

# LINE OF DUTY DEATH REPORT

F2021-16 • August 2023

1000 FREDERICK LANE, MORGANTOWN, WV 26508 • 304.285.5916

## **57-Year-Old Engineer Suffers Fatal Heart Attack After Fighting a Multi-Vehicle Fire in a Commercial Parking Garage – California**

### **Executive Summary**

On June 8, 2021, a 57-year-old Engineer suffered a fatal heart attack several hours after fighting an early morning vehicle fire. Fire dispatch was notified at approximately 0615 hours of a vehicle fire in the parking garage of a large commercial airport. An alarm assignment was dispatched that included an engine (E1) and a truck (T1). The Engineer responded on T1 as a firefighter. At approximately 0628 hours, E1 advised dispatch of heavy smoke coming from the fourth floor of the multi-level parking garage and requested a chief (B5) and an additional engine (E4). E1, E4, T1, and B5 were able to control the multi-vehicle fire at approximately 0655 hours. The crews remained on scene until approximately 0930 hours conducting extinguishment of the vehicles and picking up the hose lines.

After completing their assignment, T1 returned to quarters at approximately 0930. The Engineer was off duty and went home after working a 48-hour shift. Then at approximately 2305 hours that same day, emergency personnel were dispatched to the Engineer's home for a medical emergency. Upon arrival, fire and medic crews found the Engineer pulseless and not breathing. Crews performed lifesaving procedures for about 20 minutes without success and ultimately pronounced the Engineer deceased at home at approximately 2330 hours. The medical examiner's report listed the cause of death as fatal cardiac dysrhythmia due to hypertensive and atherosclerotic coronary artery disease.

### **Key Recommendations**

NIOSH offers the following recommendations to reduce the risk of heart attacks and sudden cardiac arrest among firefighters at this and other fire departments across the country.

- *Key Recommendation #1: Implement comprehensive pre-placement and annual medical evaluations consistent with NFPA 1582 Standard on Comprehensive Occupational Medical Program for Fire Departments, which should include a baseline EKG in all individuals prior to engagement in strenuous physical activity to rule out underlying cardiac abnormalities [NFPA 2022].*
- *Key Recommendation #2: Implement a pre-placement and annual cardiac exercise stress test to determine the capacity for physical exertion and decrease the risk for sudden cardiac death.*
- *Key Recommendation #3: Implement an annual fitness evaluation consistent with NFPA 1582 Standard on Comprehensive Occupational Medical Program for Fire Departments to ensure personnel are physically fit to perform job expectations at emergencies [NFPA 2022].*

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The National Institute for Occupational Safety and Health (NIOSH) initiated the Fire Fighter Fatality Investigation and Prevention Program to examine deaths of fire fighters in the line of duty so that fire departments, fire fighters, fire service organizations, safety experts and researchers could learn from these incidents. The primary goal of these investigations is for NIOSH to make recommendations to prevent similar occurrences. These NIOSH investigations are intended to reduce or prevent future fire fighter deaths and are completely separate from the rulemaking, enforcement and inspection activities of any other federal or state agency. Under its program, NIOSH investigators interview persons with knowledge of the incident and review available records to develop a description of the conditions and circumstances leading to the deaths in order to provide a context for the agency's recommendations. The NIOSH summary of these conditions and circumstances in its reports is not intended as a legal statement of facts. This summary, as well as the conclusions and recommendations made by NIOSH, should not be used for the purpose of litigation or the adjudication of any claim.

For further information, visit the program Web site at [www.cdc.gov/niosh/fire](http://www.cdc.gov/niosh/fire) or call toll free 1-800-CDC-INFO (1-800-232-4636).

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### **Introduction**

On June 8, 2021, a 57-year-old Engineer suffered a fatal heart attack several hours after fighting an early morning vehicle fire. The U.S. Fire Administration notified the National Institute for Occupational Safety and Health (NIOSH) of this fatality on June 9, 2021. NIOSH contacted the affected department to gather additional information and initiate the investigation.

A medical officer and a contractor firefighter safety specialist with the NIOSH Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) conducted the investigation. In July 2021, the firefighter safety specialist conducted a series of telephone, email, and in-person interviews to investigate the incident.

During the investigation, NIOSH investigators interviewed the following people:

- *Two battalion chiefs*
- *Truck lieutenant and two crew members*
- *Engine lieutenant and two crew members*
- *Family members of the Engineer*

The NIOSH investigators reviewed the following documents:

- *Fire department (FD) incident records*
- *FD hiring requirements and standard operating procedures*
- *Emergency medical service (ambulance) report*
- *Emergency department records*
- *Autopsy and toxicology reports*

### **Fire Department**

At the time of the NIOSH investigation, this career FD consisted of 47 fire stations with 44 engines, 20 trucks, 21 ambulances, staffed with 1,738 uniformed personnel. The FD serves a population of approximately 874,000 in a geographic area of about 232 square miles and responds to approximately 148,490 calls annually.

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### **Employment and Training**

The employment selection process is open to individuals meeting all the minimum qualifications based on the department's standards:

1. A high school diploma or an equivalency certificate (e.g., G.E.D., California High School Proficiency Certificate).
2. Minimum 19 years of age at time of application and 20 years of age at time of appointment. Additional Minimum Qualifications for Level I.
3. Possession of a current and valid California Emergency Medical Technician (EMT) Certification issued by the State of California and the ability to accredit with the local Emergency Medical Services (EMS) Authority.
4. Possession and maintenance of valid Class A, B, or C California Driver License with Ambulance Driver certificate / endorsement.
5. Any combination of 500 hours of verifiable work experience as an EMT (on an ambulance or first responder vehicle) or hours of documented ambulance ride-along as a member of the Fire Reserves within the last three years, at the time of hiring.

### **Preplacement/Periodic/Return to Work Medical Evaluations**

The FD physician conducts a thorough physical examination of all new or promoted members prior to appointment in the department and examines the member a second time before expiration of the probationary period. The physician also examines other members as required by the FD.

At the time of the investigation, the department did not have an annual medical evaluation program.

After an injury or illness, the member's treating physician must provide a statement that the member has sufficiently recovered to return to duty and specify if there are restrictions on the return to duty and if so, for how long. The FD physician clears members for full duty based on the evaluation and recommendation of the member's treating physician.

### **Wellness/Fitness Programs**

The FD provides each station with fitness equipment and time to exercise each shift. The department also offers a voluntary screening event, such as "Know Your Numbers" which measures glucose, cholesterol, blood pressure, body mass index, and percent body fat, allowing members the ability to calculate their 10-year cardiovascular risk score. The department also offers behavioral wellness events and resources. Members need to meet minimum performance standards and maintain physical conditioning necessary to perform their job duties.

At the time of the incident, annual fit for duty tests were only required for members who participated in the wildland program of this department and not for those who solely functioned as structural firefighters. Members who participate in the out of county mutual aid for wildland fires are required to successfully complete the U.S. Forest Service pack test annually. The National Wildland Coordinating Group (NWCG), an agency that oversees all federal wildland firefighters including those in the U.S. Forest Service, defines the pack test as "a job-related test to determine an individual's ability to



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perform the minimum standards of arduous duty. It consists of completing a 3-mile walk over level terrain in 45 minutes or less while carrying a 45-pound pack” [USFS (no date) and NWCG (no date)].

### Investigation

On June 8, 2021, at approximately 0615 in the morning, a smoke detector alerted fire dispatch of a possible fire in a large commercial airport parking garage. Minutes later, at approximately 0618 hours, a 911 caller confirmed that a car was on fire on the 4<sup>th</sup> floor of the 5-story parking structure adjacent to the domestic flight ticketing area of the airport. The parking garage was a fully sprinklered concrete Type 1 structure (noncombustible or limited-combustible construction with a high level of fire resistance) that was open on all sides and allowed parking for approximately 4,000 vehicles (Figure 1).

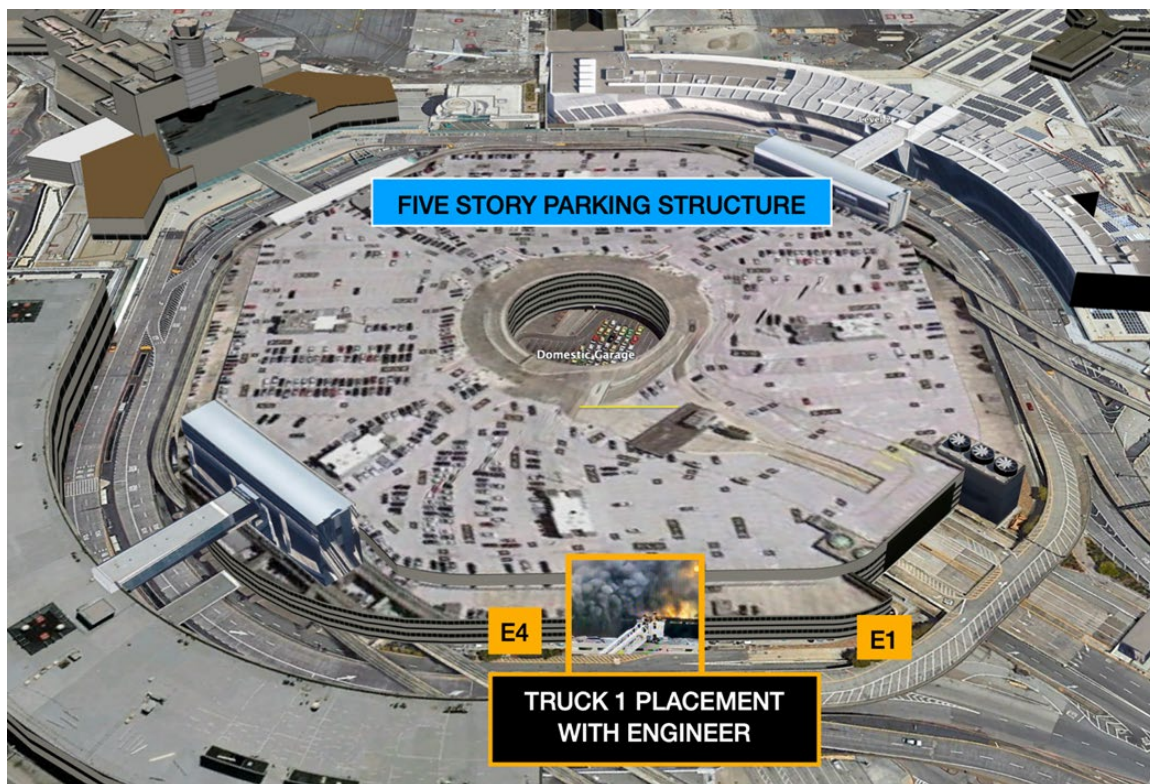


Figure 1. Placement of resources at Parking Structure. Image adapted from Google Earth.

An initial alarm assignment consisting of Engine 1 (E1) and Truck 1 (T1) was dispatched to the parking structure for the reported auto fire. E1 arrived at approximately 0628 hours and requested a battalion chief (BC) and an additional engine due to heavy fire and smoke. Additional alarm resources, Engine 4 (E4) and Battalion 5 (B5), were dispatched. Due to height restrictions inside the parking structure, E1 staged the apparatus on the street, and the crew took the stairwell to the fire floor. Once E1 crew arrived at the 4<sup>th</sup> floor they were unable to make access through the stairwell door, which was warped due to severe heat damage from the fire. E1 radioed that they were having access issues to the fire floor and that they would attempt to make access from the 5<sup>th</sup> floor and requested that T1 use the elevated platform to attack the fire. Acknowledging the request, T1 staged on the street in proximity to

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the fourth-floor fire. T1 officer and the Engineer loaded four rolls of 1 ¾” hose line on the platform and raised it to the 4<sup>th</sup> floor for fire attack (Figure 2). T1 requested that E4 supply them from a hydrant as they extended the fire attack lines from the manifold on the truck platform. Additional lengths of hose were needed to reach the fire, so the Engineer hoisted several more lengths aloft using a rope.



**Figure 2. Fire personnel at the incident. Photo courtesy of the fire department.**

B5 established a unified command with airport security due to the impacts to the airport. Incident Command (IC) requested that police close access to the garage and assist airport staff with removing people from the 5<sup>th</sup> level due to heavy dense smoke. IC also requested a medic crew for a civilian reported of having shortness of breath in the garage.

T1 and E4 crew members in full PPE, including SCBA, advanced two fire attack lines from the truck's elevated platform and began extinguishing the vehicle fires. As crews began attacking the fire, they notified IC that there were multiple vehicles on fire. E3 brought an attack line from the fifth level to assist T1 and E4 in the extinguishment of the vehicle fires.

At approximately 0652 hours, E1 notified IC that they had a handle on the fire. After being notified that the fire was under control, the IC requested a crew to conduct a search of the entire parking structure for possible victims of heat or smoke inhalation, starting with the 5<sup>th</sup> level of the garage and concluding at the 1<sup>st</sup> level.

T1 continued to overhaul the vehicle fires. One vehicle had a spare tire with a magnesium wheel that continued to flare up causing significant black smoke until it was removed from under the vehicle and extinguished at approximately 0900 hours. Magnesium fires are challenging to extinguish as contact with water creates hydrogen gas which is volatile and explosive; Class D fire extinguishers are used to smother the fire. Water is focused on cooling the metal which has not ignited to prevent that

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occurrence. Due to this issue, fires involving magnesium often take more time and exertion to extinguish than non-magnesium associated fires [James 2014]. After extinguishing the fires, the Engineer and other crew members rolled up and loaded the fire hoses, serviced the parking structure hose cabinets, and returned to quarters. After placing the truck back in service at approximately 0930 hours, the Engineer went home for his scheduled day off.

The Engineer spent the remainder of the day at home having family and friends over for dinner and a movie. During this time, he talked with them about the fire and the amount of work it took to extinguish the multiple car fire. He did not complain of any medical issues and his company left at approximately 2030 hours. A call was placed to 911 and at approximately 2305 hours, fire and ambulance members arrived at the Engineers home for a medical problem. Medical and fire personnel found the Engineer in his home laying supine at the top of the stairs with no signs of trauma, cyanotic, and pulseless. Medics initiated CPR and attached a heart monitor. The monitor indicated the Engineer was in ventricular fibrillation. An interosseous line was established, an advanced airway placed, and medications were administered per protocol. A total of seven defibrillations were given with four rounds of epinephrine and two doses of amiodarone. Base contact was made by paramedics with a concern they could not navigate several flights of stairs while continuing CPR, and the base physician advised to stop all resuscitation efforts. The Engineer was pronounced deceased at his residence at 2331 hours.

### **Medical Findings**

According to the autopsy report, the aorta and branches showed slight atherosclerosis. The vena cava and pulmonary arteries had no thrombus or embolus. The markedly enlarged and moderately dilated 660-gram heart had a normal distribution of right dominant coronary arteries. The epicardial vessels showed slight, multifocal narrowing by atherosclerosis with up to 50% maximal narrowing of the mid-left anterior descending artery, and less than 15% narrowing of the remaining major vessels. The myocardium was uniformly red brown without hemorrhage, softening or pallor. The left ventricle wall thickness measured 1.4 centimeters. The endocardial surfaces, heart valves, chordae tendineae, and papillary muscles were normal. The toxicology report was negative.

The Engineer was not being treated for any illnesses. The coroner's report stated there were no significant findings from medical records or family members. The medical records mentioned that he was a smoker and pre-diabetic.

### **Cause of Death**

According to the death certificate, the medical examiner listed cause of death as fatal cardiac dysrhythmia due to hypertensive and atherosclerotic coronary artery disease.

### **Discussion**

#### **Sudden Cardiac Events**

Sudden cardiac arrest (SCA) is when the heart suddenly fails to pump blood. If the individual does not survive, the term sudden cardiac death (SCD) is used. These events mostly occur in patients with



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structural heart disease (that may not have been previously diagnosed), particularly coronary heart disease (CHD).

SCD accounts for 300,000–400,000 deaths annually in the United States. Most sudden deaths are cardiac, and most SCDs are related to arrhythmias secondary to structural heart disease or primary electrical abnormalities of the heart [Isbister et al. 2019; Jazayeri et al. 2019; Kuriachan et al. 2015]. SCA usually occurs in people with some form of underlying structural heart disease, and as much as 70 percent of SCAs have been attributed to CHD. The risk of experiencing SCA increases dramatically with age and with underlying cardiac disease. Men are two to three times more likely to experience SCA than women. SCD is the mechanism of death in over 60 percent of patients with known CHD. In addition, SCA is the initial clinical manifestation of CHD in approximately 15 percent. Even among the young, CHD is a relatively common cause of SCD. In one study, CHD was the second most common condition (22%) underlying SCD among subjects aged 5 to 34 years. In this study, the most common SCA-related conditions were sudden arrhythmic death syndrome (31%), coronary artery disease (22%), and hypertrophic cardiomyopathy (14%). There was a high overall prevalence of established cardiovascular risk factors (obesity, diabetes mellitus, hypertension, elevated blood cholesterol, smoking) with  $\geq 1$  risk factor present in 58% of persons with SCA [Jayaraman et al. 2018].

Risk factors for SCA include elevated blood cholesterol, hypertension, cigarette smoking, physical inactivity, obesity, diabetes mellitus, and a family history of premature CHD or myocardial infarction. There is also some evidence that acutely stressful situations increase the risk of SCA. Individuals of African American descent appear to have a higher rate of SCD, and poorer outcomes compared to those of Caucasian or Hispanic descent [Wong et al. 2019].

Prevention of SCA and SCD is focused on identifying underlying risk factors. Some risk factors are modifiable and can be changed such as reducing cholesterol and blood pressure, quitting smoking, increasing physical activity, losing weight, and controlling diabetes. Other risk factors are not modifiable such as age or family history of CAD. Several risk factors can be used to calculate a risk score for CHD (Table 1); these factors include body mass index (BMI), blood pressure, serum lipids and glucose. Based on age and other risk factors, the American College of Cardiology /American Heart Association Atherosclerotic Cardiovascular Disease Risk Calculator can estimate the percent 10-year risk of heart attack or stroke [Andrus 2013].



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Table 1. Cardiovascular disease risk factors and associated category of risk

Risk Factor	Interpretation	Category Guidelines
Systolic BP*	Normal Elevated Stage 1 Hypertension Stage 2 Hypertension	< 120 mmHg 120–129 mmHg 130–139 mmHg ≥ 140 mmHg
Diastolic BP*	Normal Elevated Stage 1 Hypertension Stage 2 Hypertension	< 80 mmHg > 80 mmHg 80–89 mmHg ≥ 90 mmHg
Total Cholesterol†	Desirable Borderline high High	< 200 mg/dL 200–239 mg/dL ≥ 240 mg/dL
HDL‡	Low High (Desirable)	< 40 mg/dL ≥ 60 mg/dL
LDL‡	Optimal Above normal Borderline high High	< 100 mg/dL 100–129 mg/dL 130–159 mg/dL > 160 mg/dL
Triglycerides‡	Normal Hypertriglyceridemia Severe hypertriglyceridemia	> 175 mg/dL 175–499 mg/dL ≥ 500 mg/dL
Blood Glucose§	Normal Prediabetes Diabetes	< 100 mg/dL 100–125 mg/dL ≥ 126 mg/dL
BMI¶	Underweight Normal weight Overweight Obesity	< 18.5 kg/m <sup>2</sup> 18.5–24.9 kg/m <sup>2</sup> 25–29.9 kg/m <sup>2</sup> ≥ 30 kg/m <sup>2</sup>

\*Whelton et al. 2018, †Kratz 2004, ‡Grundy et al. 2019, §ADA 2014, ¶CDC 2020

The Engineer in this case was pre-diabetic but his other risk factors are uncertain and therefore the CVD Risk Factor Score could not be calculated.

The presence of an enlarged and dilated heart on autopsy suggests that the Engineer may have had cardiovascular disease or cardiomyopathy that may have been detected by an exercise tolerance test. An exercise tolerance test can identify the presence of CHD that increases the risk of fatal and non-fatal cardiac events. An abnormal EKG that shows myocardial ischemia with exercise (loss of blood flow to the heart muscle) is associated with an increased risk of future CHD events, especially in those

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individuals with other risk factors for heart disease (high blood pressure, high lipid levels, elevated blood sugar or obesity) [Balady 2004; Bruce 1980; Megnien 2009; Michaelides 1990, 1995, 2005; Sumanen 2005; Van Campen 1996].

### **Recommendations**

***Recommendation #1: Implement comprehensive pre-placement and annual medical evaluations consistent with NFPA 1582 Standard on Comprehensive Occupational Medical Program for Fire Departments, which includes a baseline EKG for all individuals prior to engagement in any strenuous physical activity to rule out underlying cardiac anomalies [NFPA 2022].***

Discussion: NIOSH recommends that all new and incumbent personnel participate in annual medical evaluations to determine that personnel are healthy enough to participate in strenuous activity and to identify potential injuries or illnesses. Guidance regarding the content and frequency of the medical evaluations for firefighters can be found in Chapter 7 of NFPA 1582. At the time of the incident, the department did not have annual medical examination requirements for personnel. The Engineer suffered from atherosclerotic cardiovascular disease, a condition where the arteries become narrowed and hardened due to buildup of plaque (fats) in the artery wall. When detected, atherosclerotic cardiovascular disease is treatable [NFPA 2022].

***Recommendation #2: Implement a pre-placement and annual cardiac exercise stress test to determine the capacity for physical exertion and decrease the risk for sudden cardiac death.***

Discussion: In an individual with CHD, an exercise stress test can detect ischemia (areas of the heart where the blood supply is not adequate) that increases the risk of fatal and non-fatal cardiac events. An exercise stress test should be considered for new firefighter job applicants (preplacement), especially for those individuals who have risk factors for heart disease (high blood pressure, high lipid levels, elevated blood sugar or obesity). If the stress EKG indicates ischemia, the individual should be referred to a heart specialist for additional evaluation to determine if there may be an increased risk for SCA and SCD while performing firefighter job tasks.

***Recommendation #3: Implement an annual fitness evaluation consistent with NFPA 1582 Standard on Comprehensive Occupational Medical Program for Fire Departments to ensure personnel are physically fit to perform job expectations at emergencies [NFPA 2022].***

Discussion: NIOSH recommends that fire departments phase in annual fitness evaluation programs that are consistent with NFPA 1582 [NFPA 2022].

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### **Investigator Information**

This incident was investigated by the NIOSH Fire Fighter Fatality Investigation and Prevention Program, Cardiac/Medical Team, in Cincinnati, Ohio. Co-author TJ Welch is a Firefighter Safety Specialist that has worked in volunteer, industrial and municipal fire departments. Mr. Welch is a State Certified Fire Officer, founding member of the California Incident Command Certification System, and chaired the CICC committee on Physical Fitness Standards. Robert Harrison MD, MPH, (California Department of Public Health) provided medical consultation, and Laura Styles, MPH (Public Health Institute), also contributed to this report.

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### **Highlights from Investigation F2021-16**

The Fire Fighter Fatality Investigation and Prevention Program (FFFIPP) investigated the death of a 57-year-old Engineer that occurred at home 13½ hours after fighting a multi-vehicle fire in a commercial parking garage. He suffered sudden cardiac death on June 8, 2021.

#### **What We Did**

- Interviewed two battalion chiefs, truck lieutenant and two crew members, engine lieutenant and two crew members, and family members about the incident.
- Reviewed fire department procedures, incident records, work practices, safety training, autopsy and toxicology reports, ambulance report, and physician records.

#### **What We Found**

- The fire department conducts physical exams of all new or promoted members, but these do not contain all the components as recommended by NFPA 1582: Standard on Comprehensive Occupational Medical Program for Fire Departments.
- The fire department provides fitness equipment and time for personnel to exercise each shift. Members must meet minimum performance standards and maintain physical conditioning.
- The Engineer had a history of atherosclerotic cardiovascular disease (ASCVD) and pre-diabetes prior to the incident. Early detection and treatment of both conditions may reduce risk of cardiac complications.
- On the last morning of his 48-hour shift, the Engineer was involved in fighting a multi-vehicle fire in the parking garage of a large commercial airport. He returned to the station at 0930 and did not report any medical symptoms or issues. Soon after, he went home for his scheduled day off. Later that night, he had a medical emergency and died at home.
- An autopsy determined the cause of death was a fatal cardiac dysrhythmia due to hypertensive and atherosclerotic coronary artery disease.

#### **What Fire Departments and Firefighters Can Do**

- Provide educational materials and learn about atherosclerotic cardiovascular disease and possible risk reduction methods as part of physical fitness education.
- Provide and participate in pre-placement medical evaluations, including a baseline resting electrocardiogram (EKG) which should be repeated at the annual medical examinations starting at age 40 as recommended by NFPA 1582.
- Provide and participate in pre-placement and annual cardiac exercise stress tests if indicated by the American College of Cardiology/American Heart Association ASCVD risk calculator to

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determine individual capacity for physical exertion, and to decrease the risk for sudden cardiac death. If the stress EKG indicates ischemia, the individual should be referred to a heart specialist to determine risk of sudden cardiac arrest as recommended by NFPA 1582.

- Provide and participate in annual fitness evaluations to ensure personnel can meet State and job requirements as recommended by NFPA 1582.