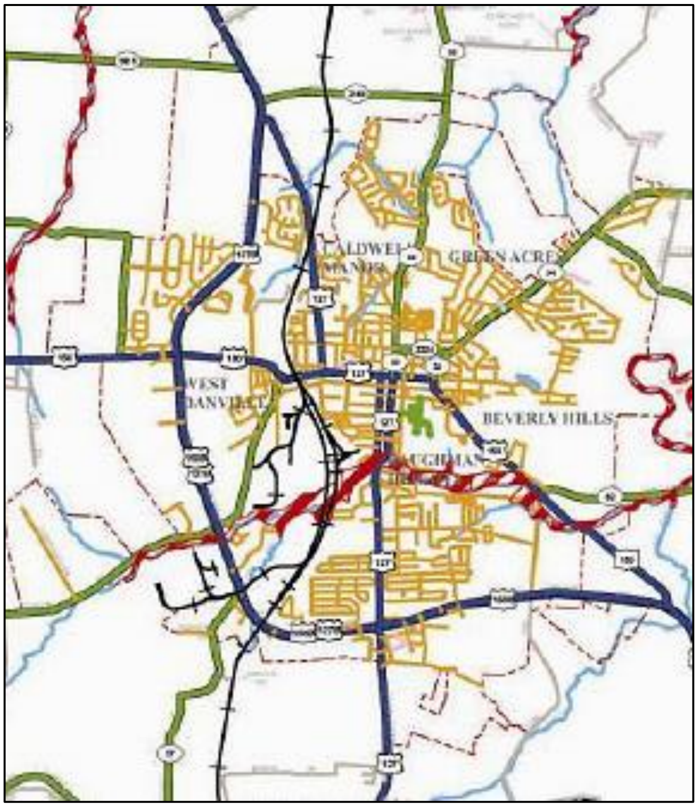
FIGURE 4-1: Kentucky Flood Risk Assessment Map



5. Commonwealth of Kentucky Emergency Operations Plan, 2014.
6. Danville-Boyle County Comprehensive Plan, 2017.

The following figure illustrates flood hazard areas specific to Danville.

FIGURE 4-2: Danville Flood Hazard Areas Map7



Legend

Boyle County Flood Hazard Areas

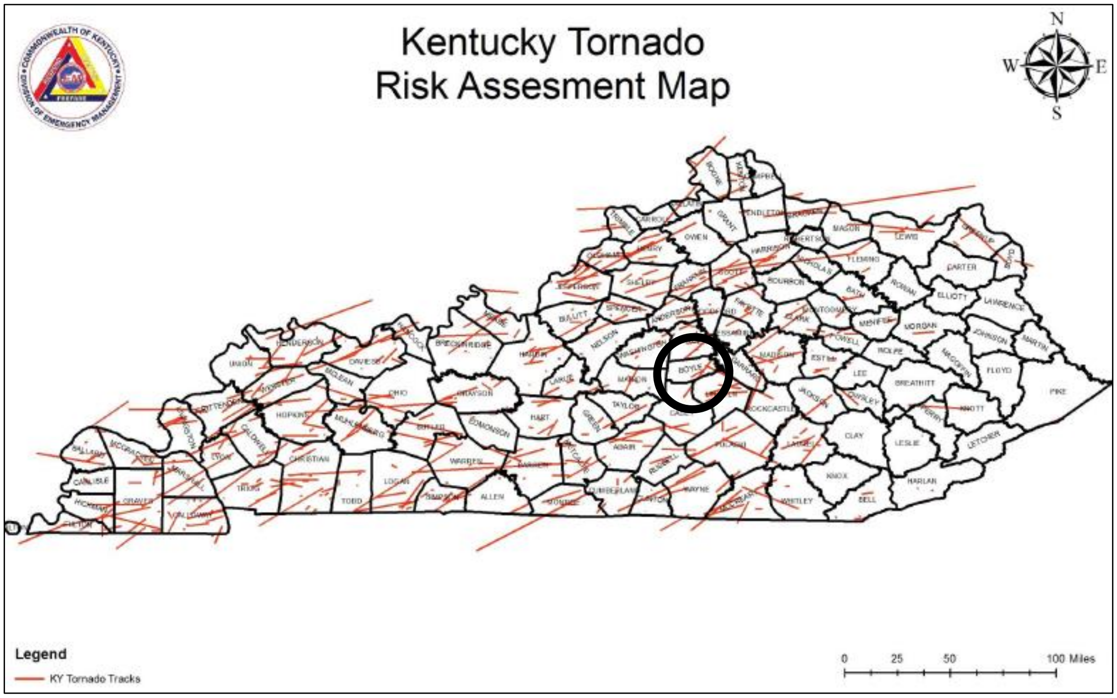
Severe Storms/Natural Hazards: The state of Kentucky, Boyle County, and Danville are at risk for severe weather and natural hazards such as heavy rain, tornadoes, ice, wind storms, wild land fires that interface with structures, and snow storms. Natural hazards are natural events that threaten lives, property, and other community assets. Natural hazards often can be predicted; however, this does not necessarily lessen the impacts. Natural hazards tend to occur repeatedly in the same geographical locations, as they are related to weather patterns or physical characteristics of an area.

Because the county and city are exposed to a predominantly southerly wind pattern, and have a warm and humid climate in the summer time, both are vulnerable to severe weather from thunderstorms, as well as mild drought conditions.[8] An additional natural hazard threat in Kentucky overall is from tornadoes. Historic tornado tracks in Boyle County are predominately in the southwest portion of the county.

The next figure illustrates tornado tracks in Kentucky and Boyle County.

7. Danville-Boyle County Comprehensive Plan, 2017.
8. Ibid.

FIGURE 4-3: Tornado Tracks in Kentucky and Boyle County



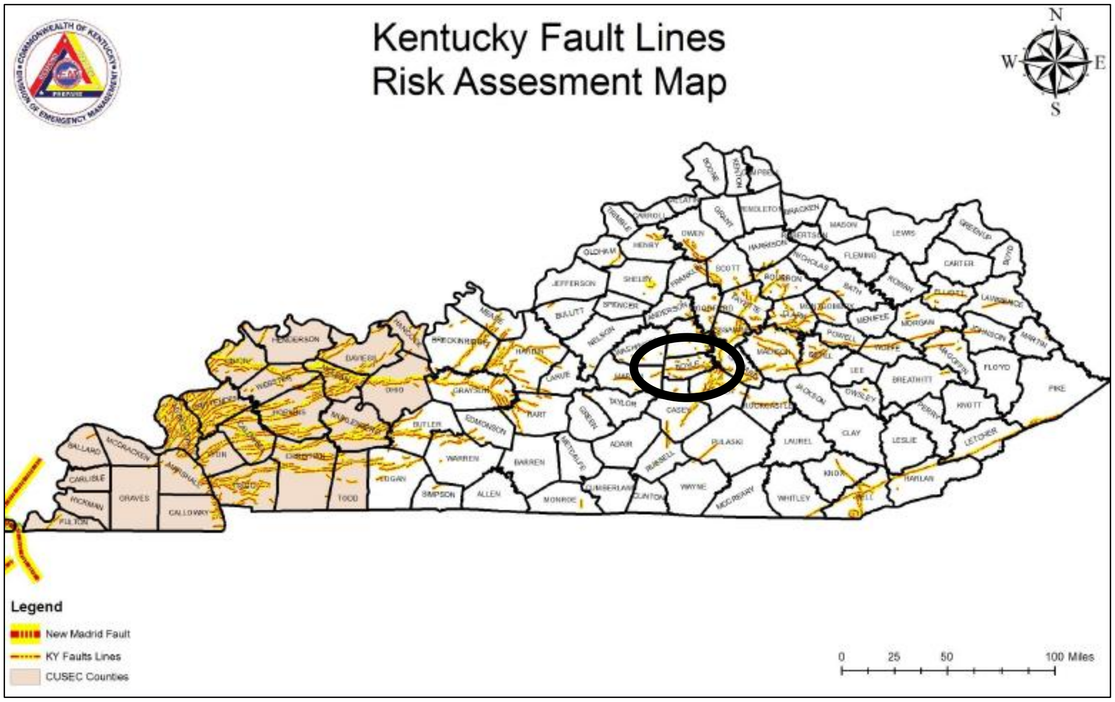
Public Health Emergencies: The state of Kentucky, Boyle County, and Danville are at risk for public health emergencies such as the 2020 pandemic known as COVID-19 or coronavirus, and may include influenza, smallpox, tuberculosis, human immunodeficiency virus infection / acquired immunodeficiency syndrome, cholera, polio, typhus, and hepatitis.[9] Public Health emergencies predominately affect the social and economic environments of the community, and have a direct impact on health and medical services, as well as first responder agencies.

As seen in the current COVID-19 pandemic, there are significant challenges to first responders during public health emergencies. These include changes in the operational environment, available resources particularly staffing and personal protective equipment and ensembles, work conditions, and the level or type of demand for services. There are also direct effects to personnel such as related illness, absenteeism, stress, and potential quarantines of personnel, which can lead to staffing shortages and the overworking of available staff to keep minimum staffed positions filled so that there is no reduction in service delivery. Indirect effects include impacts on agency operations that changes how services are delivered, reduction in training, and increased healthcare costs for staff.

Earthquake: The state of Kentucky, Boyle County, and Danville are at risk for earthquakes. There are several fault lines that run through the state, including one that runs east-west through central Boyle County, two in the southwestern portion of the county, and several small fault lines located in the northern and southeastern portions of the county. The following figure illustrates fault lines in Kentucky.

9. Ibid

FIGURE 4-4: Fault Lines in Kentucky and Boyle County



BUILDING AND TARGET HAZARD FACTORS

A community risk and vulnerability exercise evaluates the community as a whole, and with regard to buildings, measures all buildings and the risk associated with each property, and then segregates the property as either a high-, medium-, or low-hazard depending on factors such as the life and building content hazard, and the potential fire flow and staffing required to mitigate an emergency in the specific property. According to the NFPA *Fire Protection Handbook*, these hazards are defined as:

High-hazard occupancies: Schools, hospitals, nursing homes, explosives plants, refineries, high-rise buildings, and other high life-hazard (vulnerable population) or large fire-potential occupancies.

Medium-hazard occupancies: Apartments, offices, and mercantile and industrial occupancies not normally requiring extensive rescue by firefighting forces.

Low-hazard occupancies: One-, two-, or three-family dwellings and scattered small business and industrial occupancies.[10]

The construction type for residential structures in Danville is predominantly wood frame. Residential construction includes platform wood framing, lightweight truss construction, and balloon construction (studs run continuous from sole plate to rafter plate with no fire stops between floors creating fire chases). Some homes also have basements, finished and unfinished. Danville has some manufactured or factory-built homes of light meta/wood construction with

10. Cote, Grant, Hall & Solomon, eds., *Fire Protection Handbook* (Quincy, MA: National Fire Protection Association, 2008), 12.

various exterior coverings. The majority of the commercial/industrial structure building inventory is ordinary (block/brick) construction with some metal (butler type).

Danville has the following building types:

- Single-family homes.
- Manufactured homes.
- Apartment buildings/complexes, duplex, other multifamily (multistory).
- Commercial/industrial/professional business/educational structures.
- Strip malls.
- Hotel structures (multistory up to four levels).
- Rooming/lodging structures (rentals).
- Educational dormitories.
- Assisted living/long-term care structures.
- Housing/commercial/professional business structures over 75 feet in height (high rise).
- Public education structures.
- Correctional institution (regional jail).
- Danville Regional Medical Center.

In terms of identifying target hazards, consideration must be given to the activities that take place (manufacturing, processing, etc.), the number and types of occupants (elderly, youth, handicapped, imprisoned, etc.), and other specific aspects relating to the construction features of the building.

Danville has a variety of target hazards that include:

- Hotel/Dormitory Target Hazards (life safety).
- Correctional Institution Target Hazard (life safety/access).
- Educational/School/Public Assembly Target Hazard (life safety).
- Mercantile/Business/Industrial (life safety, hazardous storage and or processes).
- Long-Term Care Target Hazard (life safety, vulnerable population).
- Government Infrastructure Target Hazard (hazardous storage/processes and continuity of operations).
- Government Business Target Hazards (life safety, continuity of operations).
- Private Business Target Hazards (life safety).
- Hospital/Medical Center Target Hazards (life safety, hazardous materials storage and use).

The city has a predominately low-hazard building risk (single-family dwellings, certain small private business buildings with low life safety hazards, and certain mercantile buildings with low life safety hazards) dwellings. Medium- and high-hazard building risks are noted in this section as well. There is a moderate number of housing units managed by the Housing Authority of Danville designated for those needing assistance with rental payments. High life safety hazards include hotels, rooming/lodging structures, public assembly structures, the regional jail, the Danville Regional Medical Center, certain mercantile buildings, and certain Centre College structures.

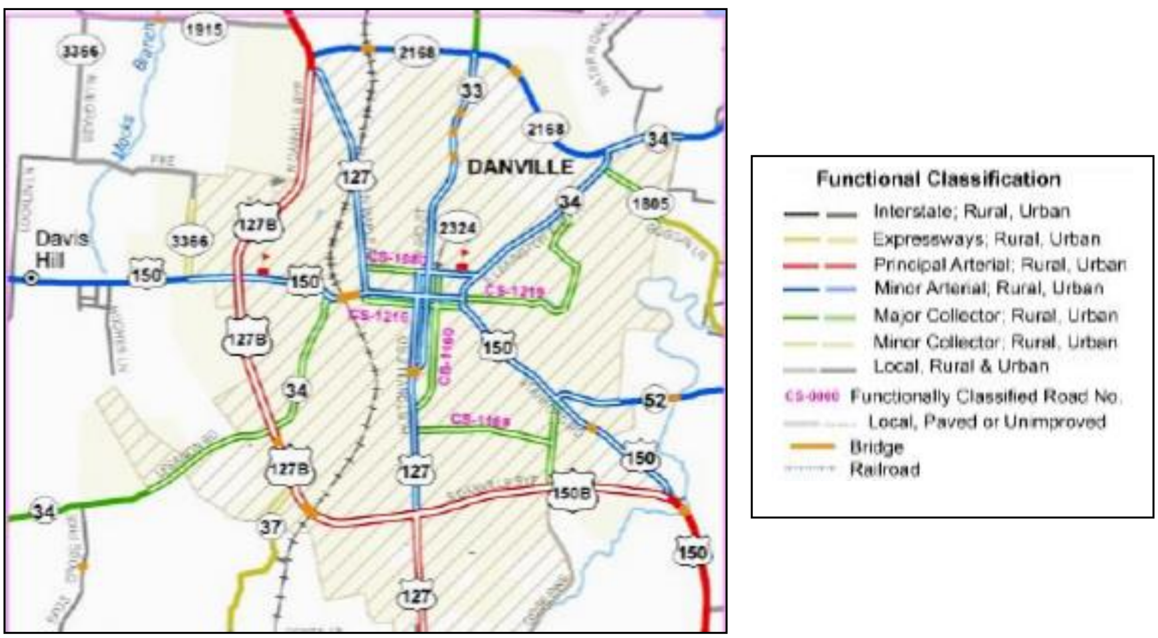
TRANSPORTATION FACTORS

The road network in Danville is typical of cities across the country and includes principal arterial streets, which carry high volumes of traffic; minor arterial streets, which in Danville augment primary arterial streets and that have emphasis on land access; collector streets, which provide connection to arterial roads and local street networks as well as residential and commercial land uses; and local streets, which provide a direct road network to property and move traffic through neighborhoods and business communities.

Danville is served by several major roads. These are: US Route 127 and US 127 Bypass, US Route 150 and US 150 Bypass, and Kentucky Route 34. According to the 2017 Danville Comprehensive Plan, these roads aggregately handle more than 110,000 vehicles each day.[11]

The road network described herein poses a vehicular accident and vehicular-versus-pedestrian risk in Danville. There are additional transportation risks since tractor-trailer and other commercial vehicles traverse the roadways of Danville to deliver mixed commodities to businesses and residential locations. Fires involving these products can produce smoke and other products of combustion risks that may be hazardous to health. The next figure illustrates major road transportation components in Danville.

FIGURE 4-5: Danville Principal Road and Rail Network[12]

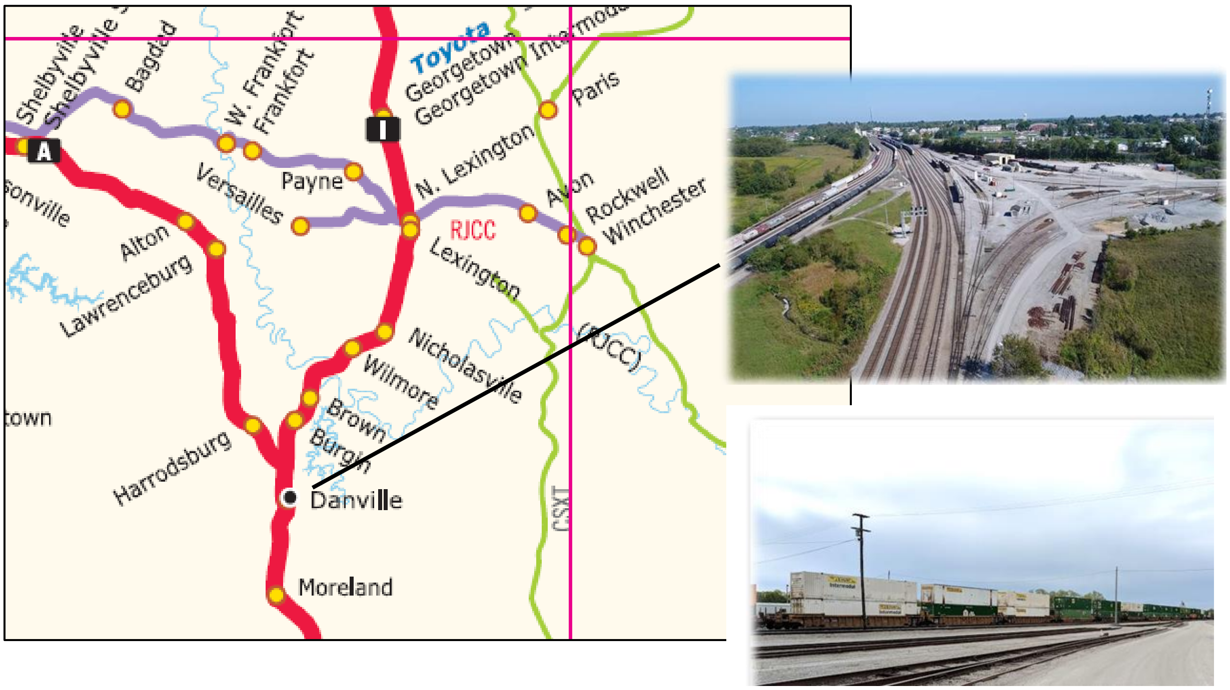


A Norfolk Southern Railway mainline passes through Danville. In addition, Norfolk Southern also maintains an active terminal yard in Danville. There are minimal at-grade crossings on local roads, which creates a low transportation risk. Arterial streets and highways do not intersect

11. Danville-Boyle County Comprehensive Plan, 2017
12. Ibid

directly with rail traffic, thus neutralizing rail/vehicular traffic accidents. Primary commodities handled by Norfolk Southern thorough Danville include coal, vehicle transport, and containerized consumer goods. Consist can also include chemicals and other freight. While not all of these commodities are considered hazardous materials, fires involving these commodities can produce smoke and other products of combustion risks that may be hazardous to health. Hazardous materials themselves present hazards to health risks. The next figure illustrates the Norfolk Southern main line that travels through Danville.

FIGURE 4-6: Norfolk Southern Railway Mainline Through Danville13



ISO RATING

The ISO is a national, not-for-profit organization that collects and evaluates information from communities across the United States regarding their capabilities to combat building fires. The data collected from a community is analyzed and applied to ISO's Fire Suppression Rating Schedule (FSRS) from which a Public Protection Classification (PPC™) grade is assigned to a community (1 to 10). A Class 1 represents an exemplary fire suppression program that includes all of the components outlined below. A Class 10 indicates that the community's fire suppression program does not meet ISO's minimum criteria. It is important to understand the PPC is not just a fire department classification, but rather a compilation of community services that include the fire department, the emergency communications center, community risk reduction (fire prevention code adoption and enforcement, public fire safety education, and fire investigation) and the community's potable water supply system operator.[14]

A community's PPC grade depends on:

13. http://www.nscorp.com/content/dam/nscorp/maps/2016-system-map
14. https://www.isomitigation.com/ppc/

- **Needed Fire Flows** (building locations used to determine the theoretical amount of water necessary for fire suppression purposes).
- **Emergency Communications** (10 percent of the evaluation).
- **Fire Department** (50 percent of the evaluation).
- **Water Supply** (40 percent of the evaluation).
- **Community Risk Reduction** (Additional credit available of 5.50 points)

The City of Danville maintains an ISO rating of Class 04/4X, which was achieved in December 2014.[15]

Our review of the city's PPC report revealed that the following credits were awarded in each of the categories the ISO analyzes:

Fire Suppression Rating System (FSRS) Feature	Credit Available	Credit Earned
Emergency Communications	10	7
Fire Department	50	25.77
Water Supply	40	29.33
Community Risk Reduction	5.50	4.36
Totals	**105.50**	**62.10**

Credits earned from the PPC analysis rank the community (1-10) as follows:

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. 0.0 to 9.99

City of Danville: Credits Earned-62.10 = PPC Rating of 4/4X

Further analysis of the city's PPC reports reveals:

- The city is deficient in Section 414 of the FSRS feature: Emergency Reporting. This section analyzes and awards credits for emergency communications center facilities, management information systems, and available systems for the public to report incidents for the fire department. The city received 10.00/25.00 for E9-1-1 Voice Over Internet Protocol (VOIP) and 10.00/15.00 for the computer-aided dispatch (CAD) system in place at the time of the review.
- The city is deficient in Section 432 of the FSRS feature: Emergency Communications. This section analyzes and awards credits for dispatch circuits, which are the components utilized

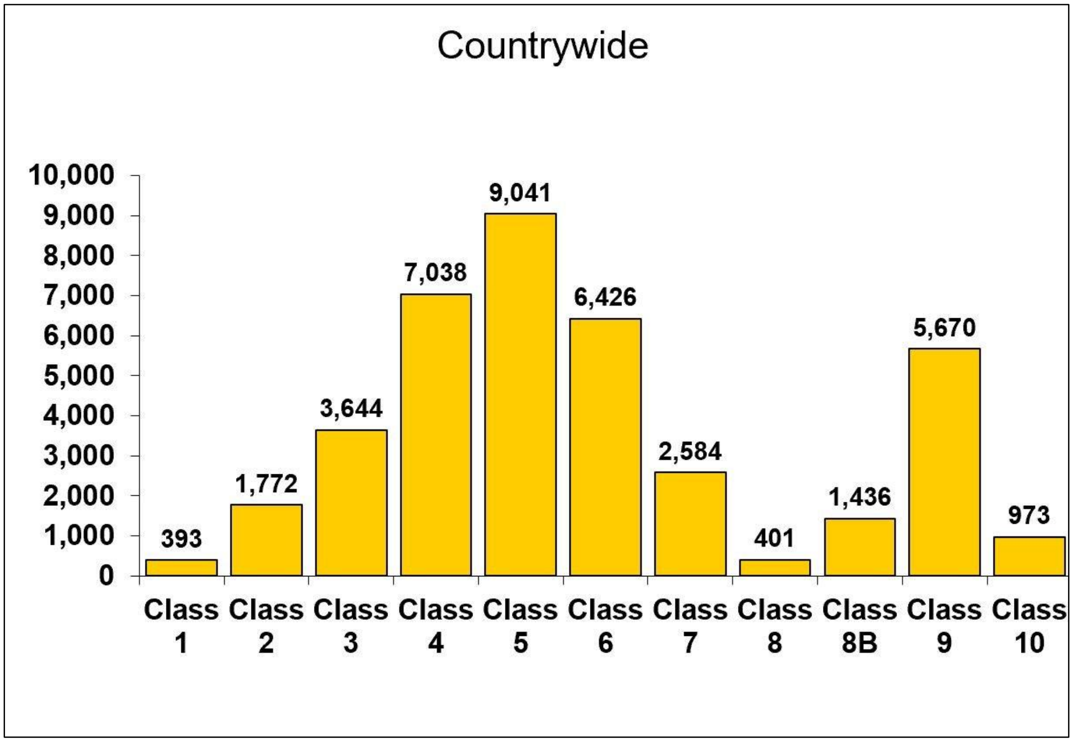
15. DFD ISO PPC report; December 2014

to transmit alarms to fire department members. For departments receiving more than 730 alarms a year, a primary and secondary dispatch circuit system is required. This standard applies to Danville. The city received 0.60/3.00 credits for this section.

- The city is deficient is in Sections 561 Deployment Analysis (6.14/10.00), 571 Company Personnel (1.76/15.00), and 581 Training (4.51/9.00) of the FSRS feature: Fire Department. Aggregately the city only received 25.77/50.00 for the Fire Department feature after analysis.
- The city is deficient in Section 616 of the FSRS feature: Water Supply. This section analyzes the ability of the water supply system (municipal or water tender delivery where hydrants are not available) to meet the needed fire flows at selected locations up to 3,500 gallons per minute. The city received 19.44/30.00 credits for this section.

The following figure depicts the dispersion of PPC ratings across the United States.

FIGURE 4-7: PPC Ratings in the United States[16]



Recommendation:

- CPSM recommends the city and the DFD develop a plan that includes short-, medium-, and long-range goals to address the deficiencies in the 2014 Public Protection Classification analysis conducted by ISO. The planning elements should address those FSRS features where the city is most deficient, as outlined in this report. Addressing other, less significant deficiencies, should also be included in this plan. (Recommendation No. 2.)

16. https://www.isomitigation.com/ppc/program-works/facts-and-figures-about-ppc-codes-around-the-country/

COMMUNITY LOSS AND SAVE INFORMATION

Fire loss is an estimation of the total loss from a fire to a structure and contents in terms of replacement. Fire loss includes contents damaged by fire, smoke, water, and overhaul. Fire loss does not include indirect loss, such as business interruption.

In a 2019 report published by the National Fire Protection Association on trends and patterns of U.S. fire losses, it was determined that home fires still cause the majority of all civilian fire deaths, civilian injuries, and property loss due to fire. Key findings from this report include:[17]

- Public fire departments responded to 1,318,500 fires in 2018, virtually the same as the previous year.
- Every 24 seconds, a fire department in the United States responds to a fire somewhere in the nation. A fire occurs in a structure at the rate of one every 63 seconds, and a home fire occurs every 87 seconds.
- Seventy-four percent of all fire deaths occurred in the home.
- Home fires were responsible for 11,200 civilian injuries, or 74 percent of all civilian injuries, in 2018.
- An estimated $25.6 billion in property damage occurred as a result of fire in 2018; that is a large increase, as this number includes a $12 billion loss in wildfires in Northern California.
- An estimated 25,500 structure fires were intentionally set in 2018, an increase of 13 percent over the year before.

For the five-year period of 2015–2020, the DFD reported the following loss in terms of dollars as a result of fire-related calls for service.

FIGURE 4-8: City of Danville Fire Loss[18]

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17. https://www.nfpa.org/News-and-Research/Data-research-and-tools/US-Fire-Problem/Fire-loss-in-the-United-States
18. City of Danville Fire Department, Records Management System

FIRE AND FIRE-RELATED INCIDENT RISK

An indication of the community's fire risk is the type and number of fire-related incidents the fire department responds to. During the CPSM data analysis study period of January 1, 2019 to December 3, 2019, the DFD responded to 559 fire-related calls for service. The following table details the call types and call type totals for these types of fire-related risks. Of these responses, 78 responses were directly fire related (outside and structural fires).

TABLE 4-1: Fire Call Types (CPSM Data Analysis)

Call Type	Number of Calls	Calls per Day	Call Percentage*
False alarm	216	0.6	11.7
Good intent	49	0.1	2.7
Hazard	109	0.3	5.9
Outside fire	47	0.1	2.6
Public service	107	0.3	5.8
Structure fire	31	0.1	1.7
Fire Total	**559**	**1.5**	**30.4**

Note: *Includes EMS calls.

EMS RISK

As with fire risks, an indication of the community's pre-hospital emergency medical risk is the type and number of EMS calls to which the fire department responds. During the CPSM data analysis study period of January 1, 2019 through December 31, 2019, the DFD responded to 1,120 EMS-related calls for service. The following table outlines the call types and call type totals for these types of EMS risks. EMS responses accounted for 61 percent of all calls to which the DFD responded during the study period. This is typical of fire department response across the country.

TABLE 4-2: EMS Call Types (CPSM Data Analysis)

Call Type	Number of Calls	Calls per Day	Call Percentage*
Breathing difficulty	217	0.6	11.8
Cardiac and stroke	207	0.6	11.3
Fall and injury	106	0.3	5.8
Illness and other	177	0.5	9.6
MVA	200	0.5	10.9
Overdose and psychiatric	45	0.1	2.4
Seizure and unconsciousness	168	0.5	9.1
EMS Total	**1,120**	**3.1**	**60.9**

Note: *Includes fire calls.

The CPSM data analysis was pefromed in advance of this Operations Report. In 2020 the Operations Report was delayed by the city. Subsequently, the DFD provided CPSM withg 2020 fire and EMS incident data as outlined in the following table.

TABLE 4-3: Fire and EMS Call Types (DFD Provided: CY 2020)

Major Incident Type	No. of Incidents	% of Total
Fires	65	2.79
Overpressure rupture, explosion, heat – no fire	19	0.82
Rescue & emergency medical service	1,273	54.71
Hazardous condition (no fire)	71	3.05
Service call	126	5.41
Good intent call	516	22.17
False alarm and false call	241	10.36
Severe weather & natural disaster	6	0.26
Special incident type	10	0.43
Total	**2,327**	**100**

FIRE INCIDENT DEMAND AND EMS INCIDENT DEMAND

The fire and EMS risk in terms of numbers and types of incidents is important to know when analyzing a community's risk, as outlined above. Analyzing where the fire and EMS incidents occur, and the demand density of fire and EMS incidents, determines adequate fire management zone resource assignment and deployment. The following figures illustrate fire and EMS demand in the DFD fire management zones. Figure 4-9 illustrates fire incidents (structural and outside fires, alarm activations etc.); Figure 4-10 illustrates other types of fire-related incidents such as good intent and public service calls, which are calls for service such as smoke scares (no fire), wires down, lock outs, water leaks, etc.; Figure 4-11 illustrates the call density of all fire responses; and Figure 4-12 illustrates EMS incident demand.

These four demand maps tell us that fire-related responses and EMS incident demand is highest in the core/central and southern areas of the city. Actual fire incidents (outside and structural) are more concentrated in the central, western, and southern areas of the city.

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FIGURE 4-9: Fire Incident Demand Density (Structural and Outside Fires)

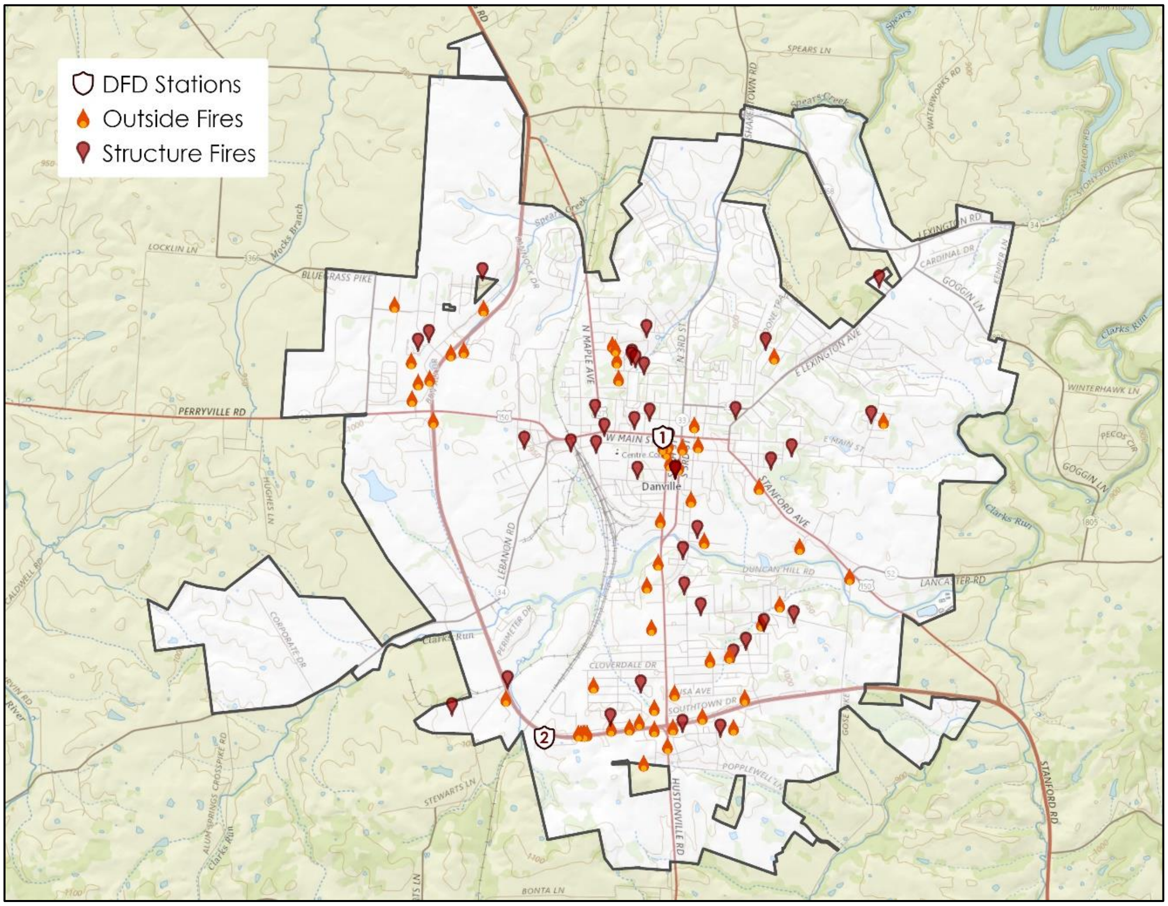


FIGURE 4-10: Fire Incident Demand Density (Other Fire-related Incidents)

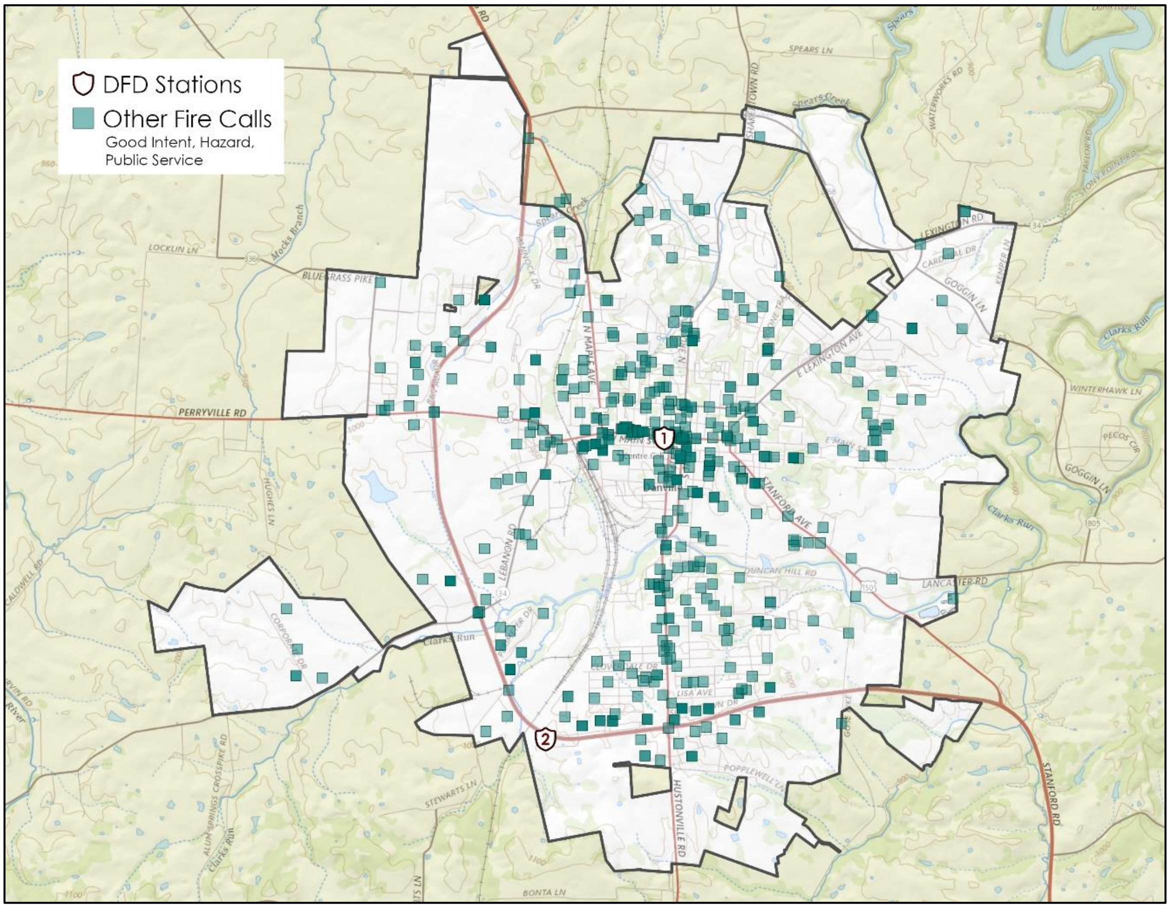


FIGURE 4-11: All Fire Responses Incident Demand Density

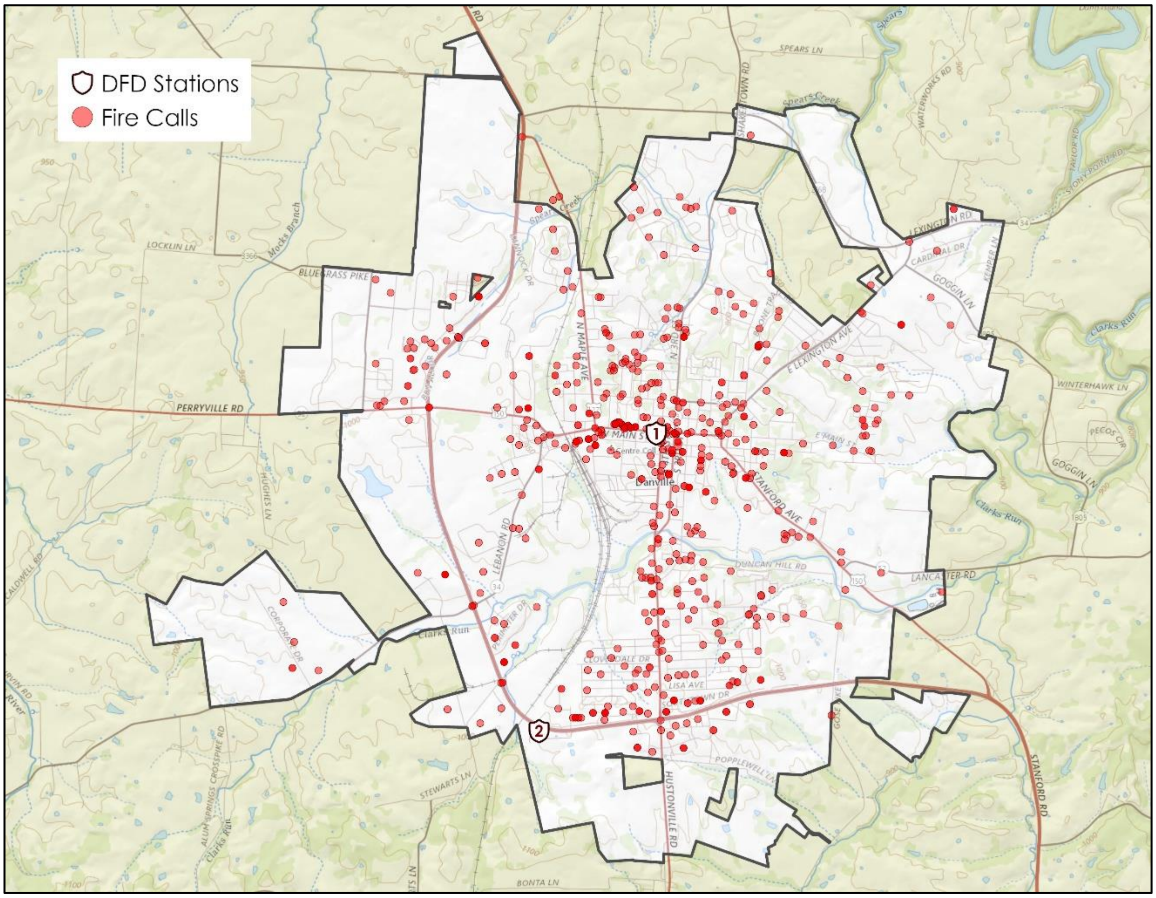
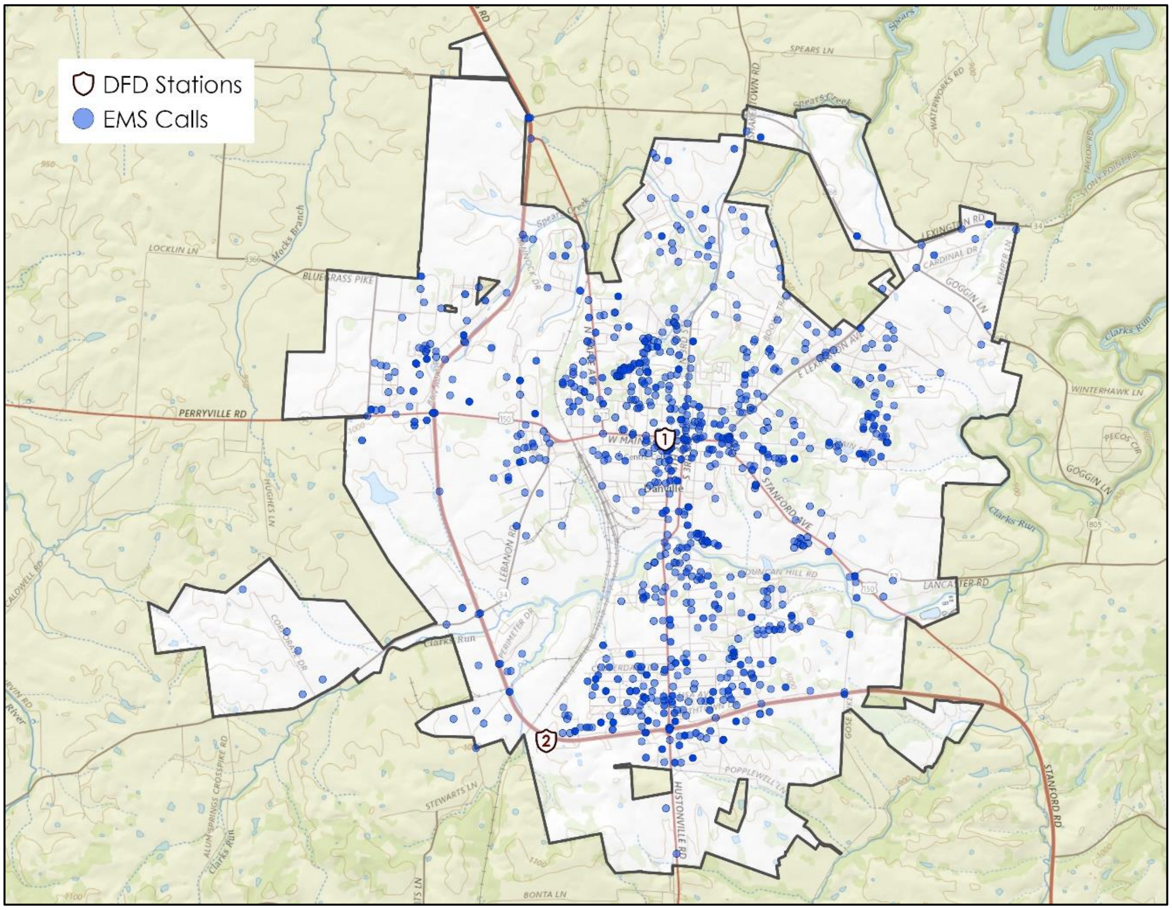


FIGURE 4-12: EMS Incident Demand Density



RESILIENCY

Resiliency as defined by the Center for Public Safety Excellence (CPSE) in the *Fire and Emergency Services Self-Assessment Manual* (FESSAM) 9th edition is "an organization's ability to quickly recover from an incident or events, or to adjust easily to changing needs or requirements." Greater resiliency can be achieved by constant review and analysis of the response system and should focus on three key components:

- Resistance: The ability to deploy only resources necessary to safely and effectively control an incident and bring it to termination, which is achieved through the development and implementation of critical tasking and its application to the establishment of an effective response force for all types of incidents.
- Absorption: The ability of the agency to quickly add or duplicate resources necessary to maintain service levels during heavy call volume or incidents of high resource demand.
- Restoration: The agency's ability to quickly return to a state of normalcy.

Resistance is controlled by the DFD through planned staffing and response protocol, and with DFD resources dependent on the level of staffing and units available at the time of the alarm. As discussed in the next section, the current DFD staffing model may not, for certain incident types, allow for the assembly of an Effective Response Force needed to perform the necessary, critical tasks in a simultaneous fashion to safely control an incident.

Absorption is accomplished through initial responding units available to respond by the DFD and through mutual aid agreements. As discussed above, the DFD largely receives mutual aid from volunteer companies, but which are not regularly staffed. This delays response and does not guarantee a specific number of firefighters responding.

Restoration is managed by DFD unit availability as simultaneous calls occur, recall of staff to staff fire units during campaign events when warranted, efficient work on incidents for a quick return to service, and mutual aid agreements.

Regarding restoration, the following three tables analyze the station availability to respond to calls, and the frequency by number of hours that units are dedicated to a single or multiple incidents.

The DFD staffs two engine companies, and the engine crew at Station 2 cross-staffs the ladder and rescue apparatus. This means the on-duty crew at Station 2 responds to the call by type (fire, technical rescue) with the most appropriate unit (aerial ladder, engine, rescue).

The first table looks at the overall workload of the DFD, which links to restoration.

TABLE 4-4: Annual Runs and Deployed Time by Run Type

Call Type	Deployed Minutes per Run	Total Annual Hours	Percent of Total Hours	Deployed Minutes per Day	Total Annual Runs	Runs per Day
Breathing difficulty	20.6	81.2	6.3	13.3	237	0.6
Cardiac and stroke	22.2	92.3	7.1	15.2	249	0.7
Fall and injury	23.9	59.3	4.6	9.8	149	0.4
Illness and other	24.6	88.2	6.8	14.5	215	0.6
MVA	27.8	230.2	17.7	37.8	497	1.4
Overdose and psychiatric	22.2	23.0	1.8	3.8	62	0.2
Seizure and unconsciousness	19.2	71.2	5.5	11.7	223	0.6
EMS Total	**23.7**	**645.4**	**49.7**	**106.1**	**1,632**	**4.5**
False alarm	17.6	169.9	13.1	27.9	580	1.6
Good intent	21.8	40.3	3.1	6.6	111	0.3
Hazard	43.0	179.3	13.8	29.5	250	0.7
Outside fire	27.9	44.1	3.4	7.3	95	0.3
Public service	23.4	65.5	5.0	10.8	168	0.5
Structure fire	65.1	107.5	8.3	17.7	99	0.3
Fire Total	**27.9**	**606.6**	**46.7**	**99.7**	**1,303**	**3.6**
Canceled	7.5	27.8	2.1	4.6	223	0.6
Mutual aid	16.0	18.9	1.5	3.1	71	0.2
Other Total	**9.5**	**46.7**	**3.6**	**7.7**	**294**	**0.8**
Total	**24.1**	**1,298.7**	**100.0**	**213.5**	**3,229**	**8.8**

The next table looks at station availability to respond to calls in the first due fire management zone, which links to restoration.

TABLE 4-5: Station Availability to Respond to Calls

Station	Calls in Area	First Due Responded	First Due Arrived	First Due First	Percent Responded	Percent Arrived	Percent First
1	1,143	1,036	1,024	981	90.6	89.6	85.8
2	547	447	425	354	81.7	77.8	64.7
Total	**1,690**	**1,483**	**1,449**	**1,335**	**87.8**	**85.7**	**79.0**

Note: For each station, we count the number of calls occurring within its first due area. Then, we count the number of calls to where at least one DFD unit arrived. Next, we focus on units from the first due station to see if any units responded, arrived, or arrived first.

The next table looks at the frequency of calls in a given hour, followed by an illustration of the number of calls occurring during each hour of the day.

TABLE 4-6: Frequency Distribution of the Number of Calls

Calls in an Hour	Frequency	Percentage
0	7,164	81.8
1	1,384	15.8
2	187	2.1
3+	25	0.3
Total	**8,760**	**100.0**

The next two figures illustrate the number of DFD units, and the frequency of this number, that responded to fire and EMS calls, which links to resistance.

FIGURE 4-13: Calls by Number of Units Dispatched – EMS

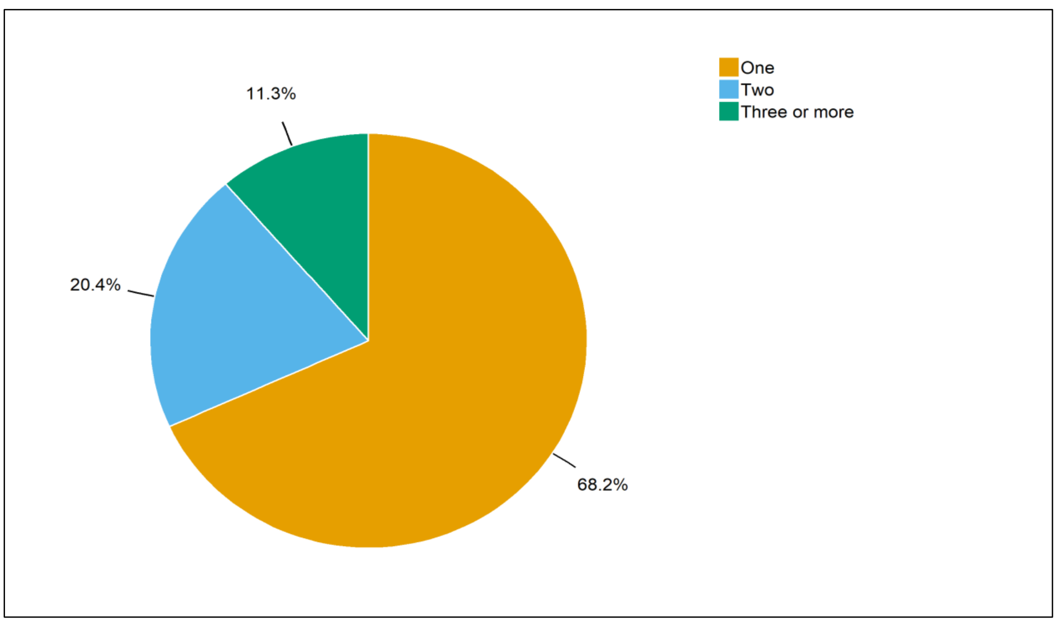
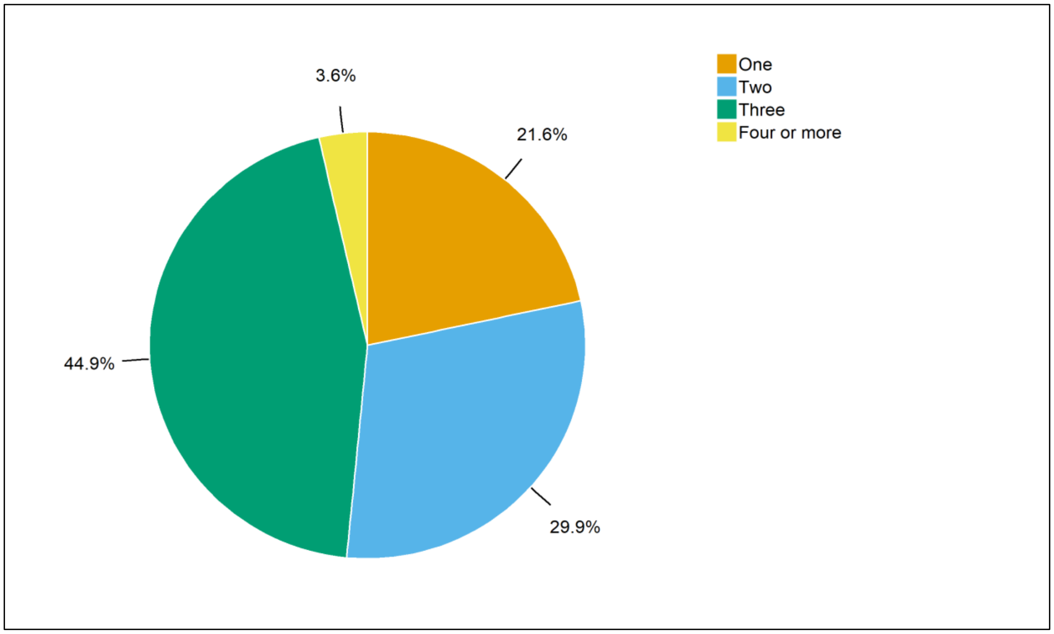


FIGURE 4-14: Calls by Number of Units Dispatched – Fire



The final table examines the frequency of overlapping calls per station, which links to absorption.

TABLE 4-7: Frequency of Overlapping Calls

Station	Scenario	Number of Calls	Percent of All Calls	Total Hours
1	No overlapped call	1,138	93.9	479.0
	Overlapped with one call	69	5.7	13.1
	Overlapped with two calls	4	0.3	0.5
	Overlapped with three calls	1	0.1	0.0
2	No overlapped call	564	96.9	215.5
	Overlapped with one call	18	3.1	3.2

Overall, this discussion shows that the DFD does not have a resiliency issue in terms of overlapped calls, since, on average, about 95 percent of the time the DFD has a unit from either Station 1 or Station 2 available to respond to an incident, albeit not always from the first-due station. Station 1 had an overlapped call 6 percent of the time and Station 2 had an overlapped call 3 percent of the time. This, combined with each station's availability to respond to calls in their first due area as detailed above (86 percent overall), does raise some concern with regard to unit and crew availability to respond in each fire management zone.

As outlined in the next section, the DFD staffs one engine apparatus at Station 1 with three personnel, and one engine apparatus at Station 2 with three personnel. Station 2 cross-staffs the ladder apparatus with the engine crew. In this model a single crew is assigned to Station 2 with multiple pieces of apparatus. The single crew responds the appropriate piece of apparatus to an incident based on call type.

RISK CATEGORIZATION

A comprehensive risk assessment is a critical aspect of creating standards of cover and can assist the DFD in quantifying the risks that it faces in the city. Once it knows these risks, the department is better equipped to determine if the current response resources are sufficiently staffed, equipped, trained, and positioned. In this component, the factors that drive the service needs are examined and then link directly to discussions regarding the assembly of an effective response force (EFR) and when contemplating the response capabilities needed to adequately address the existing risks, which encompasses the component of critical tasking.

The risks that the department faces can be natural or man-made and may be affected by the changing demographics of the community served. With the information available from the CPSM data analysis, the DFD, the city, and public research, CPSM and the DFD can begin an analysis of the city's risks, and can begin working towards recommendations and strategies to mitigate and minimize their effects. This section contains an analysis of the various risks considered within the DFD's service area.

Effects on the community are often categorized in three ways: the consequence of the event on the community, the probability the event will occur in the community, and the impact on the fire department. The following three tables look at the probability of the event occurring (Table 4-8), which ranges from unlikely to frequent; consequence to the community (Table 4-9), which is categorized ranging from insignificant to catastrophic; and the impact to the organization (Table 4-10), which ranges from insignificant to catastrophic. For each risk categorization (Low, Moderate, High, Special), a risk score from each table (Probability, Consequence, Impact) is applied to a formula (Heron's Formula), and a three-axis risk calculation is created. This concept is illustrated in Figures 4-15 through 4-19.

TABLE 4-8: Event Probability

Probability	Chance of Occurrence	Description	Risk Score
Unlikely	2%-25%	Event may occur only in exceptional circumstances.	2
Possible	26%-50%	Event could occur at some time and/or no recorded incidents. Little opportunity, reason, or means to occur.	4
Probable	51%-75%	Event should occur at some time and/or few, infrequent, random recorded incidents or little anecdotal evidence. Some opportunity, reason, or means to occur; may occur.	6
Highly Probable	76%-90%	Event will probably occur and/or regular recorded incidents and strong anecdotal evidence. Considerable opportunity, means, reason to occur.	8
Frequent	90%-100%	Event is expected to occur. High level of recorded incidents and/or very strong anecdotal evidence.	10

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TABLE 4-9: Consequence to Community Matrix

Impact	Impact Categories	Description	Risk Score
Insignificant	Life Safety	■ 1 or 2 people affected, minor injuries, minor property damage, and no environmental impact.	**2**
Minor	Life Safety Economic and Infrastructure Environmental	■ Small number of people affected, no fatalities, and small number of minor injuries with first aid treatment. Minor displacement of people for <6 hours and minor personal support required. ■ Minor localized disruption to community services or infrastructure for <6 hours. Minor impact on environment with no lasting effects.	**4**
Moderate	Life Safety Economic and Infrastructure Environmental	■ Limited number of people affected (11 to 25), no fatalities, but some hospitalization and medical treatment required. Localized displacement of small number of people for 6 to 24 hours. Personal support satisfied through local arrangements. Localized damage is rectified by routine arrangements. ■ Normal community functioning with some inconvenience. ■ Some impact on environment with short-term effects or small impact on environment with long-term effects.	**6**
Significant	Life Safety Economic and Infrastructure Environmental	■ Significant number of people (>25) in affected area impacted with multiple fatalities, multiple serious or extensive injuries, and significant hospitalization. ■ Large number of people displaced for 6 to 24 hours or possibly beyond. External resources required for personal support. Significant damage that requires external resources. Community only partially functioning, some services unavailable. ■ Significant impact on environment with medium- to long-term effects.	**8**
Catastrophic	Life Safety Economic and Infrastructure Environmental	■ Very large number of people in affected area(s) impacted with significant numbers of fatalities, large number of people requiring hospitalization with serious injuries with long-term effects. General and widespread displacement for prolonged duration and extensive personal support required. Extensive damage to properties in affected area requiring major demolition. ■ Serious damage to infrastructure causing significant disruption to, or loss of, key services for prolonged period. ■ Community unable to function without significant support. ■ Significant long-term impact on environment and/or permanent damage.	**10**

TABLE 4-10: Impact on DFD

Impact	Impact Categories	Description	Risk Score
Insignificant	Personnel and Resources	One apparatus out of service for period not to exceed one hour.	2
Minor	Personnel and Resources	More than one but not more than two apparatus out of service for a period not to exceed one hour.	4
Moderate	Personnel and Resources	More than 50% of available resources committed to incident for over 30 minutes.	6
Significant	Personnel and Resources	More than 75% of available resources committed to an incident for over 30 minutes.	8
Catastrophic	Personnel, Resources, and Facilities	More than 90% of available resources committed to incident for more than two hours or event which limits the ability of resources to respond.	10

This section also contains an analysis of the various risks considered in the city. In this analysis, information presented and reviewed in this section (All-Hazards Risk Assessment of the Community) have been considered. Risk is categorized as Low, Moderate, High, or Special.

Prior risk analysis has only attempted to evaluate two factors of risk: probability and consequence. Contemporary risk analysis considers the impact of each risk to the organization, thus creating a three-axis approach to evaluating risk as depicted in the following figure. A contemporary risk analysis now includes probability, consequences to the community, and impact on the organization, which in this case is the DFD.

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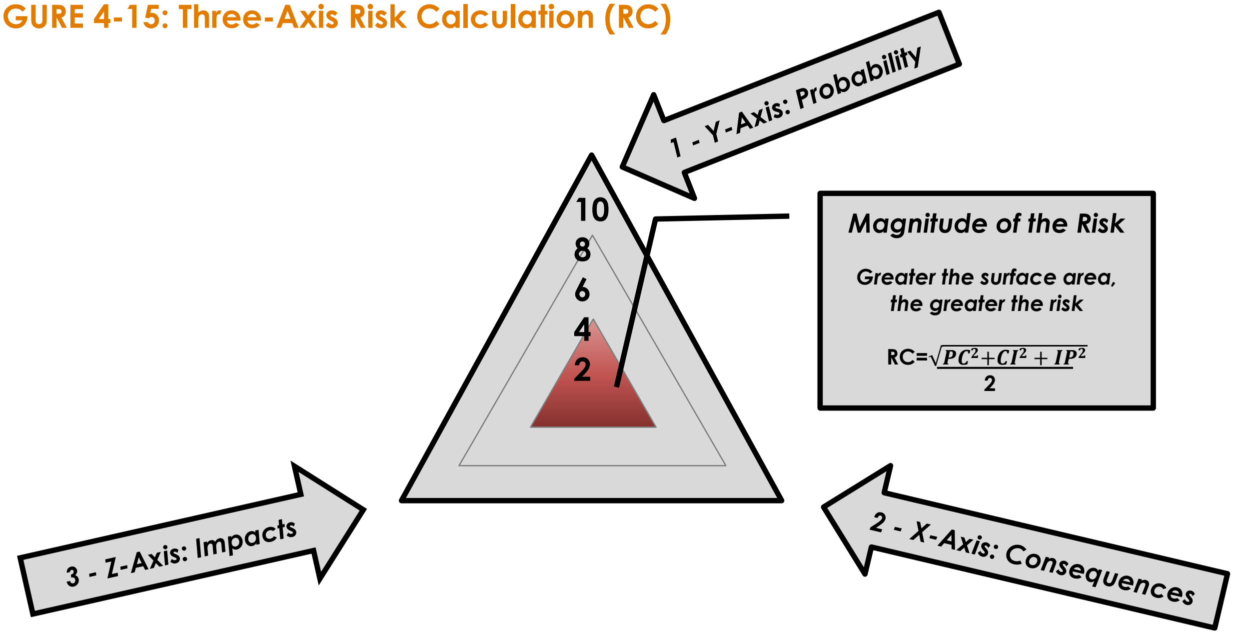
FIGURE 4-15: Three-Axis Risk Calculation (RC)



The following factors/hazards were identified and considered:

- **Demographic factors** such as age, socio-economic, vulnerability.
- **Natural hazards** such as flooding, severe weather, wind events, wild land fires.
- **Man-made hazards** such as rail lines, roads and intersections, target hazards.
- **Structural/building risks**.
- **Fire and EMS incident numbers and demand**.
- **Public health emergencies.**

The assessment of each factor and hazard as listed below took into consideration the likelihood of the event, the impact on the city itself, and the impact on DFD's ability to deliver emergency services, which includes automatic aid capabilities as well. The list is not all inclusive but includes categories most common or that may present to the city and the DFD.

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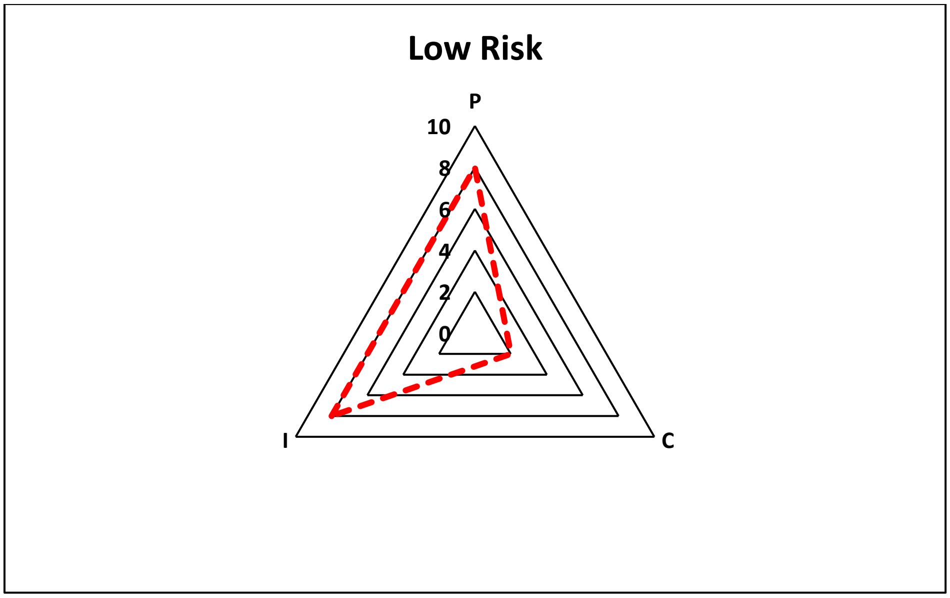
Low Risk

- Automatic fire/false alarms.
- BLS EMS Incidents.
- Minor flooding with thunderstorms.
- Good intent/hazard/public service fire incidents with no life safety exposure.
- Outside fires such as grass, rubbish, dumpster, vehicle with no structural/life safety exposure.

FIGURE 4-16: Low Risk Diagram



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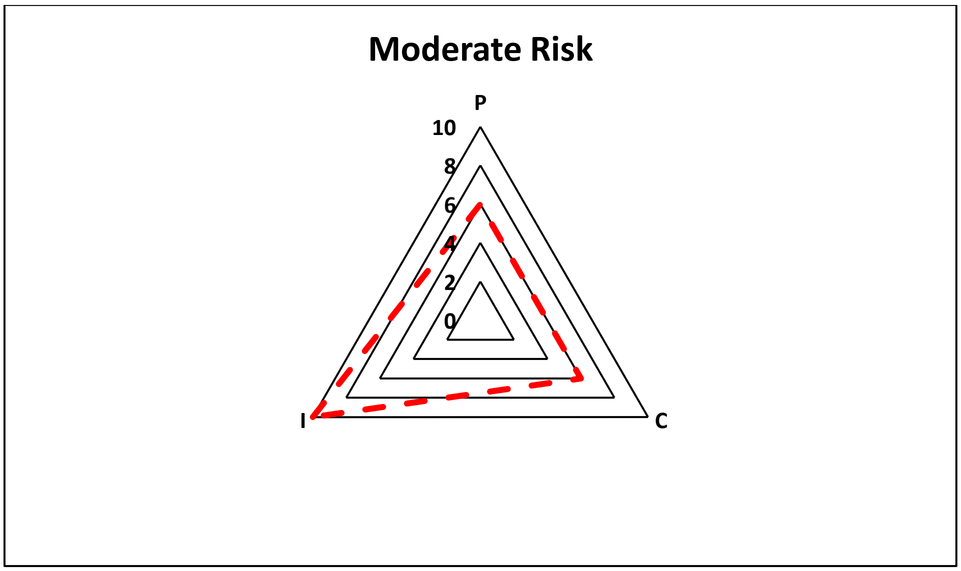
Moderate Risk

- Fire incident in a single-family dwelling where fire and smoke or smoke is visible, indicating a working fire.
- Suspicious substance investigation involving multiple fire companies and law enforcement agencies.
- Advanced EMS incident.
- Motor vehicle accident (MVA).
- MVA with entrapment of passengers.
- Grass/brush fire with structural endangerment/exposure.
- Low angle rescue involving ropes and rope rescue equipment and resources.
- Surface water rescue.
- Good intent/hazard/public service fire incidents with life safety exposure.

FIGURE 4-17: Moderate Risk Diagram



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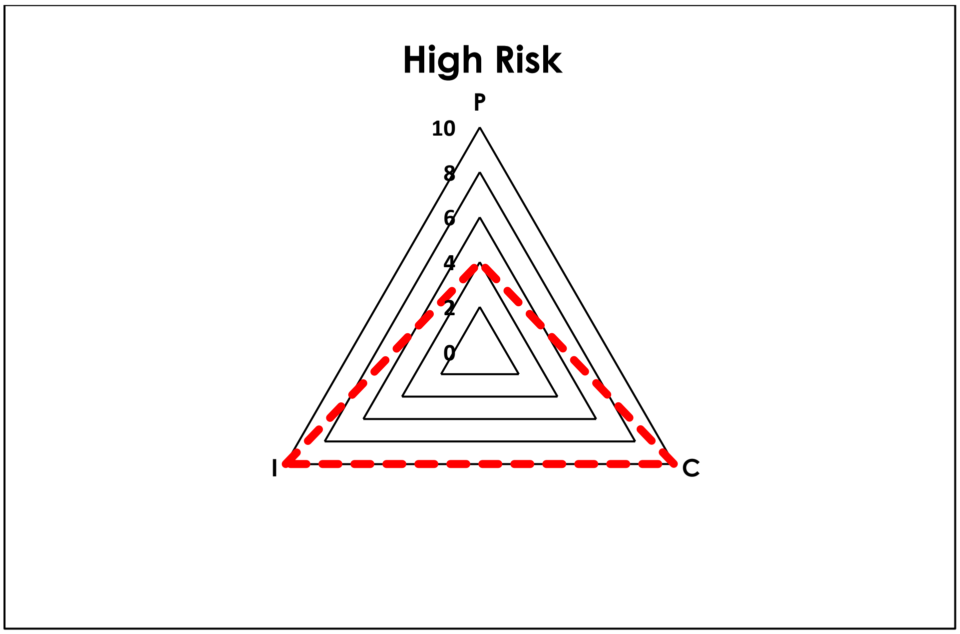
High Risk

- Working fire in a target hazard.
- Mass casualty incident of more than 10 patients but fewer than 25 patients.
- Confined space/cavern rescue.
- Structural collapse involving life safety exposure.
- High angle rescue involving ropes and rope rescue equipment.
- Trench rescue.
- Suspicious substance incident with injuries.
- Industrial leak of hazardous materials that causes exposure to persons or threatens life safety.
- Weather event that creates widespread flooding, power outages, building damage, and/or life safety exposure.

FIGURE 4-18: High Risk Diagram



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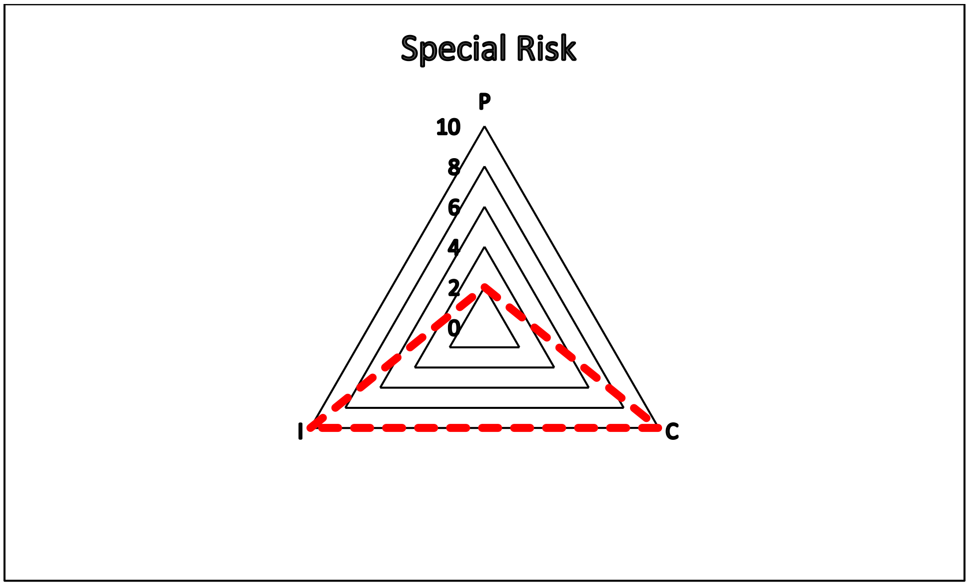
Special Risk

- Working fire in a structure of more than three floors.
- Fire at an industrial building or complex with hazardous materials.
- Fire in an occupied targeted hazard with special life safety risks such as age, medical condition, or other identified vulnerabilities.
- Mass casualty incident of more than 25 patients.
- Rail or transportation incident that causes life safety exposure or threatens life safety through the release of hazardous smoke or materials.
- Explosion in a building that causes exposure to persons or threatens life safety or outside of a building that creates exposure to occupied buildings or threatens life safety.
- Massive river flooding, earthquake, pandemic, multiple landslides.

FIGURE 4-19: Special Risk Diagram



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SECTION 5. RESPONSE TIME ANALYSIS

MEASURING RESPONSE TIMES

Response times are typically the primary measurement for evaluating fire and EMS services. Response times can be used as a benchmark to determine how well a fire department is currently performing, to help identify response trends, and to predict future operational needs. Achieving the quickest and safest response times possible should be a fundamental goal of every fire department.

That being said, however, the actual impact of a speedy response time is limited to very few incidents. For example, in a full cardiac arrest, analysis shows that successful outcomes are rarely achieved if basic life support (CPR) is not initiated within four to six minutes of the onset. However, cardiac arrests occur very infrequently; on average they are 1 percent to 1.5 percent of all EMS incidents.[19] There are also other EMS incidents that are truly life-threatening and the time of response can clearly impact the outcome. These involve cardiac and respiratory emergencies, full drownings, obstetrical emergencies, allergic reactions, electrocutions, and severe trauma (often caused by gunshot wounds, stabbings, and severe motor vehicle accidents, etc.). Again, the frequencies of these types of calls are limited.

An important factor in the whole response time question is what we term "**detection time**." This is the time it takes to detect a fire or a medical situation and notify 911 to initiate the response. In many instances, particularly at night or when automatic detection systems (fire sprinklers and smoke detectors) are not present or inoperable, the detection process can be extended. Fires that go undetected and are allowed to expand in size become more destructive and are difficult to extinguish.

For the purpose of this analysis, ***response time*** is a product of three components: ***dispatch time***, ***turnout time***, and ***travel time***.

Dispatch time (alarm processing time) is the difference between the time a call is received and the time a unit is dispatched. Dispatch time includes call processing time, which is the time required to determine the nature of the emergency and types of resources to dispatch. ***Turnout time*** is when the emergency response units are notified of the incident and ends when travel time begins. ***Travel Time*** is the difference between the time the unit is en route and arrival on scene. ***Response time*** is the total time elapsed between receiving a call to arriving on scene.

For this study, and unless otherwise indicated, response times and travel times measure the first arriving unit only. The primary focus of this section is the dispatch and response time of the first arriving units for calls responded to with lights and sirens (Code 3).

According to NFPA 1710, the alarm processing time or dispatch time should be less than or equal to 60 seconds 90 percent of the time. NFPA 1710 also states that turnout time should be less than or equal to 80 seconds (1.33 minutes) for fire and special operations 90 percent of the time and 60 seconds (1.0 minute) for EMS. As noted above, turnout time is the segment of total response time that the fire department has the most ability to control. Travel time shall be less than or equal to 240 seconds for the first arriving engine company 90 percent of the time and for the second due engine 360 seconds 90 percent of the time. The standard further states the initial first

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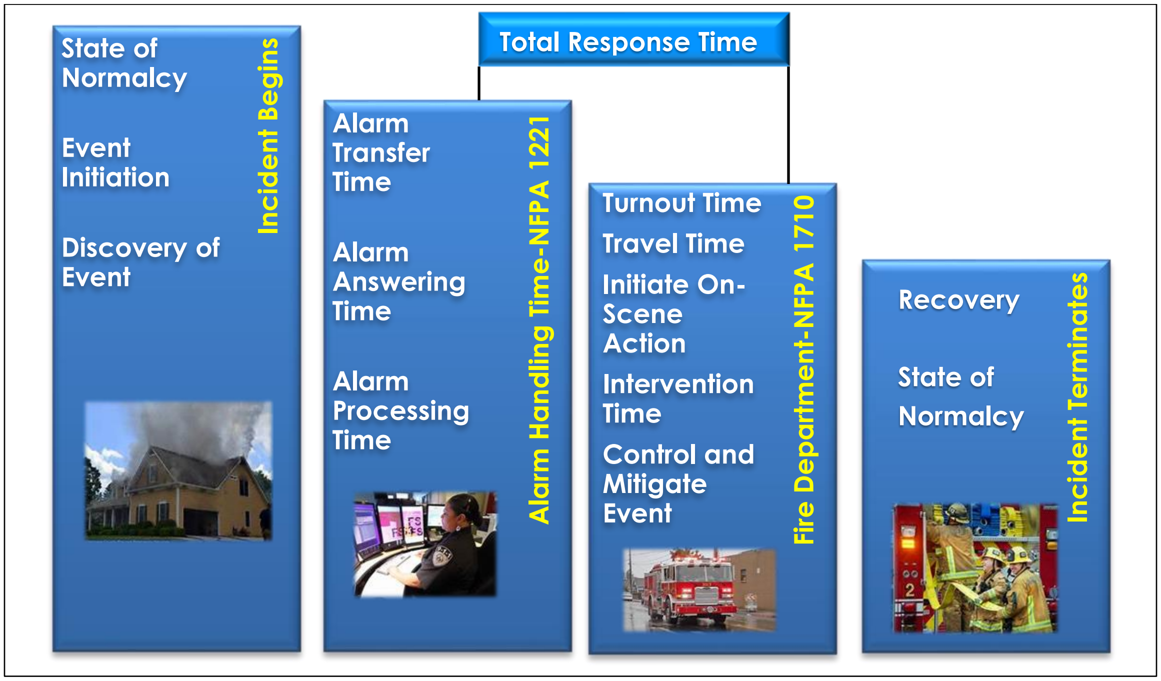
19. Myers, Slovis, Eckstein, Goodloe et al. (2007). "Evidence-based Performance Measures for Emergency Medical Services System: A Model for Expanded EMS Benchmarking." *Pre-hospital Emergency Care*.

alarm assignment should be assembled on scene in 480 seconds, 90 percent of the time for low/medium hazards, and 610 seconds for high-rise or high hazards. Note that NFPA 1710 response time criterion is a benchmark for service delivery and not a CPSM recommendation.

The following figure provides an overview of the fire department incident cascade of events.

FIGURE 5-1: Incident Cascade of Events



Regarding response times for fire incidents, the criterion is linked to the concept of "flashover." This is the state at which super-heated gasses from a fire are released rapidly, causing the fire to burn freely and become so volatile that the fire reaches an explosive state (simultaneous ignition of all the combustible materials in a room). In this situation, usually after an extended period (often eight to twelve minutes after ignition but at times as quickly as five to seven minutes), and a combination of the right conditions (fuel and oxygen), the fire expands rapidly and is much more difficult to contain. When the fire does reach this extremely hazardous state, initial firefighting forces are often overwhelmed, larger and more destructive fire occurs, the fire escapes the room and possibly even the building of origin, and significantly more resources are required to affect fire control and extinguishment.

Flashover occurs more quickly and more frequently today and is caused at least in part by the introduction of significant quantities of plastic- and foam-based products into homes and businesses (e.g., furnishings, mattresses, bedding, plumbing and electrical components, home and business electronics, decorative materials, insulation, and structural components). These materials ignite and burn quickly and produce extreme heat and toxic smoke.

National Fire Protection Association (NFPA) Standard 1710, *Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations and Special Operations to the Public by Career Fire Departments,* 2020 edition (National Fire Protection Association, Quincy, Mass.) outlines recommended organization and deployment of operations by career, and primarily career fire and rescue organizations.[20] It is the benchmark standard that the United States Department of Homeland Security utilizes when evaluating applications for staffing grants under the Staffing for Adequate Fire and Emergency Response (SAFER) grant program.

As a benchmark, paragraph 4.1.2.1(3) of NFPA 1710 recommends the first arriving engine at a fire suppression incident have **a travel time of 240 seconds or less**. Paragraph 4.1.2.1(4) recommends that other than for a high-rise incident, **the entire initial response of personnel be on scene within eight minutes (480 seconds) travel time.** It is also important to keep in mind that once units arrive on scene, they will need to get set up to commence operations. NFPA 1710 recommends that units be able to commence an initial attack within two minutes of arrival, 90 percent of the time.

Although trying to reach the NFPA benchmark for travel time may be laudable, the question is, at what cost. What is the evidence that supports such recommendations? Seemingly, NFPA 1710's travel times are established for two primary reasons: (1) the fire propagation curve, where flashover occurs, and (2) sudden cardiac arrest, where brain damage and permanent brain death occurs in four to six minutes.

According to fire service educator Clinton Smoke, the fire propagation curve establishes that temperature rise and time within in a room on fire corresponds with property destruction and potential loss of life if present.[21] At approximately the eight to ten-minute mark of fire progression, the fire flashes over (due to superheating of room contents and other combustibles) and extends beyond the room of origin, thus increasing proportionately the destruction to property and potential endangerment of life. The ability to quickly deploy adequate fire staff prior to flashover thus limits the fire's extension beyond the room or area of origin.

Regarding the risk of flashover, the authors of an IAFF report conclude:

> *Clearly, an early aggressive and offensive initial interior attack on a working structural fire results in greatly reduced loss of life and property damage. Consequently, given that the progression of a structural fire to the point of "flashover" (the very rapid spreading of the fire due to super-heating of room contents and other combustibles) generally occurs in less than 10 minutes, two of the most important elements in limiting fire spread are the quick arrival of sufficient numbers of personnel and equipment to attack and extinguish the fire as close to the point of its origin as possible.*[22]

The following figure illustrates the time progression of a fire from inception through flashover and full involvement of the structure if the fire is left unchecked. Flashover occurs at eight to ten minutes (***or less dependent on fuel***), allowing the fire to extend beyond the room of origin. Typically, if firefighting crews arrive, set-up, and begin fire extinguishment prior to flashover, the fire is contained to the room of origin.

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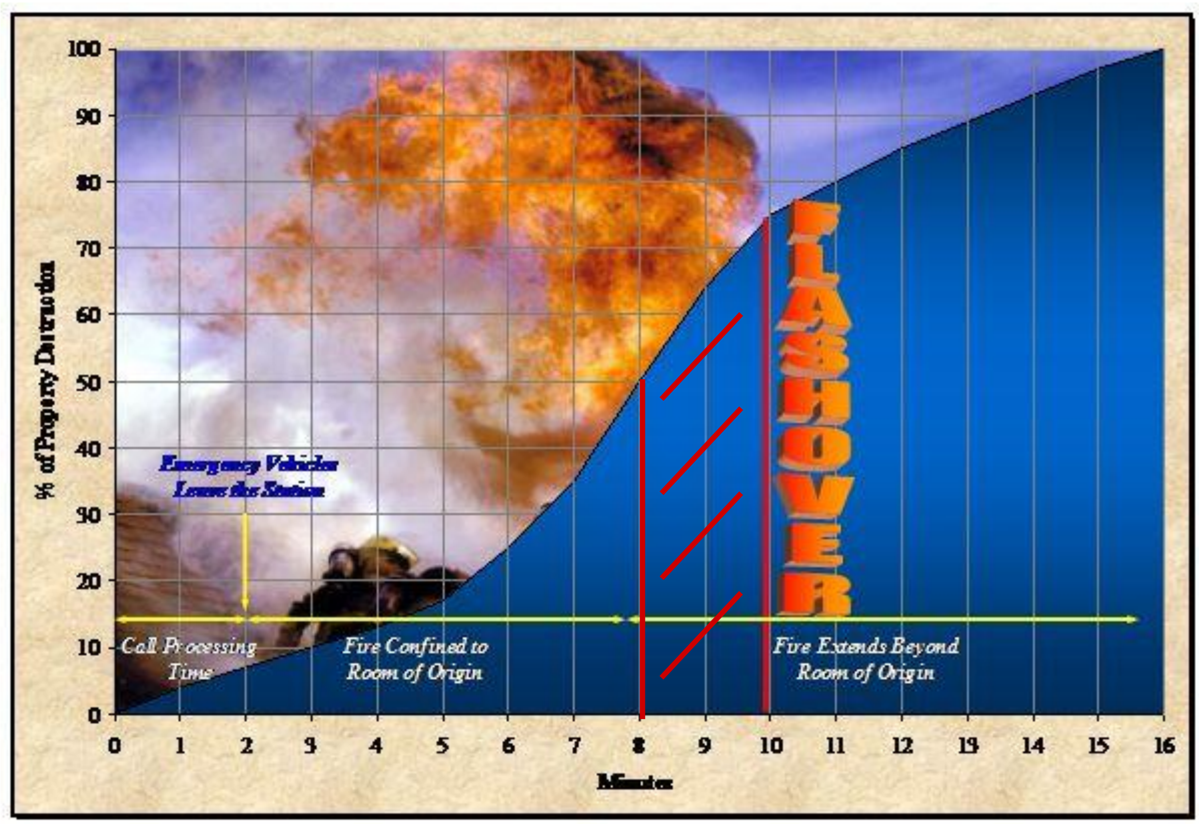
20. NFPA 1710 is a nationally recognized standard, but it has not been adopted as a mandatory regulation by the federal government or the Commonwealth of Kentucky. It is a valuable resource for establishing and measuring performance objectives for the City of Danville but should not be the only determining factor when making local decisions about the city's fire and EMS first response services.
21. Clinton Smoke, *Company Officer*, 2nd ed. (Clifton Park, NY: Delmar, 2005).
22. *Safe Fire Fighter Staffing: Critical Considerations*, 2nd ed. (Washington, DC: International Association of Fire Fighters), 5.

FIGURE 5-2: Fire Growth from Inception to Flashover[23]



EMS response times are measured differently than fire service response times. Where the fire service uses NFPA 1710 and 1720 as response time benchmarking documents, the focus for EMS is and should be directed to the evidence-based research relationship between clinical outcomes and response times. Much of the current research suggests response times have little impact on clinical outcomes outside of a small segment of call types. These include cerebrovascular accidents (stroke), injury or illness compromising the respiratory system, injury or illness compromising the cardiovascular system to include S-T segment elevation emergencies, and certain obstetrical emergencies to name a few. Each require rapid response times, rapid on-scene treatment and packaging for transport, and rapid transport to the hospital.

Paragraph 4.1.2.1(7) of NFPA 1710 recommends that for EMS incidents a fire unit with first responder or higher-level trained personnel and equipped with an AED should arrive on scene within four minutes of travel time (time after call is processed, dispatched, and the unit turns out). An advanced life support (ALS) unit should arrive on scene within eight minutes travel time, provided the fire department responded first with a first responder or higher-level trained personnel and equipped with an AED. According the NFPA 1710, "This requirement is based on experience, expert consensus, and science. Many studies note the role of time and the delivery of early defibrillation in patient survival due to heart attacks and cardiac arrest, which are the most time-critical, resource-intensive medical emergency events to which fire departments respond." The next figure illustrates the chance of survival for a victim in cardiac arrest who does not have access to critical emergency defibrillation.

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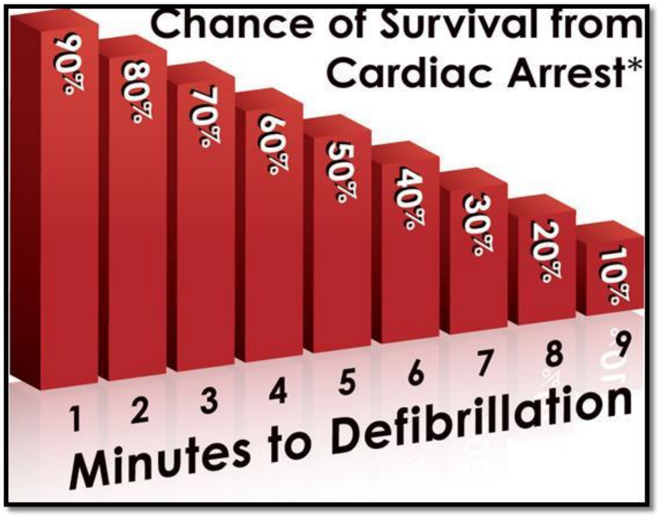
23. Source: https://www.slideserve.com/tavon/the-international-society-of-fire-service-instructors

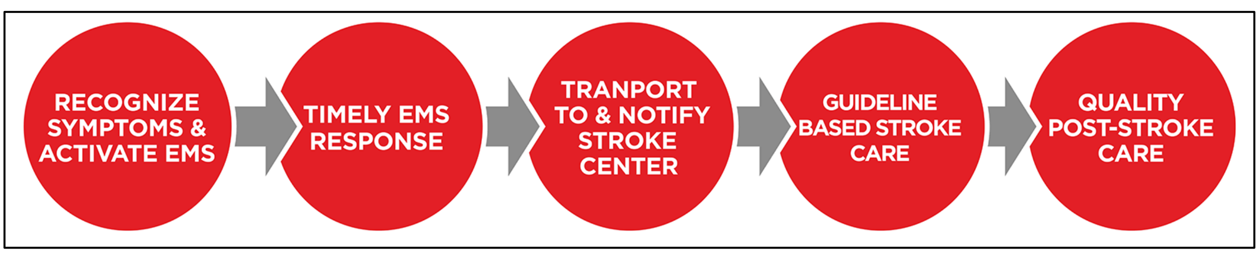
FIGURE 5-3: Cardiac Arrest Survival Probability by Minute



Typically, a low percentage of 9-1-1 patients have time-sensitive and advanced life support (ALS) needs. But, for those patients that do, time can be a critical issue of morbidity and mortality. For the remainder of those calling 9-1-1 for a medical emergency, though they may not have a medical necessity, they still expect rapid customer service. Response times for patients and their families are often the most important measurement of the EMS department. Regardless of the service delivery model, appropriate response times are more than a clinical issue; they are also a customer service issue and should not be ignored.

In addition, a true emergency is when an illness or injury places a person's health or life in serious jeopardy and treatment cannot be delayed. Examples include severe trauma with cardiovascular system compromise, difficulty breathing, chest pain with S-T segment elevation (STEMI), a head injury, stroke, or ingestion of a toxic substance.[24] The next figure illustrates the out-of-hospital chain of survival for a stroke emergency, which is a series of actions that, when put in motion, reduce the mortality of a stroke emergency.

FIGURE 5-4: Cerebrovascular Emergency (Stroke) Chain of Survival



Source: https://nhcps.com/lesson/acls-acute-stroke-care/

If a person is experiencing severe pain, that is also an indicator of an emergency. Again, the frequencies of these types of calls are infrequent as compared to the routine, low-priority EMS incident responses. In some cases, these dire emergencies often make up no more than 5 percent of all EMS calls.[25]

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24. Mills-Peninsula Health Blog, Bruce Wapen, MD.
25. www.firehouse.com/apparatus/article/10545016/operations-back-to-basics-true-emergency-and-due-regard

Cardiac arrest is one emergency for which EMS response times were initially built around. The science tells us that the brain begins to die without oxygenated blood flow at the four- to six-minute mark. Without immediate cardiopulmonary resuscitation (CPR) and rapid defibrillation, the chances of survival diminish rapidly at the cessation of breathing and heart pumping activity. For every minute without CPR and/or defibrillation, chances of survival decrease 7 to 10 percent. Further, only 10 percent of victims who suffer cardiac arrest outside of the hospital survive.[26]

The following figure illustrates the out-of-hospital chain of survival, which is a series of actions that, when put in motion, reduce the mortality of sudden cardiac arrest. Adequate EMS response times coupled with community and public access defibrillator programs potentially can impact the survival rate of sudden cardiac arrest victims by deploying early CPR, early defibrillation, and early advanced life support care provided in the prehospital setting.

FIGURE 5-5: Sudden Cardiac Arrest Chain of Survival

From: "Out of Hospital Chain of Survival," https://cpr.heart.org/en/resources/cpr-facts-and-stats/out-of-hospital-chain-of-survival

When analyzing the DFD response times to fire and EMS incidents, CPSM included all calls to which at least one non-administrative DFD unit responded while excluding canceled and mutual aid calls. In addition, non-emergency calls and calls with a total response time of more than 30 minutes were excluded. The data analysis focused on units that had complete time stamps, that is, units with all components recorded, so that we could calculate each segment of response time.

Based on the methodology outlined above, CPSM excluded from the response time analysis 160 canceled and mutual aid calls, 312 non-emergency calls, 48 calls where no units recorded a valid on-scene time, 12 calls where the first arriving unit response was greater than 30 minutes, and 232 calls where one or more segments of first arriving unit's response time could not be calculated due to missing data. As a result of these exclusions, a total of 1,075 calls are included in the response time analysis.

Table 5-1 provides an analysis of DFD average response times and Table 5-2 provides analysis of 90th percentile response times; 90th percentile times are the strictest measurement of fire and rescue response times. A 90th percentile time means that 90 percent of calls had response times at or below that number. For example, Table 5-2 shows a 90th percentile travel time for EMS calls of 4.4 minutes, which means that 90 percent of the time an EMS call had a response time of no more than 4.4 minutes.

26. American Heart Association. *A Race Against the Clock, Out of Hospital Cardiac Arrest*. 2014

TABLE 5-1: Average Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.9	1.9	3.3	7.0	170
Cardiac and stroke	2.3	1.8	3.0	7.1	166
Fall and injury	2.6	2.1	2.5	7.2	61
Illness and other	2.6	1.7	2.8	7.1	119
MVA	2.2	1.4	1.9	5.6	134
Overdose and psychiatric	1.9	2.2	2.7	6.8	35
Seizure and unconsciousness	1.9	1.8	2.6	6.3	123
EMS Total	**2.2**	**1.8**	**2.7**	**6.7**	**808**
False alarm	1.6	1.9	2.0	5.5	165
Good intent	1.7	1.7	2.6	6.0	14
Hazard	2.0	1.9	2.3	6.1	40
Outside fire	2.5	1.8	2.3	6.6	17
Public service	2.5	2.5	2.3	7.3	7
Structure fire	1.8	1.7	2.9	6.5	24
Fire Total	**1.7**	**1.9**	**2.2**	**5.8**	**267**
Total	**2.1**	**1.8**	**2.6**	**6.5**	**1,075**

Analysis of the data in this table tells us:

- The aggregate fire and EMS average dispatch time was 2.1 minutes.
  - Fire is 1.7 minutes.
  - EMS is 2.2 minutes.
- The aggregate fire and EMS average turnout time was 1.8 minutes.
  - Fire is 1.9 minutes.
  - EMS is 1.8 minutes.
- The aggregate fire and EMS average travel time was 2.6 minutes.
  - Fire is 2.2 minutes.
  - EMS is 2.7 minutes.
- The aggregate Fire and EMS average total response time was 6.5 minutes.
  - Fire is 5.8 minutes.
  - EMS is 6.7 minutes.

TABLE 5-2: 90th Percentile Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	3.1	3.6	4.9	9.5	170
Cardiac and stroke	3.6	3.1	4.6	10.1	166
Fall and injury	3.6	4.2	4.2	10.6	61
Illness and other	3.9	2.8	4.3	10.0	119
MVA	3.2	2.3	3.6	7.3	134
Overdose and psychiatric	3.1	3.5	4.8	9.8	35
Seizure and unconsciousness	2.7	3.4	3.8	8.9	123
EMS Total	**3.4**	**3.2**	**4.4**	**9.5**	**808**
False alarm	2.5	2.9	4.0	7.7	165
Good intent	2.8	2.8	4.0	7.5	14
Hazard	3.2	2.9	3.7	8.8	40
Outside fire	1.7	2.8	3.4	7.0	17
Public service	5.8	8.2	3.7	13.2	7
Structure fire	2.8	3.0	4.4	7.9	24
Fire Total	**2.8**	**2.9**	**3.9**	**8.0**	**267**
Total	**3.2**	**3.1**	**4.2**	**9.1**	**1,075**

Analysis of the data in this table tells us:

- The aggregate of Fire and EMS 90th percentile dispatch time was 3.2 minutes. ***Both fire (2.8 minutes) and EMS (3.4 minutes) dispatching times are well above the recommended NFPA 1710 and NFPA 1221 benchmarks (64 seconds 90 percent of the time; 106 seconds 95 percent of the time; 90 seconds 90 percent or 120 seconds 99 percent of the time for calls requiring emergency medical dispatch questioning and pre-arrival instructions if utilized by the 911 center). Both fire and EMS dispatch times (alarm processing time) are totally inadequate, impact the total response time significantly, and should be addressed immediately.***
- The aggregate of fire and EMS 90th percentile turnout time was 3.1 minutes (fire is 2.9 minutes and EMS is 3.2 minutes). ***This is well above the NFPA 1710 benchmark of 1.0 minutes for EMS and 1.33 minutes for fire. These are equally inadequate time elements as the dispatch time, and the one aspect of total response time the fire department has the most direct control over. This needs to be addressed immediately as it has a significant impact on the total response time.***
- The aggregate of fire and EMS 90th percentile travel time was 4.2 minutes (fire is 3.9 minutes and EMS is 4.4 minutes). ***This is at or below (in some call types) the NFPA 1710 benchmark.***
- The aggregate of fire and EMS 90th percentile total response time was 9.1 minutes.
- The 90th percentile total response time was 9.5 minutes for EMS calls and 8.0 minutes for fire calls.

Recommendation:

- CPSM recommends the DFD address call processing time with the Emergency Communications Center and develop a plan that has a goal of reducing alarm processing time to a level that is within NFPA 1710 standards. CPSM further recommends the DFD address turnout time internally and develop a plan that has a goal of reducing turnout time to a level that is within NFPA 1710 standards. (Recommendation No. 3.)

ASSESSMENT OF FIRE MANAGEMENT ZONES

Travel time is key to understanding how fire and EMS station location influences a community's aggregate response time performance. Travel time can be mapped when existing and proposed station locations are known. The location of responding units is one important factor in response time; reducing response times, which is typically a key performance measure in determining the efficiency of department operations, often depends on this factor. The goal of placement of a single fire station or creating a network of responding fire stations in a single community is to optimize coverage with short travel distances when possible, while giving special attention to natural and manmade barriers, and response routes that can create response-time problems.[27] This goal is generally budget-driven and based on demand intensity of fire and EMS incidents, which for this report were mapped earlier.

As already discussed, the DFD responds from two stations. As also discussed above, NFPA 1710 outlines national consensus travel time benchmarks of less than or equal to 240 seconds for the first arriving engine company 90 percent of the time and the arrival of the second due engine in 360 seconds, 90 percent of the time. NFPA further outlines that the initial first alarm assignment should be assembled on scene in 480 seconds, 90 percent of the time for low/medium hazards and 610 seconds for high-rise or high hazards. Hazards are outlined above as well in the community risk analysis section.

This section expands on the travel times outlined above, depicting how travel times of 240, 360, and 480 seconds look when mapped from the current fire station locations. Illustrating response time is important when considering the location from which assets should be deployed. When historic demand is coupled with risk analysis, a more informed decision can be made. The following figures use GIS mapping to illustrate 240-second, 360-second, and 480-second travel time bleed estimates, utilizing the existing street network from each current DFD station. As currently deployed, nearly the entire City of Danville generally falls within the first unit travel time benchmark of 240 seconds when considering both stations.

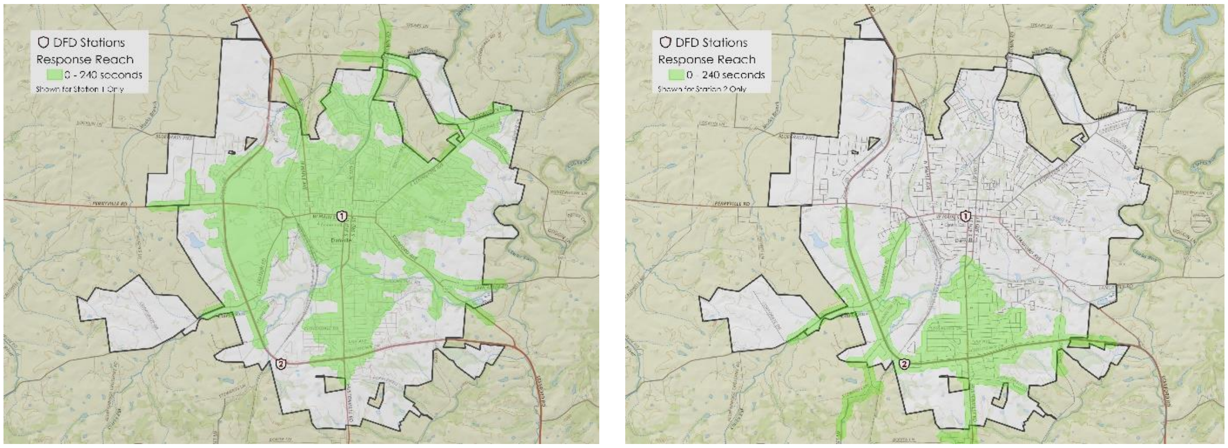
The GIS data for streets includes speed limits for each street segment and allows for "U-turns" for dead-end streets and intersections. This analysis is not all inclusive as it does not contemplate traffic, weather, and such things as road obstructions caused by construction, public transportation movement, and the like.

It is, however, important to note that while GIS-drawn, theoretical travel times do reflect favorably on the adequacy of station facilities and their corresponding locations within the city to support efficient fire and EMS response. Keep in mind, the benefits of favorable travel time findings are only meaningfully realized when apparatus can be predictably staffed for response and have aggressive turnout times.

27. NFPA 1710, Standard for the Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Departments, 2010 Edition, 122.

FIGURE 5-6: Travel Time of 240 Seconds from DFD Stations 1 and 2

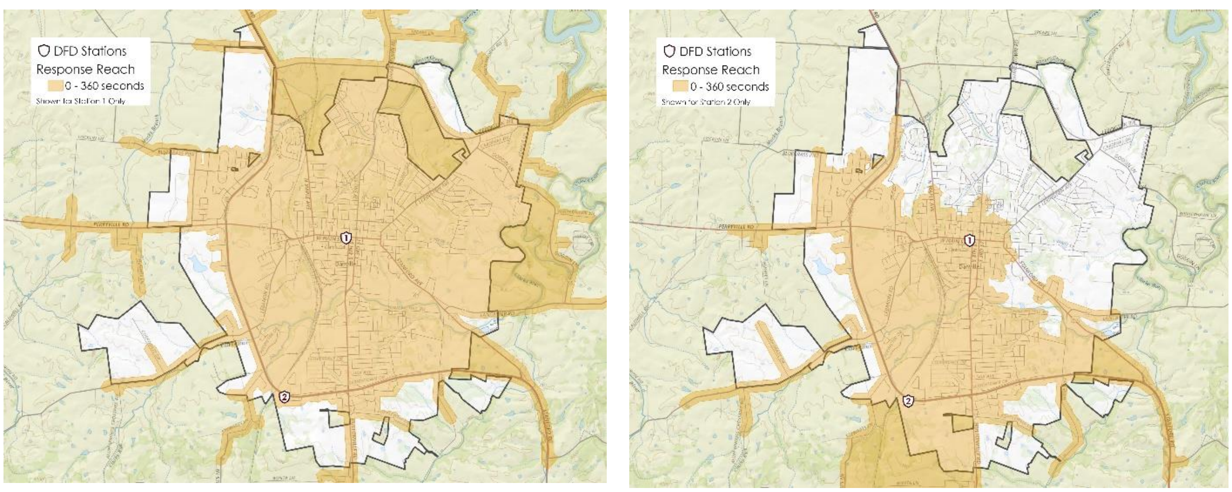
Station 1 Station 2



At 240 seconds, almost all of the city is covered from the central fire station. Station 2 covers almost all of the southern areas of the city. Those areas not covered are only minimally beyond the 240 seconds travel time.

FIGURE 5-7: Travel Time of 360 Seconds from DFD Stations 1 and 2

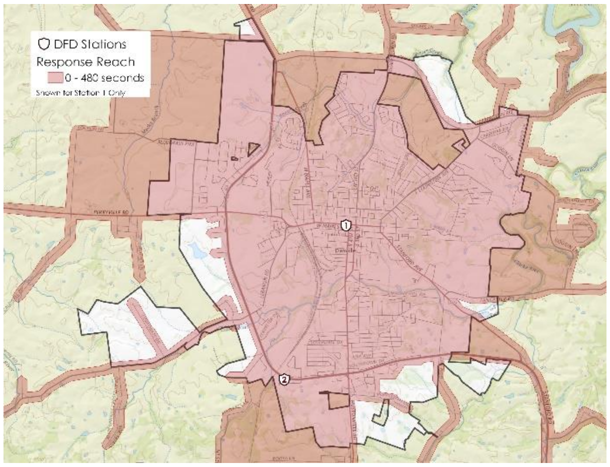
Station 1 Station 2



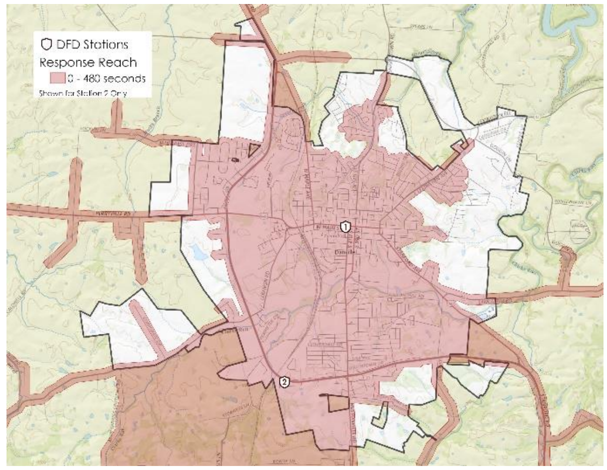
At 360 seconds, the Central Fire Station covers the city. Station 2 covers the southern portion of the city and into the core downtown area as well. The 360 seconds coverage area is important when considering the arrival of the second fire suppression unit on a fire incident as it relates to the building of the Effective Response Force and deploying on-scene staff to conduct critical fireground tasks.

FIGURE 5-8: Travel Time of 480 Seconds from DFD Stations 1 and 2

Station 1



Station 2

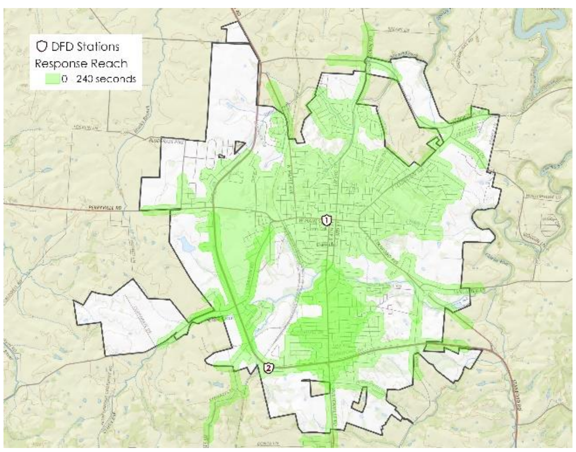


At 480 seconds, the Central Fire Station and Station 2 can both cover the city. As with the 360 seconds station response coverage area, the 480 seconds coverage area is important when considering the arrival of the initial first alarm assignment on low/moderate hazards as it relates to the assembling of the Effective Response Force and deploying on-scene staff to conduct critical fireground tasks. The DFD can assemble seven of the sixteen personnel required for low/moderate hazards with its current staffing complement.

The next figures show the effect of adding Station 3 to the response matrix of travel times and the positive impact of timely adding personnel to the Effective Response Force.

FIGURE 5-9: Travel Time of 240 Seconds from DFD Stations 1, 2, and Proposed Station 3

Stations 1 and 2



Stations 1 and 2 with Station 3

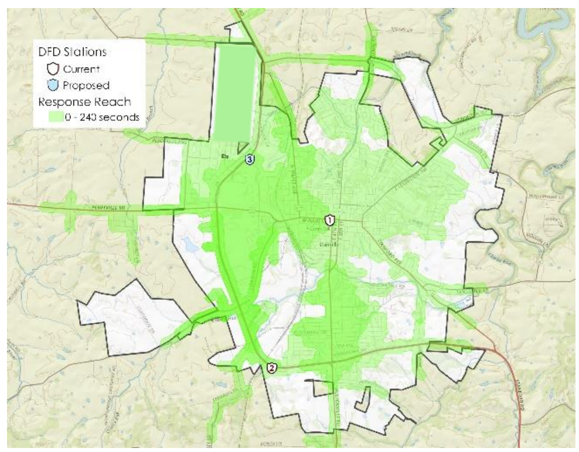


FIGURE 5-10: Travel Time of 360 Seconds from DFD Stations 1, 2, and Proposed Station 3

Stations 1 and 2 | Stations 1, 2, and 3

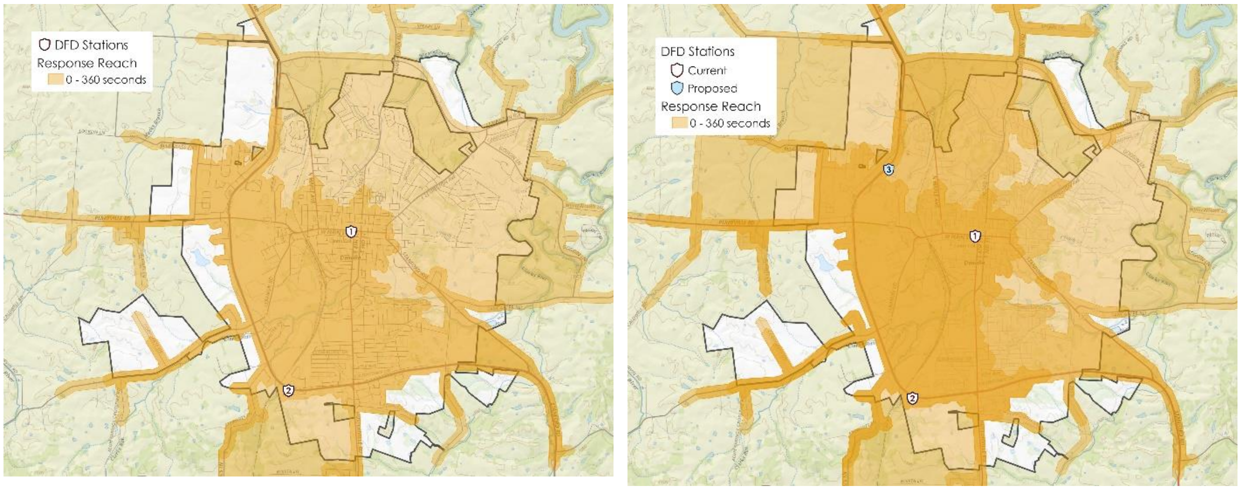
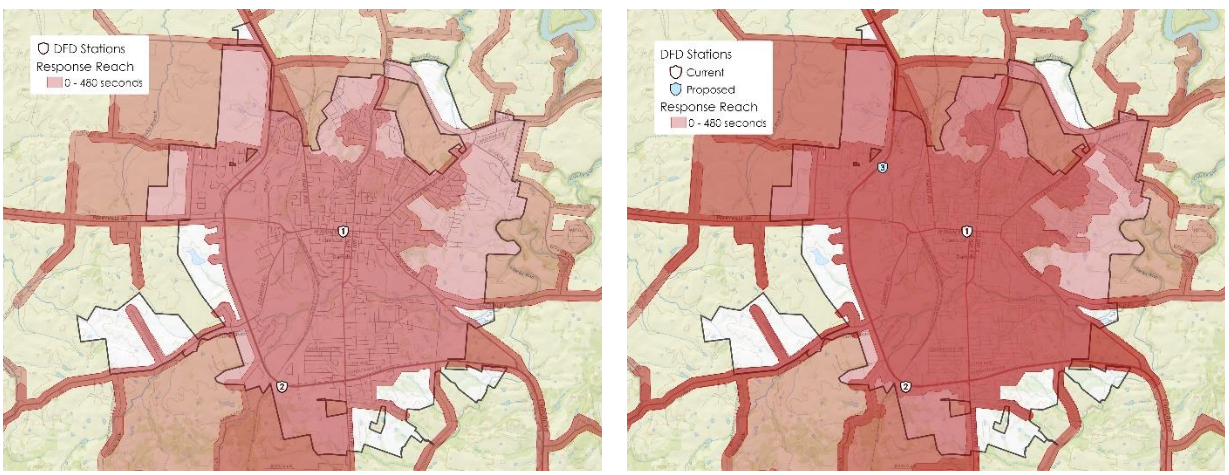


FIGURE 5-11: Travel Time of 360 Seconds from DFD Stations 1, 2, and Proposed Station 3

Stations 1and 2 | Stations 1,2, and 3



The ISO has established different indices for determining fire station distribution. The ISO Fire Suppression Rating Schedule, section 560, indicates that first-due engine companies should serve areas that are within a 1.5-mile travel distance. This is referred to as a deployment analysis by ISO. The placement of fire stations (engine companies) that achieves this type of separation creates service areas that are approximately 4.5 square miles in size, depending on the road network and other geographical barriers (rivers, lakes, railroads, limited access highways, etc.). The ISO Fire Suppression Rating Schedule also indicates that first-due ladder companies should serve areas that are within a 2.5-mile travel distance. The placement of fire stations with ladder companies that achieves this type of separation creates service areas that are approximately 6.25 square miles in size, depending on the road network and other geographical barriers.

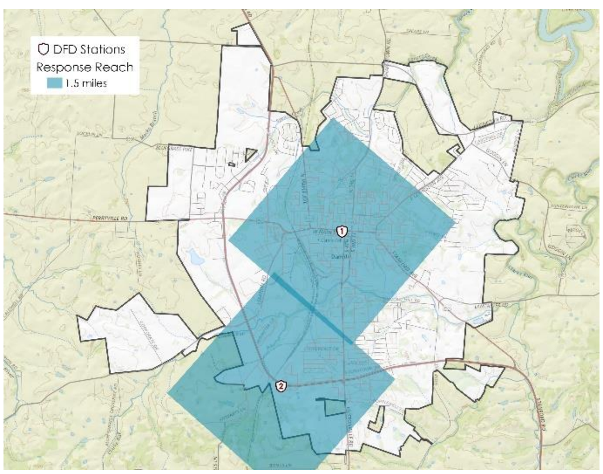
As discussed above, NFPA references the placement of fire stations in an indirect way. It recommends that fire stations be placed in a distribution that achieves the desired minimum response times. This is referred to as systematic performance evaluation by the ISO. As already stated, NFPA Standard 1710, section 4.1.2.1(3) and (6) suggests an engine placement that achieves a 240-second (four-minute) travel time for the first arriving unit. Using an empirical model called the "piece-wise linear travel time function" the Rand Institute has estimated that the average emergency response speed for fire apparatus is 35 mph. At this speed, the distance a fire engine can travel in four minutes is approximately 1.97 miles.[28] A polygon based on a 1.97-mile travel distance results in a service area that, on average, is 7.3 square miles.[29]

It is important to make several notes regarding the polygon models and the associated travel distances and times. First, the model often assumes that resources are distributed equally throughout the service area, which is generally not the case. In addition, the road network, and geographical barriers such as a railroad or limited access highways, can impact the distance units can cover over the same amount of time. That said, the formulas do provide a useful reference when attempting to benchmark travel distances and response times.

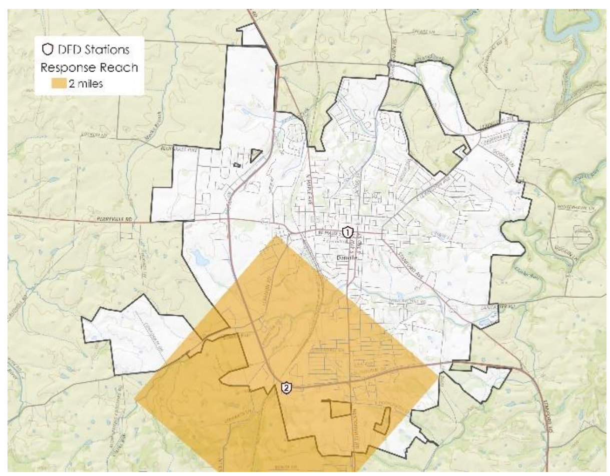
The next figure illustrates the 1.5-mile polygon overlay for each DFD station along with a 2-5-mile polygon for Station 2 as that is where the DFD ladder apparatus is located.

FIGURE 5-12: 1.5-Mile Polygon Overlay for Engines, 2.5-Mile Overlay for Ladder

1.5 Miles (Engine Companies)



2.5 Miles (Ladder Company)



The ISO maps tell us that there are built-upon areas in Danville that are greater than 1.5 miles from the closest fire station. The 2.5 mile map tells us that a majority of the city, particularly the core downtown area is beyond the 2.5 mile reach of the DFD ladder apparatus.

28. University of Tennessee Municipal Technical Advisory Service, *Clinton Fire Location Station Study*, Knoxville, TN, November 2012. p. 8.
29. Ibid., p.9

Recommendation:

- CPSM recommends the DFD relocate the ladder apparatus from Station 2 to the Central Fire Station once the new facility is built and occupied, so that aerial ladder service/coverage is available to multilevel buildings in the city's core and the most densely populated built-upon areas of the city. (Recommendation No. 4.)

AUTOMATIC AND MUTUAL AID

Fire departments outside of the city consist of volunteer agencies in Boyle County, Stanford Fire (combination department), and Junction City (volunteer department). The DFD currently does not have current automatic or mutual aid arrangements with these agencies/jurisdictions.

When the demands of an incident exceed a jurisdiction's response capabilities, mutual or automatic aid may be needed to augment on-scene assets so that the incident can be safely and effectively mitigated. Smaller cities such as Danville cannot provide all of the staffing and deployable assets to assemble an Effective Response Force for a fire or other incident where critical tasks outnumber available resources (this will be explained in-depth in the next section).

Fire departments provide mutual aid assistance to fires, medical emergencies, hazardous materials incidents, technical rescues, and other types of emergency incidents that are within the scope of their services. This response of assets across boundary lines is typical memorialized through an agreement between the two jurisdictions (intergovernmental mutual aid agreement).

When mutual aid assistance is provided, the Authority Having Jurisdiction (AHJ) remains ultimately responsible for the incident. Other specifics such as whether a jurisdiction is automatically dispatched to an incident in another jurisdiction, or if a specific request for aid has to be made, are tenets of these agreements. As well, aspects that are key to a mutual aid agreement are radio communications (interoperability), responsibility for personnel issues and injuries (worker's compensation), indemnification, and cost for service (personnel and equipment).

Mutual aid agreements also spell out what assets a jurisdiction will provide, what the jurisdiction's responsibilities are, and that the mutual aid is two-way, meaning not only will a jurisdiction receive assets from another agency, but the jurisdiction will also provide assets should they be needed.

Recommendation:

- CPSM recommends the DFD identify and work with fire departments that can provide mutual and automatic aid assets, and then enter into agreements with these departments so that staffing and deployable assets to assemble an Effective Response Force for a fire or other incident where critical tasks outnumber available resources can be enhanced for not only Danville, but these jurisdictions as well. (Recommendation No. 5.)

SECTION 6. STAFFING AND DEPLOYMENT OF RESOURCES

The staffing of fire and EMS companies is a never-ending focus of attention among fire service and governmental leadership. While NFPA 1710 and OSHA provide guidelines (and to some extent the law, specifically OSHA in OSHA states) as to the level of staffing and response of personnel, the adoption of these agency documents varies from state to state, and department to department. NFPA 1710 addresses the recommended staffing in terms of specific types of occupancies. The needed staffing to accomplish the critical tasks for each specific occupancy are determined to be the Effective Response Force (ERF). The ERF for each of these occupancies is detailed in NFPA 1710 (2020 edition), section 5.2.4, Deployment.

One of the factors that has helped the fire service in terms of staffing is technology. The fire service continues to benefit from technological advances that help firefighters extinguish fires more effectively. More advanced equipment in terms of nozzles, personal protective gear, thermal imaging systems, advancements in self-contained breathing apparatus, incident command strategies, and devices used to track personnel air supply are some of the technologies and techniques that help firefighters extinguish fires faster and manage the fireground more effectively and safely. While some of these technologies do not reduce the staffing or manpower required, they can have an impact on workload capacity, property loss, and crew fatigue.

Even with the many advances in technology and equipment, the fireground is an unforgiving and dynamic environment where critical tasks must be completed by firefighters. Lightweight wood construction, truss roofs, dwellings and buildings with basements, increased set-backs making accessibility to the building difficult, and estate homes are examples of the challenges that firefighting forces are met with when mitigating structural fires. Newly constructed homes are larger than many of the older homes in the community. These homes tend to incorporate open floor plans, with large spaces that contribute to rapid fire spread. The challenge of rapid fire spread is exacerbated by the use of lightweight roof trusses, vinyl siding, and combustible sheathing. The result is that more personnel are required to safely and effectively mitigate the incidents in these structures. Providing adequate staffing (Effective Response Force) for these environments depends on many factors.

While staffing and deployment of fire services is not an exact science, CPSM has developed metrics it follows and recommends that communities consider when we make recommendations regarding staffing and deployment of fire resources. While there are many benchmarks that communities and management utilize in justifying certain staffing levels, there are certain considerations that are data driven and reached through national consensus that serve this purpose as well.

In addition to metrics, fire and EMS staffing is also linked to station location, what type of apparatus is responding, that is, the combination of engine, ladder, ambulance, or specialty piece. These combined factors help to determine what level of fire and EMS service is going to be delivered in terms of manpower, response time, and resources.

Linked to these components of staffing and deployment are 11 critical factors that drive various levels and models from which fire and EMS departments staff and deploy. These factors are:

All-Hazard Risk Assessment of the Community: A fire department collects and organizes risk evaluation information about community risk (population and demographics; environmental; transportation; fire and EMS call demand and call types), and individual property types. Based on the rated factors, the assessment then derives a "fire risk score" and response strategy for each community risk and property type. The all-hazard community risk and community assessment is used to evaluate the community. With regard to individual property types, the assessment is used to measure all property and the risk associated with that property and then segregate the property as either a high-, medium-, or low-hazard/risk depending on factors such as the life and building content hazard, the potential fire flow, and the staffing and apparatus types required to mitigate an emergency in the specific property. The factors such as fire protection systems are considered in each building evaluation. Included in this assessment should be both a structural and nonstructural (weather, wildland-urban interface, transportation routes, etc.) analysis. All factors are then analyzed and the probability of an event occurring, the impact on the fire department, and the consequences on the community are measured and scored.

Population, Demographics, and Socioeconomics of a Community: Population and population density drives calls for local government service, particularly public safety. The risk from fire is not the same for everyone, with studies telling us age, gender, race, socio-economic factors, and what region in the country one might live in contribute to the risk of death from fire. Studies also tell us these same factors affect demand for EMS, such as the heightened use of hospital emergency departments by uninsured or underinsured patients, who rely on emergency services for their primary and emergency care and utilize pre-hospital EMS transport systems as their entry point.

Call Demand: Demand is made up of the types of calls to which units are responding and the location of the calls. This drives workload and station staffing considerations. Higher population centers with increased demand require greater resources.

Workload of Units: This factor involved the types of calls to which units are responding and the workload of each unit in the deployment model. This defines what resources are needed and where; it links to demand and station location, or in a dynamic deployed system, the area(s) in which to post units.

Travel Times from Fire Stations: Analyzes the ability to cover the fire management zone/response area in a reasonable and acceptable travel time when measured against national benchmarks. Links to demand and risk assessment.

NFPA Standards, ISO, OSHA, State OSH requirements (and other national benchmarking).

EMS Demand: Community demand; demand on available units and crews; demand on non-EMS units responding to calls for service (fire/police units); availability of crews in departments that utilize cross-trained EMS staff to perform fire suppression.

Critical Tasking: On-scene capabilities to control and mitigate emergencies is determined by staffing and deployment of certain resources for low-, medium-, and high-risk responses. Critical tasking is the individual or team level task that is required to be performed by on-scene personnel based on the type of incident the firefighting and EMS force is responding to.

Effective Response Force: The ability of the jurisdiction to assemble the necessary personnel on the scene to perform the critical tasks necessary in rapid sequence to mitigate the emergency.

The speed, efficiency, and safety of on-scene operations are dependent upon the number of firefighters performing the tasks. If fewer firefighters are available to complete critical on-scene tasks, those tasks will require more time to complete.

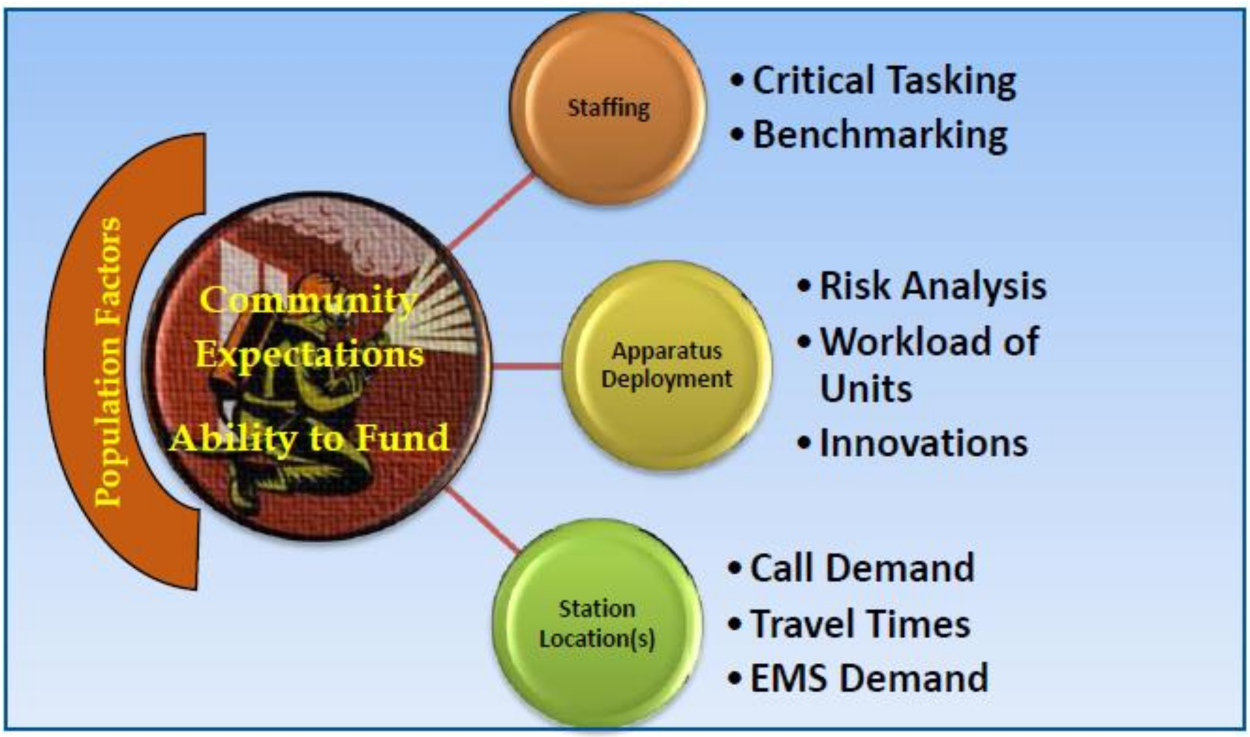
Innovations in Staffing and Deployable Apparatus: The fire department's ability and willingness to develop and deploy innovative apparatus (combining two apparatus functions into one to maximize available staffing, as an example). Deploying quick response vehicles (light vehicles equipped with medical equipment and some light fire suppression capabilities) on those calls (typically the largest percentage) that do not require heavy fire apparatus.

Community Expectations: The gathering of input and feedback from the community, then measuring, understanding, and developing goals and objectives to meet community expectations.

Ability to Fund: The community's understanding of, and its ability and willingness to fund fire and EMS services, while understanding how budgetary revenues are divided up to meet all community's expectations.

These factors are further illustrated in the following figure.

FIGURE 6-1: Fire Department Staffing Diagram



While each component presents its own metrics of data, consensus opinion, and/or discussion points, aggregately they form the foundation for informed decision making that is geared toward the implementation of sustainable, data- and theory-supported, effective fire and EMS staffing and deployment models that fit the community's profile, risk, and expectations.

FIRE AND EMS STAFFING AND RESPONSE METHODOLOGIES

When looking at response times it is prudent to design a deployment strategy around the actual circumstances that exist in the community and the fire problem that is identified. The strategic and tactical challenges presented by the widely varied hazards that a department protects against need to be identified and planned for through a community risk analysis planning and management process as identified in this report. It is ultimately the responsibility of elected officials to determine the level of risk that is acceptable to their community. Once the acceptable level of risk has been determined, then operational service objectives can be established. Whether looking at acceptable risk, or level of service objectives, it would be imprudent, and probably very costly, to build a deployment strategy that is based solely upon response times.

Fire, rescue, and EMS incidents, and the fire department's ability to respond to, manage, and mitigate them effectively, efficiently, and safely, are mission-critical components of the emergency services delivery system. In fact, fire, rescue, and EMS operations provide the primary, and certainly most important, basis for the very existence of the fire department.

Nationwide, fire departments are responding to more EMS calls and fewer fire calls, particularly fire calls that result in active firefighting operations by responders. This is well documented in both national statistical data, as well as in CPSM fire studies. Danville's experience is consistent with these trends. Nationally, improved building construction, code enforcement, automatic sprinkler systems, and aggressive public education programs have contributed to a decrease in serious fires and, more importantly, fire deaths among civilians.

These trends and improvements in the overall fire protection system notwithstanding, fires still do occur, and the largest percentage of those occur in residential occupancies, where they place the civilian population at risk. Although they occur with less frequency than they did several decades ago, when they occur today they grow much quicker and burn more intensely than they did in the past due to building construction features, more flammable interior finishes and furniture, and in the case of localities such as Danville with older buildings, multiple renovations that have led to hidden voids and spaces that act as channels for fire and smoke. As will be discussed later in this section, ***it is imperative that the fire department is able to assemble an effective response force (ERF) within a reasonable time period in order to successfully mitigate these incidents with the least amount of loss possible.***

Fire and rescue work are task-oriented and labor intensive, performed by personnel wearing heavy, bulky personal protective equipment (PPE). Many critical fireground tasks require the skillful operation and maneuvering of heavy equipment.

The speed, efficiency, and safety of fireground operations are dependent upon the number of firefighters performing the tasks. If fewer firefighters are available to complete critical fireground tasks, those tasks will require more time to complete. This increased time is associated with elevated risk to both firefighters and civilians who may still be trapped in a structure.

To ensure civilian and firefighter safety, fireground tasks must be coordinated and performed in rapid sequence. Assembling an Effective Response Force (ERF) is essential to accomplish on-scene goals and objectives safely and efficiently. Without adequate resources to control the fire, the structure and its contents continue to burn. This increases the likelihood of a sudden change in fire conditions, the potential for failure of structural components leading to collapse, and limits firefighters' ability to successfully perform a search and potential rescue of any occupants.

NFPA 1710

National Fire Protection Association (NFPA) standards are consensus standards and not the law. Many cites and countries strive to achieve these standards to the extent possible without an adverse financial impact to the community. Cities and communities must decide on the level of service they can deliver based on several factors as discussed herein, including budgetary considerations. Questions of legal responsibilities are often discussed in terms of compliance with NFPA Standards. Again, these are national consensus standards, representing best practices and applied science and research.

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*, 2020 edition (National Fire Protection Association, Quincy, Mass.) outlines organization and deployment of operations by career, and primarily career fire and rescue organizations.[30] It serves as a benchmark to measure staffing and deployment of resources to certain structures and emergencies.

NFPA 1710 was the first organized approach to defining levels of service, deployment capabilities, and staffing levels for substantially career departments. Research work and empirical studies in North America were used by NFPA committees as the basis for developing response times and resource capabilities for those services as identified by the fire department.[31]

According to NFPA 1710, fire departments should base their capabilities on a formal all-hazards community risk assessment, as discussed earlier in this report, and taking into consideration:[32]

- Life hazard to the population protected.
- Provisions for safe and effective firefighting performance conditions for the firefighters.
- Potential property loss.
- Nature, configuration, hazards, and internal protection of the properties involved.
- Types of fireground tactics and evolutions employed as standard procedure, type of apparatus used, and results expected to be obtained at the fire scene.

According to NFPA 1710, if a community follows this standard, engine companies shall be staffed with a minimum of four on-duty members[33] and ladder companies shall be staffed with *five* and six based on geographical isolation and tactical hazards.[34] This staffing configuration is designed to ensure a fire department can complete the critical tasking necessary on building fires and other emergency incidents simultaneously rather that consecutively, and efficiently assemble an effective response force. ***While CPSM is not recommending the City of Danville follow this standard, as this is a jurisdictional decision, CPSM does support NFPA staffing and deployment of resources benchmarking regarding the assembling of an adequate Effective Response Force to control and mitigate the emergencies to which the DFD responds.***

30. NFPA 1710 is a nationally recognized standard, but it has not been adopted as a mandatory regulation by the federal government or the State of Kentucky. It is a valuable resource for establishing and measuring performance objectives for the City of Danville but should not be the only determining factor when making local decisions about the city's fire and EMS services.
31. NFPA, Origin and Development of the NFPA 1710, 1710-1
32. NFPA 1710, 5.2.1.1, 5.2.2.2
33. NFPA 1710, 5.2.3.1.1
34. NFPA 1710, 5.2.3.1.2, 5.2.3.1.2.1.,5.2.3.2.2.,5.3.2.3.2.2.1

Code of Federal Regulations, NFPA 1500, and Two-In/Two-Out

Another consideration, and one that links to critical tasking and assembling an Effective Response Force, is that of two-in/two-out regulations. Essentially, prior to initiating any fire attack in an immediately dangerous to life and health (IDLH) environment [with no confirmed rescue in progress], the initial two-person entry team shall ensure that there are sufficient resources on-scene to establish a two-person initial rapid intervention team (IRIT) located outside of the building.

This critical tasking model has its genesis with the Occupational Safety and Health Administration, specifically 29 CFR 1910.134(g)(4). The Kentucky State Occupational Safety and Health Plan applies to state and local government employers. Federal OSHA covers the issues not covered by the Kentucky State Plan, except for the enforcement of the field sanitation and temporary labor camp standards. The federal rule (29 CFR 1910.134(g)(4)) applies to the DFD.

The DFD responds to structural fires with seven on-duty firefighters and a command officer (battalion chief) if no units/staffing are already assigned to other incidents. Under this response model, the DFD provides the minimum number of firefighters on the initial response in order to comply with CFR 1910.134(g)(4), regarding two-in/two-out rules and an initial rapid intervention team (IRIT).

CFR 1910.134: Procedures for interior structural firefighting. The employer shall ensure that:

(i) At least two employees enter the IDLH atmosphere and remain in visual or voice contact with one another at all times;

(ii) At least two employees are located outside the IDLH atmosphere; and

(iii) All employees engaged in interior structural firefighting use SCBAs.[35]

According to the standard, one of the two individuals located outside the IDLH atmosphere may be assigned to an additional role, such as incident commander in charge of the emergency or safety officer, so long as this individual is able to perform assistance or rescue activities without jeopardizing the safety or health of any firefighter working at the incident.

NFPA 1500 *Standard on Fire Department Occupational Health, Safety, and Wellness,* 2018 Edition has similar language as CFR 1910.134)g)(4) to address the issue of two-in/two-out, stating *the initial stages of the incident where only one crew is operating in the hazardous area of a working structural fire, a minimum of four individuals shall be required consisting of two members working as a crew in the hazardous area and two standby members present outside this hazard area available for assistance or rescue at emergency operations where entry into the danger area is required.*[36]

NFPA 1500 also speaks to the utilization of the two-out personnel in the context of the health and safety of the firefighters working at the incident. *The assignment of any personnel including the incident commander, the safety officer, or operations of fire apparatus, shall not be permitted as standby personnel if by abandoning their critical task(s) to assist, or if necessary, perform rescue, this clearly jeopardizes the safety and health of any firefighter working at the incident.*[37]

35. CFR 1910.134 (g) 4
36. NFPA 1500, 2018, 8.8.2.
37. NFPA 1500, 2018, 8.8.2.5.

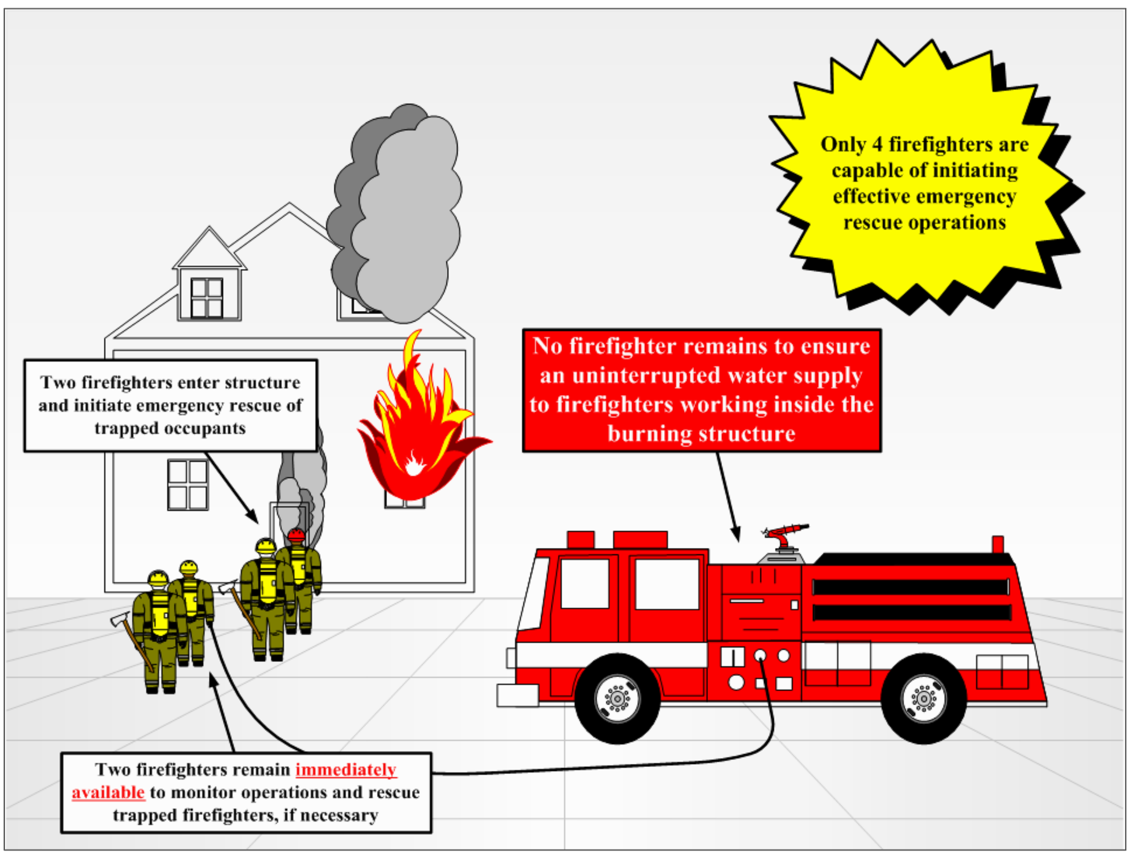
In order to meet CFR 1910.134(g)(4), and NFPA 1500, the DFD must utilize two personnel to commit to interior fire attack while two firefighters remain out of the hazardous area or immediately dangerous to life and health (IDLH) area to form the IRIT, while attack lines are charged and a continuous water supply is established.

However, NFPA 1500 allows for fewer than four personnel under specific circumstances. It states, *Initial attack operations shall be organized to ensure that if on arrival at the emergency scene, initial attack personnel find an imminent life-threatening situation where immediate action could prevent the loss of life or serious injury, such action shall be permitted with fewer than four personnel.*[38]

CFR 1910.134(g)(4) also states that nothing in section (g) is meant to preclude firefighters from performing emergency rescue activities before an entire team has assembled.[39]

It is also important to note that the OSHA standard (and NFPA 1710) specifically references "interior firefighting." Firefighting activities that are performed from the exterior of the building are not regulated by this portion of the OSHA standard. However, in the end, the ability to assemble adequate personnel, along with appropriate apparatus, on the scene of a structure fire, is critical to operational success and firefighter safety.

FIGURE 6-2: Two-In/Two-Out Interior Firefighting Model*



Note: *Four-person staffing, with single engine arrive at scene, or
Two 2-person staffed units (engine/engine; engine/ambulance) arrive at scene.

38. NFPA 1500, 2018 8.8.2.10.
39. CFR 190.134, (g).

The variables of how and where personnel and companies are located, and how quickly they can arrive on scene, play major roles in controlling and mitigating emergencies. ***The reality is that the DFD relies heavily on its own on-duty staffing and deployable resources and equipment because mutual aid companies are almost all volunteer staffed or are combination (career/volunteer) departments, and not always immediately ready to respond.*** The DFD's isolated continuous career staffing model in relation to volunteer mutual aid companies will continue to impact assembling enough personnel and resources to the scene. Given this, interior vs. exterior fire attacks that do not involve life safety have to be considered by the DFD until responding companies arrive on the scene, or unless Danville increases staffing in support of assembling an Effective Response Force quicker and to a greater level than it can at present.

Fire Operations

As a fire grows and leaves the room and then floor of origin, or extends beyond the building of origin, it is most probable that additional personnel and equipment will be needed, as initial response personnel will be taxed beyond their available resources. From this perspective it is critical that the DFD and mutual/automatic aid units respond quickly and initiate extinguishment efforts as rapidly as possible after notification of an incident. It is, however, difficult to determine in every case the effectiveness of the initial response in limiting the fire spread and fire damage. Many variables will impact these outcomes, including:

- The time of detection, notification, and ultimately response of fire units.
- The age and type of construction of the structure.
- The presence of any built-in protection (automatic fire sprinklers) or fire detection systems.
- The contents stored in the structure and its flammability.
- The presence of any flammable liquids, explosives, or compressed gas canisters.
- Weather conditions and the availability of water for extinguishment.

Subsequently, in those situations in which there are extended delays in the extinguishment effort or the fire has progressed sufficiently upon arrival of fire units, there is actually very little that can be done to limit the extent of damage to the entire structure and its contents. In these situations, suppression efforts may need to focus on the protection of nearby or adjacent structures (exterior exposures) with the goal being to limit the spread of the fire beyond the building of origin, and sometimes the exposed building. This is often termed ***protecting exposures***. When the scope of damage is extensive, and the building becomes unstable, firefighting tactics typically move to what is called a ***defensive attack***, or one in which hose lines and more importantly personnel are on the outside of the structure and their focus is to merely discharge large volumes of water until the fire goes out. In these situations, the ability to enter the building is very limited and if victims are trapped in the structure, there are very few safe options for making entry.

Today's fire service is actively debating the options of interior firefighting vs. exterior firefighting. These terms are self-descriptive in that an ***interior fire attack*** is one in which firefighters enter a burning building in an attempt to find the seat of the fire and from this interior position extinguish the fire with limited amounts of water. An ***exterior fire attack***, also sometimes referred to as a ***transitional attack***, is a tactic in which firefighters initially discharge water from the exterior of the building, either through a window or door and knock down the fire before entry in the building is made. The concept is to introduce larger volumes of water initially from the outside of the building, cool the interior temperatures, and reduce the intensity of the fire before firefighters enter the building. A transitional attack is most applicable in smaller structures, typically single-family, one-story detached units that are smaller than 2,500 square feet in total floor area. For fires in larger structures, the defensive type, exterior attacks generally involve the use of master streams, typically from an elevated aerial device, and capable of delivering large volumes of water for an extended period of time.

Recent studies by UL have evaluated the effectiveness of interior vs. exterior attacks in certain simulated fire environments. These studies have found the exterior attack to be equally effective in these simulations.[40] This debate is deep-seated in the fire service and traditional tactical measures have always proposed an interior fire attack, specifically when there is a possibility that victims may be present in the burning structure. The long-held belief in opposition to an exterior attack is that this approach may actually push the fire into areas that are not burning or where victims may be located. The counterpoint supporting the exterior attack centers on firefighter safety. In the end, how an interior fire is attacked is a jurisdictional choice, and should be based on resources immediately available on the fireground to combat the fire, available water supply, and the situation faced initially by crews and throughout the incident.

The exterior attack limits the firefighter from making entry into those super-heated structures that may be susceptible to collapse. From CPSM's perspective, there is an increased likelihood a DFD single response crew of two or three personnel will encounter a significant and rapidly developing fire situation. This situation can occur during times of multiple incident activity when a unit may be committed on another emergency, or when there is a reliance on mutual/automatic aid companies responding to the incident that have long turnout and response times to arrive on the scene. ***It is prudent, therefore, that the DFD build at least a component of its training and operating procedures around the tactical concept of this occurring.***

Critical Tasking, and Effective Response Force

Critical tasks are those activities that must be conducted in a timely manner by responders at emergency incidents to control the situation and stop loss. Critical tasking for fire operations is the minimum number of personnel needed to perform the tasks required to effectively control and mitigate a fire or other emergency. To be effective, critical tasking must assign enough personnel so that all identified functions can be performed simultaneously. However, it is important to note that secondary support functions may be handled by initial response personnel once they have completed their primary assignment. Thus, while an incident may end up requiring a greater commitment of resources or a specialized response, a properly executed critical tasking assignment will provide adequate resources to immediately begin bringing the incident under control.

The specific number of people required to perform all the critical tasks associated with an identified risk or incident type is referred to as an Effective Response Force (ERF). The goal is to deliver an ERF within a prescribed time frame. NFPA 1710 provides a benchmark for effective response forces.

The following discussion and tables will outline how critical tasking and assembling an effective response force is first measured in NFPA 1710, and how the DFD is benchmarked against this standard. This discussion will cover single-family dwelling buildings, open-air strip mall buildings, apartment buildings, and high-rise buildings. As mentioned already in this report, the DFD cannot rely on mutual or automatic aid to support its efforts in assembling an Effective Response Force,

40. "Innovating Fire Attack Tactics," U.L.COM/News Science, Summer 2013.

as these responding companies are volunteer and are not reliable 24/7 to respond with adequate staffing.

Single-Family Dwelling: NFPA 1710, 5.2.4.1

The initial full alarm assignment to a structural fire in a typical 2,000 square-foot, two-story, single-family dwelling without a basement and with no exposures must provide for a minimum of 16 members (17 if an aerial device is used). The following figure illustrates this and the subsequent table outlines the critical task matrix.

FIGURE 6-3: Effective Response Force for Single-Family Dwelling Fire

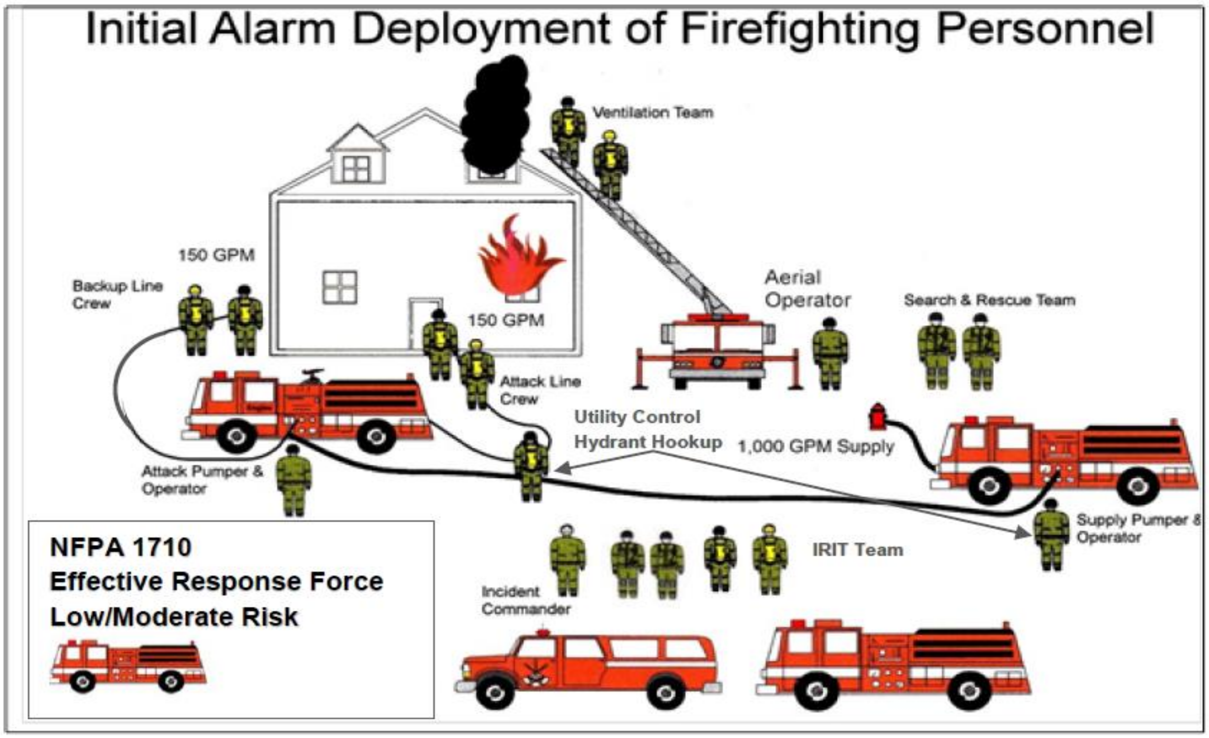


TABLE 6-1: Effective Response Force for Single-Family Dwelling Fire

Critical Tasks	Personnel
Incident Command	1
Continuous Water Supply	1
Fire Attack via Two Handlines	4
Hydrant Hook Up - Forcible Entry - Utilities	2
Primary Search and Rescue	2
Ground Ladders and Ventilation	2
Aerial Operator if Aerial is Used	1
Establishment of IRIC (Initial Rapid Intervention Crew)	4
Total Effective Response Force	**16** (17 If aerial is used)

The following table outlines how the DFD assembles staffing and deployable resources as measured against NFPA 1710 benchmarking for an effective response force for a single-family dwelling fire.

TABLE 6-2: DFD Effective Response Force for Single-Family Dwelling Fire

Apparatus	Personnel
DFD Battalion Chief	1
DFD Engine	3
DFD Engine/Ladder	3
Total DFD ERF	**7**

As a single responding agency, DFD does not meet the minimum benchmarks of NFPA 1710 for an Effective Response Force for single-family dwelling fires. With reliable mutual or automatic aid, it is possible the DFD can meet this benchmark. NFPA 1710 permits fire departments to use established automatic aid and mutual aid agreements to comply with section 5.2 of this standard.[41]

Open-Air Strip Mall, NFPA 5.4.2

The initial full alarm assignment to a structural fire in a typical open-air strip center ranging from 13,000 square feet to 196,000 square feet in size must provide for a minimum of 27 members (28 if an aerial device is used). The following table outlines the critical tasking matrix for this type of fire.

TABLE 6-3: Effective Response Force for Open-Air Strip Mall Fire

Critical Tasks	Personnel
Incident Command	2
Continuous Water Supply	2
Fire Attack via Two Handlines	6
Hydrant Hook Up - Forcible Entry - Utilities	3
Primary Search and Rescue	4
Ground Ladders and Ventilation	4
Aerial Operator if Aerial is Used	1
Establishment of IRIC (Initial Rapid Intervention Crew)	4
Medical Care Team	2
Total Effective Response Force	**27** (28 If aerial is used)

The following table outlines how the DFD assembles staffing and deployable resources as measured against NFPA 1710 benchmarking for an effective response force for an open-air strip mall fire.

41. NFPA 1710. 5.2.1.3

TABLE 6-4: DFD Effective Response Force for Open-Air Strip Mall Fire

Apparatus	Personnel
DFD Battalion Chief	1
DFD Engine	3
DFD Engine/Ladder	3
Total ERF	**7**

As a single responding agency, DFD does not meet the minimum benchmarks of NFPA 1710 for an Effective Response Force for an open-air strip mall fire. With reliable mutual or automatic aid, it is possible the DFD can meet this benchmark. NFPA 1710 permits fire departments to use established automatic aid and mutual aid agreements to comply with section 5.2 of this standard.[42]

Apartment Building

The initial full alarm assignment to a structural fire in a typical 1,200 square-foot apartment within a three-story, garden-style apartment building must provide for a minimum of 27 members (28 if an aerial device is used). The following table outlines the critical tasking matrix for this type of building fire.

TABLE 6-5: Effective Response Force for Apartment Building Fire

Critical Tasks	Personnel
Incident Command	2
Continuous Water Supply	2
Fire Attack via Two Handlines	6
Hydrant Hook Up - Forcible Entry - Utilities	3
Primary Search and Rescue	4
Ground Ladders and Ventilation	4
Aerial Operator if Aerial is Used	1
Establishment of IRIC (Initial Rapid Intervention Crew	4
Medical Care Team	2
Total Effective Response Force	**27** (28 If aerial is used)

The following table outlines how the DFD assembles staffing and deployable resources as measured against NFPA 1710 benchmarking for an effective response force for an apartment building fire.

TABLE 6-6: DFD Effective Response Force for Apartment Building Fire

Apparatus	Personnel
DFD Battalion Chief	1
DFD Engine	3
DFD Engine/Ladder	2
Total ERF	**7**

42. NFPA 1710. 5.2.1.3

As a single responding agency, DFD does not meet the minimum benchmarks of NFPA 1710 for an Effective Response Force for an apartment building fire. With reliable mutual or automatic aid, it is possible the DFD can meet this benchmark. NFPA 1710 permits fire departments to use established automatic aid and mutual aid agreements to comply with section 5.2 of this standard.[43]

High-Rise, NFPA 1710 5.2.4.4

The initial full alarm assignment to a fire in a building where the highest floor is greater than 75 feet above the lowest level of fire department vehicle access must provide for a minimum of 42 members (43 if the building is equipped with a fire pump). The following table outlines the critical tasking matrix for this type of building fire.

TABLE 6-7: Effective Response Force for High-Rise Fire Matrix

Critical Tasks	Personnel
Incident Command	2
Continuous Water Supply	1 FF for continuous water; if fire pump exists, 1 additional FF required.
Fire Attack via Two Handlines	4
One handline above the Fire Floor	2
Establishment of IRIC (Initial Rapid Intervention Crew)	4
Primary Search and Rescue Teams	4
Entry Level Officer with Aide near entry point of Fire Floor	2
Entry Level Officer with Aide near the entry point above the Fire Floor	2
Two Evacuation Teams	4
Elevation Operations	1
Safety Officer	1
FF two floors below fire to coordinate staging	1
Rehabilitation Management	2
Officer and FFs to manage vertical ventilation	4
Lobby Operations	1
Transportation of Equipment below Fire Floor	2
Officer to Management Base Operations	1
Two ALS Medical Care Teams	4
Total Effective Response Force	**42** (43 If building is equipped with pump)

The following table outlines how the DFD assembles staffing and deployable resources as measured against NFPA 1710 benchmarking for an effective response force for a high-rise building fire.

43. NFPA 1710. 5.2.1.3

TABLE 6-8: DFD Effective Response Force for High-Rise Building

Apparatus	Personnel
DFD Battalion Chief	1
DFD Engine	3
DFD Engine/Ladder	2
Total ERF	**7**

As a single responding agency, DFD does not meet the minimum benchmarks of NFPA 1710 for an Effective Response Force in a high-rise building fire. With reliable mutual or automatic aid, it is possible the DFD can meet this benchmark. NFPA 1710 permits fire departments to use established automatic aid and mutual aid agreements to comply with section 5.2 of this standard.[44]

EMS Operations

Emergency medical service (EMS) operations are an important component of the comprehensive emergency services delivery system in any community. Together with the delivery of police and fire services, it forms the backbone of the community's overall public safety net. As was noted in several sections of this report, the DFD, like many, if not most, fire departments respond to significantly more emergency medical incidents and low acuity incidents than actual fires or other types of emergency incidents.

The EMS component of the emergency services delivery system is more heavily regulated than the fire side. In addition to National Fire Protection Association (NFPA) Standard 1710, *Organization and Deployment of Fire Suppression Operations, Emergency Medical Operations, and Special Operations to the Public by Career Fire Departments* (2020 edition), NFPA 450 *Guidelines for Emergency Medical Services (EMS) and Systems*, (2017 edition), provides a template for local stakeholders to evaluate an EMS system and to make improvements based on that evaluation.

In terms of overall incidents responded to by the emergency agencies in most communities, it could be argued that EMS incidents constitute the greatest number of "true" emergencies, where intervention by trained personnel does truly make a difference, sometimes literally between life and death.

Heart attack and stroke victims require rapid intervention, care, and transport to a medical facility. The longer the time duration without care, the less likely the patient is to fully recover. Numerous studies have shown that irreversible brain damage can occur if the brain is deprived of oxygen for more than four minutes.

Emergency medical services (EMS) for the City of Danville are provided at the basic life support (BLS) first responder level by the DFD. Boyle County Emergency Medical Services (BCEMS) provides EMS ground transportation at the advanced life support (ALS) level. ALS-level care refers to prehospital interventions that can be brought into the field by paramedics. Typically, this service level includes the ability to bring much of the emergency room capability to the patient. Paramedics can administer intravenous fluids, manage a patient's airway, provide drug therapy, utilize the full capabilities of a 12-lead cardiac monitor, and provide a vital communication link to the medical control physician who can provide specific medical direction based on the situation. The DFD provides first response EMS services in support of

44. NFPA 1710. 5.2.1.3

BCEMS at the basic life support (BLS) level. All DFD personnel are minimally trained and certified to the emergency medical technician-basic (EMT) level.

DFD STAFFING MATRIX

The DFD has three operational shifts, A, B, and C. Each of the shifts is staffed with four firefighters, two lieutenants (company officer), and one battalion chief (shift commander), for an on-duty operational response force of seven personnel.

The following table details the positions for each shift.

TABLE 6-9: DFD Shift Matrix

A Shift	B Shift	C Shift
Station 1: LT, FF, FF, Battalion Chief	Station 1: LT, FF, FF, Battalion Chief	Station 1: LT, FF, FF, Battalion Chief
Station 2: LT, FF, FF	Station 2: LT, FF, FF	Station 2: LT, FF, FF

The table above depicts minimum staffing levels for the department. The DFD does not have extra personnel to fill in for scheduled and unscheduled leave (overstaffing). The DFD, like many fire departments across the country, staffs through the constant-staffing level model, meaning that on each shift there is minimum number of staffed positions to be filled. In the case of the DFD that number is seven each shift. When a position is vacated by scheduled or unscheduled leave, and because it represents minimum staffing, the position is backfilled by overtime staffing. If a position cannot be filled, the DFD will operate with a minimum of two on duty at the affected station. There may be times when both stations are operating with two on duty, for a total of five on duty (count includes the Battalion Chief). ***This falls far short of the recommended Effective Response Force of 16 (17 when the aerial ladder is utilized) for low/moderate hazards, and for all other structural fire deployments as outlined in NFPA 1710.***

While the DFD has done a good job with cross-staffing the ladder apparatus over the years, this model is difficult to sustain when regularly tested against current community risks and building hazards, and against the potential increase in growth and development (increased population and risk), which typically drives up demand. A ladder company, which is primarily designed for firefighting and rescue operations, differs from the capabilities of engines in that it also has a hydraulically operated aerial device designed to reach above grade floors to transport crew members, effect rescues, and provide an elevated water stream. The ladder truck also transports crew members, ground ladders, self-contained breathing apparatus, various forcible entry tools, ventilation equipment, and hydraulic rescue tools as well as other equipment to deal with an assortment of fires and technical rescues. Some ladder trucks, such as the one in the DFD, carry hose (fire attack and larger supply) and tank water. In an urban/suburban city such as Danville, ladder company critical tasks (search and rescue, ventilation, utility control, ground ladder placement for emergency escape) and the availability of the aerial ladder device only improves the effectiveness of fireground capabilities.

The following table details the combinations for cross-staffing that the DFD utilizes for fire responses based on the number of on-duty staffing available. Matrix dependent on call type and DFD response matrix.

TABLE 6-10: Distribution of Personnel / Current Deployment Strategies

Fire Response: Single Engine (3 personnel)		Fire Response: One Engine and One Ladder (7 personnel)		Fire Response: Two Engines (7 personnel)	
	1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One station available	**1 Lieutenant 2 Firefighters**		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
Battalion Chief Available	**1 command position**		1 Battalion Chief		1 Battalion Chief

In the short to medium term, the DFD will need to move away from the cross-staffing model at Station 2 (engine/ladder), and make the ladder apparatus a stand-alone company with a minimum shift staffing of three. This will do several things:

- It will increase overall minimum daily staffing from seven to ten, which will contribute to meeting the NFPA 1710 benchmark of 16 personnel on the scene of a low/moderate hazard (the most common type in Danville). This will make an immediate positive impact on the simultaneous completion of fireground critical tasks.
- It will have a positive impact/improve the ISO Public Protection Classification analysis. The city currently is deficient in Sections 561 Deployment Analysis (6.14/10.00) and 571 Company Personnel (1.76/15.00) of the FSRS feature: Fire Department. Aggregately the city only received 25.77/50.00 for the Fire Department feature after the 2014 analysis.
- It will have a positive impact on the health and safety of on-scene firefighting personnel.
- It will have a positive impact on fireground decision making as the increase in available staffing allows the incident commander to make assignments based on industry standard critical tasking-order of tasks.

The next table illustrates the combinations the DFD will realize for fire responses based on the number of on-duty staffing available with the ladder staffed with three personnel. Matrix dependent on call type and DFD response matrix.

TABLE 6-11: Distribution of Personnel / Deployment Strategies with Ladder Staffed

Fire Response: Single Engine (3 personnel)		Fire Response: One Engine and One Ladder (7 personnel)		Fire Response: Two Engines and One Ladder (10 personnel)	
	1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One engine available	**1 Lieutenant 2 Firefighters**		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One ladder available	**1 Lieutenant 2 Firefighters**		1 Battalion Chief		1 Lieutenant 2 Firefighters
Battalion Chief Available	**1 command position**	**One engine available**	**1 Lieutenant 2 Firefighters**		1 Battalion Chief

In addition to staffing the ladder company with three personnel on each shift, the addition of Station 3 (currently being considered by the city) will also increase the available staffing/apparatus to respond to single and multicompany calls for service, and will spread the service deliverables (stations/fire management zones) out to a larger area of the city. The impacts of Station 3 regarding staffing and assembling an Effective Response Force align with the bullet points above. It is axiomatic that response times will be reduced in the fire management zone where Station 3 resides.

The next table illustrates the combinations the DFD will realize for fire responses based on the number of on-duty staffing available with the ladder staffed with three personnel and Station 3 staffed with one engine and three personnel. Matrix dependent on call type and DFD response matrix.

TABLE 6-12: Distribution of Personnel / Deployment Strategies with Ladder Staffed and Station 3 staffed with One Engine

Fire Response: Single Engine (3 personnel)		Fire Response: Two Engines and One Ladder (10 personnel)		Fire Response: Three Engines and One Ladder (13 personnel)	
	1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One engine available	**1 Lieutenant 2 Firefighters**		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One engine available	**1 Lieutenant 2 Firefighters**		1 Lieutenant 2 Firefighters		1 Lieutenant 2 Firefighters
One ladder available	**1 Lieutenant 2 Firefighters**		1 Battalion Chief		1 Lieutenant 2 Firefighters
Battalion Chief Available	**1 command position**	**One engine available**	**1 Lieutenant 2 Firefighters**		1 Battalion Chief

Recommendations:

CPSM recommends the following staffing strategies for the DFD and for the city to consider. These strategies are focused on enhancing the DFD's ability to assemble an Effective Response Force to mitigate fires and other emergencies, and to complete incident critical tasks simultaneously rather than in succession, which has a relevant impact on successfully and safely controlling and mitigating the emergency.

- Maintain minimum staffing on each engine company at three each work shift and at each station. CPSM does not recommend any engine company drop to two personnel as this impacts the fire department's already strained ability to assemble an Effective Response Force to mitigate an emergency and complete critical tasks simultaneously rather than in succession. CPSM recommends this be considered in the immediate term (current planning period). (Recommendation No. 6.)
- Eliminate the cross-staffing of the ladder apparatus with engine company personnel and staff the ladder apparatus with three personnel (one lieutenant and two firefighters) each work shift. This would require the addition of nine personnel. CPSM recommends this be considered in the short term (two- to three-year planning period). (Recommendation No. 7)
- Continue the planning and funding/budget efforts for the construction, staffing, and equipping of Station 3, and the hiring of personnel (three per shift, nine total). CPSM further recommends this be considered over a mid-term time frame (five-year planning period). (Recommendation No. 8.)
- Monitor development in the northeast section of the city. As this area experiences growth and as demand for service increases, CPSM recommends the city consider a fourth fire station staffed with one engine and three personnel per shift. CPSM further recommends this be considered over a long-term time frame (seven- to ten-year planning period). (Recommendation No. 9.)

SECTION 7. DATA ANALYSIS

This data analysis examines all calls for service between January 1, 2019, and December 31, 2019, as recorded in the Danville-Boyle County 911 Dispatch Center's computer-aided dispatch (CAD) system and the Danville Fire Department's National Fire Incident Reporting System (NFIRS).

This analysis is made up of four parts. The first part focuses on call types and dispatches. The second part explores the time spent and the workload of individual units. The third part presents an analysis of the busiest hours in the year studied. The fourth part provides a response time analysis of DFD units.

During the year covered by this study, DFD operated out of two stations, utilizing three engines, one battalion chief, one hazmat truck, one ladder, one rescue truck, one squad, two pickups, and one SUV.

During the study period, the Danville Fire Department responded to 1,839 calls, of which 61 percent were EMS calls. The total combined workload (deployed time) for all DFD units was 1,298.7 hours. The average dispatch time for the first arriving unit was 2.1 minutes and the average response time of the first arriving DFD unit was 6.5 minutes. The 90th percentile dispatch time was 3.2 minutes and the 90th percentile response time was 9.1 minutes.

METHODOLOGY

In this report, CPSM analyzes calls and runs. A call is an emergency service request or incident. A run is a dispatch of a unit (i.e., a unit responding to a call). Thus, a call may include multiple runs.

We received CAD data and NFIRS data for the Danville Fire Department. We first matched the NFIRS and CAD data based on incident numbers provided. Then, we classified the calls in a series of steps. We first used the NFIRS incident type to identify canceled calls and to assign EMS, motor vehicle accident (MVA), and fire category call types. EMS calls were then assigned detailed categories based on their Priority Dispatch codes. Mutual aid calls were identified based on the CAD data's longitude and latitude fields.

In this analysis, we included 18 calls and 197 runs that only appeared in the NFIRS data. We note that the timestamps on these runs may be inaccurate. Units without an en route or arrival time were removed, as were calls that had no responding DFD units. Also, a total of five incidents to which command or administrative units were the sole responders are not included in the analysis sections of the report. However, the workload of administrative units is documented in Attachment II.

In this report, canceled and mutual aid calls are included in all analyses other than the response time analyses.

AGGREGATE CALL TOTALS AND RUNS

During the year studied, DFD responded to 1,839 calls. Of these, 31 were structure fire calls and 47 were outside fire calls within DFD's jurisdiction.

Calls by Type

The following table and two figures show the number of calls by call type, average calls per day, and the percentage of calls that fall into each call type category for the 12 months studied.

TABLE 7-1: Call Types

Call Type	Number of Calls	Calls per Day	Call Percentage
Breathing difficulty	217	0.6	11.8
Cardiac and stroke	207	0.6	11.3
Fall and injury	106	0.3	5.8
Illness and other	177	0.5	9.6
MVA	200	0.5	10.9
Overdose and psychiatric	45	0.1	2.4
Seizure and unconsciousness	168	0.5	9.1
EMS Total	**1,120**	**3.1**	**60.9**
False alarm	216	0.6	11.7
Good intent	49	0.1	2.7
Hazard	109	0.3	5.9
Outside fire	47	0.1	2.6
Public service	107	0.3	5.8
Structure fire	31	0.1	1.7
Fire Total	**559**	**1.5**	**30.4**
Canceled	120	0.3	6.5
Mutual aid	40	0.1	2.2
Total	**1,839**	**5.0**	**100.0**

FIGURE 7-1: EMS Calls by Type

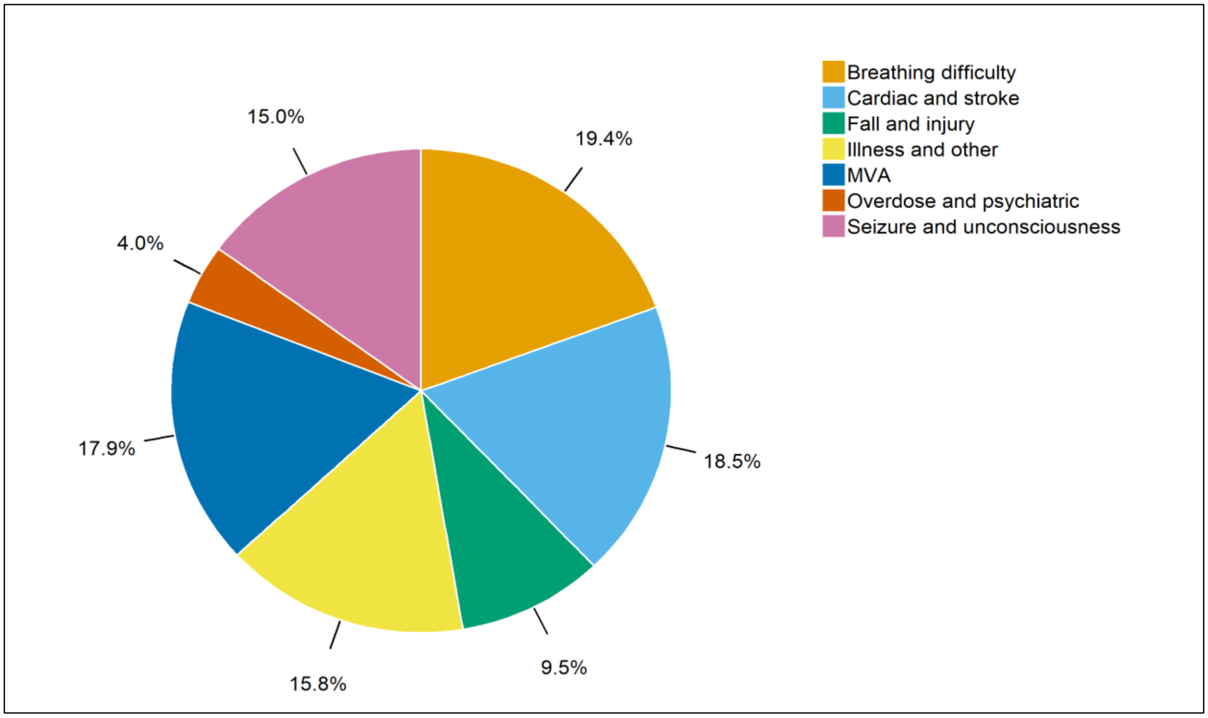
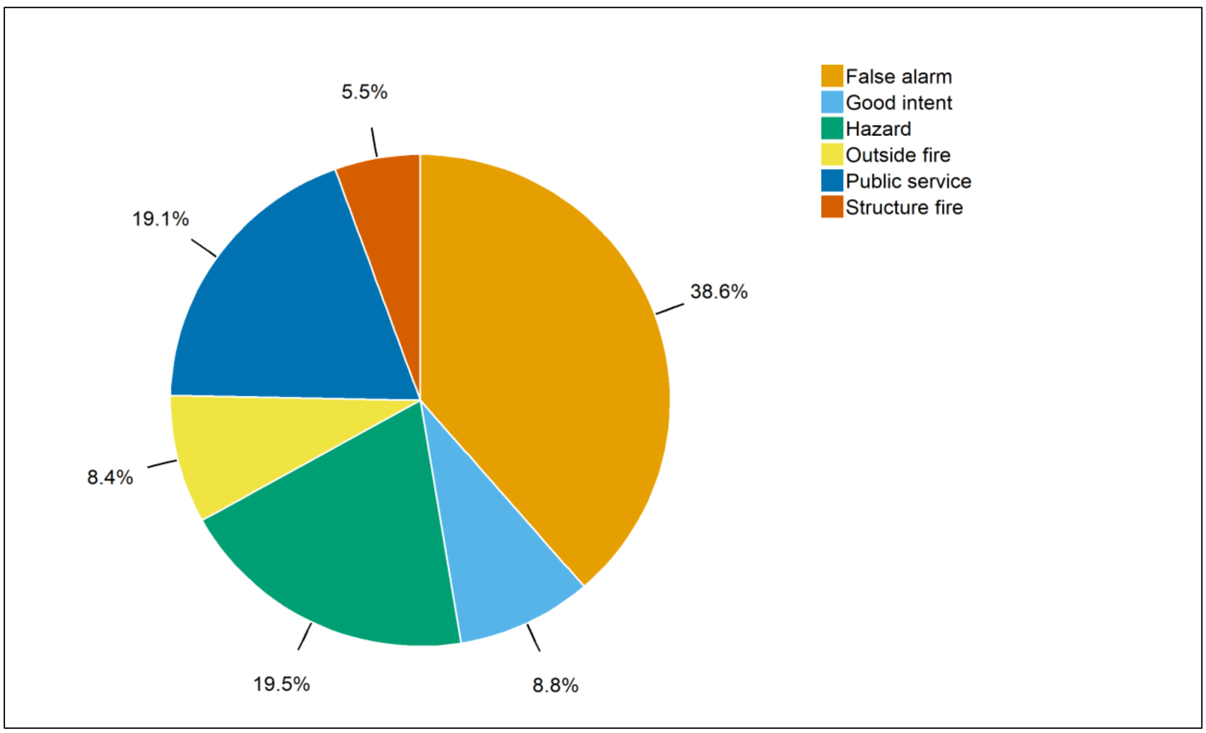


FIGURE 7-2: Fire Calls by Type



Observations:

Overall

- The department received an average of 5.0 calls, including 0.3 canceled and 0.1 mutual aid calls, per day.
- EMS calls for the year totaled 1,120 (61 percent of all calls), an average of 3.1 per day.
- Fire calls for the year totaled 559 (30 percent of all calls), an average of 1.5 per day.

EMS

- Breathing difficulty calls were the largest category of EMS calls at 19 percent of EMS calls, an average of 0.6 calls per day.
- Cardiac and stroke calls made up 18 percent of EMS calls, an average of 0.6 calls per day.
- Motor vehicle accidents made up 18 percent of EMS calls, an average of 0.5 calls per day.

Fire

- False alarm calls were the largest category of fire calls at 39 percent of fire calls, an average of 0.6 calls per day.
- Structure and outside fire calls combined made up 14 percent of fire calls, an average of 0.2 calls per day, or one call every 5 days.

Calls by Type and Duration

The following table shows the duration of calls by type using four duration categories: less than 30 minutes, 30 minutes to one hour, one to two hours, and more than an hour.

TABLE 7-2: Calls by Type and Duration

Call Type	Less than 30 Minutes	30 Minutes to One Hour	One to Two Hours	More Than Two Hours	Total
Breathing difficulty	196	18	3	0	217
Cardiac and stroke	179	23	5	0	207
Fall and injury	81	20	4	1	106
Illness and other	136	36	3	2	177
MVA	101	85	12	2	200
Overdose and psychiatric	36	6	3	0	45
Seizure and unconsciousness	149	15	4	0	168
EMS Total	**878**	**203**	**34**	**5**	**1,120**
False alarm	178	33	5	0	216
Good intent	34	14	1	0	49
Hazard	48	41	16	4	109
Outside fire	33	13	0	1	47
Public service	86	15	3	3	107
Structure fire	16	6	4	5	31
Fire Total	**395**	**122**	**29**	**13**	**559**
Canceled	117	1	2	0	120
Mutual aid	32	7	1	0	40
Total	**1,422**	**333**	**66**	**18**	**1,839**

Observations:

EMS

- A total of 1,081 EMS calls (97 percent) lasted less than one hour, 34 EMS calls (3 percent) lasted one to two hours, and 5 EMS calls (less than 1 percent) lasted two or more hours.
- On average, there were 0.1 EMS calls per day that lasted more than one hour.
- A total of 202 cardiac and stroke calls (98 percent) lasted less than one hour, and 5 cardiac and stroke calls (2 percent) lasted one to two hours.
- A total of 186 motor vehicle accidents (93 percent) lasted less than one hour, 12 motor vehicle accidents (6 percent) lasted one to two hours, and 2 motor vehicle accidents (1 percent) lasted two or more hours.

Fire

- A total of 517 fire calls (92 percent) lasted less than one hour, 29 fire calls (5 percent) lasted one to two hours, and 13 fire calls (2 percent) lasted two or more hours.
- On average, there were 0.1 fire calls per day that lasted more than one hour.
- A total of 22 structure fire calls (71 percent) lasted less than one hour, 4 structure fire calls (13 percent) lasted one to two hours, and 5 structure fire calls (16 percent) lasted two or more hours.
- A total of 46 outside fire calls (98 percent) lasted less than one hour, and 1 outside fire call (2 percent) lasted two or more hours.
- A total of 211 false alarm calls (98 percent) lasted less than one hour, and 5 false alarm calls (2 percent) lasted one to two hours.

Calls By Month and Hour

Figure 7-3 shows the monthly variation in the average daily number of calls handled by the DFD during the year studied. Similarly, Figure 7-4 illustrates the average number of calls received each hour of the day over the year.

FIGURE 7-3: Calls per Day by Month

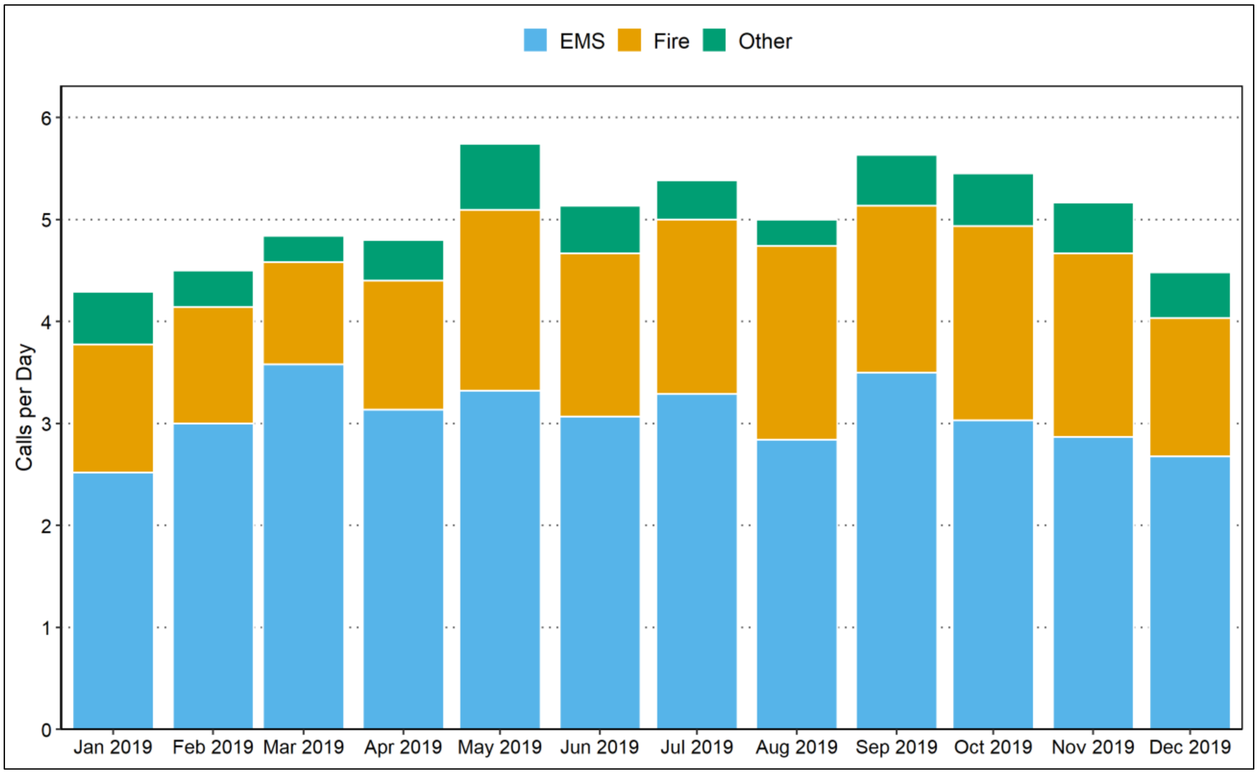
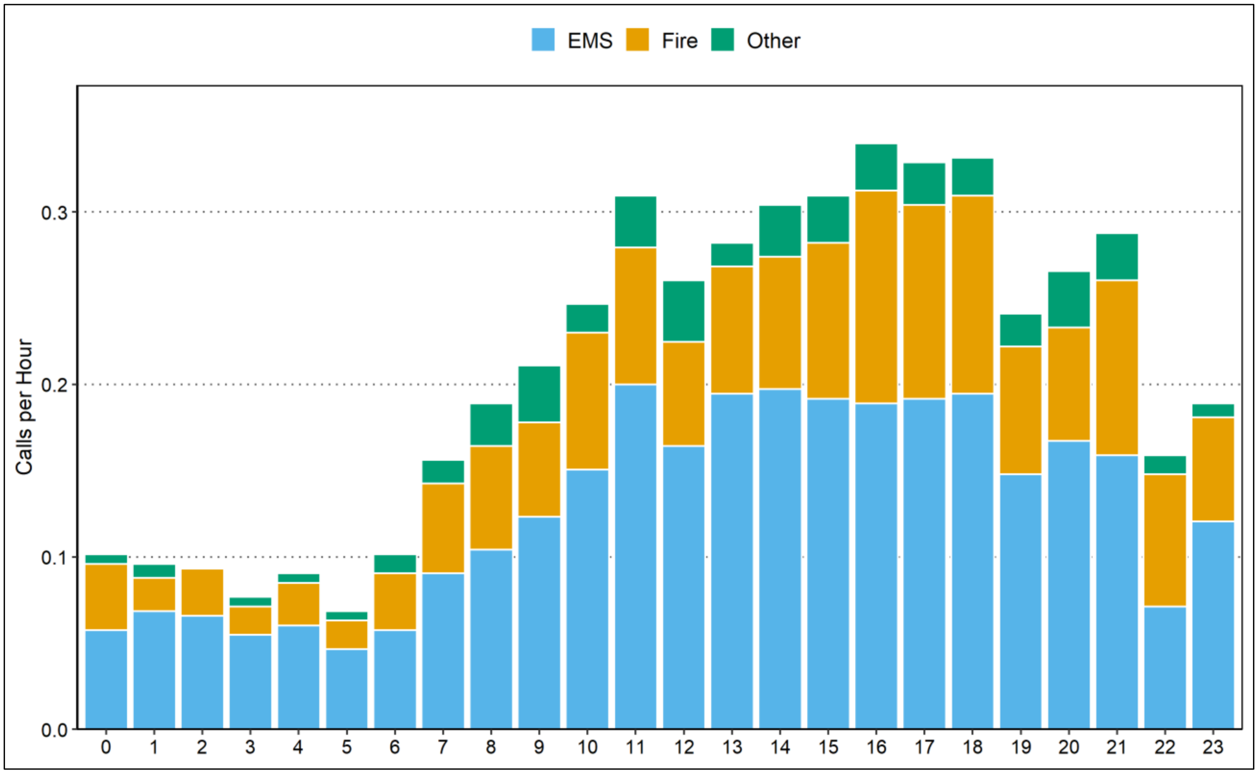


FIGURE 7-4: Calls by Hour of Day



Observations:

Average Calls per Month

- Average EMS calls per day ranged from 2.5 in January 2019 to 3.6 in March 2019.
- Average fire calls per day ranged from 1.0 in March 2019 to 1.9 in August 2019 and in October 2019.
- Average other calls per day ranged from 0.3 in March 2019 and in August 2019 to 0.6 in May 2019.
- Average calls per day overall ranged from 4.3 in January 2019 to 5.7 in May 2019.

Average Calls per Hour

- Average EMS calls per hour ranged from 0.05 between 5:00 a.m. and 6:00 a.m. to 0.20 between 11:00 a.m. and noon.
- Average fire calls per hour ranged from 0.02 between 3:00 a.m. and 4:00 a.m., and between 5:00 a.m. and 6:00 a.m., to 0.12 between 4:00 p.m. and 5:00 p.m.
- Average other calls per hour ranged from none between 2:00 a.m. and 3:00 a.m. to 0.04 between noon and 1 p.m.
- Average calls per hour overall ranged from 0.07 between 5:00 a.m. and 6:00 a.m. to 0.34 between 4:00 p.m. and 5:00 p.m.

Units Dispatched to Calls

Table 7-3, along with Figures 7-5 and 7-6, detail the number of DFD calls with one, two, or three or more units dispatched overall and broken down by call type. Figure 7-6 provides further detail for fire calls.

TABLE 7-3: Calls by Call Type and Number of Units Dispatched

Call Type	Number of Units			Total Calls
	One	Two	Three or More	
Breathing difficulty	197	20	0	217
Cardiac and stroke	173	30	4	207
Fall and injury	72	29	5	106
Illness and other	146	27	4	177
MVA	23	68	109	200
Overdose and psychiatric	29	15	1	45
Seizure and unconsciousness	124	40	4	168
EMS Total	**764**	**229**	**127**	**1,120**
False alarm	17	44	155	216
Good intent	8	21	20	49
Hazard	20	43	46	109
Outside fire	13	21	13	47
Public service	61	34	12	107
Structure fire	2	4	25	31
Fire Total	**121**	**167**	**271**	**559**
Canceled	53	35	32	120
Mutual aid	23	8	9	40
Total	**961**	**439**	**439**	**1,839**
Percentage	**52.3**	**23.9**	**23.9**	**100.0**

FIGURE 7-5: Calls by Number of Units Dispatched – EMS

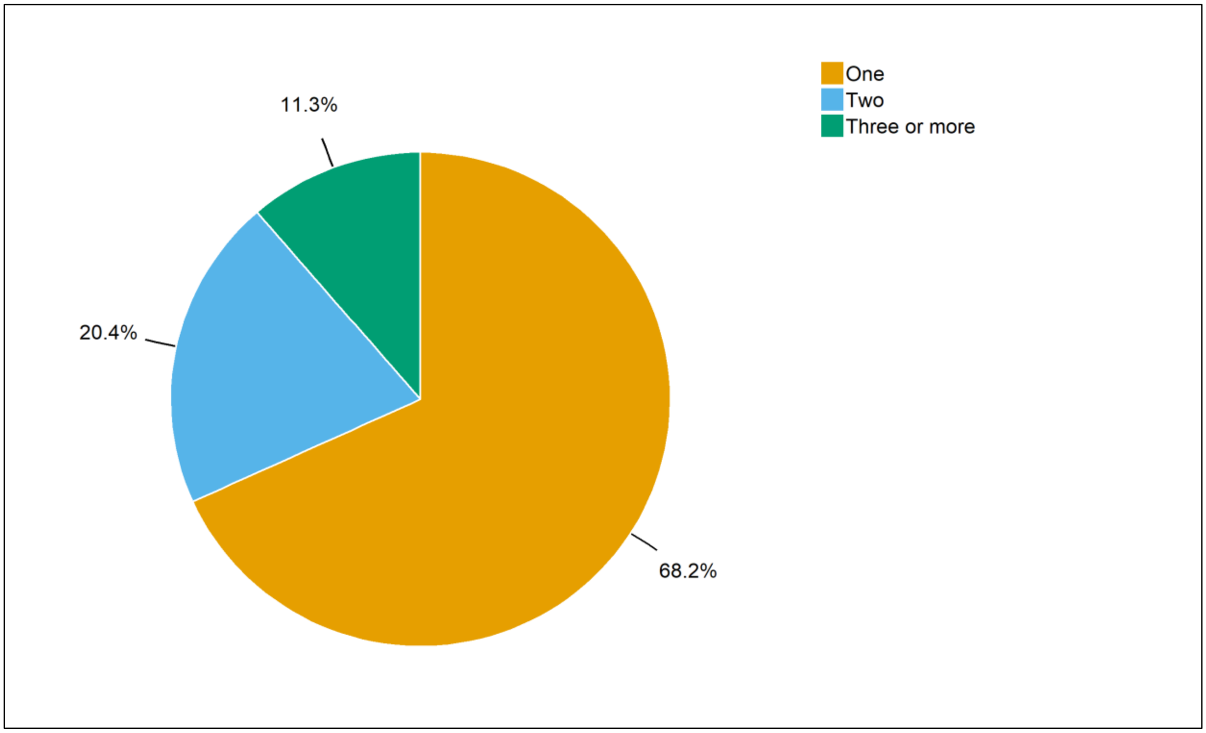
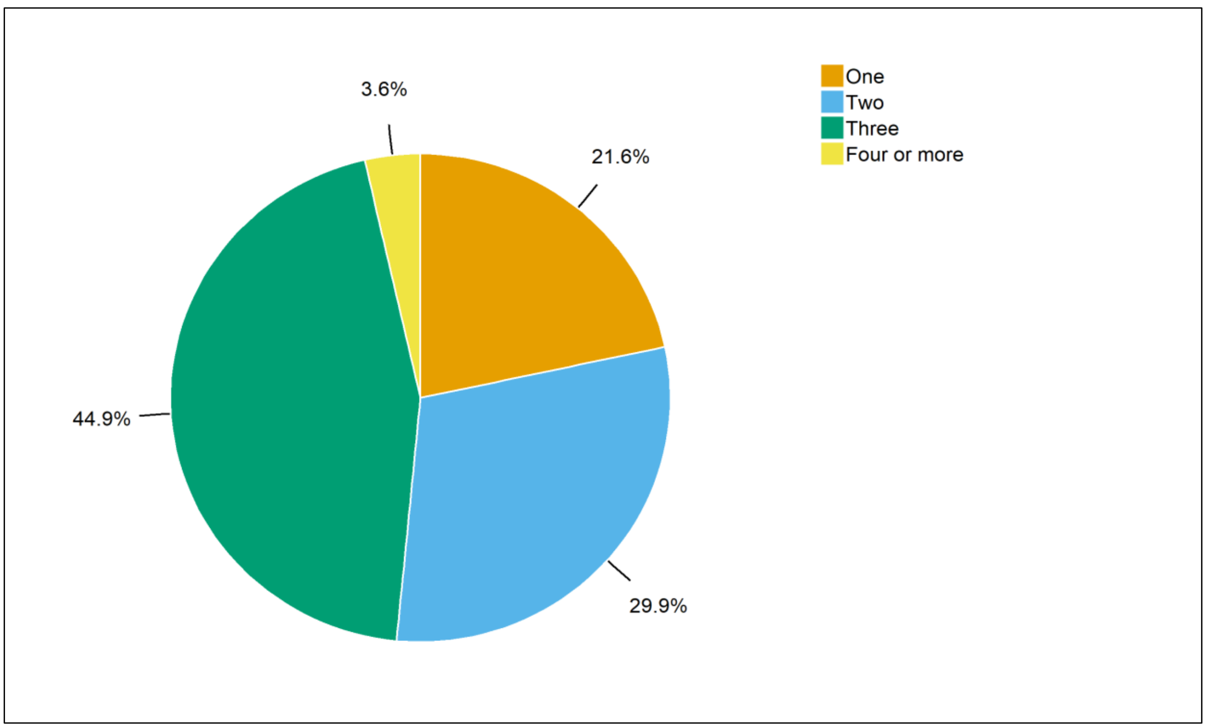


FIGURE 7-6: Calls by Number of Units Dispatched – Fire



Observations:

Overall

- On average, 1.7 units were dispatched to all calls; for 52 percent of calls, only one unit was dispatched.
- Overall, three or more units were dispatched to 24 percent of calls.

EMS

- For EMS calls, one unit was dispatched 68 percent of the time, two units were dispatched 20 percent of the time, and three or more calls were dispatched 11 percent of the time.
- On average, 1.4 units were dispatched per EMS call.

Fire

- For fire calls, one unit was dispatched 22 percent of the time, two units were dispatched 30 percent of the time, three units were dispatched 45 percent of the time, and four or more units were dispatched 4 percent of the time.
- On average, 2.3 units were dispatched per fire call.
- For outside fire calls, three or more units were dispatched 28 percent of the time.
- For structure fire calls, three or more units were dispatched 81 percent of the time.

WORKLOAD: RUNS AND TOTAL TIME SPENT

The workload of each unit is measured in two ways: runs and deployed time. The deployed time of a run is measured from the time a unit is dispatched through the time the unit is cleared. Because multiple units respond to some calls, there are more runs than calls, and the average deployed time per run varies from the total duration of calls.

Runs and Deployed Time – All Units

Deployed time, also referred to as deployed hours, is the total deployment time of all units deployed on all runs. The following table shows the total deployed time, both overall and broken down by type of run, for DFD units during the year studied.

TABLE 7-4: Annual Runs and Deployed Time by Run Type

Call Type	Deployed Minutes per Run	Total Annual Hours	Percent of Total Hours	Deployed Minutes per Day	Total Annual Runs	Runs per Day
Breathing difficulty	20.6	81.2	6.3	13.3	237	0.6
Cardiac and stroke	22.2	92.3	7.1	15.2	249	0.7
Fall and injury	23.9	59.3	4.6	9.8	149	0.4
Illness and other	24.6	88.2	6.8	14.5	215	0.6
MVA	27.8	230.2	17.7	37.8	497	1.4
Overdose and psychiatric	22.2	23.0	1.8	3.8	62	0.2
Seizure and unconsciousness	19.2	71.2	5.5	11.7	223	0.6
EMS Total	**23.7**	**645.4**	**49.7**	**106.1**	**1,632**	**4.5**
False alarm	17.6	169.9	13.1	27.9	580	1.6
Good intent	21.8	40.3	3.1	6.6	111	0.3
Hazard	43.0	179.3	13.8	29.5	250	0.7
Outside fire	27.9	44.1	3.4	7.3	95	0.3
Public service	23.4	65.5	5.0	10.8	168	0.5
Structure fire	65.1	107.5	8.3	17.7	99	0.3
Fire Total	**27.9**	**606.6**	**46.7**	**99.7**	**1,303**	**3.6**
Canceled	7.5	27.8	2.1	4.6	223	0.6
Mutual aid	16.0	18.9	1.5	3.1	71	0.2
Other Total	**9.5**	**46.7**	**3.6**	**7.7**	**294**	**0.8**
Total	**24.1**	**1,298.7**	**100.0**	**213.5**	**3,229**	**8.8**

Observations:

Overall

- Total deployed time for the year was 1,298.7 hours. The daily average was 3.6 hours for all units combined.
- There were 3,229 runs, including 223 runs dispatched for canceled calls and 71 runs dispatched for mutual aid calls. The daily average was 8.8 runs.

EMS

- EMS runs accounted for 50 percent of the total workload.
- The average deployed time for EMS runs was 23.7 minutes. The deployed time for all EMS runs averaged 1.8 hours per day.

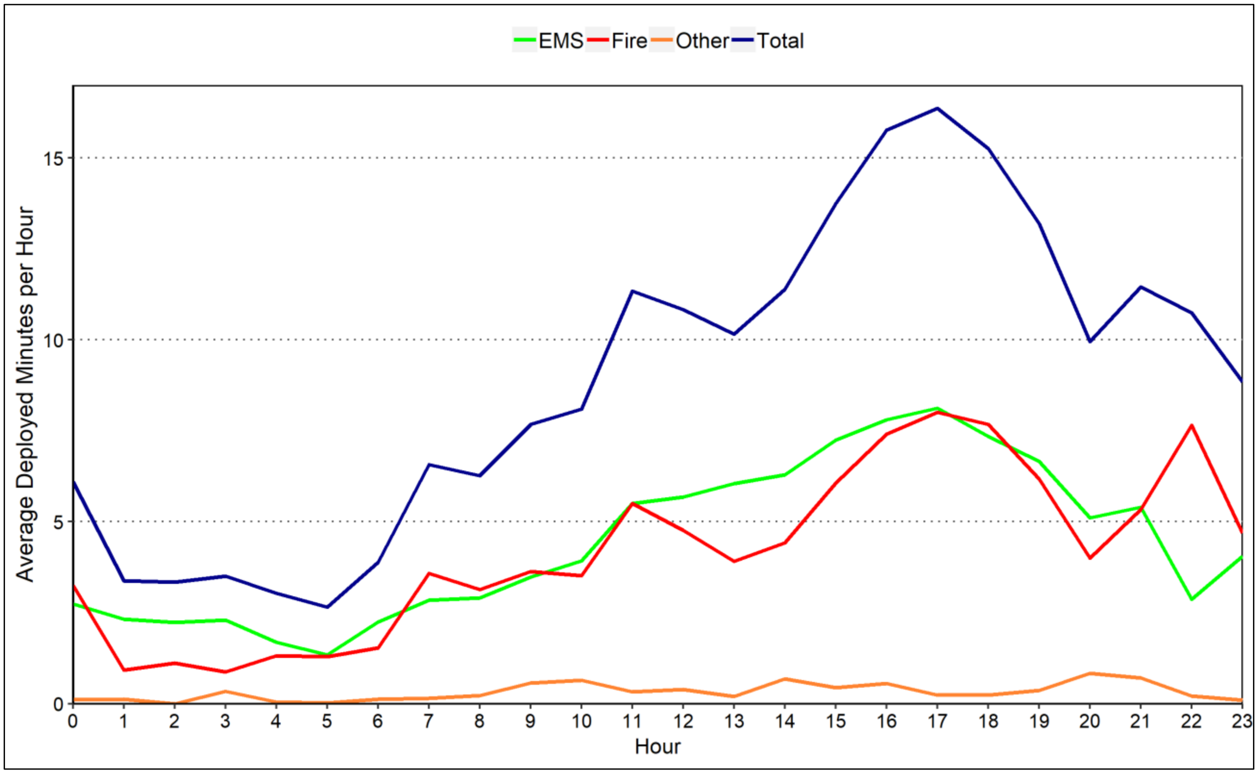
Fire

- Fire runs accounted for 47 percent of the total workload.
- The average deployed time for fire runs was 27.9 minutes. The deployed time for all fire runs averaged 1.7 hours per day.
- There were 194 runs for structure and outside fire calls combined, with a total workload of 151.6 hours. This accounted for 12 percent of the total workload.
- The average deployed time for outside fire runs was 27.9 minutes per run, and the average deployed time for structure fire runs was 65.1 minutes per run.

TABLE 7-5: Average Deployed Minutes by Hour of Day

Hour	EMS	Fire	Other	Total
0	2.7	3.3	0.1	6.1
1	2.3	0.9	0.1	3.4
2	2.2	1.1	0.0	3.3
3	2.3	0.9	0.3	3.5
4	1.7	1.3	0.0	3.0
5	1.3	1.3	0.0	2.7
6	2.2	1.5	0.1	3.9
7	2.8	3.6	0.1	6.6
8	2.9	3.1	0.2	6.3
9	3.5	3.6	0.6	7.7
10	3.9	3.5	0.6	8.1
11	5.5	5.5	0.3	11.3
12	5.7	4.8	0.4	10.8
13	6.0	3.9	0.2	10.2
14	6.3	4.4	0.7	11.4
15	7.2	6.1	0.4	13.7
16	7.8	7.4	0.6	15.8
17	8.1	8.0	0.2	16.4
18	7.3	7.7	0.2	15.3
19	6.7	6.2	0.4	13.2
20	5.1	4.0	0.8	9.9
21	5.4	5.3	0.7	11.5
22	2.9	7.6	0.2	10.7
23	4.1	4.7	0.1	8.8
Total	**106.1**	**99.8**	**7.6**	**213.5**

FIGURE 7-7: Average Deployed Minutes by Hour of Day



Observations:

- Hourly deployed time was highest during the day from 11:00 a.m. to 11:00 p.m., averaging between 10 minutes and 16 minutes.
- Average deployed time peaked between 4:00 p.m. and 6:00 p.m., averaging 16 minutes.
- Average deployed time was lowest between 4:00 a.m. and 6:00 a.m., averaging 3 minutes.

Workload by Unit

Table 7-6 provides a summary of each unit's workload overall. Tables 7-7 and 7-8 provide a more detailed view of workload, showing each unit's runs broken out by run type (Table 7-7) and the resulting daily average deployed time by run type (Table 7-8).

TABLE 7-6: Call Workload by Unit

Station	Unit ID	Unit Type	Deployed Minutes per Run	Total Annual Hours	Deployed Minutes per Day	Annual Runs	Runs per Day
1	BATT	Battalion chief	25.7	386.9	63.6	902	2.5
	E12	Engine	23.9	458.8	75.4	1,150	3.2
	E17	Engine	21.9	25.5	4.2	70	0.2
	Total		**24.6**	**871.2**	**143.2**	**2,122**	**5.8**
2	E18	Engine	22.0	293.4	48.2	799	2.2
	L1	Ladder	23.4	72.6	11.9	186	0.5
	R1	Rescue truck	102.5	17.1	2.8	10	0.0
	Total		**23.1**	**383.1**	**63.0**	**995**	**2.7**
Both	103	Pickup	32.4	8.6	1.4	16	0.0
	SQ14	Squad	22.4	35.8	5.9	96	0.3
	Total		**23.8**	**44.4**	**7.3**	**112**	**0.3**
Total			**24.1**	**1,298.7**	**213.5**	**3,229**	**8.8**

TABLE 7-7: Total Annual Runs by Run Type and Unit

Station	Unit ID	Unit Type	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
1	BATT	Battalion chief	354	195	42	93	31	67	27	75	18	902
	E12	Engine	680	161	34	76	26	57	28	69	19	1,150
	E17	Engine	29	16	3	5	1	8	2	3	3	70
	Total		**1,063**	**372**	**79**	**174**	**58**	**132**	**57**	**147**	**40**	**2,122**
2	E18	Engine	424	144	22	56	23	26	25	60	19	799
	L1	Ladder	70	50	9	15	13	5	7	12	5	186
	R1	Rescue truck	1	0	0	2	1	0	4	0	2	10
	Total		**495**	**194**	**31**	**73**	**37**	**31**	**36**	**72**	**26**	**995**
Both	103	Pickup	8	2	0	1	0	0	2	2	1	16
	SQ14	Squad	66	12	1	2	0	5	4	2	4	96
	Total		**74**	**14**	**1**	**3**	**0**	**5**	**6**	**4**	**5**	**112**
Total			**1,632**	**580**	**111**	**250**	**95**	**168**	**99**	**223**	**71**	**3,229**

TABLE 7-8: Daily Average Deployed Minutes by Run Type and Unit

Station	Unit ID	Unit Type	EMS	False Alarm	Good Intent	Hazard	Outside Fire	Public Service	Structure Fire	Canceled	Mutual Aid	Total
1	BATT	Battalion chief	25.7	10.4	2.7	10.8	2.5	5.0	3.8	1.7	1.0	63.6
	E12	Engine	44.8	8.0	1.9	8.9	2.1	3.0	4.3	1.7	0.7	75.4
	E17	Engine	1.6	0.6	0.2	0.5	0.0	0.9	0.4	0.0	0.1	4.2
	Total		**72.1**	**19.1**	**4.8**	**20.1**	**4.6**	**8.9**	**8.5**	**3.4**	**1.8**	**143.2**
2	E18	Engine	25.5	6.0	1.3	7.2	1.4	1.3	3.6	0.9	1.1	48.2
	L1	Ladder	4.2	2.3	0.5	1.4	0.9	0.2	1.9	0.2	0.2	11.9
	R1	Rescue truck	0.1	0.0	0.0	0.5	0.4	0.0	1.8	0.0	0.0	2.8
	Total		**29.8**	**8.3**	**1.8**	**9.1**	**2.7**	**1.6**	**7.3**	**1.1**	**1.3**	**63.0**
Both	103	Pickup	0.4	0.1	0.0	0.2	0.0	0.0	0.7	0.0	0.0	1.4
	SQ14	Squad	3.8	0.5	0.0	0.1	0.0	0.3	1.1	0.0	0.0	5.9
	Total		**4.2**	**0.6**	**0.0**	**0.3**	**0.0**	**0.3**	**1.9**	**0.1**	**0.0**	**7.3**
Total			**106.1**	**27.9**	**6.6**	**29.5**	**7.3**	**10.8**	**17.7**	**4.6**	**3.1**	**213.5**

Observations:

- On a station level, Station 1 made the most runs (2,122, or an average of 5.8 runs per day) and had the highest total annual deployed time (871.2 hours, or an average of 2.4 hours per day).
  - EMS calls accounted for 50 percent of runs and 50 percent of total deployed time.
  - Structure and outside fire calls accounted for 5 percent of runs and 9 percent of total deployed time.
- On a station level, Station 2 made the second-most runs (995, or an average of 2.7 runs per day) and had the second-highest total annual deployed time (383.1 hours, or an average of 1.0 hours per day).
  - EMS calls accounted for 50 percent of runs and 47 percent of total deployed time.
  - Structure and outside fire calls accounted for 7 percent of runs and 16 percent of total deployed time.
- On a unit level, E12 made the most runs (1,150, or an average of 3.2 runs per day) and had the highest total annual deployed time (458.8 hours, or an average of 75.4 minutes per day).
  - EMS calls accounted for 59 percent of runs and 59 percent of total deployed time.
  - Structure and outside fire calls accounted for 5 percent of runs and 8 percent of total deployed time.
- On a unit level, BATT made the second-most runs (902, or an average of 2.5 runs per day) and had the second-highest total annual deployed time (386.9 hours, or an average of 63.6 minutes per day).
  - EMS calls accounted for 39 percent of runs and 40 percent of total deployed time.
  - Structure and outside fire calls accounted for 6 percent of runs and 10 percent of total deployed time.

ANALYSIS OF BUSIEST HOURS

There is significant variability in the number of calls from hour to hour. One special concern relates to the resources available for hours with the heaviest workload. We tabulated the data for each of the 8,760 hours in the year. Table 7-9 shows the number of hours in the year in which there were zero to three or more calls during the hour. Table 7-10 examines the number of times a call within a station's first due area overlapped with another call within the same area. Table 7-11 examines the availability of a unit at a station to respond to calls within its first due area. Table 7-12 shows the 10 one-hour intervals which had the most calls during the year.

TABLE 7-9: Frequency Distribution of the Number of Calls

Calls in an Hour	Frequency	Percentage
0	7,164	81.8
1	1,384	15.8
2	187	2.1
3+	25	0.3
Total	**8,760**	**100.0**

TABLE 7-10: Frequency of Overlapping Calls

Station	Scenario	Number of Calls	Percent of All Calls	Total Hours
1	No overlapped call	1,138	93.9	479.0
	Overlapped with one call	69	5.7	13.1
	Overlapped with two calls	4	0.3	0.5
	Overlapped with three calls	1	0.1	0.0
2	No overlapped call	564	96.9	215.5
	Overlapped with one call	18	3.1	3.2

TABLE 7-11: Station Availability to Respond to Calls

Station	Calls in Area	First Due Responded	First Due Arrived	First Due First	Percent Responded	Percent Arrived	Percent First
1	1,143	1,036	1,024	981	90.6	89.6	85.8
2	547	447	425	354	81.7	77.8	64.7
Total	**1,690**	**1,483**	**1,449**	**1,335**	**87.8**	**85.7**	**79.0**

Note: For each station, we count the number of calls occurring within its first due area. Then, we count the number of calls to where at least one DFD unit arrived. Next, we focus on units from the first due station to see if any units responded, arrived, or arrived first.

TABLE 7-12: Top 10 Hours with the Most Calls Received

Hour	Number of Calls	Number of Runs	Total Deployed Hours
7/11/2019, 4:00 p.m. to 5:00 p.m.	5	7	1.4
9/2/2019, noon to 1:00 p.m.	4	8	2.2
7/11/2019, 5:00 p.m. to 6:00 p.m.	4	7	1.6
5/8/2019, 1:00 p.m. to 2:00 p.m.	4	5	2.1
3/1/2019, 11:00 a.m. to noon	4	4	0.8
12/20/2019, 2:00 p.m. to 3:00 p.m.	3	8	2.1
5/20/2019, 5:00 p.m. to 6:00 p.m.	3	7	8.8
8/30/2019, 5:00 p.m. to 6:00 p.m.	3	7	2.6
5/20/2019, noon to 1:00 p.m.	3	7	2.1
10/10/2019, 5:00 p.m. to 6:00 p.m.	3	6	3.1

Note: Total deployed hours is a measure of the total time spent responding to calls received in the hour, and which may extend into the next hour or hours. The number of runs and deployed hours only includes DFD units.

Observations:

- During 25 hours (0.3 percent of all hours), three or more calls occurred; in other words, the department responded to three or more calls in an hour once every 15 days.
  - The highest number of calls to occur in an hour was 5, which happened once.
- The hour with the most calls was 4:00 p.m. to 5:00 p.m. on July 11, 2019.
  - The hour's 5 calls involved 7 individual dispatches resulting in 1.4 hours of deployed time. These 5 calls included five hazard calls. Each call involved a fallen tree.
- The hour with the second-most calls and most associated runs was noon to 1:00 p.m. on September 2, 2019.
  - The hour's 4 calls involved 8 individual dispatches resulting in 2.2 hours of deployed time. These 4 calls included two motor vehicle accident calls, one canceled call, and one false alarm call.

RESPONSE TIME

In this part of the analysis, we present response time statistics for different call types. We separate response time into its identifiable components. *Dispatch time* is the difference between the time a call is received and the time a unit is dispatched. Dispatch time includes call processing time, which is the time required to determine the nature of the emergency and types of resources to dispatch. *Turnout time* is the difference between dispatch time and the time a unit is en route to a call's location. *Travel time* is the difference between the time en route and arrival on scene. *Response time* is the total time elapsed between receiving a call to arriving on scene.

In this analysis, we included all calls to which at least one non-administrative DFD unit responded while excluding canceled and mutual aid calls. In addition, non-emergency calls and calls with a total response time of more than 30 minutes were excluded. Finally, we focused on units that had complete time stamps, that is, units with all components recorded, so that we could calculate each segment of response time.

Based on the methodology above, we excluded 160 canceled and mutual aid calls, 312 non-emergency calls, 48 calls where no units recorded a valid on-scene time, 12 calls where the first arriving unit response was greater than 30 minutes, and 232 calls where one or more segments of first arriving unit's response time could not be calculated due to missing data. As a result, in this section, a total of 1,075 calls are included in the analysis.

Response Time by Type of Call

Table 7-13 provides average dispatch, turnout, travel, and total response time for the first arriving unit to each call in the city, broken out by call type. Figures 7-8 and 7-9 illustrate the same information. Table 7-14 gives the 90th percentile time broken out in the same manner. A 90th percentile time means that 90 percent of calls had response times at or below that number. For example, Table 7-14 shows a 90th percentile response time of 9.1 minutes which means that 90 percent of the time a call had a response time of no more than 9.1 minutes.

TABLE 7-13: Average Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	1.9	1.9	3.3	7.0	170
Cardiac and stroke	2.3	1.8	3.0	7.1	166
Fall and injury	2.6	2.1	2.5	7.2	61
Illness and other	2.6	1.7	2.8	7.1	119
MVA	2.2	1.4	1.9	5.6	134
Overdose and psychiatric	1.9	2.2	2.7	6.8	35
Seizure and unconsciousness	1.9	1.8	2.6	6.3	123
EMS Total	**2.2**	**1.8**	**2.7**	**6.7**	**808**
False alarm	1.6	1.9	2.0	5.5	165
Good intent	1.7	1.7	2.6	6.0	14
Hazard	2.0	1.9	2.3	6.1	40
Outside fire	2.5	1.8	2.3	6.6	17
Public service	2.5	2.5	2.3	7.3	7
Structure fire	1.8	1.7	2.9	6.5	24
Fire Total	**1.7**	**1.9**	**2.2**	**5.8**	**267**
Total	**2.1**	**1.8**	**2.6**	**6.5**	**1,075**

FIGURE 7-8: Average Response Time of First Arriving Unit, by Call Type – EMS

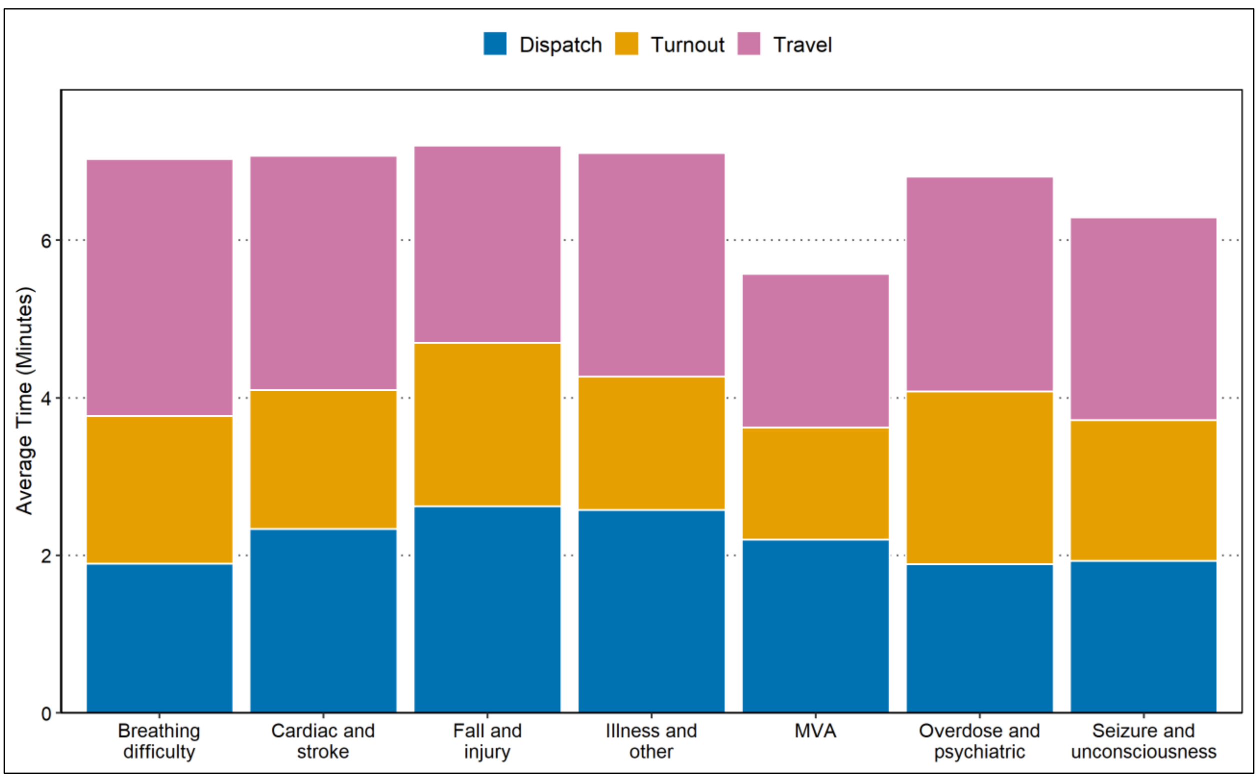


FIGURE 7-9: Average Response Time of First Arriving Unit, by Call Type – Fire

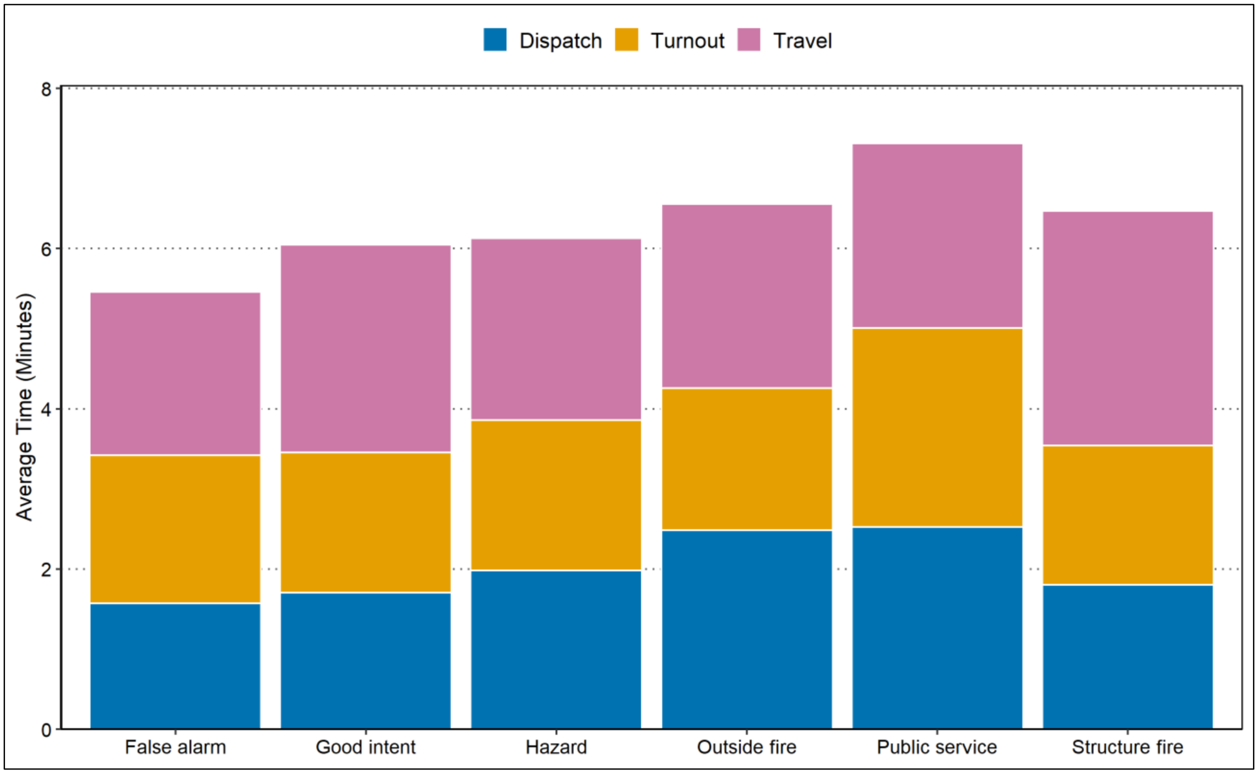


TABLE 7-14: 90th Percentile Response Time of First Arriving Unit, by Call Type

Call Type	Time in Minutes				Number of Calls
	Dispatch	Turnout	Travel	Total	
Breathing difficulty	3.1	3.6	4.9	9.5	170
Cardiac and stroke	3.6	3.1	4.6	10.1	166
Fall and injury	3.6	4.2	4.2	10.6	61
Illness and other	3.9	2.8	4.3	10.0	119
MVA	3.2	2.3	3.6	7.3	134
Overdose and psychiatric	3.1	3.5	4.8	9.8	35
Seizure and unconsciousness	2.7	3.4	3.8	8.9	123
EMS Total	**3.4**	**3.2**	**4.4**	**9.5**	**808**
False alarm	2.5	2.9	4.0	7.7	165
Good intent	2.8	2.8	4.0	7.5	14
Hazard	3.2	2.9	3.7	8.8	40
Outside fire	1.7	2.8	3.4	7.0	17
Public service	5.8	8.2	3.7	13.2	7
Structure fire	2.8	3.0	4.4	7.9	24
Fire Total	**2.8**	**2.9**	**3.9**	**8.0**	**267**
Total	**3.2**	**3.1**	**4.2**	**9.1**	**1,075**

Observations:

- The average dispatch time was 2.1 minutes.
- The average turnout time was 1.8 minutes.
- The average travel time was 2.6 minutes.
- The average total response time was 6.5 minutes.
- The average response time was 6.7 minutes for EMS calls and 5.8 minutes for fire calls.
- The average response time was 6.6 minutes for outside fires and 6.5 minutes for structure fires.
- The 90th percentile dispatch time was 3.2 minutes.
- The 90th percentile turnout time was 3.1 minutes.
- The 90th percentile travel time was 4.2 minutes.
- The 90th percentile total response time was 9.1 minutes.
- The 90th percentile response time was 9.5 minutes for EMS calls and 8.0 minutes for fire calls.
- The 90th percentile response time was 7.0 minutes for outside fires and 7.9 minutes for structure fires.

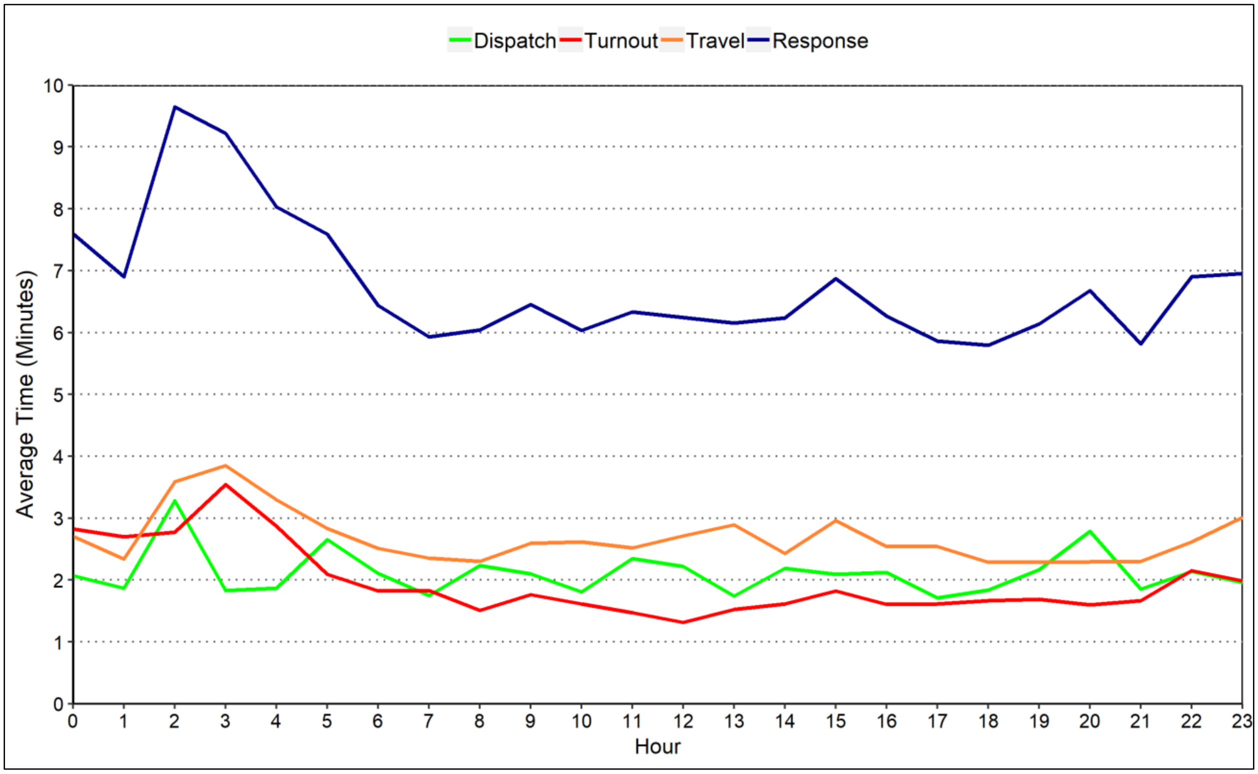
Response Time by Hour

Average dispatch, turnout, travel, and total response time by hour for calls are shown in Table 7-15 and Figure 7-10. The table also shows 90th percentile response times.

TABLE 7-15: Average and 90th Percentile Response Time of First Arriving Unit, by Hour of Day

Hour	Time in Minutes					Number of Calls
	Dispatch	Turnout	Travel	Response	90th Percentile Response	
0	2.1	2.8	2.7	7.6	13.2	19
1	1.9	2.7	2.3	6.9	9.0	21
2	3.3	2.8	3.6	9.6	18.6	24
3	1.8	3.5	3.8	9.2	22.6	19
4	1.9	2.9	3.3	8.0	9.9	21
5	2.7	2.1	2.8	7.6	11.0	16
6	2.1	1.8	2.5	6.4	9.0	29
7	1.7	1.8	2.4	5.9	8.6	34
8	2.2	1.5	2.3	6.0	8.0	47
9	2.1	1.8	2.6	6.5	8.0	34
10	1.8	1.6	2.6	6.0	7.9	54
11	2.3	1.5	2.5	6.3	8.6	60
12	2.2	1.3	2.7	6.2	10.8	49
13	1.7	1.5	2.9	6.2	9.3	58
14	2.2	1.6	2.4	6.2	8.8	69
15	2.1	1.8	3.0	6.9	10.6	68
16	2.1	1.6	2.5	6.3	8.8	72
17	1.7	1.6	2.5	5.9	8.0	71
18	1.8	1.7	2.3	5.8	8.8	69
19	2.2	1.7	2.3	6.1	8.2	61
20	2.8	1.6	2.3	6.7	8.8	50
21	1.9	1.7	2.3	5.8	8.2	53
22	2.1	2.2	2.6	6.9	9.2	33
23	2.0	2.0	3.0	7.0	8.8	44
Total	**2.1**	**1.8**	**2.6**	**6.5**	**9.1**	**1,075**

FIGURE 7-10: Average Response Time of First Arriving Unit, by Hour of Day



Observations:

- Average dispatch time was between 1.7 minutes (5:00 p.m. to 6:00 p.m.) and 3.3 minutes (2:00 a.m. to 3:00 a.m.).
- Average turnout time was between 1.3 minutes (noon to 1:00 p.m.) and 3.5 minutes (3:00 a.m. to 4:00 a.m.).
- Average travel time was between 2.3 minutes (6:00 p.m. to 7:00 p.m.) and 3.8 minutes (3:00 a.m. to 4:00 a.m.).
- Average response time was between 5.8 minutes (6:00 p.m. to 7:00 p.m.) and 9.6 minutes (2:00 a.m. to 3:00 a.m.).
- The 90th percentile response time was between 7.9 minutes (10:00 a.m. to 11:00 a.m.) and 22.6 minutes (3:00 a.m. to 4:00 a.m.).

Response Time Distribution

Here, we present a more detailed look at how response times to calls are distributed. The cumulative distribution of total response time for the first arriving unit to EMS calls is shown in Figure 7-11 and Table 7-16. Figure 7-11 shows response times for the first arriving DFD unit to EMS calls as a frequency distribution in whole-minute increments, and Figure 7-12 shows the same for the first arriving unit to outside and structure fire calls.

The cumulative percentages here are read in the same way as a percentile. In Figure 7-11, the 90th percentile of 9.5 minutes means that 90 percent of EMS calls had a response time of 9.5 minutes or less. In Table 7-16, the cumulative percentage of 79.2, for example, means that 79.2 percent of EMS calls had a response time under 8 minutes.

FIGURE 7-11: Cumulative Distribution of Response Time – First Arriving Unit – EMS

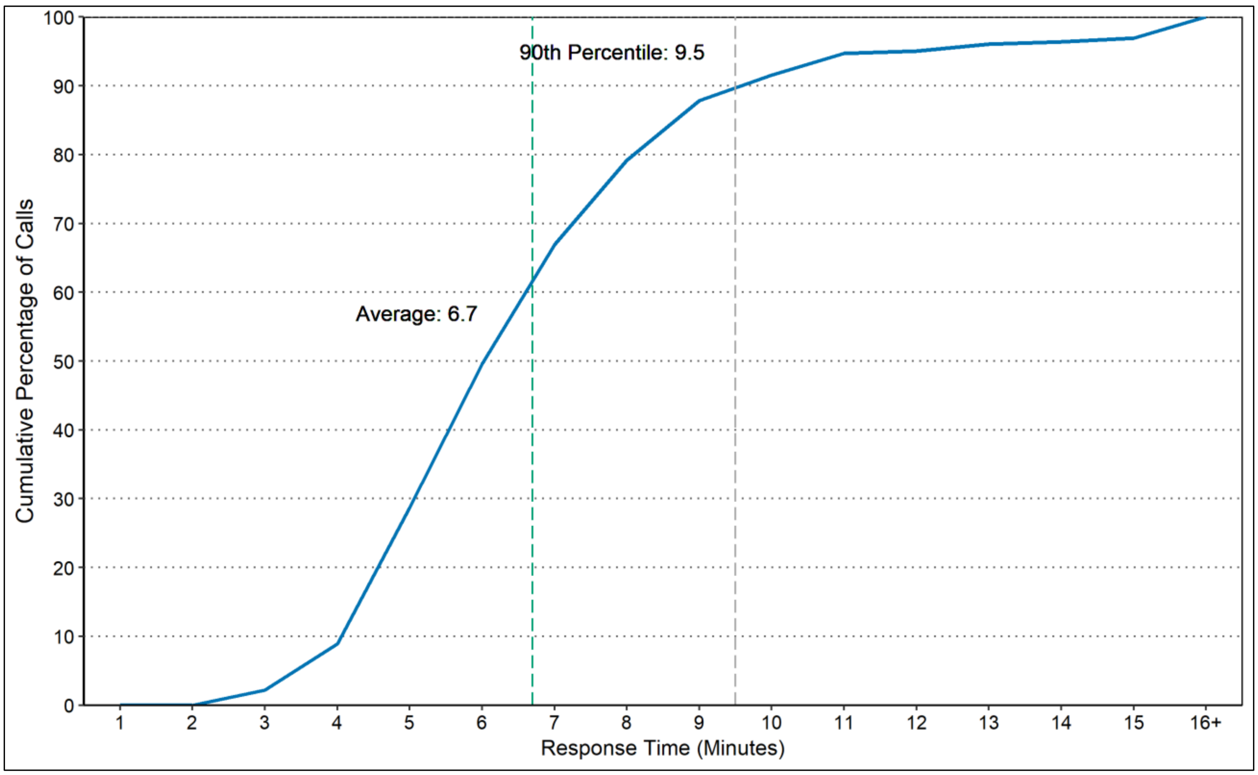


FIGURE 7-12: Cumulative Distribution of Response Time – First Arriving Unit – Outside and Structure Fires

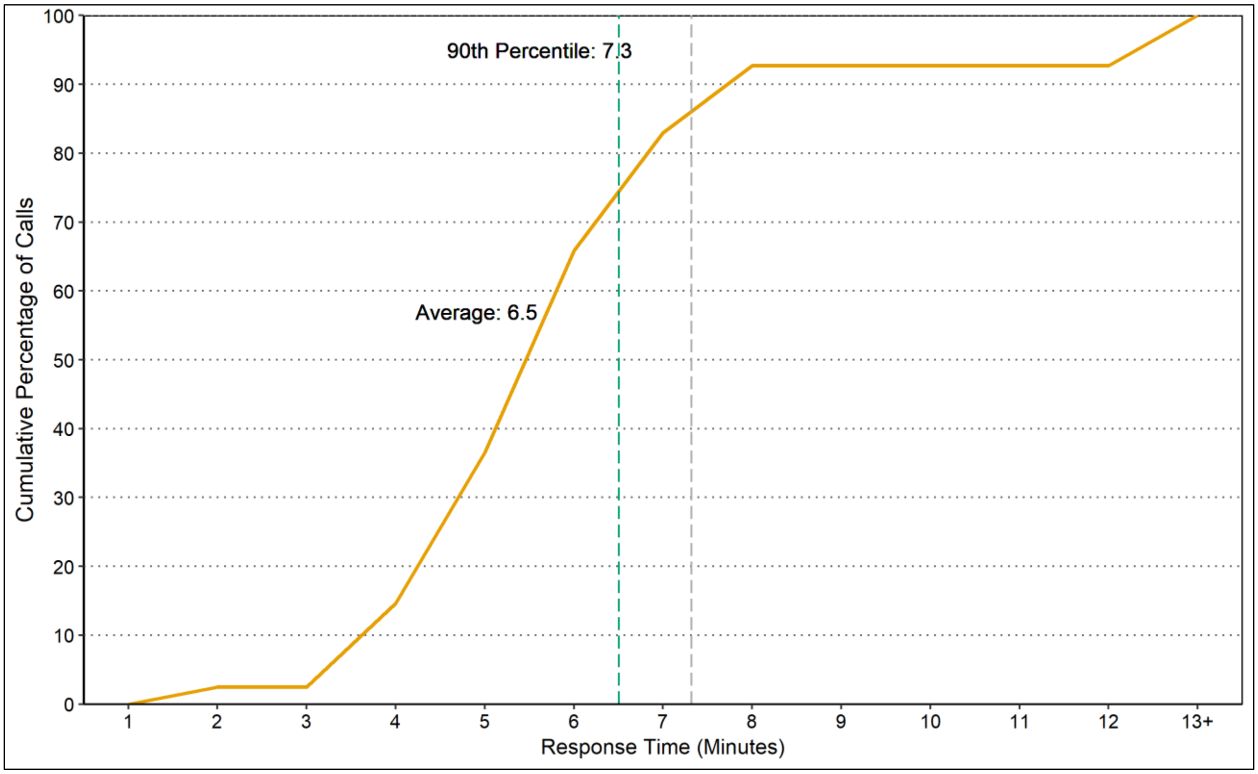


TABLE 7-16: Cumulative Distribution of Response Time – First Arriving Unit – EMS

Response Time (minute)	Frequency	Cumulative Percentage
1	0	0.0
2	0	0.0
3	18	2.2
4	54	8.9
5	160	28.7
6	169	49.6
7	140	67.0
8	99	79.2
9	70	87.9
10	30	91.6
11	25	94.7
12	3	95.0
13	8	96.0
14	3	96.4
15	4	96.9
16+	25	100.0

TABLE 7-17: Cumulative Distribution of Response Time – First Arriving Unit – Outside and Structure Fires

Response Time (minute)	Frequency	Cumulative Percentage
1	0	0.0
2	1	2.4
3	0	2.4
4	5	14.6
5	9	36.6
6	12	65.9
7	7	82.9
8	4	92.7
9	0	92.7
10	0	92.7
11	0	92.7
12	0	92.7
13+	3	100.0

Observations:

- For 79.2 percent of EMS calls, the response time of the first arriving unit was less than 8 minutes.
- For 92.7 percent of outside and structure fire calls, the response time of the first arriving unit was less than 8 minutes.

ATTACHMENT I: ACTIONS TAKEN ANALYSIS

TABLE 7-18: Actions Taken Analysis for Structure and Outside Fire Calls

Action Taken	Number of Calls	
	Outside Fire	Structure Fire
Contain fire (wildland)	1	0
Control traffic	3	0
Enforce codes	1	0
Extinguishment by fire service personnel	26	4
Fire control or extinguishment, other	14	8
HazMat detection, monitoring, sampling, & analysis	0	1
Investigate	8	16
Investigate fire out on arrival	5	7
Notify other agencies.	1	0
Remove hazard	0	6
Restore fire alarm system	0	5
Salvage & overhaul	17	7
Shut down system	3	1
Ventilate	0	7
Total	**79**	**62**

Note: Totals are higher than the total number of structure and outside fire calls because some calls had more than one action taken.

Observations:

- Out of 47 outside fires, 26 were extinguished by fire service personnel, which accounted for 55 percent of outside fires.
- Out of 31 structure fires, 4 were extinguished by fire service personnel, which accounted for 13 percent of structure fires.

ATTACHMENT II: ADMINISTRATIVE WORKLOAD

TABLE 7-19: Workload of Administrative Units

Unit ID	Unit Type	Annual Hours	Annual Runs
1	Fire chief	2.1	5
101	Deputy chief	16.7	32
102	Fire marshal	16.2	19
F1	SUV	0.1	2

ATTACHMENT III: FIRE LOSS

TABLE 7-20: Content and Property Loss – Structure and Outside Fires

Call Type	Property Loss		Content Loss	
	Loss Value	Number of Calls	Loss Value	Number of Calls
Outside fire	$3,000	1	$0	0
Structure fire	$48,000	3	$15,400	2
Total	**$51,000**	**4**	**$15,400**	**2**

Note: This includes only calls with a recorded loss greater than 0.

TABLE 7-21: Total Fire Loss Above and Below $20,000

Call Type	No Loss	Under $20,000	$20,000 plus
Outside fire	46	1	0
Structure fire	28	2	1
Total	74	3	1

Observations:

- Out of 47 outside fires, 1 had a recorded property loss of $3,000. No outside fire had a recorded content loss.
- Out of 31 structure fires, 3 had recorded property losses, with a combined $48,000 in losses.
- 2 structure fires had recorded content losses with a combined $15,400 in losses.
- The average total loss for structure fires with loss was $21,133.
- The highest total loss for a structure fire was $55,000.

- END -