Reducing the Risk of Injury and Disease among Fire Investigators at Washington Township

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ABSTRACT

The purpose of this study was to identify the causes of injury and disease among fire investigators at the Washington Township Fire Department. Fireground operations have been the basis of most research in the field of fire suppression, while not recognizing that the danger does not end with fire extinguishment.

The problem studied was the inconsistencies found among fire investigators in their personal protective gear and the dangers that exist when a fire investigation occurs. After the research was completed, a draft policy was created to guide departments, including Washington Township, in decision making with regards to fire investigator safety.

Descriptive research was used to answer four questions:

- What are the physical, toxic, and biological dangers on the post fire scene that increase the risk of injury or exposure to carcinogens?
- What are the barriers that prevent the fire service from decreasing the risk of injury and exposure to carcinogens for fire investigators?
- What are the current best practices to reduce risk of injury and exposure to carcinogens for fire investigators?
- What are other Ohio fire departments currently doing in regards to fire investigator personal protective equipment?

A focus group of fire investigators from a local task force, NAS-T, was interviewed and each member was asked their thoughts on fire investigator safety. Second, a survey was sent to fire officers across the state of Ohio. In addition, a literature review was completed that focused on safety issues for fire investigators.

Results of the focus group showed that time of day is the biggest hindrance to a safe fire scene, while the survey revealed that personal protective equipment use and respiratory protection are very inconsistent across departments. The recommendations were to conduct investigations in daylight hours and for departments to have a standard operating procedure, including respiratory protection, that covers scene safety for fire investigators.

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Statement of the Problem

Washington Township's typical ensemble for a firefighter is consistent across the ranks, from firefighter to investigator, starting with a bunker coat and pants. In addition to those items, gloves, hood, helmet and a full self-contained breathing apparatus are the acceptable level of protection for firefighters in the field. At Washington Township, fire investigators are required to follow the same rules and guidelines as firefighters in regards to personal protective wear, up to and including self-contained breathing apparatus.

The problem this research addressed is the inconsistencies in personal protective equipment among fire investigators, and the dangers that exist when proper equipment is not worn consistently during all phases of operations, from initial fire attack to the investigation of the scene.

Purpose of the Study and Research Method

The purpose of this study was to provide the fire department with research-based information to effectively protect fire investigators on emergency scenes and throughout their careers.

The research method chosen for this study was descriptive. Washington Township needed direction and guidance when it came to writing an effective SOP in regards to fire investigator respiratory and physical protection. The SOP in effect at the time only addressed firefighters, with a footnote at the end for investigators to follow the guidelines set forth within it.

The research addressed the following questions:

1. What are the physical, toxic, and biological dangers on the post fire scene that increase the risk of injury or exposure to carcinogens?
2. What are the barriers that prevent the fire service from decreasing the risk of injury and exposure to carcinogens for fire investigators?
3. What are the current best practices to reduce risk of injury and exposure to carcinogens for fire investigators?
4. What are other Ohio fire departments currently doing in regards to fire investigator personal protective equipment?
5.

BACKGROUND AND SIGNIFICANCE

The Washington Township Fire Department is a combination agency employing both full and part-time employees. Of these employees, there are 110 full-time members, supplemented by anywhere from 20 to 30 part-time firefighters. The Township protects the City of Dublin, as well as the unincorporated area of the Township. The population for the area, as of 2010, was close to 41,000 people. This is the number of people that actively live in Dublin. During the day, the population more than doubles in size due to the large amount of industry within the city and township. Washington Township has an annual budget of twenty three million dollars. The department responded to 5,681 calls for emergency services in 2017, including twelve investigated fires. These investigations were in Washington Township and in areas covered by automatic response agreements. In addition to providing primary fire and EMS services to the residents, the department

has mutual aid agreements with all of the departments in Franklin County, as well as all other surrounding counties. Agreements are also in place with all departments in Ohio due to a statewide disaster response plan. Although this agreement is not used often, Washington Township still could be utilized anywhere in Ohio.

The fire investigation bureau of Washington Township is a member of the Northern Area Response Team. In short, NAS-T is a group of six departments that share resources in regards to fire investigations and other fire duties. If a member department needs help investigating a fire, all agencies on the team are expected to send an investigator to the scene if requested. This enables the members of the departments to gain valuable experience with many fires over the course of a year, but also exposing those members to more products of combustion.

Fire investigators at Washington Township in the past have not had a set of guidelines to follow to protect themselves. Investigators have a certain amount of apathy and complacency in regards to taking precautions to help themselves stay safe. Dangers exist though that cannot be readily seen. In his research, Fabian found that high levels of ultrafine particles exist on fire scenes even after the fire is out. These particles cannot be seen, and are largely ignored by crews. He explains it as follows, "The invisibility of ultrafine particles to the human eye creates a false sense of safety that leads firefighters to remove their protective equipment in order to ameliorate the physical burden and potential heat stress associated with continued utilization of SCBA during overhaul". (Fabian 2010). In addition to the apathy that is created by not being able to see the particles that are harming firefighters, physical exertion has kept many investigators from wearing a full set of protective equipment. By not wearing full sets of protective gear,

including SCBA, firefighters and investigators have shown that they can work a lot more efficiently. (Saas 2014).

Fire investigators have typically been ignored when it comes to operational decisions on fire scenes. In the past, the investigator showed up to a emergency scene after the fire was out, anywhere from minutes after extinguishment to a few hours, depending on the location of the person doing the investigation. Wearing only a pair of jeans and work boots, they would dig through piles of fire debris and breath in the products of combustion without giving it a second thought. Sometimes a simple filter mask would be used, but most times not. The charred soot would cover their clothes and body. Then they would jump in the truck to go home, throwing the soot covered clothes in the washer and tracking debris all throughout the house or fire station (Altomare 2018).

In short, investigations were not professional and consistent (NFPA 1033). Because of this lack of professionalism and consistency, NFPA 1033 and NFPA 921 were drafted and changed the way investigations were undertaken. These documents treated fire investigations as a science. The scientific method became the normal process in which to investigate a fire after these documents were released.

The prevalence of almost every type of cancer known to man has increased among firefighters and fire investigators, almost to the point that as a profession, firefighters expect to get it at some time over their career. The statistics show that approximately 60% of career firefighters will die of cancer and that the leading cause of death for those in the fire service is cancer (Fire Service Occupational Cancer Alliance 2017).

The high rate of cancer led to the creation of the Firefighter Cancer network and the Firefighter Cancer Foundation, whose sole purpose is reducing the risk to the occupation.

In the past fifteen years, priorities have changed and investigations have become much more structured and professional. Fire investigators are exposed to the products of combustion from the moment they enter a fire scene until they decontaminate themselves and their equipment. In fact, due to the changing nature of the items being consumed in fires (petroleum and synthetic based products), investigators are in danger of being exposed to higher levels of carcinogens than ever before (Herbert 2008). This has occurred because the building and construction materials that are in use today are changing in their chemical makeup. Hydrogen Cyanide and formaldehyde are being introduced in new products in increasing rates (Herbert). This has created awareness in the investigator community, which has slowly found its way into the fire departments across the country.

Member departments of NAS-T all have different approaches to personal protective equipment. Washington Township requires investigators to wear full SCBA protection (self contained breathing apparatus) until the investigation is complete. In addition, investigators are required to wear long sleeve shirts and pants when conducting an investigation. Norwich Township investigators, which is the area just south of Washington Township, use air-purifying respirators. This difference in required gear leads to confusion on investigation scenes and operating procedures not being followed. For example, if an investigator from a neighboring agency comes to Washington Township to investigate a fire, they may not have an SCBA in their vehicle. On the flip

side, if a Washington Township investigator goes to another agency, Washington employees are required to wear SCBA. The department may not have SCBA available for use.

Fire investigators are also subjected to other dangers while in the course of their duties. Sprains, strains, and falls are just a few of the dangers that can be increased or decreased depending on the attention being given to procedures. In addition to the numerous dangers inherent to fire scenes, time of day may be the biggest concern of all. Many communities will not even start an investigation until daylight if the incident occurs at night, due to the increased risk of injury at night. Instead of quickly rushing in to investigate, the scene gets secured by police officers or additional firefighters until daylight hours. By doing this, the scene also "cools off" and products of combustion dissipate.

The overall goal of this research is to create an effective SOP (Standard Operating Procedure) for Washington Township investigators that addresses personal protective equipment and safety measures on fire scenes. Firefighters are currently covered by an SOP on fireground respiratory protection and PPE, but it is geared towards suppression activities. Investigations have always followed that one. The department would be better served however, to have a separate policy that addresses actions after the fire is out. This research will impact the department by creating a safer environment, both long term and short term, for fire investigators.

Literature Review

Cancer and other diseases are high on the list of ailments that affect fire investigators and firefighters alike. In fact, the incidence of cancer in the population of those in the fire service was almost fifteen percent higher than the general population in a study conducted by the National Institute of Occupational Safety and Health completed in 2013 (Daniels 2014). This has led to laws being crafted in many states that help the fire service deal with the increasing rates by giving presumptive liability to many cancers and other diseases. The laws generally allow firefighters to receive workers compensation benefits if they are diagnosed with any of a list of diseases. Proof does not need to be presented, only the fact that the person was a firefighter or fire investigator. The laws come with differing degrees of stipulations for coverage, but most all cover cancer. On January 4, 2017, Ohio passed such a bill, Senate Bill 27. It was named the Michael Louis Palumbo Act in honor of its namesake (Luzzi 2017). Michael was a captain in Ohio who died of work related brain cancer in 2015. Ohio is the 35th state to enact presumptive liability legislation.

Bohm (2009) researched hazards that were present at fire scenes after initial fire extinguishment. The author referenced the Oregon Occupational Safety and Health Code (OROSHA), as well as NFPA 921, NFPA 1033, NFPA 1037, and NFPA 1500, to conclude that fire investigation scenes contain two main types of dangers for personnel, physical and respiratory. Bohm noted that there are both acute and chronic hazards on the fire scene that are being driven by the increased use of synthetics in our everyday lives. Society is demanding products to meet their needs that contain different types of plastics. When burned, these plastics release gases as

well as unknown vapors. The author found that these plastics leave behind unburnt particles that float around the atmosphere at fires, entering the respiratory tract of unprotected investigators. In addition to these particles, the author noted that scenes contain numerous toxic inhalants (ammonia, acrolein, benzene, phosgene, hydrogen cyanide, carbon monoxide, etc.) that greatly increase the risk of acute and chronic disease when inhaled (Bohm 2009).

Bohm (2009) also found the physical hazards on fire scenes are very diverse in nature. They include electrical dangers, environmental factors such as weather, noise, holes and damage to the structure being investigated, and traps (explosives, incendiary devices, etc.). Missing from his research was the existence of biological hazards.

Horn and a team of other researchers studied how wearing a full self-contained breathing apparatus affected physiological factors of a firefighters performance (Horn 2015). In their studies, it was recommended that firefighters follow a strict rehabilitation schedule if using more than one bottle of air on a scene. This included large breaks in between bottle changes. The study found that after the first bottle of air is expired, the risk of slip, trip, and fall injuries significantly increased. By taking breaks and ceasing to operate after the second bottle, injury risks were decreased on the fireground.

Tualatin Valley Fire and Rescue (2011) studied the use of Positive Pressure Ventilation to assist with decreasing the amount of particulates and toxins in the post fire scene. The study showed that there was a natural dissipation of chemical levels detected over the first forty-five minutes after fire knock down. After one

hour, most products of combustion had completely dissipated (Tualatin Valley 2011). In addition to positive pressure ventilation, Tualatin took samples of the air using UV Spectrometry. The dangerous products of combustion are not just limited to carbon monoxide. Tualatin Valley's studies encouraged fire departments to take samples of the air using this technology. They recommended that investigators not wear SCBA when in a non-IDLH, or immediately dangerous to life and health atmosphere, as the heavy equipment is not practical for a fire investigation scene.

Pauley (2017) found that in addition to toxic and physical hazards, fire investigators are exposed to biological hazards, such as bodies (human and animal), animals, and poisonous plants. He discussed the various sources of toxic gases produced from fires, most notably carbon monoxide and hydrogen cyanide. Pauley (2017) called these two gases the "toxic twins". He discussed how to mitigate the effects of these toxic gases, as well as others, through use of ventilation. He stressed however, that it was not a cure-all to a safe scene in regards to respiratory hazards, due to particulates being stirred up through the ventilation process. Monitoring of air is required. Only half of departments surveyed monitored the air after fire extinguishment. Time, ventilation, and PPE are the biggest allies according to the author. To assure adequate respiratory protection, air purifying respirators (APR) or self-contained breathing apparatus (SCBA) are a required piece of equipment for gases and particulates.

How self-contained breathing apparatus' affected the wearer was studied by IIham Bakri (2012). Bakri compared physical responses of each volunteer when wearing different SCBA. They differed in weight and overall structural design of the

harness that the user wore during the testing period. Participants were studied on a treadmill and their physiological responses at different temperatures were noted. Physiological strain, muscle fatigue, thermal sensation, and thermal discomfort were compared to a control group not wearing a breathing apparatus. The participants' oxygen update, metabolic rate, heart rate, temperature and total sweat rate were measured during work and in a recovery period.

The results of the study concluded that wearing a heavy self contained breathing apparatus significantly increased oxygen consumption and metabolic rate of the participants, an increase of 50% in one of the test groups (Bakri 2012). Other test groups saw increases of anywhere from 23% to 40% when compared to the control group. The study also found that heart rate remained unchanged except when an increase in temperature was added to the test factors. He noted that the most interesting part of the research was the fact that lighter weight breathing apparatus and harness design can significantly reduce oxygen consumption of the user by decreasing metabolic rates. Muscle fatigue and thermal discomfort were also lower as SCBA weight lowered and harness design changed. No statistical differences were found in rectal temperature of the test subjects between the control and test groups.

Donahue (2017), when discussing barriers or reasons why fire investigators are being exposed to high amounts of cancer causing materials when conducting investigations, found that the majority of investigators were not even wearing respiratory protection during fire investigations. Overall, he found that funding, training, research, and education are neglected in regards to fire investigations.

Even though respiratory protection is recommended across the occupation during overhaul and investigation, it is not being practiced. This is leading to exposure of irritants, chemical asphyxiates and carcinogens. Donahue also talked about ventilation, and how a well-ventilated scene, when combined with respiratory protection, can greatly reduce exposure to respiratory carcinogens and irritants (Donahue 2017).

Saas (2014) studied reasons why workers on the fireground removed their self-contained breathing apparatus and found that it occurred for a few reasons. Removing the equipment was due to "peer pressure, habit, and the awkwardness of the apparatus. Thus, the issue of non-compliance points directly to the need for a change in attitude when it comes to wearing a SCBA in IDLH environments." (Saas 2014, pg. 43). A correlation was found between education and compliance. Those with college degrees removed their equipment earlier than those with only a high school education.

Rank played a role as well in compliance. Saas found that lieutenants and captains were the least compliant of all groups studied. He attributed this to the fact that officers had to be able to communicate with their crews and the face piece hindered that work. (Saas 2014).

When carbon monoxide levels were less than 35 ppm (parts per million), data collected from a study by Thomas Brice (2010) indicated that associated levels of hydrogen cyanide, phosgene, sulfur dioxide, and acid gas were at safe levels. Brice concluded that if the level of carbon monoxide was less than 8 ppm, the four gases also correlated with this low level and produced no detectable quantities in an

amount that would be considered dangerous to firefighters. This study was considered limited though due to the small number of fires, four, that were actually looked at for the research. Although his research showed safe levels during overhaul, he cautioned that other research contradicted his studies. Brice also contended that due to his position as Deputy Chief, many of those reporting findings may have been untruthful due to the fear of reprisal for not adhering to strict self contained breathing apparatus procedures (Brice 2010).

Davis (2013), working with the ATF, studied a bladder cancer cluster that occurred within the agency in the late 1990's and early 2000's. The data uncovered seven cases of bladder cancer within the specialty units of the Bureau. Specifically, certified fire investigators were found to have a twelve-fold increase in bladder cancer risk. These members were exposed to hundreds of fire scenes in their training program to become investigators, which was part of a two year certification process (Davis 2013). Due to this increase in cancer risk, the Bureau of Alcohol, Tobacco and Firearms decided that precautionary actions among agents working on fire scenes needed to change. They raised awareness through training, a formalized respiratory protection program, and through personal decontamination in the field. Since starting this program six years ago, the ATF has not had a case of bladder cancer among agents in the fire investigation field (Davis 2013).

The notable part of this investigation that differed from others is the fact that the pool of agents involved stayed relatively consistent over the duration of the study. In fact, all of the employees that tested positive for bladder cancer during the

study (2003-2007) were still employed upon completion. This allowed the completion of work history questionnaires throughout their careers (Davis 2013).

Berger (2015) noted that data and research in the field of fire investigation personal protection is small when compared to overall fireground operations such as suppression. Because of that fact, many departments do not have formalized standard operating procedures for fire investigators, and rely on fireground suppression policies to cover them. His research led to a respiratory protection program for the Travis County Fire Marshals Office and it's employees. This program found that respirators need to have "filters that are NIOSH rated to protect against organic vapors, acid gases, dusts, mists, fumes, formaldehyde, asbestos, and particulates" (Berger 2015). Included in his recommendation for respiratory protection was a program administrator position that oversees the created respiratory protection program to make sure it is effective over time. In addition to the respiratory requirement, Berger also designed an SOP for the Travis County Fire Marshal's Office that included protection for the rest of a fire investigator's body. Berger stated in his conclusion that all of these programs will not work unless a cultural change occurred and fire investigators wore gear consistently (Berger 2015).

The International Association of Arson Investigators presented a recent study that discussed best practices for fire investigators, from arrival at the fire scene to after the incident (IAAI 2018). This study focused attention on areas that had been overlooked in the past, such as the vehicles in which investigators were driving and decontamination after the job was complete. In addition, this study

broke the fire scene down into different time periods, from overhaul phase to 72 hours post incident.

The IAAI found that due to the high level of contaminants and particulates, self contained breathing apparatus should be worn by investigators that were entering the scene during the overhaul phase. The study went on to make recommendations at the two-hour mark and seventy-two hour mark. At the two-hour mark of extinguishment, the IAAI found that air purifying respirators with a P100 cartridge capable of removing particulates, organic vapors, and acid gases was sufficient for protection. After seventy-two hours, the scene was considered cold and respiratory protection was at the discretion of the department (IAAI 2018).

In addition to respiratory protection, the study also had recommendations for decontamination of responders. Recommended practices were to remove all outer clothes and place them in sealed bags for transportation to a cleaning or disposal area. They also recommended that PPE be transported either in sealed containers or the utility area in the case of trucks (IAAI 2018).

Procedures

In order to answer the questions posed by this research paper, two separate procedures were used to gather data; a survey that was emailed statewide, and a focus group consisting of local members of the fire investigation community, NAS-T (Northwest Area Strike Team), as well as an author and highly respected member of the worldwide fire investigation community. In addition, a literature review was completed to assist with the answers to the questions presented.

Survey

The first procedure was a survey that was mailed to 215 fire officers across the state of Ohio and 20 members of Class 17 of the Ohio Fire Executive Program. The fire officers were all graduates of the Ohio Fire Executive Program and as such, were expected to have a great amount of institutional knowledge about their department as a whole, and of the separate bureaus within. The members of OFE Class 17 were expected to have the same knowledge. Respondents to this survey instrument would be apt to know the answers to the questions being sent without having to ask different members of their respective departments for additional information. This accomplished two things; surveys were answered in their entirety and not submitted incomplete and that they would respond due to their past involvement and interest in the OFE Program. In addition, the respondents were chosen because of their ability to be decision makers at their respective departments.

The departments represented by the survey consisted of full-time, part-time, and combination departments across the state of Ohio. No preference was given to size or budget of the departments surveyed, as a simple random sample (SRS) was what was desired.

Respondents were informed what the study was about and why it would be helpful to the profession of fire investigation. The questions were mostly closed ended, with an open ended final question. The survey is included, as well as the answers to the open ended question, in Appendix A and B of this research paper.

The survey was open for thirty days to allow those that did not check their email frequently the chance to respond.

The email format was chosen because results had to be obtained in a relatively short period of time, less than thirty days, and because it was the most cost effective method that could be found to obtain information on the subject. After two weeks, an email reminder was sent out to those that had not completed the survey. The survey generated 72 unique responses, which equated to a response rate of 31%.

Group Discussion

The second data collection instrument used was a group discussion, consisting of members of the NAS-T (Northwest Area Strike Team) group. This group meets monthly at a member fire department facility. These monthly meetings involve training and topical discussions.

The following questions were presented to the NAS-T group:

- What do you and your department feel are the biggest dangers faced as fire investigators on post fire investigations? Are they physical in nature or related to time of day?
- What barriers exist in the workplace (fire scenes) that prevent you from being safer in regards to your profession? Is there anything that can be done to change the culture at member departments and make fire investigators adhere to respiratory and barrier protection?

- What are your departments doing in regards to personal protective equipment for fire investigators?

The research questions were presented to members and they were invited to respond in front of the group or in private via email and/or personal discussion. The same questions were also sent to Michael Donahue, an author of fire investigation books and frequent contributor to published material in fire journals.

Four member departments returned emails answering the questions, as well as Michael Donahue. In the round table discussion, notes were taken in regards to how member departments felt about the questions in relation to their own departments.

Limitations of the Study

Limitations that could affect the results of this research were the lack of scholarly articles available dealing with fire investigator safety. The profession is just starting to make research based decisions in the field, and has always based operating procedures for fire investigators on the research that has been done in the field of firefighting.

In addition, the results of the survey were not verified by rank and could have been filled out by subordinates. The open-ended question answers found in Appendix B were vague in a few instances and did not contain a detailed response.

Results

The group discussion and literature review provided answers to the first question presented; What are the physical, toxic, and biological dangers on the post fire scene that increase the risk of injury or exposure to carcinogens?

The results of the group discussion showed that the biggest danger to the investigator was the time of day that the fire occurred. NAS-T members discussed the fact that darkness on the fireground was the largest obstacle to safety of the investigator. Members shared that when fires occurred at their respective departments, they waited until daylight to start their investigation of the scene if it was possible. By waiting until daylight, hazards could be seen more clearly. All four departments that returned email responses, as well as Donahue, were unanimous in their response. The group also reaffirmed this answer. As a whole, the group added that electrical hazards created a dangerous environment as well. The danger of electrical hazards also increased at night and was partially mitigated by waiting until daylight to begin investigations.

The literature review showed that biological dangers on the fireground include bodies, both human and animal, in varying degrees of decomposition or fire damage. In addition, laboratories and other businesses store biological dangers in different forms. Biological hazards are not limited to bodies and laboratory dangers. They can also include poisonous plants and bites from both animals and bugs (Pauley 2017).

The literature review provided the answer for what toxic hazards exist on a fire investigation scene. The main toxic dangers were found to be hydrogen cyanide

and carbon monoxide. In addition, organic and acid vapors were the two other large concerns for fire investigators on fire scenes. Included in the gases were ammonia, acrolein, benzene, phosgene, and hydrogen sulfide (Bohm 2009). The gases are not the only inhalation danger however. Particulates from unburned plastics floating in the atmosphere created a respiratory hazard to fire investigators.

The second research question asked what the barriers were that prevent the fire service from decreasing the risk of injury and exposure to carcinogens for fire investigators. This question was answered through the group discussion of fire investigators, through both email responses and round table discussion. One of the respondents, Michael Donohue, offered that training, research, funding, and education are most often neglected in the fire investigation field. Donohue said that shifting some of the resources to investigations would make a huge difference in mitigating dangers on the fireground. Most of the funding and research has gone to fire suppression. Three of the members said that the largest barrier to decreasing exposure was a lack of standard operating procedures at their department. Two of those in the group noted that a lack of standard operating procedures kept fire investigators from protecting their respiratory tract. They stated that although firefighters were required to wear self contained breathing apparatus while working in a hot zone, fire investigators were not mentioned, and therefore did not adhere to the stricter requirement.

The literature review also provided insight into another barrier to exposure, rank. Lieutenants and captains were the least compliant of all the groups studied, which was found to be because the officers felt they had to be able to be able to

communicate effectively with those on the scene. Wearing a face piece did not allow for proper communication to some of them, and created an atmosphere where respiratory protection was not worn (Saas 2014).

The third question was answered by the literature review. What are the current best practices to reduce risk of injury and exposure to carcinogens for fire investigators? Although many of the cited reviews offered insight, the IAAI and their Health and Safety Committee presented recommendations for both incident safety and post incident safety (IAAI 2018).

The IAAI Health and Safety Committee listed the appropriate personal protective equipment as follows:

- Steel-toed boots with a puncture resistant sole.
- Disposable Tyvek suit with hood. Where this was not available, long sleeve shirt and pants at a minimum to prevent skin absorption.
- Protective helmet suitable for industrial use.
- Hearing protection.
- Proper respiratory protection for the situation found.
- Vented goggles.
- Disposable outer gloves and nitrile inner gloves.

The respiratory protection level was further discussed in Appendix A of their research paper, including indications of level of protection (IAAI 2018). For example, full SCBA was indicated in active overhaul scenes, while an air -purifying respirator was the preference for scenes that were two hours old.

A minimum of two investigators was the recommended manpower for fire scenes unless the scene is deemed to be safe for one person (IAAI 2018).

Post incident best practices were also listed in the IAAI report as follows:

- Immediately remove all PPE and if disposable, place in a sealed bag for later disposal.
- Non-disposable items are to be sealed in a plastic bag and not opened until a cleaning source is available.
- Non-disposable items are to be cleaned by a commercial service or extractor. At no time should items be cleaned in the same washer as everyday clothing unless an empty complete cycle with soap has been completed after they are washed.
- Clean tools and respirator prior to returning them to vehicle.
- Do not transport dirty tools, evidence containers with samples, or contaminated PPE in the passenger compartment. These items should be sealed in a container for transport or transported in the bed of a truck.
- Replace footwear prior to entering vehicle.

Last, current best practices recommended by the International Association of Arson Investigators deal with skin cancer. Annual skin checks are required to check for skin cancer and should be performed by a dermatologist. A written log should be maintained by the fire investigator, including the following:

- Date, location, and nature of each incident.
- The number of hours spent on the scene.
- Any hazardous conditions should be noted or any exposure/injury.

The last question asked was local and was answered by the survey that was sent out to fire officers across Ohio. What are other fire departments currently doing in regards to fire investigator personal protective equipment?

How is your agency staffed?

Answer Choices	Responses	
fulltime	45.83%	33
part-time	1.39%	1
volunteer	0.00%	0
fulltime/part-time mix	51.39%	37
other	1.39%	1

How many firefighters are employed by your agency?

Answer Choices	Responses	
1-15	0.00%	0
16-50	63.89%	46
50-100	31.94%	23
101-150	4.17%	3
151+	0.00%	0

How likely are your fire investigators to wear personal protective equipment? (not including respiratory protection)

Answer Choices	Responses	
Very likely	23.61%	17
Likely	51.39%	37
Neither likely nor unlikely	11.11%	8
Unlikely	11.11%	8
Very unlikely	2.78%	2

What type of PPE does your department supply for fire investigators?

Answer Choices	Responses	
bunker gear	94.37%	67
helmet	92.96%	66
hood	81.69%	58
tyvex	54.93%	39
gloves	94.37%	67
eye protection	88.73%	63
ear protection	59.15%	42

What type of respiratory protection do your fire investigators wear?

Answer Choices	Responses	
SCBA	26.76%	19

APR (Air Purifying Respirator)	11.27%	8
PAPR (Powered Air Purifying Respirator)	0.00%	0
particulate mask	29.58%	21
none	32.39%	23

If you have an SOP on PPE, do you feel it provides sufficient guidance?

Answer Choices	Responses	
Yes	23.61%	17
No	18.06%	13
Not Applicable (no SOP in place for fire investigator protection)	58.33%	42

How likely are your fire investigators to wear respiratory protection on a post-fire scene?

Answer Choices	Responses	
Very likely	4.17%	3
Likely	27.78%	20
Neither likely nor unlikely	23.61%	17
Unlikely	34.72%	25
Very unlikely	9.72%	7

At a typical fire-scene, what amount of PPE do your fire investigators typically wear?

Answer Choices	Responses	
head protection	76.06%	54
eye protection	46.48%	33
body protection (Tyvek, turnout gear, etc.)	77.46%	55
long sleeve shirt and long pants	40.85%	29

Does your agency do an annual fit test for respiratory protection?

Answer Choices	Responses	
Yes	93.06%	67
No	6.94%	5

Does your agency require an annual physical for fire investigators?

Answer Choices	Responses	
Yes	49.30%	35
No	50.70%	36

What types of training does your agency provide to fire investigators?

Answer Choices	Responses	
Scene Safety	95.65%	66
Respiratory Protection	82.61%	57
Personal Protective Equipment	85.51%	59
Blood Borne Pathogens	75.36%	52

In addition to the multiple choice answers, the final question posed in the survey asked respondents what they felt could be done to increase safety and reduce exposure to carcinogens at their respective agency. Fifty-five responses were given. Of those responses, 27 percent, or 15 out of 55 responses, said that standard operating procedures were the answer to increasing safety. Appendix A lists the all questions included in the survey. Appendix B lists the individual answers submitted with the survey.

Discussion

Firefighting is a dangerous profession and respiratory protection is at the top of the list to make it a safer environment in which to work. Although investigators are exposed to the same products of combustion and environments, many things have kept them from properly protecting themselves.

The survey results were consistent with what the researcher has seen on the fireground over the past twenty years.

The survey showed that departments are doing a good job of providing fire investigators with PPE when respiratory protection is excluded. Ninety-four percent provide bunker gear and gloves, while 93% issue a helmet. No explanation was given for the one department that issued gear but not a helmet. Eighty-nine percent of departments provide eye protection, while only 59% provide protection

for hearing. Personal protective equipment does not appear to be a problem among Ohio fire departments.

Respiratory protection is the area in which Ohio fire departments need to concentrate their attention. There is a need in Ohio to provide better respiratory protections to department fire investigators. The survey revealed that only 38% wore an air purifying respirator or SCBA on scenes. Thirty percent wore a simple particulate mask, while 32% wore no respiratory protection at all. This is the area in which our fire departments can make the biggest contribution to decreasing their employees risk of developing disease or cancer. We as a profession need to assure that both our firefighters, as well as investigators, are wearing the proper respiratory protection. As a profession, we cannot accept anything less.

Physicals for fire investigators were also an area in which departments are not doing a good job. Half of the departments surveyed did not do an annual physical of their employees. While many are under budget constraints, others simply feel they are not necessary. Departments should make physicals a priority to find problems before they become larger issues. Skins cancers can be caught early, as well as other physical ailments. By not requiring annual physicals, departments are merely "kicking the can down the road". Health and safety should be at the forefront of the department's concern.

Standard operating procedures, or SOPs, were not in place at 58% of departments, and another 18% had them but felt they did not provide guidance for investigators. By not having procedures or guidelines for investigators to follow, we are allowing bad habits in our profession. These bad habits lead to complacency

and lack of willingness to adhere to recommended practices. National and state standards may provide excellent guidance, but without a local procedure in place, employees will not follow the more strict rules that are established for personal protection. Departments across Ohio are not doing a good job at guiding investigators. After the fire is out, guidance is minimal.

Barriers to preventing injury and exposure to carcinogens was surprising. Many departments said that rank was a reason for not wearing proper protection while on the fireground(Saas 2014). The answer given by most respondents is that it limited communication with the people that were under their command as officers. I found this answer to not have any basis in reality. While doing an investigation, the fire is out and the emergency has been resolved. Wearing an air purifying respirator or SCBA would still enable the user to communicate with their crews. Officers are able to wear them and communicate during an active fire, and an investigation is no different. In fact, the opposite is true. When the emergency is over, crews work in a more deliberate fashion and have more time to understand and comprehend directions. In addition, background noise is less after the fire is extinguished.

Standard operating procedures were also lacking at departments, according to the group discussion. The group felt that a lack of a procedure was the reason why many investigators were failing to protect themselves to exposures. The group agreed that apathy was the one of the largest barriers to overcome to get investigators to wear the proper equipment. Funding was also mentioned by one

member of the group. He offered that most of the funding was given to fire suppression, both by internal budgets and external grants.

Recommendations

After researching the topic of injury and disease prevention for Washington Township Fire Department, this researcher has come up with recommendations to improve the department currently and for years to come. These recommendations were constructed based on the literature review and survey results.

Implementation of the recommendations should start immediately and continue unless additional research contradicts the findings.

A standard operating procedure for fire investigators should be written and implemented based on the findings of the literature review, in particular the findings of the International Association of Arson Investigators (IAAI 2018). This report listed best practices based on their own findings and was based on scholarly research. The SOP should be primarily for fire investigators, as fire suppression crews already have one in place in most jurisdictions. A few key points should be addressed in the new SOP that differ from the one that is currently in place for firefighters, the most important of which being selection of respiratory protection. There is no one solution that fits all fire scenes, however, and the scene commander should ultimately make the decision on the proper respiratory protection for the scene.

The second major change should be directed at respiratory protection. Currently, investigators are required to wear SCBA until the run is complete, also referred to as “Signal O”. Although this is the highest of respiratory protection

available for fire personnel, it physically limits investigators when taking pictures and in the amount of time spent inside the affected structure. Physiological factors should be considered due to the long periods of time that investigators must remain on scene compared to firefighters. Long term SCBA use was found to have major physical effects on the body(Bakri 2012), and should be taken into consideration when developing a new policy. The guidance of the IAAI and their research should be followed at Washington Township (IAAI 2018). P100 air purifying respirators are the current standard and should be used at the discretion of the scene commander.

Finally, fire investigations should be delayed until daylight. If the scene needs to be held for long periods of time, a single firefighter or police officer is able to accomplish that without legal ramifications. One public safety person in the jurisdiction is all it takes to keep a scene secure. The group discussion showed that the main concern of most investigators is working in darkness. After the fire is extinguished, the emergency is over. Giving a scene time to be ventilated and "cool off" decreases the particulates and carcinogenic gases that are found in smoke and off gassing. This "cooling off" time can be accomplished by waiting until daylight on scenes that occur at night. By waiting until daylight to start investigations, fire investigators are also less likely to injure themselves due to scene safety increasing with daylight.

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Appendix A

Fire Investigator Data Collection

1. How is your agency organized:

- ◯ fulltime
- ◯ fulltime/part-time mix
- ◯ part-time
- ◯ other
- ◯ volunteer

2. How many firefighters are employed by your agency?

- ◯ 1-15
- ◯ 100-150
- ◯ 16-50
- ◯ 151+
- ◯ 50-100

3. Does your department complete its own fire investigations or are they done by an outside agency (ex. State Fire Marshal)

- ◯ Department
- ◯ Outside Agency

4. How likely are your fire investigators to wear personal protective equipment, not including respiratory protection?

- ◯ Very likely
- ◯ Unlikely
- ◯ Likely
- ◯ Very unlikely
- ◯ Neither likely nor unlikely

5. What type of personal protective equipment does your department supply for fire investigators?

- ☐ bunker gear
- ☐ helmet
- ☐ hood
- ☐ tyvex
- ☐ gloves
- ☐ eye protection
- ☐ ear protection

6. What type of respiratory protection do your fire investigators wear while conducting investigations?

- ◯ SCBA
- ◯ APR (Air Purifying Respirator)
- ◯ PAPR (Powered Air Purifying Respirator)
- ◯ particulate mask
- ◯ none

7. If you have an SOP, do you feel it provides sufficient guidance against scene dangers, including respiratory issues?

- ◯ Yes
- ◯ No
- ◯ Not Applicable (no SOP in place for fire investigator protection)

8. Does your agency monitor air quality prior to entry of fire investigators?

- ◯ Yes
- ◯ No

If so, what gases do you monitor?

9. How likely are your fire investigators to wear respiratory protection on a post-fire scene?

- ◯ Very likely
- ◯ Likely
- ◯ Neither likely nor unlikely
- ◯ Unlikely
- ◯ Very unlikely

10. At a typical fire-scene, what amount of PPE do your fire investigators typically wear?

- ☐ head protection
- ☐ eye protection
- ☐ body protection (tyvek, turnout gear, etc.)
- ☐ long sleeve shirt and long pants

11. Does your agency do an annual fit test for respiratory protection?

- ◯ Yes
- ◯ No

12. Does your agency require an annual physical for fire investigators?

- ◯ Yes
- ◯ No

13. What is the manpower requirement for a fire investigation at your agency?

- ◯ Single investigator
- ◯ Investigators work in pairs
- ◯ Investigator has a fire crew on scene at all times
- ◯ Investigator has a police officer on scene

14. How familiar do you feel your firefighters and fire investigators are in the products of combustion and how they affect health and welfare?

- ◯ Extremely familiar
- ◯ Very familiar
- ◯ Somewhat familiar
- ◯ Not so familiar
- ◯ Not at all familiar

15. What types of training does your agency provide to fire investigators?

- ☐ Scene Safety
- ☐ Respiratory Protection
- ☐ Personal Protective Equipment
- ☐ Blood Borne Pathogens

16. What do you feel could be done to increase safety and reduce exposure to carcinogens for fire investigators at your agency?

Appendix B

Q16 What do you feel could be done to increase safety and reduce exposure to carcinogens for fire investigators at your agency?

Answered: 55 Skipped: 17

#	RESPONSES	DATE
1	Make it mandatory(SOP)	7/11/2018 11:24 AM
2	air monitoring and use of respiratory protection	7/11/2018 10:44 AM
3	With regards to PPE, approach a fire investigation as you would if you were on the attack line.	7/3/2018 4:07 PM
4	Have a policy and training in place for investigators specifically to be able to ensure they have the proper PPE and respiratory protection in place at all times.	7/3/2018 2:46 PM
5	Continued monitoring of atmosphere with available gas detectors and adding monitoring equipment for known carcinogens post-incident	7/3/2018 9:33 AM
6	NA	6/30/2018 10:56 AM
7	Require proper PPE to be worn during all investigations and require a fire crew to remain on scene at all times.	6/29/2018 9:13 AM
8	For the limited investigations we complete a S.O.G coupled with training and appropriate PPE levels would be an effective beginning to what we do now.	6/29/2018 7:22 AM
9	The department needs to have policy in place and provide equipment and training necessary to maintain a safe environment. The investigator must take it upon themselves to take appropriate actions to minimize their risk/hazards surrounding the fire scene. Appropriate training on safety and awareness needs to repeated often so it stays fresh in their minds and complacency is minimized.	6/29/2018 7:14 AM
10	For my department, the development and implementation of an OP that sets the expectations for PPE to be worn during investigations.	6/28/2018 12:53 PM
11	A thorough SOP, that covers the required protection needs implemented and followed. Currently in our department its based on what investigator is working.	6/28/2018 9:29 AM
12	Full Respiratory Protection SCBA at all times	6/28/2018 7:41 AM
13	Provide respirators	6/28/2018 7:38 AM
14	They wear the PPE that is provided to them	6/28/2018 5:46 AM
15	more frequent use of ppe	6/27/2018 10:34 PM
16	Set standard PPE requirements.	6/27/2018 10:29 PM
17	more training	6/27/2018 10:03 PM
18	SOG for PPE during fire investigation. We rely on the county FIU team for anything on a larger scale or suspicious. On the FIU team there is also no SOG for PPE to my knowledge.	6/27/2018 10:00 PM
19	Nothing. It is up to the investigator(s) themselves to make sure they are wearing the correct PPE	6/27/2018 9:11 PM
20	Consistent training. Teachback from the continued education to the rest of the dept so that we may aide in the position.	6/27/2018 8:58 PM
21	Look into monitoring phosgene, cyanide gases or other products of combustion	6/27/2018 6:30 PM
22	Fit testing. Physicals.	6/27/2018 5:41 PM
23	SOG Better PPE	6/27/2018 5:03 PM
24	Increase duration of SCBA use during fire incidents	6/27/2018 2:24 PM
25	We use outside agencies so I have no comment	6/27/2018 2:24 PM
26	Continuous air monitoring	6/27/2018 1:45 PM

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27	We always monitor the air before entry without protection. Better protection for the body could be provided other than turnout gear.	6/27/2018 1:22 PM
28	Increase respiratory protection that will actually be used; protection that does not significantly hinder FIU operations.	6/27/2018 1:10 PM
29	Use the PPE provoded	6/27/2018 1:09 PM
30	Mandatory SCBA use	6/27/2018 12:53 PM
31	Cancer prevention and decontamination	6/27/2018 12:46 PM
32	Better protective gear relative to the climate, better follow-up procedures for cleaning self, tools, vehicles, uniforms etc.	6/27/2018 12:13 PM
33	Patience, allow ample time for the scene to off gas to reduce the exposure potential.	6/27/2018 12:06 PM
34	emphasize the need to clean up self and PPE prior to leaving scene.	6/27/2018 12:05 PM
35	A policy or SOP to be followed instead of no guidance..	6/27/2018 12:04 PM
36	Better monitoring of the atmosphere	6/27/2018 12:04 PM
37	Use NFPA health and safety standard and invesigator standard.	6/27/2018 12:03 PM
38	Post clean up procedures	6/27/2018 12:02 PM
39	Require SCBA for investigations and develop an SOP/SOG for the Investigator's position	6/27/2018 11:58 AM
40	Provide appropriate training and equipment.	6/27/2018 11:44 AM
41	Better training for investigators. We do not have formal training exclusively for investigators, but we should. Carcinogen hazards still exist even though the fire is out and smoke is clear	6/27/2018 11:42 AM
42	Wear propergear	6/27/2018 11:41 AM
43	appropriate resp. equipment along with proper PPE, air monitoring and decon. as needed.	6/27/2018 11:34 AM
44	Strengthen requirements for respiratory protection.	6/27/2018 11:29 AM
45	I believe continuing training as well as new requlations as Cancer is being recognized as a line of duty issue now	6/27/2018 11:24 AM
46	Create a magic button that makes everyone buy in to the value of wearing ppe, including scba, when entering all post fire emergency scenes.	6/27/2018 11:19 AM
47	Don't call them out to the scene. lol	6/27/2018 11:14 AM
48	decon on scene and shower immediately after investigation	6/27/2018 11:12 AM
49	Respiratory protection	6/27/2018 11:08 AM
50	SOP's which included SCBA use for investigations.	6/27/2018 11:03 AM
51	Education for culture change	6/27/2018 10:59 AM
52	PPV	6/27/2018 10:57 AM
53	Make sure the IC checks for air quality prior to turning scene over to investigator.	6/27/2018 10:56 AM
54	Respirators with disposable cartridge containers	6/27/2018 10:55 AM
55	Have a policy in place to address this.	6/27/2018 10:53 AM

Appendix C

Draft Policy

Washington Township Fire Department
Standard Operating Guidelines

Respiratory Safety P100 Air Purifying Respirator Usage

Intent and Purpose

1. It is the policy of the Washington Township Fire Department to implement a systematic approach for using the P100 air purifying respirator during fire investigations.
2. The purpose of this guideline is the respiratory safety of all Washington Township fire investigators.

Responsibilities

1. Responsibility of the Incident Commander to implement the guideline.
2. Responsibility of the Fire Marshal to train members in the usage of the guideline.
3. Responsibility of all members to know and understand this guideline.

Guidelines

1. When all fire suppression is completed, the P100 air purifying respirator will be used for respiratory protection from organic vapors, acids, and particulates.
2. Before P100 masks are permitted, Interior Command will monitor the atmosphere.
3. Using the 4 gas monitor, the oxygen, CO, and LEL will be monitored.
4. Oxygen levels must be no lower than 19.5% to remove SCBA (NFPA standard).
5. CO levels will be no higher than 25 ppm to remove SCBA.
6. LEL must be at a safe level.
7. At any point, if the fire investigator or Incident Command feels the atmosphere is unsafe, they may don an SCBA.

8. P100 may be worn when particulates are a concern, but SCBA is not warranted.
9. Follow the manufacturer recommendations for storage and replacement of cartridges.

Replacement

1. Replacement cartridges and equipment will be ordered by the Safety Officer.
2. All fire investigators shall have enough cartridges in their vehicle for two working incidents.