Atmospheric Monitoring at Structure Fires

By: Scott Reymann
Lieutenant
Fairlawn Fire Department
3525 South Smith Road
Fairlawn, OH 44333

A proposed research project submitted to the Ohio Fire Executive Program
April 04, 2018

CERTIFICATION STATEMENT

I hereby certify that the following statements are true:

1. This paper constitutes my own product, that where the language of others is set forth, quotation marks so indicate, and that appropriate credit is given where I have used the language, ideas, expressions, or writings of another.

2. I have affirmed the use of proper spelling and grammar in this document by using the spell and grammar check functions of a word processing software program and correcting the errors as suggested by the program.

Signed: _____

Printed Name: _____

ABSTRACT

The problem researched was if the Fairlawn Fire Department (FFD) should be monitoring interior atmospheric gasses at structure fires. The purpose of this study is to identify whether current department operating guidelines effectively protect firefighters from the hazardous atmospheres encountered at structure fires. Research questions included:

1. Do atmospheres at structure fires need to be monitored?
2. When do atmospheric conditions need to be monitored?
3. What gasses should be monitored?
4. Are personnel aware of the signs and symptoms of an exposure?

Action research was used for this applied research project and the methods used included a review of department National Fire Incident Reporting System (NFIRS) records, consultation with local doctors, Google, Google Scholar and Cleveland Clinic Library Coordinator. The results indicate that personnel would benefit from the mandatory use of interior atmospheric monitoring at structure fires and self-contained breathing apparatus be worn until the atmosphere has been determined to be safe.

TABLE OF CONTENTS

INTRODUCTION

Statement of the Problem

The problem this research paper will address is that the Fairlawn Fire Department (FFD) does not consistently monitor the interior atmospheric gases at structure fires and whether or not it should. This inconsistency may lead to firefighters and civilians exposed to dangerous gasses that could be potentially fatal.

Purpose of the Study

The purpose of this study is to identify whether current department operating guidelines effectively protect firefighters from the hazardous atmospheres encountered at structure fires.

Research Questions

The research questions this study will investigate are:

1. Do atmospheric gasses at structure fires need to be monitored?
2. When do atmospheric gasses need to be monitored?
3. What gasses should be measured?
4. Are personnel aware of the signs and symptoms of an exposure?

BACKGROUND AND SIGNIFICANCE

Established in 1971, the City of Fairlawn (City) is located in Northeast Ohio. It is a small city covering 5.2 square miles with approximately 7,500 permanent residents. However, during business hours, the City population significantly increases with members of the corporate and professional community with an influx of more than 40,000 individuals who work, shop or eat in Fairlawn throughout the Monday to Friday work week. The City does not have any manufacturing facilities or industrial corridor but instead is home to many corporate world headquarters, diverse groups of business, a large retail mall, three nursing home facilities, two country clubs and three corporate hotels.

FFD provides all-hazard emergency service to the community as defined by the department mission statement, "The mission of the Fairlawn Fire and EMS System is to provide its community sensitive, cost-effective protection against the threat to life and property due to fire, medical emergencies, and other disasters." The fire department is defined as a combination department with sixteen (16) full time and thirty-three (33) part-time personnel. The FFD operates out of one station that houses one engine/pumper, one ladder truck, three ambulances and four support vehicles. The minimum staffing level is a minimum of four firefighters, twenty-four hours a day with staffing numbers increased during business hours (0700 - 1600) Monday through Friday.

The FFD's emergency medical calls for service have nearly doubled from 2009-2016 increasing from 913 to 2,037 (Fairlawn Fire Department Annual Report, 2009-2016) calls with no increase in daily staffing levels. A review of actual structure fires in 2016 revealed a relatively low number of five. However, the department also participates in both Mutual Aid and Automatic Aid agreements for both fire and EMS requests with departments that share a

common border with the City of Fairlawn. The FFD has a Mutual Aid agreement throughout the county. As a result, the number of structure fires responded to by FFD has increased. The dynamic working environment at a structure fire produces harmful gases that firefighters need to monitor and should also be aware of the signs and symptoms of exposure. The FFD conducts periodic revisions of their Standard Operating Guidelines (SOG) but does not have one that specifically addresses interior atmospheric monitoring while at structure fires. The absence of this SOG has likely resulted in the arbitrary use of appropriate respiratory protection during the extinguishment and overhaul phases of a structure fire. Our current multi-gas meter monitors four specific gases; oxygen, carbon monoxide, hydrogen sulfide and hydrogen cyanide with preset alarm levels for each of these gases. By not requiring the use of this piece of equipment at structure fires, we could be exposing our members and civilians to potentially fatal levels of harmful gasses. A review of FFD NFIRS records indicated a total of 54 incidents that were categorized as a "building fire" from 2012-2016. Upon review of these reports, no documentation of atmospheric monitoring was noted in the narrative. Of these 54 incidents, one incident documented a firefighter receiving a prehospital evaluation on scene by paramedics and was cleared to return to duty by an emergency room doctor. It is possible this firefighter was exposed to harmful levels of gasses, but because their symptoms were so vague, the firefighter was cleared medically to return to duty without restriction. In the event an individual was exposed to these gasses, department personnel might not know what should be done to ensure they receive proper medical treatment. In the event the multigas department meter had been utilized, the treatment they received could have been entirely different.

FFD also responds to calls involving concerns of an unknown odor. Given the nature of the call, department members may or may not use the multigas meter for atmospheric monitoring

purposes. The FFD does not have a specialty team relating to hazardous materials. However, there is one full-time member trained at the hazmat technician level. The FFD participates in a cooperative countywide hazardous materials team wherein if the FFD had an incident that required the resources of this specialty team; qualified FFD full-time members can request these resources.

Exposure to the gasses of combustion has been accepted within the fire service as being harmful to the immediate and long-term health of firefighters. Some of these gasses include, among others, carbon monoxide and a lesser known gas hydrogen cyanide. Although our department has a multi-gas meter that monitors both of these gases, recognition, and treatment for exposure to these two gases varies tremendously despite these symptoms of an exposure being fairly similar. Members of the FFD may not have received appropriate training on these devices that include how to interpret the data the multigas meter provides. Therefore, it becomes imperative for an incident commander (IC) to ensure that interior atmospheres at structure fires are being monitored and insist on the appropriate personal protective equipment (PPE) until the atmosphere has been determined to be safe.

Currently, the FFD is using an electrochemical multigas meter manufactured by Drager model X-am 5000. Before the meter was purchased, FFD specified to the manufacturer what gasses it wanted to be monitored so the appropriate sensors could be installed. This specific unit currently being used measures the following gasses: oxygen, carbon monoxide, hydrogen cyanide, and hydrogen sulfide. The device has preset limits that when detected results in the device alerting the user by both audible and visual means. The preset values vary and are dependent on the specific gas as shown in table 1 (*Drager Owner's Manual*, 2013, p. 12)

Table 1

	A1 Alarm	A2 Alarm	STEL	TWA
Hydrogen Sulfide	10.0% LEL	20.0% LEL	N/A	N/A
Oxygen	19.50 VOL%	23.00VOL%	N/A	N/A
Carbon Monoxide	35.00PPM	50.00PPM	60.00PPM	30.00PPM
Hydrogen Cyanide	2.50PPM	4.50PPM	20.00PPM	10.00PPM

Although FFD has relatively few structure fires, the signs and symptoms of exposure to both carbon monoxide and hydrogen cyanide are similar and include a headache, weakness, nausea, dizziness, irregular respirations (Carbon monoxide, 2016). The impact this study could have on the FFD is potentially lifesaving for firefighters in addition to civilians.

Implementation of an appropriate atmospheric monitoring equipment SOG could result in the prevention of exposure to the harmful gasses of combustion. In the event of an exposure, these individuals are more likely to receive appropriate pre-hospital treatment. The development of an appropriate SOG should state who determines when interior atmospheric levels are safe for civilians in addition to when firefighters can remove their self-contained breathing apparatus (SCBA). In the event exposure was to occur to a firefighter, the consequences might result in the filing a Worker's Compensation claim, use of accrued sick time and partial or permanent disability. A worst-case scenario would be a fatal exposure to the gasses of combustion at a structure fire that could have been prevented. In addition to the adverse health effects to the firefighter, an exposure has a financial component to it as well as a psychological component that could affect other members of the department in addition to surrounding communities and

immediate family members. An appropriate SOG could potentially limit these non-health related aspects of exposure.

LITERATURE REVIEW

The fire service is an inherently hazardous occupation with thousands of injuries reported annually (*NFPA News and Research*, 2018). Among these reported injuries are respiratory injuries with many, if not all of them being preventable. There currently exists a variety and standards that address a comprehensive respiratory protection program for firefighters. The research examined the applicable standards and compared them to the existing policies of the Fairlawn Fire Department with the ultimate goal of improving firefighter safety and conformity to existing regulations.

A records search of the FFD from 2012-2016 to determine the number of structure fires responded to and to ascertain whether the internal atmospheric conditions were monitored. The results revealed fifty-four "building fires" and only one of these revealed where a firefighter received medical treatment but was ultimately cleared by an emergency room doctor to resume firefighting activities without emergency room treatment. Specific to this incident, there is no mention of whether or not atmospheric conditions had been monitored. While reviewing these fifty-four incidents, it was noted that despite the FFD having an existing *Personnel Rehabilitation Log* (Appendix 5) as recommended in National Fire Protection Agency (NFPA) 1584 it was unable to be located. The research revealed that this form had not been completed. Additionally, a review of these fifty-four reports revealed no mention of atmospheric conditions being monitored and what actions were taken, if any, relating to the treatment of individuals who

were displaying symptoms of being exposed to the toxic atmospheres encountered at structure fires.

While researching whether to require atmospheric monitoring at structure fires a study conducted in 2001 identified the presence of several gasses during the overhaul phase of structure fires that identified multiple harmful gasses present during the overhaul phase of a structure fire (Burgess, 2001). Another study supported in part with a grant from the Ohio Bureau of Worker's Compensation indicated the presence of multiple harmful gasses present at a structure fire some of which resulted in a higher risk of certain cancers among firefighters LeMasters et al. (2006). According to the most recent report about firefighter injuries in 2015, 68,085 firefighters were injured with 29,130 occurring while at the fire ground with 8.2% being exposures to fire products (Haynes, 2016). The Occupational Safety & Health Administration (OSHA) issued a standard in 1971 that required employers to establish and maintain a respiratory protection program for employees who wear respirators. This standard was revised in 1998 and included the requirements for Self Contained Breathing Apparatus (SCBA) use and establishing a comprehensive respiratory protection program (OSHA 29 CFR1910.134, 1998). This standard stated at least two firefighters are necessary to enter an IDLH atmosphere and remain in visual or voice contact at all times and at least two firefighters are located outside an atmosphere determined to be Immediately Dangerous to Life and Health (IDLH). This standard has become known as the two-in/two out rule. Also included in the requirement is that all firefighters engaged in interior structure use SCBA's. (OSHA 29 CFR1910.134(g)(4). A report by The National Institute for Occupational Safety and Health (NIOSH) makes the recommendation that firefighters must report hazardous situations to the appropriate personnel which could include an officer or IC. Since structure fires are known to produce toxic gases, atmospheric monitoring

would certainly fall under this criteria. (Preventing deaths and injuries of firefighters using risk management principles at structure fires, 2017). This same agency suggests that departments develop and enforce risk management policies and standard operating procedures to address atmospheric monitoring.

According to NFPA, most civilian fire deaths are not caused by burn injuries, but instead, their death is attributable to smoke inhalation (The consequences of fire, 2016). Currently, no SOG exists at the FFD for when to monitor the atmosphere at a structure fire and under what conditions is it safe for a firefighter to remove their SCBA. In the United States alone, approximately 4,000 individuals are injured or die in residential fires many of which are not due to burn injuries, but instead result from smoke inhalation (Hoffman, 2013). The National Fallen Firefighters Foundation (NFFF) 16 Firefighter Life Safety Initiatives: Goal 8, "Technology – Utilize available technology wherever it can produce higher levels of health and safety" (National Fallen Firefighters Foundation (U.S.) 2004). The NFPA has indicated that the Authority Having Jurisdiction (AHJ) shall develop a respiratory protection program that assists personnel in identifying the primary gases of combustion (NFPA 1404: Standard for Fire Service Respiratory Protection Training, 2013, p.4). Included in this standard are written policies that are reinforced through comprehensive training. When addressing the need of when atmospheres should be monitored, the standard states that whenever an SCBA is being used at a structure fire, the atmosphere should be assumed to be oxygen deficient with unknown concentrations of toxic materials. These toxic environments continue during initial overhaul and the standard further states that the temptation to remove SCBA must be curtailed until the atmosphere has been deemed safe (through appropriate atmospheric monitoring). NFPA 1584 Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises

(NFPA, 2015, p.7), states the AHJ needs to develop a policy regarding the medical monitoring of individuals during emergency scene and training operations. Also, the standard mentions that company officers shall maintain an awareness of the individuals under their supervision. This includes the physical and mental conditions of each member operating within their span of control (NFPA 1584, p.7)

Although hundreds of chemicals are produced during a structure fire, it becomes unrealistic to monitor for all of them. Some of the factors that make this unrealistic are the cost associated with the purchasing and maintenance of the dozens of pieces of monitoring equipment. However, atmospheric monitoring equipment can be specified to detect the gases that can adversely affect us the most. For decades, firefighters have been taught to conserve the air in their SCBA until well involved in fire ground operations. This habit continues today and is exposing firefighters to the toxic byproducts of combustion which have the potential to be lethal in sufficient concentrations (Larkin, 2016, p. 24). According to Jones and Bartlett (Fire Department Incident Safety Officer Third Edition, 2016), firefighters do not recognize smoke as a hazard while breathing air through an SCBA. They go on to state that today's plastics produce dark smoke that among other products, contain benzene and hydrogen cyanide and that one breath of this smoke can cause "dizziness, loss of sensation and unconsciousness." Among some of the most common gases detected at residential structures include carbon monoxide, hydrogen cyanide, and phosgene (The consequences of fire, 2016). Both carbon monoxide and hydrogen cyanide adversely affect individuals by impairing the oxygen-carrying capacity of the blood. As a result of the synergistic effect these gasses have, they are commonly referred to as the "Toxic Twins" within the fire service. A report issued by the National Institute for Occupational Safety and Health (NIOSH) stated that a deputy chief's death was ruled to be related to inhalation

injuries from a structure fire (NIOSH, 2003). Additionally, in a recent study of five firefighters who were treated for smoke inhalation from a house fire showed all victims had elevated levels of both carbon monoxide and hydrogen cyanide (Hart, 1985). Four of the five individuals were aggressively treated with hyperbaric oxygen and a cyanide antidote kit early and survived. In 2006 during a 24-hour period in Providence, Rhode Island, twenty-seven firefighters were tested for cyanide poisoning, and the results are alarming. One sustained a heart attack with an elevated level of hydrogen cyanide, seven others had elevated levels of hydrogen cyanide, and one was diagnosed with hydrogen cyanide poisoning (Hydrogen Cyanide Recognized As Toxic Threat to Firefighters, 2011).

Because the materials commonly encountered in residential houses is different from forty or fifty years ago, the chemicals encountered and their associated clinical symptoms are different. By having an understanding of what some of these chemical compounds are, it is possible to anticipate what signs and symptoms might be observed in firefighters. Not more than a generation ago, many homes contained products manufactured from organic materials such as wood and cotton producing non-toxic gases in symptoms that included coughing, hoarseness, and tachypnea. Residential house fires for the last few decades, however, have scene contents primarily manufactured with hydrocarbon-based products and a chemical compound that produce highly toxic vapors when heated. One published article indicated that severe carbon monoxide and hydrogen cyanide poisoning have identical clinical presentations of asphyxia: altered mental status, extremely abnormal vital signs and possible seizures (Nelson, 2016). As a result, it becomes important for Emergency Medical Services (EMS) personnel to recognize the signs and symptoms of exposure to ensure firefighters and civilians receive appropriate advanced medical care. Other clinical signs of exposure to cyanide include difficulty breathing, headache,

weakness, nausea, and diaphoresis (Thompson, 2016). Any firefighter who has been involved with interior firefighting operations has experienced some if not all of these symptoms after a fire. As a result, it becomes necessary for EMS to ask relevant questions when evaluating both firefighters and civilians during rehab.

When attempting to determine if atmospheric monitoring should be conducted at house fires, there appears to be enough evidence to support this project. Although this is not a new concept, the degree to which the FFD is compliant with applicable standards varies. While OSHA defines the multiple components of a comprehensive respiratory protection program, no established program exists. However, the FFD is compliant with many of the components. The research indicated that changes can be made to bring the FFD into compliance thereby accomplishing the goal of a safer working environment at structure fires.

PROCEDURES

The purpose of this research paper is to identify if the Fairlawn Fire Department is exposing their members and civilians to dangerous conditions due to a lack of consistent interior atmospheric monitoring at structure fires. The American Psychological Association Publican Manual 6th edition was the required format. A literature review was beneficial in obtaining background information for the development of surveys and questionnaires with the desired result of answering the following questions: 1. Do atmospheres at structure fires need to be monitored? 2. When do atmospheric conditions need to be monitored? 3. What types of gasses should be monitored? 4. Are personnel aware of the signs and symptoms of exposure?

Literature review began in summer of 2016 utilizing Google Scholar (http://scholar.google.com) and Google (http://google.com) which provided several national standards, articles, reports and research papers for review. Attempts were made to identify seminal sources of research. Also, the medical library at Cleveland Clinic was utilized through the coordination of the Fairlawn Fire Medical Directors, Dr's. Mark McDowell, M.D, and Andrew Yocum, M.D., Claire Leibfarth, Coordinator Library Services, Cleveland Clinic Akron General assisted in obtaining credible medical studies related to the effects of gasses encountered during structure fires and how individuals should be medically treated. An additional website, (http://www.pubmed.gov) was an electronic resource that provided additional medical documentation.

Two separate surveys were distributed to obtain data. These surveys were developed using the Survey Monkey website (www.surveymonkey.com) to obtain both internal and external survey feedback. Internal survey questions were distributed to full-time members of the FFD through an email with a link to Survey Monkey. External survey questions were distributed to twenty-seven fire departments throughout Summit County, Ohio through a coordinated effort with the Summit County Fire Chiefs Association's Secretary, Jeff Funai, City of Green Fire Chief. The survey contained a cover letter with instructions and a direct web link to the survey on Survey Monkey. During the development of survey

questions, a local individual who has experience in research and data collection was consulted. The purpose of consulting this person was to limit the potential of leading questions and answers being included in the survey.

Definition of Terms

- AHJ: Authority Having Jurisdiction is the organization responsible for enforcing the codes and standards.
- IC: Incident Commander
- FFD: The Fairlawn Fire Department is a combination fire department that provides all-hazard emergency service to the community. It covers approximately 5.2 square miles with a nighttime population of almost 7,500 citizens. The department consists of thirty-three (33) part-time and sixteen (16) full-time personnel.
- IAFF: International Association of Fire Fighters. The IAFF is a professional organization with over 300,000 full-time professional firefighters and paramedics with more than 3,100 affiliates in the United States and Canada.
- IDLH: Immediately Dangerous to Life or Health is an area that is likely to cause death or immediate, delayed permanent adverse health effects or prevent escape from such an environment.
- Meta-Analysis: A quantitative statistical analysis of multiple separate but similar studies to determine statistical significance.
- NIOSH: National Institute for Occupational Safety and Health is the United States federal agency with the mission of developing new knowledge in the field of occupational safety and health and transferring that knowledge into practice.
- NFFF: National Fallen Firefighters Foundation was created by Congress to honor America's fallen firefighters and provide resources to their survivors.
- NFPA: National Fire Protection Association. NFPA is an association that provides information through more than 300 consensus codes and standards, research, training, education, outreach, and advocacy.
- NFIRS: National Fire Incident Reporting System is a national reporting system used by U.S fire departments to report fires and other incidents to which they respond and to maintain records of these incidents in a uniform manner.
- NFPA 1404: Standard for Fire Service Respiratory Protection training.
- NFPA 1500: Standard on Fire Department Occupational Safety, Health, and Wellness Program.
- NFPA 1584: Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises.
- OSHA: Occupational Safety and Health Administration is part of the United States Department of Labor that assures safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education, and assistance.

- PPE: Personal Protective Equipment is designed to protect firefighters from serious injuries or illnesses resulting from contact with chemical, radiological, physical, electrical, mechanical or other hazards. It covers a variety of devices and garments such as respirators, turnout gear, gloves, blankets and gas masks.
- SCBA: Self Contained Breathing Apparatus is a piece of equipment used primarily by firefighters or rescue workers to provide breathable air in an immediately dangerous to life or health atmosphere (IDLH).

Limitations of the Study

Among the limitations of this research included obtaining an adequate data set from external sources. Despite multiple attempts to increase the number of external responses received from fire departments in Summit County, a response rate of 22% was achieved. It should be noted that after the survey questions were distributed this author realized that some of the survey questions were not identical. Although this was an oversight, this author believes that the content of the questions was similar enough that allowed inferences to be made that did not adversely affect the responses.

An additional limitation of this study includes the number of responses received from departments within Summit County. Although the survey was distributed to twenty-seven departments throughout the county (FFD was excluded from this email to avoid skewing data results), only six responded to the survey. Due to the lack of responses, an additional request was made to Chief Funai to send out an additional email request to the remaining nineteen departments that did not initially respond. Despite the email being redistributed no additional responses were generated.

This study was designed to benefit the Fairlawn Fire Department. The results of the study may not accurately portray other fire departments throughout the country.

RESULTS

The action research method was implemented to answer the research questions. Survey questions were developed and disseminated to two different populations. The two different survey groups included the FFD for internal department data and twenty-six departments throughout Summit County, Ohio for external department data. Sixteen FFD surveys were distributed with fifteen being returned: a 95% response rate. The external department survey was distributed to twenty-seven fire departments with six being returned: a twenty-two percent response rate.

The results from the External Survey revealed some demographic similarities when compared to the FFD Internal Survey results. Questions 1 and 2 of the Internal Survey asked about years of service and rank whereas questions 1-4 of the External Survey dealt with attempting to determine similarities to FFD. For example, two-thirds of the External Survey responders classified themselves as a combination department that also responded to a similar number of structure fires annually. The External Survey indicated that eighty-three percent of their members had over twenty-one years of experience in the fire service compared to fifty-three percent of the FFD Internal Survey responses.

Question 3 of the Internal Survey asked: "I am aware of the Fairlawn Fire Department SOP regarding atmospheric monitoring at structure fires." The results indicated almost 93 percent of the responders were either "very familiar" or "familiar" with a mere seven percent responding "neutral." Question 4 of Internal Survey asked: "Atmospheric monitoring should be required at all structure fires." All responses indicated that they "Strongly agree" with this statement. Question 5 of the Internal Survey asked "Which gasses should be monitored at

structure fires? Check all that apply." Thirty-three percent responded indicated "carbon monoxide" or "other." Tied with thirteen percent was "oxygen" and "carbon monoxide." Lastly, only seven percent responded "hydrogen cyanide." Question 6 of the Internal Survey asked: "I have received adequate training on the use of department atmospheric monitoring equipment." Twenty-seven percent responded, "Strongly agree." Sixty percent responded "Agree," seven percent responded either "Undecided" or "Disagree." Question 7 of the Internal Survey asked: "How frequently is hydrogen cyanide produced at structure fires?" Fifty-three percent of responses indicated "Very frequently." Thirty-three percent responded "Frequently," and thirteen percent responded "Occasionally." Question 8 of the Internal Survey asked: "A potential symptom that an exposure to toxic gases occurred at a structure fire might include a headache?" Eighty-seven percent responded "Strongly agree" and thirteen percent responded, "Agree." Question 9 of the Internal Survey asked "A potential symptom that an exposure to toxic gases at a structure fire might include feeling weak? Eighty percent responded, "Strongly agree." Thirteen percent responded "Agree," and seven percent responded "Undecided." Question 10 of the Internal Survey asked: "A potential symptom that an exposure to toxic gases occurred at a structure fire might include a rapid heart rate?" Sixty-seven percent responded, "Strongly agree." Twenty percent responded "Agree," and thirteen percent responded "Undecided." Question 11 of the Internal Survey asked: "A potential symptom that an exposure to toxic gases occurred at a structure fire include dizziness?" Eighty percent responded the "Strongly agree" and twenty percent responded, "Agree."

Question 5 of the External Survey asked: "Atmospheric monitoring should be required at all structure fires." Sixty-seven percent responded "Strongly agree," and thirty-three percent responded, "Agree." Questions 6 of the External Survey asked: "I have received training on my

department's SOP regarding atmospheric monitoring?" Seventeen percent responded either "Strongly agree," "Undecided," "Disagree" or "Strongly disagree." Thirty-three percent responded, "Agree." Question 7 of the External Survey asked: "I have received training on the by-products of combustion typically encountered at structure fires?" Sixty-seven percent responded "Strongly agree," and thirty-three percent responded, "Agree." Question 8 of the External Survey asked: "Hydrogen cyanide is typically encountered at structure fires?" Forty percent responded "Strongly agree" and sixty percent responded, "Agree." Question 9 of the External Survey asked: "I have received adequate training on how to treat someone exposed to the by-products of combustion encountered at a structure fire?" Seventeen percent each responded either "Strongly agree" or "Undecided" and sixty-seven percent responded, "Agree." Question 10 of the External Survey asked: "A potential symptom that exposure to toxic gases at a structure fire might include weakness?" Sixty-seven percent responded Agree," and thirty-three percent responded, "Strongly agree." Question 11 of the External Survey asked: "A potential symptom that exposure to toxic gases occurred at a structure fire might include a headache?" Fifty per-cent each responded either "Strongly agree" or "Agree." Question 12 of the External Survey asked: "A potential symptom that exposure to toxic gases occurred at a structure fire might include a rapid heart rate?" Eighty-three percent responded "Agree," and seventeen per-cent responded, "Strongly agree." Question 13 of the External Survey asked: "A potential symptom that exposure to toxic gases occurred at a structure fire include dizziness?" Fifty per-cent each replied either "Agree" or "Strongly agree."

The first research question evaluated was, "Do atmospheres at structure fires need to be monitored?" The researcher analyzed the data from the question to determine if FFD members were aware of the SOG regarding atmospheric monitoring at structure fires. Of the fifteen

Internal Surveys returned, fourteen individuals or 93% responded that they were either "Very familiar" or "Somewhat familiar" of the SOG. In retrospect, this question should have been worded differently to determine if the survey members were aware of whether or not FFD had a SOG on atmospheric monitoring. Because no SOG exists, the research revealed that the majority of responders believed that a SOG did exist. The results from the External Survey revealed that 50% of the departments either "Strongly agreed" or "Agreed" that they had been trained on their respective departments SOG on atmospheric monitoring. OSHA 29 CFR 1910.134 states that firefighters who are engaged in interior structure fire operations are required to use SCBA's because the atmosphere has to potential to be IDLH.

The second research question evaluated was "When do atmospheric conditions need to be monitored?" Of the fifteen responses received from the Internal Survey, 100% responded that they "Strongly agreed" that atmospheric monitoring should be required for all structure fires. However, the External Survey revealed that only 66.67% of respondents "Strongly agreed" that atmospheric conditions should be monitored at all structure fires. The remaining 33.33% replied that they "Agreed." NFPA 1404 states that whenever an SCBA is being used at a structure fire, the atmosphere should be assumed to be oxygen deficient with unknown concentrations of toxic gasses that continue during overhaul and continue until determined to be safe through atmospheric monitoring.

The third research question evaluated was, "What gasses should be measured?" For this question, nine different gasses were listed with the option to select "other." The Internal Survey results indicated that 100% of the responders agreed that oxygen and carbon monoxide levels should be monitored. However, only 60% though hydrogen cyanide levels should be monitored. NFPA 1404 states that SCBA shall be used in environments that are known to be IDLH. The

survey. The initial responses to this survey question were skewed due to an oversight by this author and his lack of familiarity with Survey Monkey. The oversight involved limiting the number of responses a subject could respond to for Survey Question 5. After this error was detected, a neutral co-worker was asked if they would reissue the survey question in the form of a hard copy which was done and the results were included in the percentages above. This oversight was corrected before it was distributed to the External Survey participants. OSHA 29 CFR1910.134(c)(1)(vii) states that employers shall train employees to recognize hazards that they could be exposed to during routine and emergency situations. While it appears that FFD has done a sufficient job training employees to recognize an IDLH atmosphere, they have not done an adequate job training about the dangers of hydrogen cyanide and other atmospheres that are IDLH. Conversely, the External Survey revealed that they received adequate training on the byproducts of combustion including the presence of hydrogen cyanide. The research identified that drawing these conclusions were based on asking survey questions that were not identical to both survey populations. NFPA 1404 states that atmospheres at structure fires should be assumed to contain toxic gases during initial overhaul operations and SCBA's should not be removed until an atmosphere is determined to be safe through atmospheric monitoring.

The fourth research question evaluated was, "Are personnel aware of the signs and symptoms of exposure?" The Internal Survey revealed that at least eighty-six percent of responders indicated they were aware of the vague signs and symptoms of possible exposure to a hazardous atmosphere whereas one-hundred percent of External Survey responders indicated they were aware of the same signs and symptoms. NFPA 1584: Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises specifically

addresses the need for a policy that addresses medical monitoring of personnel at emergency scenes.

DISCUSSION

The first research question evaluated, "Do atmospheres at structure fires need to be monitored?" NFPA states that most civilian fire deaths are attributable to smoke inhalation and it can be inferred that the gasses of combustion being produced at structure fires are toxic enough also to kill firefighters (NFPA 1404). This same agency goes on to state that the AHJ evaluate the ability of fire personnel to identify the primary characteristics of combustion. According to a review of firefighter injuries from 2015, over 2,300 firefighters were treated for smoke inhalation (Haynes, 2016). Additionally, NIOSH makes the recommendation that firefighters must report hazardous conditions to an officer or IC (Preventing deaths and injuries of firefighters using risk management principles at structure fires, 2017). FFD occasionally conducted reviews of current SOG with the last revision more than seven years ago. Presently, no SOG exists at FFD that specifically address atmospheric monitoring being required at all structure fires. Of the fifteen Internal Surveys returned, fourteen individuals or 93% responded that they were either "Very familiar" or "Somewhat familiar" of the SOG. Since no SOG exists, the research identified that responders have been inadequately trained in department SOGs and additional training is needed. Included in the training would be the addition of a new SOG that addresses the use of atmospheric monitoring at all structure fires that include criteria of when SCBA can be removed. Another possible explanation is that responders did not want to appear ignorant about their lack of familiarity with department SOGs. The research identified that the responses to the question may have been misleading and should have been worded differently asking instead if department members were aware of when atmospheres should be monitored. Additionally, the results from

the External Survey revealed that 50% of the departments either “Strongly agreed” or “Agreed” that they had been trained on their respective departments SOG on atmospheric monitoring. The research identified that the number of firefighters needing treatment for smoke inhalation would be reduced if atmospheric monitoring was required at all structure fires and required the use of SCBA until the atmosphere was determined to be safe. This author discovered that the contents of many structure fires continue to produce toxic gases after the fire has been extinguished and believes enough evidence exists to make atmospheric monitoring a requirement for all structure fires at FFD and therefore recommends the implementation of a SOG attached in Appendix A.

Regarding the second research question, “When do atmospheric conditions need to be monitored?” the research identified that atmospheric monitoring should occur at all structure fires and SCBA utilized until the atmosphere is determined to be safe. A study conducted by Burgess, 2001 indicated that multiple toxic gases are present during the overhaul phase of a structure fire which might be a contributing factor of why so many firefighters are being treated for smoke inhalation. As part of a comprehensive respiratory program that is detailed in OSHA 29 CFR 1910.134, 1998 two firefighters are required to be available to facilitate a rescue when an IDLH atmosphere is identified, and firefighters are performing interior operations. After reviewing the results of a 2015 study (Hayes, 2015) of firefighter injuries, over 2,300 instances were documented that involved smoke inhalation. A review of FFD records revealed only one occurrence where a firefighter was medically evaluated at the scene of a structure fire. However, no documentation could be located concerning the use of atmospheric monitoring equipment. It is entirely possible this individual was exposed to toxic gases but was allowed to continue firefighting operations. Furthermore, NIOSH has made the recommendation that firefighters must report hazardous situations, and the researcher believes that inhaling smoke at a structure

fire meets this criterion (Preventing Deaths, 2017). The results of the Internal Survey revealed 100% "Strongly agreed" that atmospheric monitoring should be required for all structure fires. However, the External Survey revealed that only 67% of respondents "Strongly agreed" that atmospheric conditions should be monitored at all structure fires. The remaining 33% replied that they "Agreed." The research identified that although the responders of the Internal Survey felt atmospheric monitoring should occur at all structure fires, no documentation was discovered that indicates it is occurring. One of the ways this might be changed is by requiring the first due engine to take the multi-gas monitoring equipment with them when they exit the truck. Additionally, the research identified that only two-thirds of the External Survey responders felt atmospheric monitoring should be monitored. Despite the numerous literary sources that exist about the dangers of the toxic atmospheres at structure fires and the dangers they pose to firefighters, more education needs to occur concerning the use of atmospheric monitoring equipment and SCBA use. One possible solution is to slightly alter the responsibilities for the initial firefighting crew which involves the officer removing the monitoring equipment from the apparatus and handing it to the IC as a visual reminder to ensure atmospheric monitoring is accomplished at structure fires.

The third research question, "What gasses should be measured?" is more difficult to answer in part because the contents of each structure fire vary. Since the contents of structure fires vary, the gases produced by them when heated will also vary. Therefore, it becomes impractical to detect and measure all of them. This researcher recognizes that as a result of an oversight in the way responders were limited in their responses during the initial Internal Survey, the data collected might have been slightly skewed. Because our current atmospheric detection equipment can measure multiple gases, (see table 1) these four gasses should be obviously be

monitored. Due to the vague and similar symptoms of exposure to some of the gasses FFD currently monitors, (*Carbon Monoxide,2016)* individuals could be exposed to some of the byproducts of combustion and potentially lethal levels of carbon monoxide and hydrogen cyanide in the absence of appropriate atmospheric monitoring. Furthermore, the results of a study (Hart, 1985) revealed that individuals treated for smoke inhalation at a fire had elevated levels of both carbon monoxide and hydrogen cyanide. Another study from Rhode Island (Hydrogen Cyanide, 2011) revealed multiple firefighters were treated and tested for elevated levels of the same two gases in a twenty-four hour period. NFPA 1404 indicates that the AHJ evaluate the ability of personnel to identify the primary gases produced by combustion and their primary characteristics. One particular author (Larkin, 2016) states that both carbon monoxide and hydrogen cyanide are routinely detected in dark smoke typically encountered at a structure fire. The dark smoke is due in part to the wide variety of petroleum-based products typically encountered at structure fires which is why atmospheric monitoring is so important to the overall health of firefighters. As part of a comprehensive respiratory protection program, additional training should occur for FFD personnel in the use of atmospheric monitoring equipment including an overview of the IDLH atmospheres present at structure fires and an emphasis placed on the use of SCBA until the atmosphere is determined to be safe.

The fourth research question, "Are firefighters aware of the signs and symptoms of exposure?" A review of FFD NFIRS records indicated only one occurrence at a structure fire where a department member received medical treatment. Because no documentation was made about the atmospheric conditions at the fire, it is possible this individual was exposed to toxic gases but did not receive the most appropriate medical treatment. In a recent book (Larkin, 2016) the author states that exposure to the gasses of combustion can produce "dizziness, loss of

sensation and unconsciousness" from atmospheres that could be encountered at structure fires. These symptoms can be anticipated because both carbon monoxide and hydrogen cyanide impair the oxygen-carrying capacity of the blood. NFPA 1584: Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises specifically addresses the need for a policy that addresses medical monitoring of personnel at emergency scenes. The Internal Survey revealed that at least eighty-six percent of responders indicated they were aware of the vague signs and symptoms of possible exposure to a hazardous atmosphere. Although this number is relatively high, it is possible that someone exhibiting these symptoms could be sent back to resume firefighting duties which places them at an increased risk for serious injury. The research identified that with some additional training from our medical director, FFD personnel will be better equipped to recognize these potentially fatal symptoms which could save someone's life. Results of the External Survey indicated 100% of responders felt they were aware of the signs that exposure might have occurred. It is possible that the responders of the External Survey have been educated in the recognition and treatment of exposure to a toxic atmosphere or perhaps were merely lucky identifying the correct symptoms due to their vagueness.

Recommendations

As a result of this project, the research identified that several recommendations to help FFD reach a high level of compliance with applicable standards. One area that needs to be addressed is the implementation of a new policy that requires the use of SCBA at all structure fires until the atmosphere has been monitored and determined to be safe (see Appendix 4). Atmospheric monitoring is a fire ground task that needs to be accomplished. However, it does not necessarily need to be accomplished by FFD personnel. A possible alternative might include delegating this task to a mutual aid company provided they are properly trained in the use of atmospheric monitoring equipment. Due to the toxic atmospheres encountered at structure fires, consideration should be given to the use of multiple gas monitors from responding companies to verify the results of monitoring equipment. This becomes especially relevant considering many of our residential structures are more than 4000 square feet. Since many of these large square foot homes could contain a variety of safe and contaminated atmospheres simultaneously, utilizing multiple pieces of atmospheric monitoring equipment in different locations could help limit the length of exposure through early detection. The utilization of this approach assists the (IC) in making decisions that impact the health of firefighters and civilians. Another recommendation includes making atmospheric monitoring equipment available to fire investigators while on scene conducting their investigation. However, some pushback should be anticipated from “old-school” firefighters who have routinely removed their SCBA after a fire is under control and don’t wear them, especially during overhaul operations because the perceived danger is over.

Another recommendation involves rotating firefighters at the scene of a structure fire into a rehabilitation area as determined by the IC as outlined in NFPA 1584. Documentation of these

individuals who are medically evaluated shall be recorded on a form attached in Appendix 5. When evaluating individuals in a rehabilitation sector, it becomes important that the medical professionals be aware of the potential signs and symptoms of exposure to toxic gases versus simple fatigue and how to treat them appropriately. Since FFD provides both fire and EMS protection, training would be necessary for department members on how to recognize the signs and symptoms of exposure in addition to how to properly treat an individual that was exposed.

The research identified that FFD implement a comprehensive respiratory protection program as defined by OSHA 29 1910.134, 1998 for the overall safety of department members. Although there are components of this standard FFD has instituted, there are other components where FFD is deficient. The areas where FFD is compliant with the standard include annual fit testing of SCBA masks and proficiency training on its use. The department also complies with ensuring the quality of compressed air for SCBA bottles is grade "D" or better. The department, however, does not require annual medical screening to access the abilities of an individual who might be required to wear an SCBA. The FFD also lacks a program Administrator who could evaluate the effectiveness of the program. Finally, compliance with the OSHA standard would include routine training on multigas equipment and monthly SCBA inspections.

The research identidfied that one of the obstacles to becoming fully compliant with the OSHA standard is the financial cost. Additional money would be necessary for medical screening and training of personnel on the use of atmospheric monitoring equipment and how to recognize the signs and symptoms of exposure to a toxic atmosphere. One alternative to reduce training costs is by conducting training while on duty. Additional monetary costs might be incurred by the municipality in the event an individual fails their medical screening and is determined unfit for duty. Among some of these costs that are easy quantifiable include the

possible increase in overtime until a replacement can be hired, the costs associated with finding a suitable replacement, the possible increase to health insurance and Worker's Compensation premiums and legal fees associated defending a possible grievance to determine what is the definition of "fit for duty".

REFERENCES

Carbon monoxide. (2016, November 18). Retrieved from TOXNET: http://toxnet.nlm.nih.gov

Drager X-am 5000 Multi-Gas Detection [Owner's Manual]. (2013). Retrieved from Drager: www.dragersafetyonline.com

Fairlawn Fire Department NFIRS Reports [Internal records]. (2017). Fairlawn, Ohio: Author.

Hart, G. e. (1985). *Journal of Emergency Medicine*, 211-216.

Haynes, H. J. (2016). *Firefighter injuries in the United States.* National Fire Protection Association.

Hoffman, L. S. (2013, November 21). *Inhaled Toxins.* Retrieved from Clinical Key: http://www.clinicalkey.com

Hydrogen Cyanide Recognized As Toxic Threat to Firefighters. (2011, January 01). Retrieved from Fire Apparatus & Emergency Equipment: http://www.fireapparatusmagazine.com/articles/print/volume-16

Larkin, B. (Ed). (2016). Fire Department Incident Safety Officer (Third ed). Burlington, MA: Jones & Bartlett.

LeMasters, Genaidy, Succop, Deddens, Sobeih, Barriera-Viruet, Dunning & Lockey (2006, November). Cancer risk among firefighters: A review and meta-analysis of 32 studies.

Journal of Occupational and Environmental Medicine,

Doi:10.1097/01.jom.0000246229.68697.90

National Fallen Firefighters Foundation (U.S.). International Fire Service Training Association. International Association of Fire Chiefs (2004). *Firefighter life safety initiatives.*

Emmitsburg, MD: The Foundation

NFPA statistics - Firefighter injuries by type of duty [Fact sheet]. (2018). Retrieved from National Fire Protection Association: www.nfpa.org/News-and-Research

National Fire Protection Association (2013). NFPA 1404: *Standard for Fire Service Respiratory Protection Training*. Quincy, MA: National Fire Protection Association.

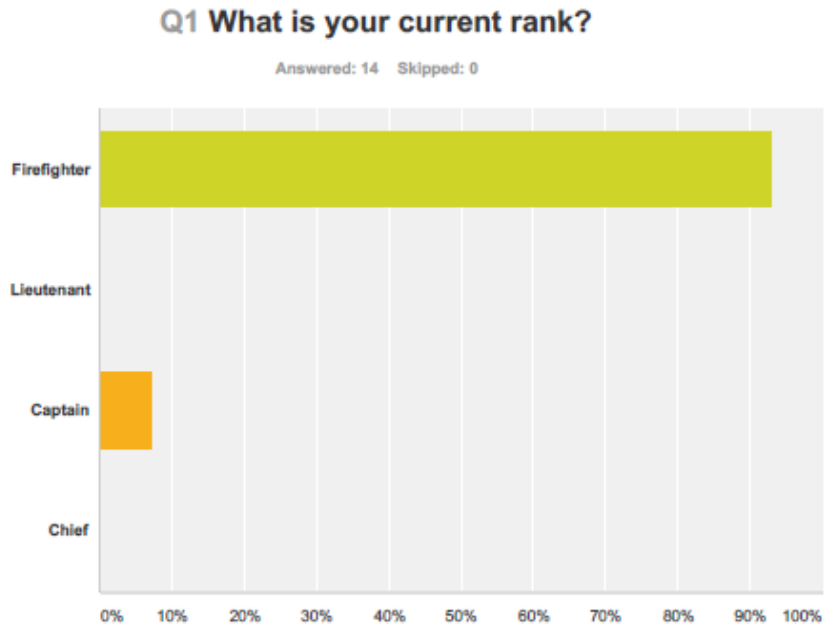
National Fire Protection Association (2015). NFPA 1584: *Standard on the Rehabilitation Process for Members During Emergency Operations and Training Exercises*. Quincy, MA: National Fire Protection Association.

Preventing deaths and injuries of firefighters using risk management principles at structure fires. (2017, January 28). Retrieved from Department of Health and Human Services: www.cdc.gov

The consequences of fire. (2016, 11 18). Retrieved from National Fire Protection Association: www.nfpa.org/news-and-research/news-and-media

APPENDIX 1

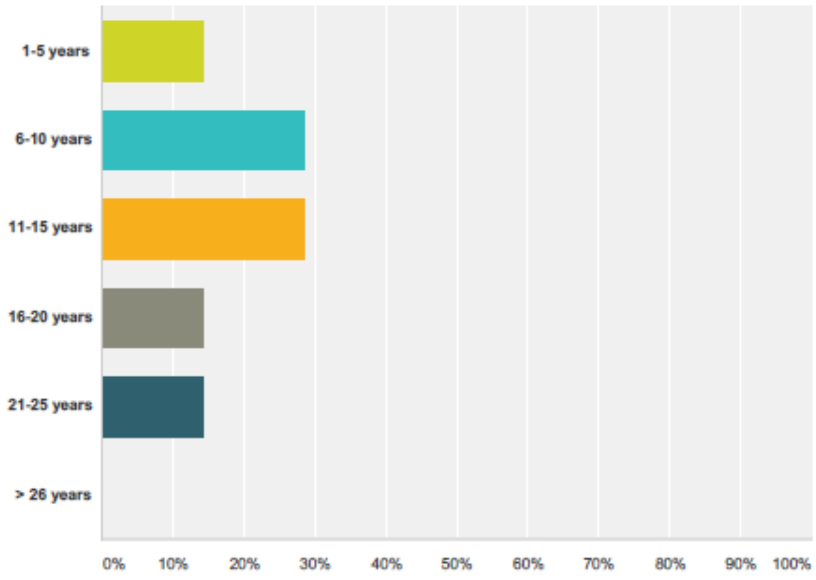
Internal Survey Questions and Responses (FFD)



Answer Choices	Responses	
Firefighter	92.86%	13
Lieutenant	0.00%	0
Captain	7.14%	1
Chief	0.00%	0
Total		14

Q2 How many total years of experience do you have in the fire service?

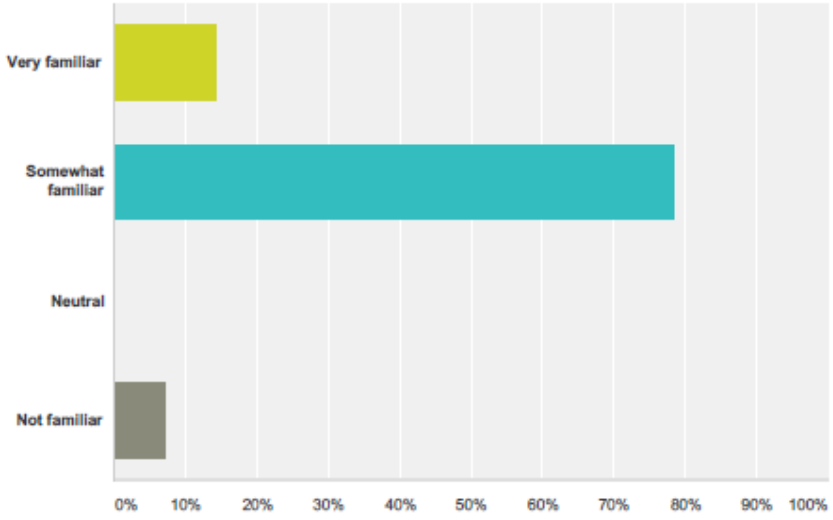
Answered: 14 Skipped: 0



Answer Choices	Responses	
1-5 years	14.29%	2
6-10 years	28.57%	4
11-15 years	28.57%	4
16-20 years	14.29%	2
21-25 years	14.29%	2
> 26 years	0.00%	0
Total		14

Q3 I am aware of the Fairlawn Fire Department SOP regarding atmospheric monitoring at structure fires.

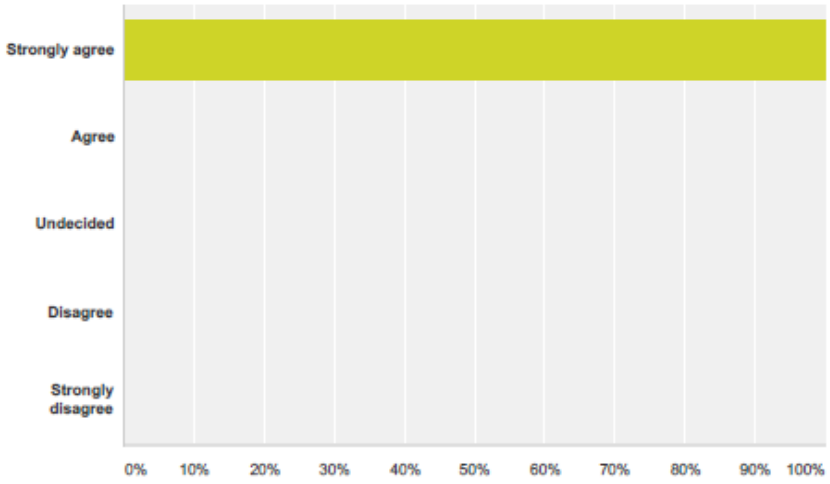
Answered: 14 Skipped: 0



Answer Choices	Responses	
Very familiar	14.29%	2
Somewhat familiar	78.57%	11
Neutral	0.00%	0
Not familiar	7.14%	1
Total		14

Q4 Atmospheric monitoring should be required at all structure fires.

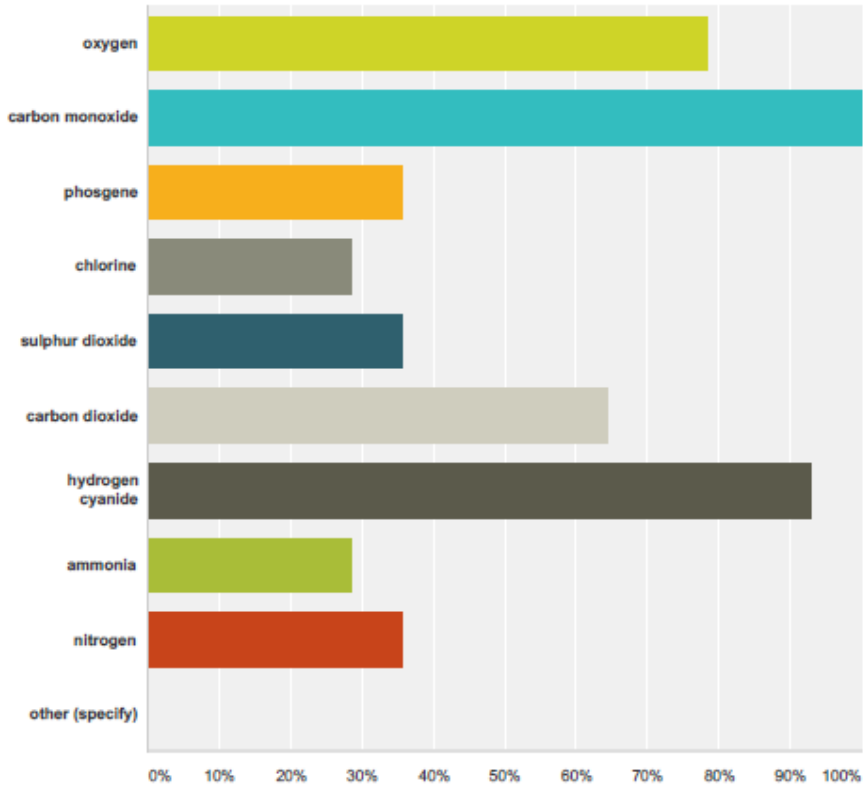
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	100.00%	14
Agree	0.00%	0
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		14

Q5 Which gases should be monitored at structure fires? Check all that apply.

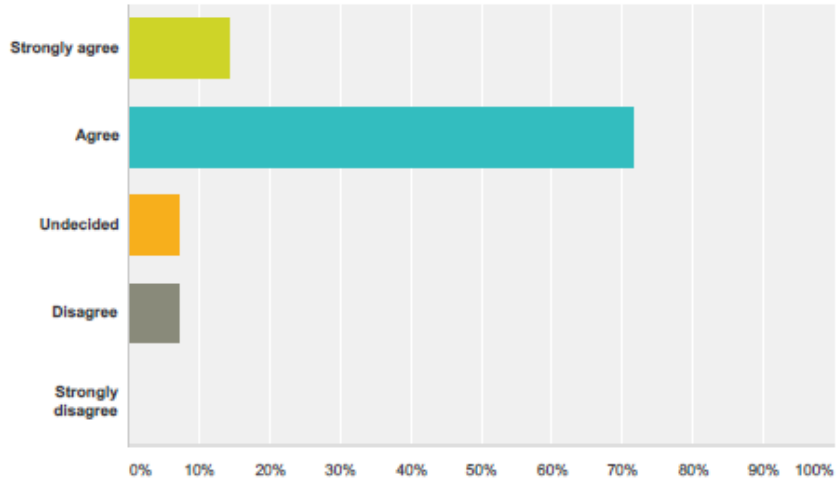
Answered: 14 Skipped: 0



Answer Choices	Responses	
oxygen	78.57%	11
carbon monoxide	100.00%	14
phosgene	35.71%	5
chlorine	28.57%	4
sulphur dioxide	35.71%	5
carbon dioxide	64.29%	9
hydrogen cyanide	92.86%	13
ammonia	28.57%	4
nitrogen	35.71%	5
other (specify)	0.00%	0
Total Respondents: 14		

Q6 I have received adequate training on the use of department atmospheric monitoring equipment.

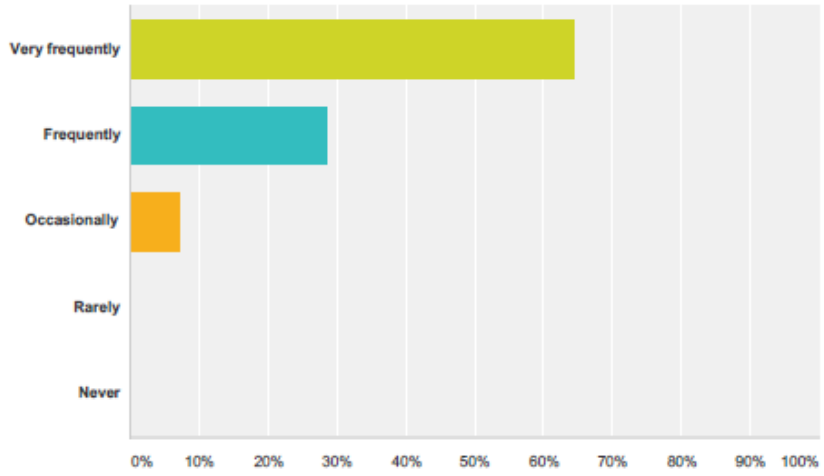
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	14.29%	2
Agree	71.43%	10
Undecided	7.14%	1
Disagree	7.14%	1
Strongly disagree	0.00%	0
Total		14

Q7 How frequently is hydrogen cyanided produced at structure fires?

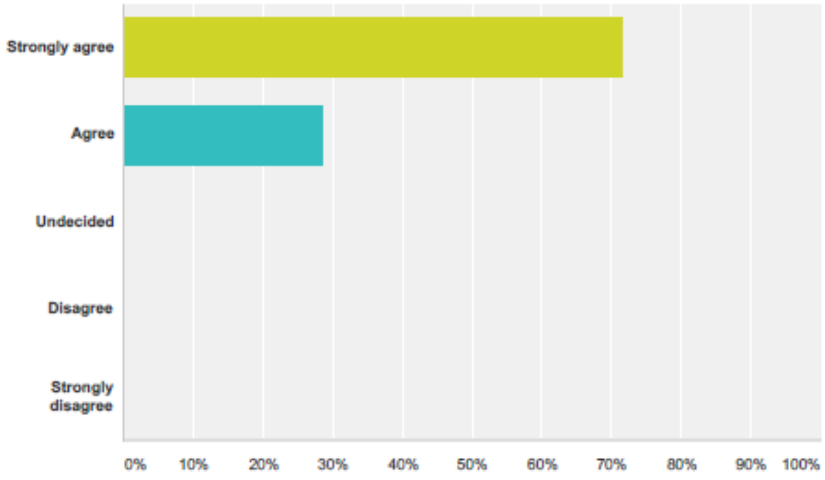
Answered: 14 Skipped: 0



Answer Choices	Responses	
Very frequently	64.29%	9
Frequently	28.57%	4
Occasionally	7.14%	1
Rarely	0.00%	0
Never	0.00%	0
Total		14

Q8 A potential symptom that an exposure to toxic gases occurred at a structure fire might include a headache?

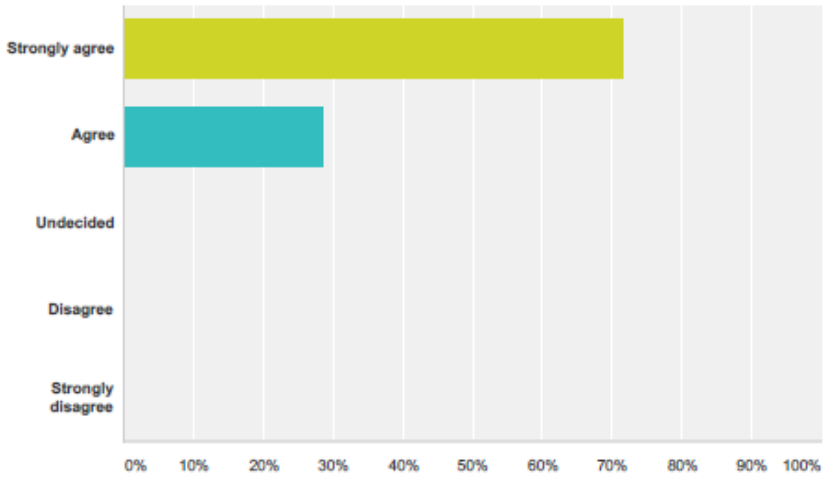
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	71.43%	10
Agree	28.57%	4
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		14

Q9 A potential symptom that an exposure to toxic gases occurred at a structure fire might include feeling weak?

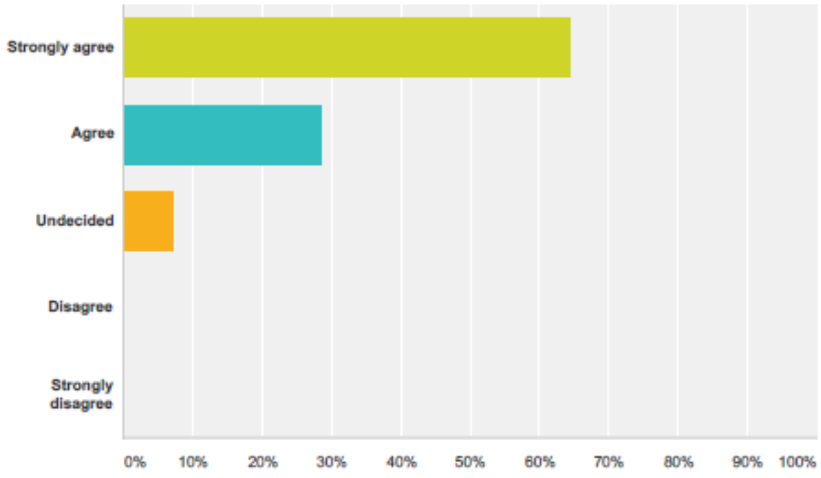
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	71.43%	10
Agree	28.57%	4
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		14

Q10 A potential symptom that an exposure to toxic gases occurred at a structure fire might include a rapid heart rate?

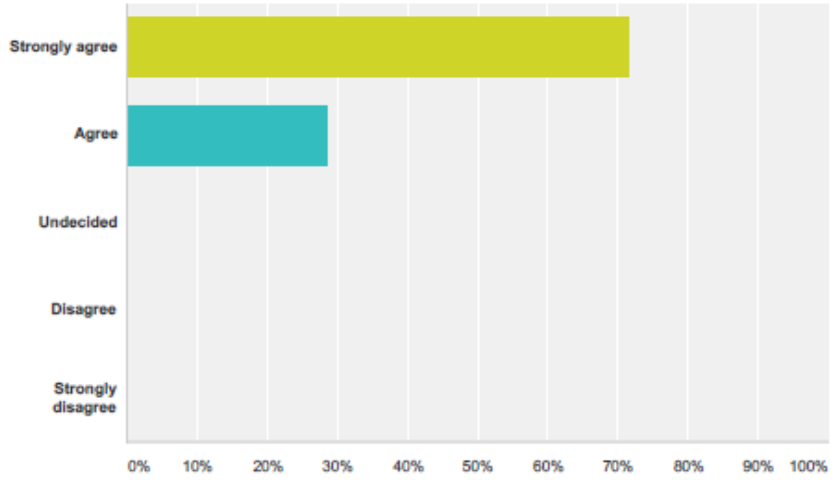
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	64.29%	9
Agree	28.57%	4
Undecided	7.14%	1
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		14

Q11 A potential symptom that an exposure to toxic gases occurred at a structure fire include dizziness?

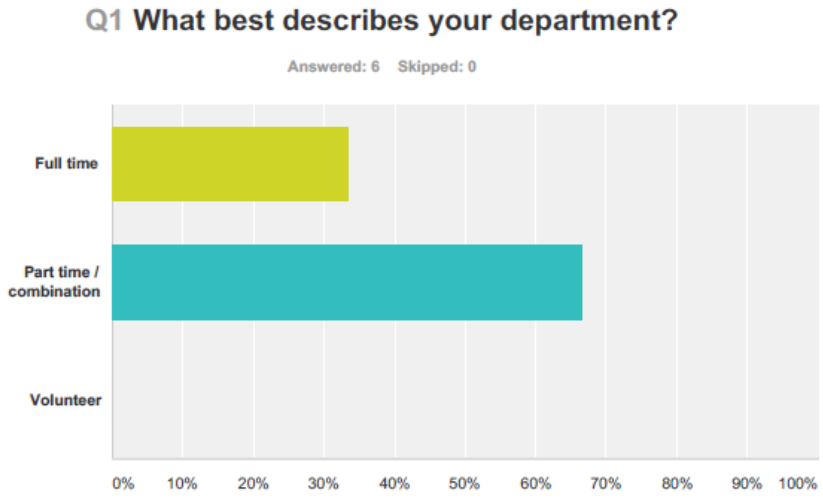
Answered: 14 Skipped: 0



Answer Choices	Responses	
Strongly agree	71.43%	10
Agree	28.57%	4
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		14

APPENDIX 2

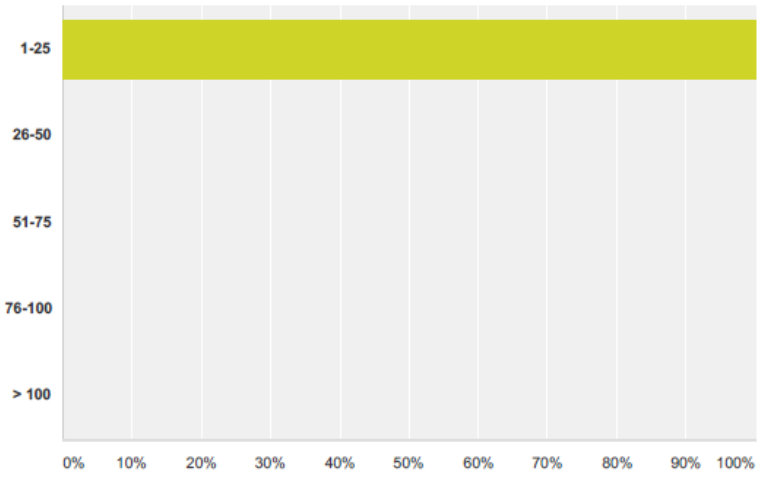
External Survey Questions and Responses (Summit County Fire Chiefs)



Answer Choices	Responses	
Full time	33.33%	2
Part time / combination	66.67%	4
Volunteer	0.00%	0
Total		6

Q2 What is your daily staffing?

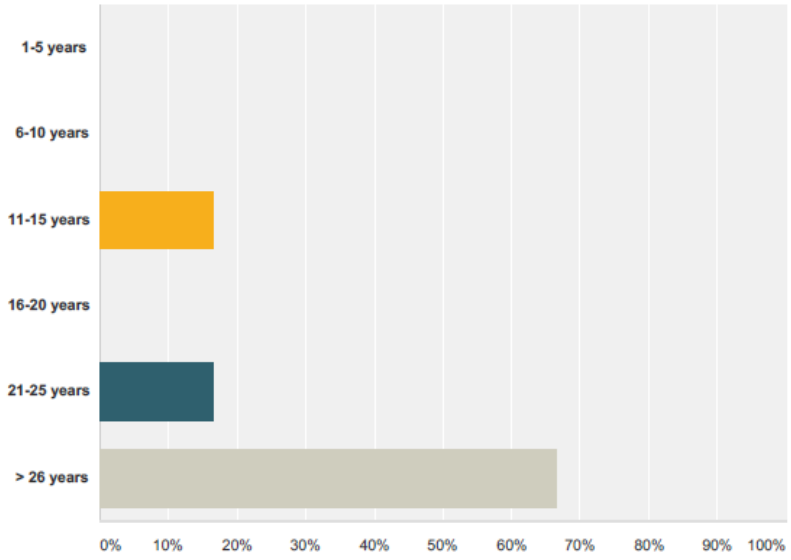
Answered: 6 Skipped: 0



Answer Choices	Responses	
1-25	100.00%	6
26-50	0.00%	0
51-75	0.00%	0
76-100	0.00%	0
> 100	0.00%	0
Total		6

Q3 How many total years of experience do you have in the fire service?

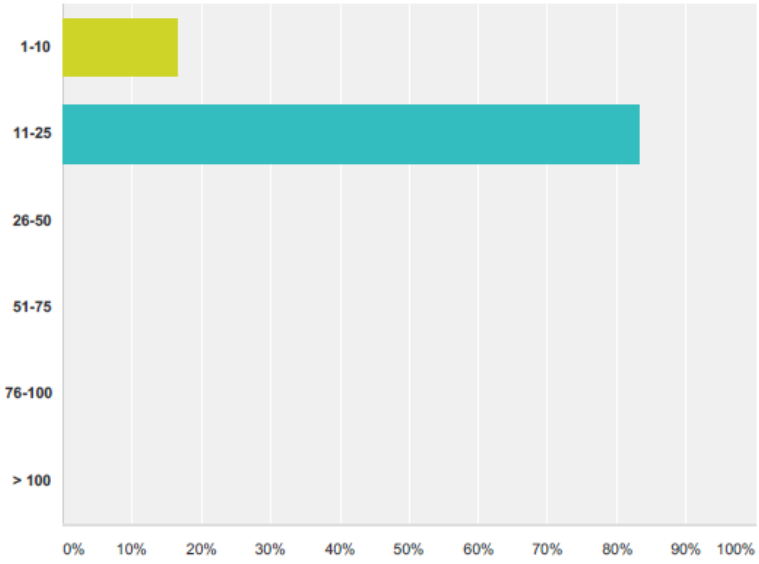
Answered: 6 Skipped: 0



Answer Choices	Responses	
1-5 years	0.00%	0
6-10 years	0.00%	0
11-15 years	16.67%	1
16-20 years	0.00%	0
21-25 years	16.67%	1
> 26 years	66.67%	4
Total		6

Q4 On average, how many structure fires does your department respond to annually?

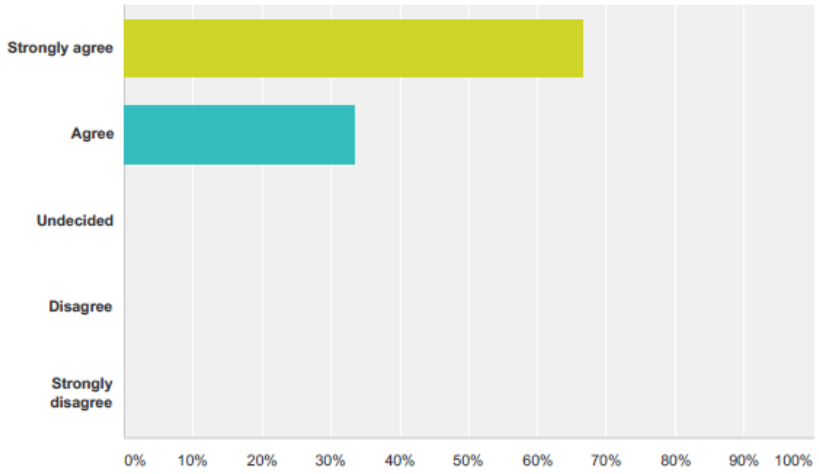
Answered: 6 Skipped: 0



Answer Choices	Responses	
1-10	16.67%	1
11-25	83.33%	5
26-50	0.00%	0
51-75	0.00%	0
76-100	0.00%	0
> 100	0.00%	0
Total		6

Q5 Interior atmospheric monitoring should be required at all structure fires?

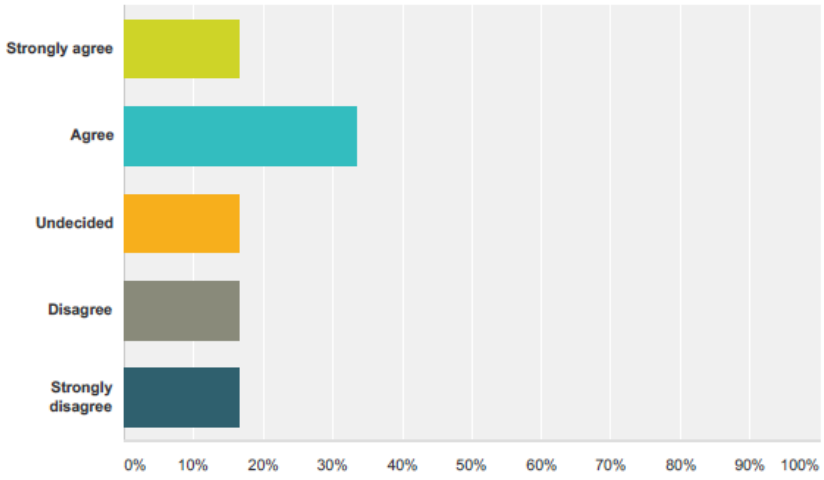
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	66.67%	4
Agree	33.33%	2
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q6 I have received training on my department's SOP regarding atmospheric monitoring?

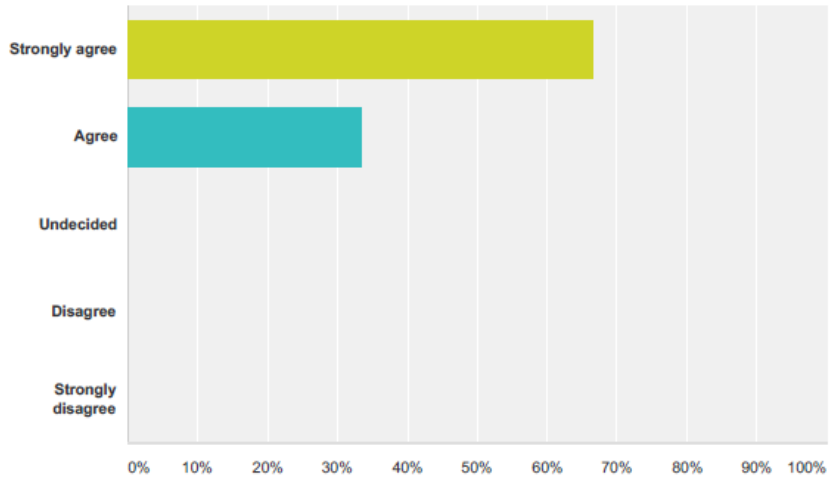
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	16.67%	1
Agree	33.33%	2
Undecided	16.67%	1
Disagree	16.67%	1
Strongly disagree	16.67%	1
Total		6

Q7 I have received training on the by-products on combustion typically encountered at structure fires?

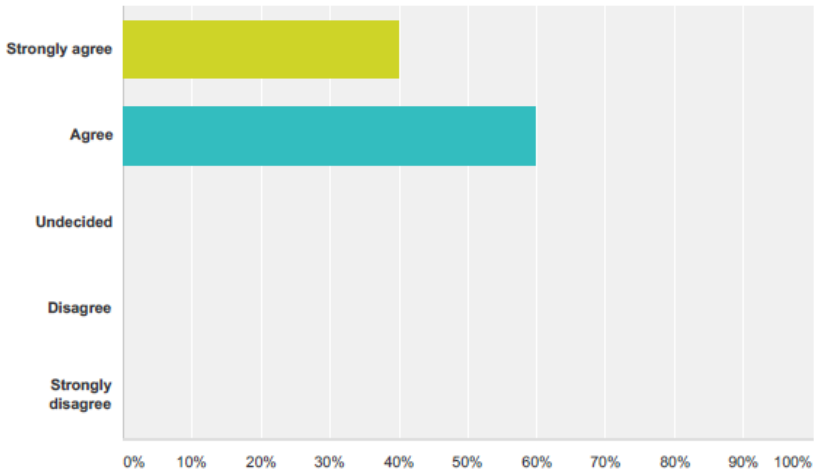
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	66.67%	4
Agree	33.33%	2
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q8 Hydrogen cyanide is typically encountered at structure fires?

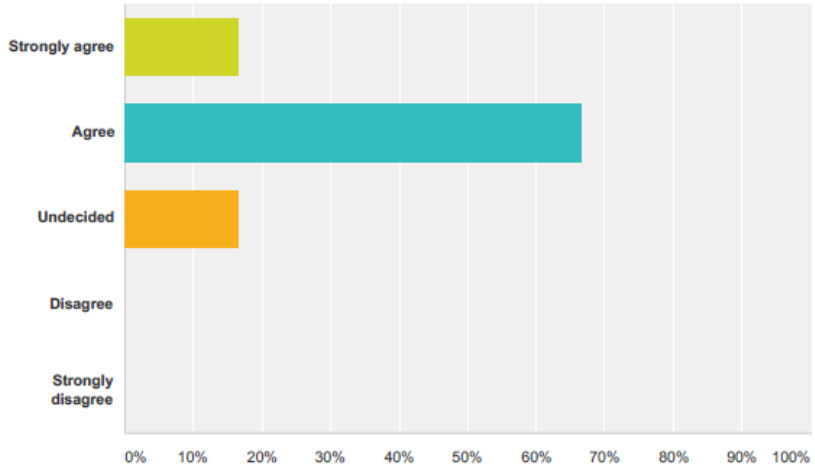
Answered: 5 Skipped: 1



Answer Choices	Responses	
Strongly agree	40.00%	2
Agree	60.00%	3
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		5

Q9 I have received adequate training on how to treat someone exposed to the by-products of combustion encountered at a structure fire?

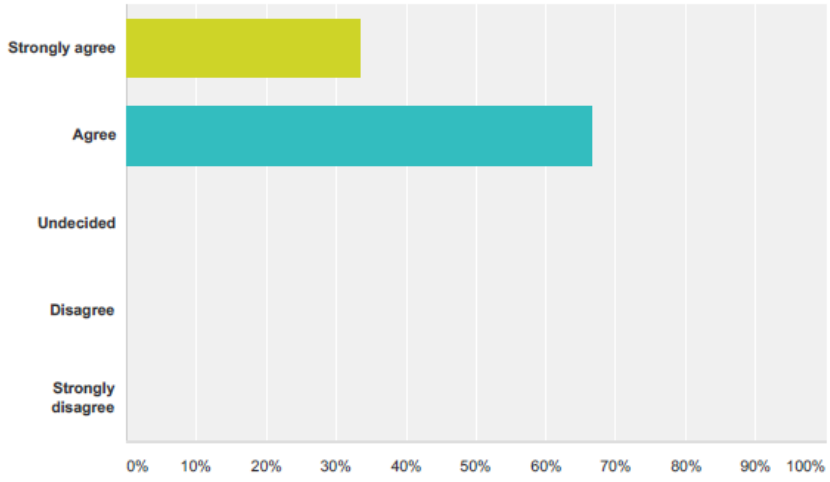
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	16.67%	1
Agree	66.67%	4
Undecided	16.67%	1
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q10 A potential symptom that an exposure to toxic gases occurred at a structure fire include weakness?

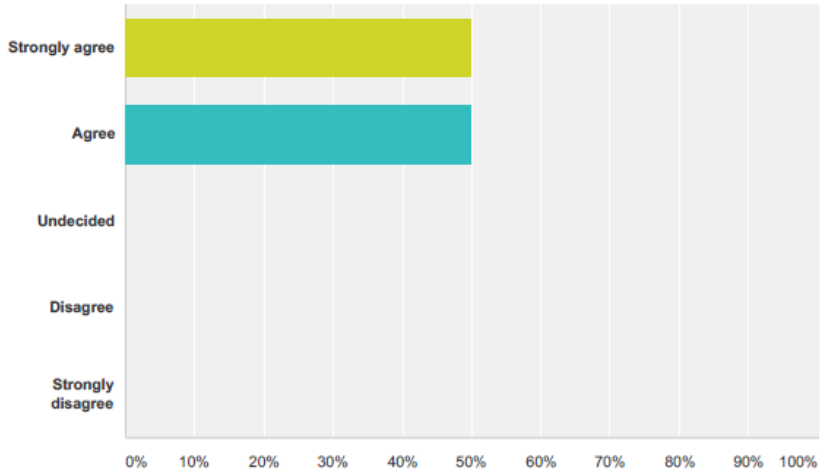
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	33.33%	2
Agree	66.67%	4
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q11 A potential symptom that an exposure to toxic gases occurred at a structure fire include a headache?

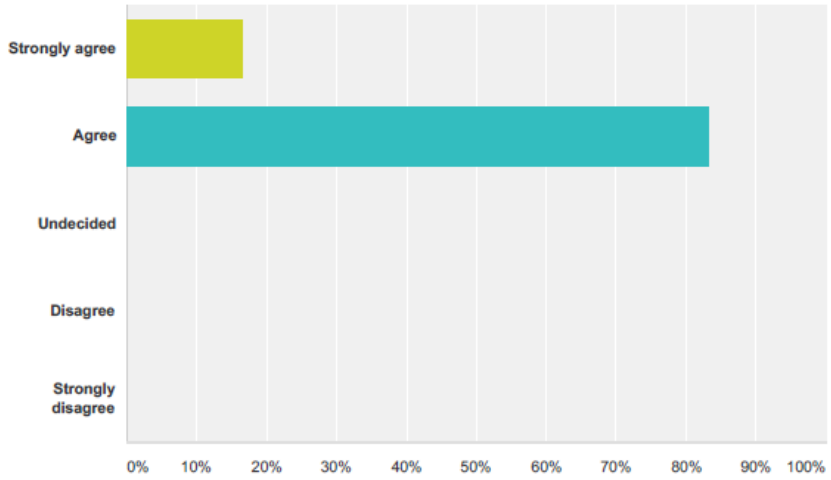
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	50.00%	3
Agree	50.00%	3
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q12 A potential symptom that an exposure to toxic gases occurred at a structure fire include a rapid heart rate?

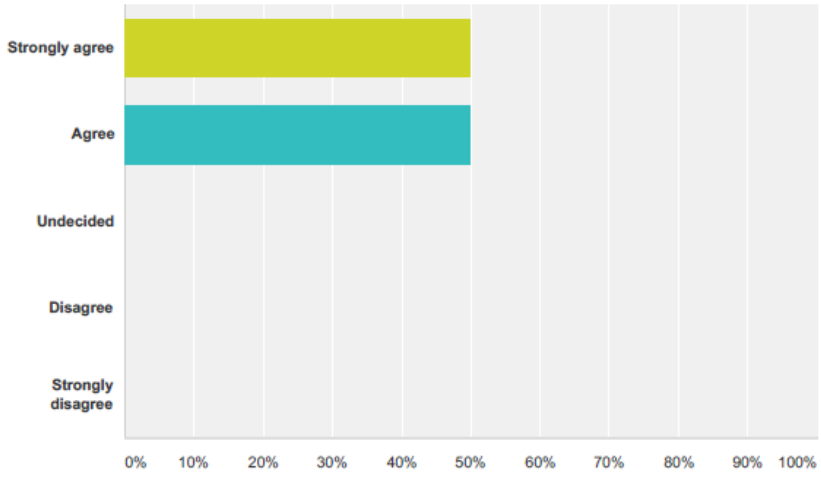
Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	16.67%	1
Agree	83.33%	5
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

Q13 A potential symptom that an exposure to toxic gases occurred at a structure fire include dizziness?

Answered: 6 Skipped: 0



Answer Choices	Responses	
Strongly agree	50.00%	3
Agree	50.00%	3
Undecided	0.00%	0
Disagree	0.00%	0
Strongly disagree	0.00%	0
Total		6

APPENDIX 3

Survey Cover Letter

June 22, 2017

Dear Fire Service Colleague,

I am currently enrolled in the Executive Fire Officer program sponsored by the Ohio Fire Chief's Association, and as a condition of the program, I am required to complete an applied research project. The premise of my paper determining if interior atmospheric conditions should be monitored at structure fires.

Your feedback is important to my paper and will be used as data for drawing conclusions. The survey is anonymous, and no department identifiers are used in my paper from this survey. In the event your department has a SOG on atmospheric monitoring, I would greatly appreciate it if it could be forwarded to me at reymanns@ci.fairlawn.oh.us. Furthermore, if you would like feedback on the survey results, I will be glad to provide them to you upon request. To access the survey, click on the following web link:

https://www.surveymonkey.com/r/QFTPKXS

Please complete the survey by July 1, 2017.

Thank you for your time and support of my project. In the event you have any questions, I can be reached at (330) 668-9540 or via email at the above address.

Respectfully,

Lt. Scott Reymann

Fairlawn Fire Department

APPENDIX 4

Recommended Standard Operating Guideline

Fairlawn Fire Department

Standard Operating Guidelines

Atmospheric Monitoring at Structure Fires

1. The first arriving individual/apparatus will establish Incident Command
2. A Command structure will be established as outlined in NFPA 1561: Standard on Emergency Services Incident Management System and Command Safety
3. All individuals operating in a hot zone of a structure fire shall have appropriate personal protection equipment including use of their SCBA
4. Before an individual removing their SCBA, internal atmospheric conditions shall be monitored with an appropriate multi-gas meter
5. SCBA's shall not be removed until after the atmospheric conditions have been determined to be safe from harmful levels gases being monitored
6. The determination of when to remove an SCBA will be made by the Incident Commander or Safety Officer

APPENDIX 5

Recommended Rehabilitation Summary Log

Rehabilitation Summary Log Date_____

Incident Commander_____ Location_____

Rehabilitation Group Supervisor_____

Rehabilitation Sector Established: Time_____

Location:_____

Designated Squad at Rehab Unit #_____

Special Equipment Needed_____

_____

_____

_____

_____

Special Equipment Used_____

_____

_____

_____

Attach Personnel Rehab Log: _____

Attach EMS run sheet for all personnel referred to Rehab Group

Number of forms attached_____

Signed by Rehab Group Supervisor_____

Reviewed by Incident Commander_____

Medical Advisor (contacted within 24 hours)_____

PERSONNEL REHABILITATION LOG

RUN # ____________________

NAME	TIME IN	HYDRATION AMOUNT	VITAL SIGNS @ 10 MIN				SIGNS/SYMPTOMS	DISPOSITION STAGING OR EMS, ETC.	TIME OUT
			T	P	R	BP			