

Air Management - Evaluating the Implementation and Effectiveness of Air Management

for Orange County Fire Rescue Department

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Certification Statement

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

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Abstract

Firefighters in the United States are dying at an alarming rate and the third leading cause of these deaths is running out of air in dangerous environments. Routinely, firefighters wait until their low air alarm activates before they leave a dangerous environment. The problem is that Orange County Fire Rescue Department (OCFRD) is allowing personnel to use this practice. The purpose of this research is to establish policies requiring firefighters to use air management in accordance with NFPA 1404. The action research method was utilized to answer the following questions:

- 1) How does the department's general order of air management comply with the Occupational Safety and Health Administration (OSHA) standards of respiratory protection?
- 2) What standards or guidelines for air management have other departments implemented?
- 3) What elements are needed to create a successful air management program for OCFRD?
- 4) What factors can contribute to a firefighter becoming low or out of air?
- 5) What elements of training during mock scenarios can be improved to enhance the implementation of air management?

Based on drills that were conducted in 2009, it was determined that the mean air usage for a firefighter using a 45 minute cylinder was just over 22 minutes while performing simulated firefighting tasks. This data and an extensive literature review demonstrate that OCFRD and other fire departments should implement a policy requiring the use of air management during emergency operations. This project concluded with the development of a written Emergency Operating Procedure requiring using the “Rule of Air Management.”

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Introduction

Over the last three decades, career and volunteer firefighters have come to understand the importance of using a self contained breathing apparatus (SCBA) when operating in toxic environments. Most understand that inhaling the "...Breath From Hell" can cause short term and long term medical consequences up to and including death (Gagliano, Phillips, Jose, & Bernocco, 2008). Fire departments around the Globe spend countless hours and money training personnel on how to properly don and use an SCBA or air-pack. Underwater divers conduct the same type of training with self contained underwater breathing apparatus (SCUBA) designed specifically for use under the water. What separates these two disciplines from each other is – the Rule of Air Management (ROAM).

Today's fires produce more toxic gases than in the past (Gagliano et al., 2008). Toxic gases are produced by almost everything we have in our home or office today during a fire. They are made of synthetic, man-made materials and petroleum based products that produce hundreds of deadly gases. Often smoke incapacitates so quickly that firefighters are overcome and cannot make it to an otherwise accessible exit. The synthetic materials commonplace in today's homes and offices produces especially dangerous substances. As a fire grows inside a building, it will often consume most of the available oxygen, slowing the burning process. This incomplete combustion results in toxic gases. The most common, carbon monoxide (CO), can be deadly, even in small quantities, as it replaces oxygen in the bloodstream 200 times faster than oxygen can be absorbed (Porter, Bledsoe, & Cherry, 2005). Hydrogen cyanide results from the burning of plastics, such as PVC pipe, and interferes with cellular respiration. Phosgene is formed when household products, such as vinyl materials, are burned. At low levels, phosgene can cause itchy eyes and a sore throat; at higher levels, it can cause pulmonary edema and death. Many of

these products of combustion, such as the present day electronics, were not produced in years past. Long after the fire is extinguished, the fuel, such as vinyl, plastics, and foam, still remains hot and produces the same toxic fumes. The Phoenix Fire Department completed a study that revealed that a typical room and contents fire in a simple residential structure can produce levels of CO above 20,000 parts per million (ppm) which is enough to kill a firefighter in approximately two breaths (Brouwer, 2009). Because of this, firefighters must now be conscious of wearing the SCBA while performing overhaul, which has not been a practice in the past.

Common practice in today's fire service is for a firefighter to wear full bunker gear including the SCBA in all Immediate Danger to Life and Health (IDLH) situations. IDLH is defined by the United States National Institute for Occupational Safety and Health (NIOSH) as exposure to airborne contaminants, such as smoke and/or other poisonous gases at sufficiently high concentrations, that is likely to cause death or immediate and/or delayed permanent adverse health effects or prevent escape from such an environment (National Institute for Occupational Safety and Health [NIOSH], 2002). The Occupational Safety and Health Administration (OSHA) regulation (1910.134(b)) defines the term as "an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere" (OSHA 1910.134, 2008).

Regrettably, it is also a common practice to exit the IDLH when the audible and visual alerts sound and show the SCBA contains its last 25% of air remaining. This last 25% is considered emergency air for the individual in case of an unforeseen situation (see Appendix A). The National Fire Protection Association (NFPA) 1404, Standard for Fire Service Respiratory Protection Training, mandates that firefighters be out of the hazard area before their low-air

alarm activates. The reason for this mandate provides the firefighters an emergency air reserve should something go wrong while they are inside the hazardous atmosphere (National Fire Protection Association [NFPA 1404], 2006). To rely exclusively on the red light to blink or the low air alarm to vibrate on the facepiece [*sic*] as a tool to alert the wearer to start the process of thinking it's time to exit is unsound. Pulling off the SCBA mask during an emergency exit or smoldering phase and experiencing that "Breath from Hell" of toxic fumes can also become detrimental to the firefighters career and health (Gagliano et al., 2008).

The problem is that Orange County Fire Rescue Department (OCFRD) is allowing personnel to use this practice as a rule for air management. The purpose of this applied research project is to establish an air management standard operating procedure (SOP) for OCFRD and implement the guideline throughout the department. The intent of establishing, implementing, and training on this air management guideline allows the department to require a safer exit procedure from an IDLH atmosphere to cleaner air. An action research method was used to answer these questions:

- 1) How does the department's general order of air management comply with the Occupational Safety and Health Administration (OSHA) standards of respiratory protection?
- 2) What standards or guidelines for air management have other departments implemented?
- 3) What elements are needed to create a successful air management program for OCFRD?
- 4) What factors can contribute to a firefighter becoming low or out of air?
- 5) What elements of training during mock scenarios can be improved to enhance the implementation of air management?

Because "managing" air is a new concept for most of the fire rescue departments including OCFRD, it will take time, experience, practice, and training to become air management proficient. The only way to do this is by knowing how much air you have before you go into the

IDLH, manage what you have while inside the hazardous atmosphere, and exit the situation before your low air alarms activates thus following the Rule of Air Management (Gagliano et al., 2008).

Background and Significance

The SCBA is a piece of safety equipment used to provide breathable air in environments incompatible to life and health. This device is worn by rescue workers, firefighters, and others to provide breathable air in an IDLH atmosphere. Firefighters who work in atmospheres that are considered IDLH are required to don an SCBA. Over the years the fire service has evolved from using a closed circuit or re-breather system, one that re-circulates exhaled gas, to an open circuit system, one that is filled with filtered breathable compressed air ("Industrial 101 SCBA", 2010). In today's modern fire service, wearing an SCBA seems as natural as tying ones shoes. When protective gear is mentioned in the fire service, bunker gear and SCBA are the first to be articulated from most firefighter's mouths. Even though the fire department mandates this level of protection, firefighters still continue to work and exit IDLH situations using emergency air.

Industry wide, the accepted practice is for firefighters to work until the low air alarm activates or until the individual takes that last breath from the cylinder allowing the mask to become a suction cup to the face and then running like the devil to get out of the building or situation (Gagliano et al., 2008). The problem with this behavior is that it leaves no margin for error in the event something goes wrong while exiting the toxic atmosphere. Time honored terms like "smoke-eaters" and "leather lungs" were used when firefighters would exit IDLH environments with no air left in their SCBA and black soot covering their faces (Gagliano et al., 2008). This practice today is unacceptable and only enhances the rise of cancer statistics or even death for fire rescue workers. From 1981 to 1999, research was conducted to determine the

relative cancer risk for firefighters compared with the Florida's general population. The objective of this study was to examine the cancer risk associated with firefighting.

Astoundingly, the study found a significant rise in many different kinds of cancer among the participants, especially females. This important research was republished in the Journal of Occupational and Environmental Medicine in September of 2006 ("JOEM", 2006).

Members of special operations or hazardous material teams, fire suppression groups, confined space experts, dive teams, and even correctional officers have been trained to use, wear, and inspect this respiratory protection apparatus daily. Most SCBA's today are regulated at 2200 to 4500 pounds per square inch (psi) rated aluminum bottles that can last from 30 to 45 minutes depending on how much the individuals exert themselves during the emergency event (NFPA 1404, 2006). According to the NFPA statistical database, 250 firefighters died on the fire ground at structure fires between the years of 1997 and 2006 (National Institute of Occupational Safety and Health [NIOSH], 2009). Of these 250 firefighters, 142 were killed inside the IDLH and 72 of those 142 died of asphyxiation (NIOSH, 2009). Why are firefighters still dying of asphyxiation? More importantly, why are these firefighters running out of air?

There are many variables affecting how long an individual's respiratory protection system, their SCBA, will last, such as, being physically fit, the person's emotional preparedness, and even if the individual is truly knowledgeable about the piece of equipment (Gagliano et al., 2008). Simply checking the equipment at the beginning of a shift rotation can alleviate most of the equipment malfunction issues as well as reacquaint the firefighter with this lifesaving piece of equipment. Over recent years, fire departments have experienced fewer fires. Because of this fact, younger contemporary firefighters are less experienced in reading and adapting to rapidly changing fire conditions and seasoned firefighters become complacent. This lack of experience

as well as idleness of the firefighters could be deadly (Hammack, n.d.). When was the last time an individual actually donned the SCBA for an emergency situation or more importantly trained on air management? This requires fire departments to implement more training on the proper use of SCBA.

The Orange County Fire and Rescue Department is a full service fire rescue department located in Central Florida. The department protects an area of approximately 786 square miles and a population of over 800,000 including a daily surge of 200,000 transient workers. Additionally, Orange County is home to three major theme parks that increase the annual tourist population to over 45 million annually (Orange County Fire Rescue Department [OCFRD], 2008). Fire and rescue services are delivered through the strategic placement of 41 fire stations, 39 engine companies, 29 paramedic Advanced Life Support (ALS) transport units, 6 ladder trucks, 3 heavy rescue squads, and 16 wildland [*sic*] firefighting units. These units are staffed by over 1030 dual certified firefighter/Emergency Medical Technicians (EMT) and firefighter/Paramedics (PM) (OCFRD, 2008).

To outfit a workforce of over 1000 firefighters requires over 2500 sets of bunker gear and 300 SCBA units (J. Canupp - OCFRD Supply/SCBA Technician, personal communication, February 10, 2010). Each firefighter is issued their own personally fitted SCBA mask in accordance with OSHA 29 CFR 1910.134 and receives annual training on the use and donning of the Scott 4.5 SCBA in compliance with NFPA 1404 and OCFRD Standard Procedures Respiratory Protection Program (Orange County Fire Rescue Department [OCFRD Admin 26], 2008).

OCFRD requires every firefighter to attend SCBA testing and recertification annually in accordance with Occupational Safety and Health Administration (OSHA) standard 29 CFR – 1910.134. This standard directs that every person “shall be provided a respirator and the

employer will be responsible for establishing a respiratory protection program which will consist of an annual fit test of the mask" ("OSHA 1910.134", 2008). Other requirements include medical evaluations for personnel required to use a respirator, proper procedures in cleaning and disinfecting the mask, training employees in the respiratory hazards and the potential repercussions when exposed to toxic fumes as well as the donning, removing, and the limitations of its use. Compliance is met when the firefighter is scheduled for a yearly medical physical. Recertification training is developed by the training division at the beginning of every calendar year and conducted for nine consecutive weeks annually. Drills consist of a complete inspection of the SCBA and all components, a sixty second timed donning of the SCBA in full bunker gear, and familiarization with the equipment involving the buddy breathing component (air sharing) with the air-pack. In addition, OCFRD also requires all hazardous materials technicians to comply with the present standards of respiratory protection and to apply the SCBA training to all situations that would warrant an individual to be in an atmosphere that is below 19.5% oxygen content and other vapor or gases unsustainable to life (OCFRD Admin 26, 2008).

As new recruits in the fire academy, every firefighter has been taught that when a firefighter's low air alarm is activated it is time to grab a partner and exit the building. Depending on what bottle is used, 2200 or 4500, a firefighter could have approximately 5 minutes of emergency air remaining depending on how the firefighter is consuming the air they have left in the SCBA (Conley, 2004). For years this concept was branded into every fire service recruit, probationary firefighter, volunteer firefighter, and career firefighter's mind, that exiting on the low alarm bell or vibralert [*sic*] was a satisfactory practice and was never questioned. This concept was accepted because in the past, most residential houses were single story and had many structural openings such as windows and doors to exit through when firefighters consumed

most, if not all, of their air (Bernocco, Phillips, & Jose, 2004). Take this same situation with a firefighter completely out of air, becoming disoriented because of decreased oxygen to the brain, and not having the ability to find the exits due to confusion even though the nearest exit is only inches away. The results could be catastrophic! Another problem results when battling fires in large commercial buildings, where the layout may be more challenging and the structural openings are farther apart and possibly several feet up in the air. This creates an even more dangerous situation for a firefighter. If the low air alarm is activating and the individual is $\frac{3}{4}$ of the way inside the building with only a $\frac{1}{4}$ of air left to exit and no exits are near, the firefighter is in a no win situation. The resulting situation could find the firefighter in a panic, consuming air faster or completely running out of air, and suffocating because their department never trained them or implemented a policy on air management.

Comparatively, SCUBA divers have the same challenge as firefighters managing their air. In fact, the water is a SCUBA diver's IDLH environment. Removing the respiratory protective equipment under the water would cause the lungs to fill up with water causing the diver to rapidly suffocate from lack of oxygen. If a firefighter, takes off their SCBA in an oxygen deficient atmosphere, death could be just as imminent because the lungs fill up with toxic gases, displacing oxygen and causing asphyxiation. Oxygen deprivation can be a short term effect however longer term health issues from smoke inhalation could also develop. The main difference between these two functions is the way the individuals manage air consumption. SCUBA divers are constantly aware of how much air they started with, how much air they have consumed, and how much air is needed to make a safe return to the surface. In fact, recreational divers are expected by the dive master to have 500 psi left in their tank when they return to the dive boat (Bernocco, Phillips, & Jose, 2004). Because air management is so important in

SCUBA diving, dive masters will not allow the individual to return to the water for other scheduled dives because the individual did not watch their regulator and return to the surface with 500 psi.

The rule of air management for firefighters is knowing how much air you have before you enter, manage the air you have inside the IDLH, and exit before the low air alarm activates (Gagliano et al., 2008). This simply means to be completely out of the IDLH environment before your air cylinder reaches the blinking red light in your HUD and/or the low air alarm activates.

Know how much air you have, manage that air while inside the IDLH, and exit before the low air alarm activates (Gagliano et al., 2008). It doesn't get simpler than that; however the statistics still illustrate firefighter fatalities under the heading of asphyxiation. The United States Fire Administration (USFA) reveals that in 5.55% of the firefighters fatalities died of asphyxiation in 2009 ("USFA 2009 Fatality Report", 2009). USFA's mission is to reduce life and economic losses as a result of fire and related emergencies (United States Fire Administration [USFA] Strategic Plan, 2010-2014). The overall objective is to address the fact that the fire service is losing firefighters who may have survived if their department had an air management procedure in place. This project also ensures firefighters operating in an IDLH use established guidelines for SCBA air management, and can improve firefighter safety in the fire service. Through extensive training and direction using the air management guideline, firefighter fatalities could significantly be reduced which in turn meets the operational objective set forth by the USFA. In the course of the procedures recognized in the Executive Fire Officer (EFO) Program at the National Fire Academy (NFA), this applied research project will directly benefit OCFRD by providing the necessary information through past experiences, present

recommendations, and future standard operating procedures for developing and implementing the “Rule of Air Management.”

Literature Review

The Federal Mine Safety and Health Act of 1977 (Mine Act) is administered by the Mine Safety and Health Administration (MSHA). This Act covers all mine operators and miner’s throughout the United States (US). As of 2009, the Mine Act covers approximately 400,000 miners and almost 15,000 mines (The Federal Mine Safety and Health Act of 1977 (Mine Act), 1977). In June of 2006, Congress amended the Mine Act to enhance safety to the underground mines by requiring a mine operator to have two self contained self rescuer (SCSR) post incident breathable air containers while working in the mines (Mine Improvement and New Emergency Response Act of 2006 (MINER Act), 2006). A SCSR can provide up to eight hours of air to a resting miner or 90 minutes of air to a miner exerting themselves. (Kantor, 2006) This emergency air device is what is known as a “rebreather” or “closed –circuit breathing device” that recovers exhaled air and recirculates it back into the system by incorporating a carbon dioxide scrubber mix that would absorb the exhaled carbon dioxide thereby making the air in the tank last longer (Kantor, 2006). The mine operators were also responsible for storing a SCSR at 30 minute intervals in remote areas in case of a disaster. Because the miners could be an hour or more inside a mine, the critical storage and placement of these SCSR’s could allow the miner to self extricate or maintain breathable air until rescue by a search team. These refuge alternatives are capable of sustaining trapped miners with breathable air for 96 hours if trained properly on the equipment (MINER Act, 2006). Each miner is required to participate in training and drills every quarter that includes physically locating the stored SCSR’s, practicing and donning the SCSR, transferring the SCSR to another miner, and locating escapeways, surface exits,

abandoned areas, and areas of refuge (MINER Act, 2006). Over a one year period every miner is required to participate in expectations training that include donning and transferring of SCSR's in simulated smoke or equivalent environment and also breathing thru a training SCSR unit that provides the sensation of restrictive airflow and heated air (MINER Act, 2006). The air management miners use with the SCSR's can somewhat mimic the fire department in conserving air with the exception that the miners must search and find their air to escape catastrophes and could possibly have good air every 30 minutes if planned correctly, where as the firefighter , who carries a SCBA at all times while in an IDLH, will only have approximately 5 minutes of emergency air to exit an IDLH or be rescued by the Rapid Intervention Team (RIT) depending on how the individual is consuming the air.

Helicopter pilots are required to have an Emergency Breathing System (EBS) while flying over open water. When a helicopter crashes into water, it will typically invert and sink rapidly. Even though the accident is survivable, the astonishing fact is that fifteen percent of the crews or occupants will perish (Brooks & Tipton, 2001). The principle cause of such a high fatality rate was that the occupants of the vessel could not hold their breath long enough to self rescue or be rescued, therefore the cause of death becomes drowning and not a traumatic event such as a broken neck, etc. Due to the fact that the breath-holding ability of a human in water is 40 seconds and the time to self rescue or to be rescued is 23 to 92 seconds, it is essential to have an EBS system integrated into the individual's gear or equipped with the helicopter (Gibbs, 2008). The Helicopter Emergency Egress 3 (HEED 3) is a compact and lightweight self contained breathing apparatus. It includes a 1.7 cu. ft. unit with a dial gauge pressure indicator showing the exact amount of air remaining in the bottle, a holster, and a set of nose plugs. This EBS provides 30 breaths of air for with an approximate duration of 2 to 5 minutes depending on the operator's

lung capacity, physical exertion, depth, and temperature of the water

(<http://www.astoverwater.com/catalog/item/5823218/5684693.htm>). Training on this equipment is mandatory for helicopter pilots and performing these drills are required at quarterly increments. It is crucial that training on this EBS is performed knowing that the pilots have only seconds to deploy this instrument and save their life (Gibbs, 2008). A pilot's air management is extremely important when an individual may have only 30 breaths or up to 5 minutes of air to self rescue or be rescued. Coincidentally, a firefighter also has approximately 5 minutes left of reserve air left in the cylinder when the low air alarm activates to exit or be rescued.

The National Aeronautical and Space Administration (NASA) have the golden seal on the SCBA, but do they have the right frame of mind for an air management policy. The Supercritical Air Mobility Pack (SCAMP) provides at least one hour of breathing air and even cools the individual's body who is wearing the pack, in turn, helping to prevent heat exhaustion (Heiney, 2004). Firefighters are required to carry heavy, high pressure compressed air cylinders where as the SCAMP is somewhat lighter and smaller than traditional SCBAs. With the SCAMP, the wearer breathes through a typical face mask while the a low pressure system forces super cooled air out of a dewar, a tank that holds super cool air, and through a series of heat exchangers which warm the air to a comfortable breathing temperature while the remaining heat exchangers cool the body through a liquid garment (Heiney, 2004). With this system, it allows the wearer to stay in an environment twice as long as a firefighter would stay in an IDLH or hazardous materials situation. A wearer can remain cool for a full hour of stressful labor and two hours of moderate activity without having to resort to outside sources of cooling such as ice (Dyson, 2001). The SCAMP also has a capacitor inside the tank that measures the density of the air and a computer in the suit recalculates how much air is left. The system contains a beeper

alarm that will indicate to the wearer that there is 25% of remaining air left in the tank signaling that it is time to exit for a refill (Heiney, 2004). Does this sound familiar? Remember in the past firefighters were exiting when the red light began to blink or the low air alarm activated leaving only 25% of air left or 5 minutes of time to exit the IDLH.

Underwater divers wear a self contained underwater breathing apparatus (SCUBA). Divers can face similar conditions as firefighters while submerged in the water. The water is the divers IDLH and anything could happen. Michael Smith said it perfectly in an article for Firehouse Magazine, "If a diver had a problem in 40 feet of water, would that not equate to a firefighter being 40 feet inside a structure filled with fire and toxic smoke to the floor" (Smith, 2004)? SCUBA divers are taught in training to manage their air and are conditioned to check the amount of air left in cylinders on a regular basis. Before a dive, the diver will preplan what is needed to make the initial dive and what will be needed to keep in emergency reserve for an unforeseen emergency. The more intense the dive, the more emergency air is needed. The use of this air (reserve) is strictly for emergencies and will never be used as part of the initial dive ("Scuba Pro", 2010). Most master divers will tell the students that they must come out of the water with 500psi left in the tank or their diving for the day will be suspended. This was calculated before the dive to be the emergency air; therefore, the diver must have that air remaining in the tanks if there was no true emergency on ascent ("NURC/UNCW ", 2009). Divers also don't have a signal, as firefighters do, relaying that the tank contains 25% of air remaining so the individual is forced to check the air level at appropriate intervals. Therefore, SCUBA divers are forced to manage the air in the tanks or face the consequences from the possible bends, or worse, death.

Firefighters running out of air can happen anywhere, anytime, and to anyone. It is not uncommon to hear low air alarms or vibralerts sounding while firefighters are still inside a

building working in an IDLH atmosphere. If the firefighter survives the incident, the fire department family acknowledges the incident as a “close call”, a “near miss”, or a “near fatal accident” (Gagliano et al., 2008). Every year firefighters from across the world are running out of air on the fire ground. Annually over one hundred firefighters and rescue workers in the United States die annually on the fire ground and the third leading cause of these deaths is asphyxiation (“USFA FEMA”, 2009).

Most SCBAs today are regulated at 2200 to 4500 pounds per square inch (psi) rated aluminum bottles that can last from 30 to 45 minutes depending on how much the individuals exert themselves during the emergency event (NFPA 1404, 2006). Many standards are already in place and have been updated to comply with firefighter safety. Two of these are the NFPA 1404, Standard for Fire Service Respiratory Protection, and the Federal Occupational Safety and Health Administration (OSHA) 29 CFR 1910.134. NFPA 1404 requires the Agency Having Jurisdiction (AHJ) to establish and reinforce written operating procedures for training in the use of respiratory equipment that “...shall include air management” (NFPA 1404, 2006). These procedures should be broken down into three parts. (1) Exit from the IDLH should be done before the consumption of the emergency air begins, (2) The low air alarm activation means that the individual is consuming the reserve emergency air, (3) Activation of the low air alarm is an immediate action item for the individual as well as the team (NFPA 1404, 2006). OSHA Regulation Standards 29 CFR, 1910.134 states “In the control of those occupational diseases caused by breathing air contaminated with harmful dusts, fogs, fumes, mists, gases, smokes, sprays, or vapors, the primary objective shall be to prevent atmospheric contamination. A respirator or SCBA shall be provided to each employee when such equipment is necessary to protect the health of such employee” (“OSHA 1910.134(a)(1)”, 2008). Even after the

implementation of these two important standards firefighters are still continually becoming the “close call” or “near miss” or even worse the “fatal injury” on the fire ground (Gagliano et al., 2008). According to the United States Fire Administration (2009), the third leading cause of non-traumatic deaths on the fire ground is becoming lost and disoriented in an IDLH or suffocating from improper air management.

The main component to implementing an air management program is becoming aware and practicing the “Rule of Air Management” (Gagliano et al., 2008). Freelancing is never tolerated on the fire ground and nor should a firefighter running out of air. Air management is a team effort. Before entering an IDLH all team members should know how much air they have upon entry into the structure. While inside the structure the team should manage how much air they have so that the team can exit before the low air alarm activates or the vibralert sounds. This can easily be accomplished for the individual by observing the lights on the heads up display (HUD) inside the SCBA mask and observing the high pressure remote gauge over the firefighter’s left shoulder. These two instruments should coincide with each other, if not, the individual needs to leave the IDLH atmosphere and retrieve another air-pack. At this point the firefighter has no idea which safety device is reading the true air pressure in the cylinder. However, if the firefighter is already in trouble and waiting for help, the firefighter can remove the SCBA and check the reading on the cylinder itself for the true reading. The cylinder gauge and the remote gauge should read approximately the same or within 100 psi. (International Fire Service Training Association [IFSTA], 2008, p. 205). If not, the SCBA should be placed out of service for maintenance.

In many fire departments, the focus of air management tends to be on the rapid intervention teams (RIT), a rescue team deployed to save a firefighter in distressed or in danger. The main

focus is to train personnel so that the RIT team is not needed or deployed. Following the Brett Tarver tragedy, a Phoenix firefighter who ran out of air and died trying to exit a commercial building, the Phoenix Arizona Fire Department conducted one of the largest open investigations ever conducted by a fire department (National Institute of Occupational Safety and Health [NIOSH-Tarver], 2002). It included an investigation of what happened; a recovery plan to implement changes in training, procedures, and equipment based on lessons learned; and a research effort regarding rapid intervention team effectiveness. This research project involved searching a large square footage building for a lost fire fighter. (NIOSH-Tarver, 2002) A timeline of events pertaining to Bret Tarver incident is provided in the Appendix for comparison to the following study (see Appendix B)

Concurrently, and independently, the Seattle Washington Fire Department conducted a similar research study of rapid intervention effectiveness in large square footage buildings. Several hundred search and rescue exercises were conducted by the two departments and data carefully collected. These two projects, though separate research efforts, interestingly, came to nearly identical conclusions, rapid intervention is not rapid ("IAFC Rapid Intervention", 2004).

The groundwork of air management for the individual begins during firefighter minimum standards with NFPA 1001, Standard for Firefighter Professional Qualifications. This standard requires the firefighter to demonstrate the ability to efficiently use an SCBA in emergency situations. (National Fire Protection Association [NFPA 1001], 2008) The firefighter's first test of this is at the end of firefighter academy class during the individual's state test. In 90 seconds the individual is required to get into a full set of bunker gear, recite the air pressure in the SCBA tank while turning the cylinder on, don an SCBA, perform a seal check with the respiratory facepiece for 10 seconds, connect the respirator to the mask and begin breathing air without

difficulties. Afterwards the firefighter is placed in a simulated burn building and asked to perform certain firefighting tasks while consuming air. It is considered unfavorable if the individual, while performing the firefighting tasks, runs out of air before finishing the test.

NFPA 1500, Standard on Fire Department Occupation Safety and Health Program, references the need for the fire department to have an established respiratory protection plan (National Fire Protection Association [NFPA 1500], 2007). OCFRD provides every firefighter, in compliance with NFPA 1500, an annual SCBA face piece fit test and HEPA mask fit testing. These tests insure that every individuals mask, both SCBA and HEPA, correctly fits the contour of the individual's face not allowing any outside toxins to enter the mask from around the sides (OCFRD Admin 26, 2008)(see Appendix C). OCFRD uses the SCOTT AP 50 4.5 SCBA. The OCFRD Respiratory Protection Program technicians and the SCBA Performance Standards 4201-4204 poilcy are responsible for the yearly fit test, annual air-pack service test, and the hydrostatic bottle testing every five years, as well as, the air quality test of the air compressor every quarter or after air contamination (OCFRD Admin 26, 2008).

NFPA 1989, Standard on Breathing Quality for Emergency Service Respiratory Protection, states the minimum requirements needed for breathable air quality used to fill SCBA cylinders and the equipment that produces this air, while NFPA 1852, Standard on Selection, Care and Maintenance of Open Circuit Self Contained Breathing Apparatus, outlines the care and maintenance of the SCBA including the harness as well as the cylinder (National Fire Protection Association [NFPA 1989], 2008) (National Fire Protection Association [NFPA 1852], 2008). NFPA 1981, Standard on Open Circuit Self Contained Breathing Apparatus for Fire and Emergency Services, mandates that all fire departments add the HUD to all face mask and a RIT Universal Air Connection male fitting to allow rapid replenishment of air from a RIT cylinder to

another firefighters SCBA (National Fire Protection Association [NFPA 1981], 2007). The Personal Alert Safety System (PASS), NFPA 1982, has become integrated into the SCBA. This device is primarily used for locating a downed firefighter by producing an annoying sound when the firefighter is motionless for more than 20 seconds (National Fire Protection Association [NFPA 1982], 2007). However, how this device has become intergraded with the SCBA is that the PASS device must activate when the SCBA is turned on at the cylinder. In short, every time the firefighter turns on the cylinder of the SCBA the PASS device will be activated and will not deactivate until the SCBA cylinder is turned off and the PASS device is manually pressed to the off position (NFPA 1982, 2007). Another safety feature to this is the PASS device cannot be deactivated completely until the cylinder is in the off position. In the past many firefighters were turning the PASS device off because of the annoying sound it made while wearing it therefore making the RIT rescue longer because there was no noise to follow to find the downed firefighter, hence the integration with the SCBA (Gagliano et al., 2008).

The Rogue Valley Fire Chiefs Association adopted an air management procedure in February of 2009. The purpose of the procedure was to establish guidelines to prevent low air emergencies. It was no longer acceptable for firefighters to work in hazardous atmospheres with the SCBA's emergency air warning device activated.

Before a firefighter enters the IDLH, a regulator check must be accomplished to determine air levels and to verify if what the regulator reads is enough air to perform the job and return to a safe environment without using the specified reserve emergency air. While inside the IDLH, the crews are to radio Command when 50% of the air supply in the cylinder is reached. Command is then to monitor the crews exit to safety prior to the low air alarm activation (Rogue Valley Fire Chiefs Association [Rogue Valley], 2009).

Phoenix Regional Fire Department developed a standard operating procedure on air management after Phoenix firefighter Bret Tarver died in a supermarket fire from running out of

air. The purpose of their air management policy was to improve safety by describing how to manage the air in the SCBA cylinders while operating in a hazard zone at an incident. After many tests were conducted to determine the death of firefighter Tarver it became conclusive that when a low air alarm activates a firefighter can crawl approximately 150 feet until the air supply is exhausted. Phoenix Regional Fire Department decided that the maximum crawl inside a structure would be 150 feet and anything further than 150 feet; the Incident Commander (IC) would decide to assign another crew to attack the fire from a closer access point. This is considered the 150 feet rule.

The policy advises that the company officer is to assess the crew's air consumption rates and to decide the crew's exit time based on the individual with the greatest assumed air consumption rate. It is the firefighter's responsibility to continually check the regulator and report their air consumption level to the company officer. When a low air alarm is activated anywhere on the fire ground it becomes an immediate action item for the individual and the crew. Command or the crew will initiate a May-Day situation and Command will ask a set of questions that will determine where the crew or individual is located in the building, can the crew or individual exit safely, and the notification of a Personnel Accountability Report (PAR) when the crew is safely out of the building (Phoenix Regional [Phoenix], 2009).

Portland Fire Rescue also developed an operational guideline for air management in September of 2006. The intent of this guideline was to implement a policy that requires members to exit the IDLH environment prior to the activation of the End of Service Time Indicator (EOTSI) or SCBA low air alarm. This will be accomplished by requiring members to maintain awareness of the air pressure on the SCBA at all times and provide an early notification of low air situations.

In the event of a low air alarm activation, Command is to be notified immediately for appropriate action for low air emergencies. If a low air alarm activation occurs in an IDLH area, the Incident Safety Officer shall investigate the situation and report the findings to the Chief Safety Officer for appropriate action. The intent of this guideline will assist Portland Fire and Rescue in meeting the guidelines set forth by NFPA 1404 regarding air management (Portland Fire & Rescue [Portland], 2006).

The White Mountain Apache fire Department adopted an Emergency Operating Procedure (EOP) on air management in June of 2009. The purpose of the EOP is to reduce the possibility of injury or death due to personnel running out of air in a hazardous atmosphere and applies to all personnel wearing a SCBA in an IDLH environment. All SCBA's are required to be checked at the beginning of the shift and no less than 2000 psi operating pressure in the cylinder. Prior to entering the IDLH each individual will perform a R.E.A.D.Y check (White Mountain Apache Fire & Rescue Department [White Mountain], 2009). R.E.A.D.Y is a mnemonic device used to remember to check your **radio**, check your **equipment**, check your **air**, know your **duty** assignment, and when you can say **yes** to all of these then you are R.E.A.D.Y to enter the IDLH (Gagliano et al., 2008.). At 75% or $\frac{3}{4}$ of air remaining, interior crews will advise of their air consumption rate and in addition, relay a PAR. At 50% or $\frac{1}{2}$ of air consumed, the crew will again alert command of the air consumption rate and begin exiting the building while relaying a PAR. If any crew member reaches 25% or $\frac{1}{4}$ of air left in the cylinder, a PAR will be conducted, the entire crew will exit the building without delay, and a Rapid Intervention Team (RIT) will be alerted to the situation for possible activation (White Mountain, 2009). One difference that this policy has from the previous policies is the IC can allow a team to continue working below $\frac{1}{4}$ or 25% of the cylinder pressure if the fire is under control and a structural evaluation is made by the IC and concurred by a Safety Officer to determine there is no structural collapse or entanglement hazards, the crew's visibility is not impaired, and a PAR indicating the crew is all together and able to continue (White Mountain, 2009). It is obvious that in this policy the IC and the Safety Officer cannot determine any and all hazards are accounted for according to Murphy's Law and that the crews are now working on the emergency reserve air that meant to be used only for

emergency situations. If crews still need to wear SCBA's while working in an environment untenable for life and health then the situation should be considered dangerous and all crews should exit the building and acquire a full cylinder to continue working or go to the rehab group for rest and replenishing fluids.

In January 1998, a revised Standard for Respiratory Protection was signed as an OSHA regulation. The new federal standard replaces the respiratory protection standards adopted by federal OSHA in 1971. It is a revision and strengthening of the original standard that requires employers to establish and maintain a respiratory protection program to protect the employees wearing respirators. Most importantly, the standard specifically addresses the use of respirators in immediately dangerous to life or health (IDLH) atmospheres, including interior structural firefighting. The standard also provides requirements for respiratory program administration, work-site specific procedures, employee training, fit testing, medical evaluation, respirator use in the 2 in/2 out rule, and the cleaning, maintenance and repair of the respirator ("OSHA 1910.134", 2008). In March of 2005, a standard operating procedure (SOP) for respiratory protection was defined for OCFRD (See Appendix C). Because of this SOP, the safety of all OCFRD personnel engaged in an IDLH situation now have a procedure established to prevent injury as a result of acute or chronic exposure to airborne toxic substances or other respiratory hazards such as oxygen deficient atmospheres.

According to the book *Air Management for the Fire Service* (2008), elements that are needed for a successful air management program include the **need** for a program, to **mandate** a policy or program, and have a **solution** for the problem (Gagliano et al., 2008). The need for a complete air management program is evident for one simple rationale; firefighters are running out of air on the fire ground day after day. Because the firefighters are running out of air, the consequences

are devastating including death, cancer, respiratory disease, close calls, and the like. There is one factor that stands out and needs to be addressed. Firefighters that die in structures are dying in higher numbers due to asphyxiation. Many times you hear in papers and magazines that a firefighter died in a fire and most people believe that this firefighter was actually killed by the fire. According to Galliano (2008), the fire service developed some bad habits when the first SCBA was introduced until now and some of these bad habits have carried over to poor air management practices with peer pressure being the worst offender (Gagliano et al., 2008). According to the NFPA firefighter fatality reports, there were 103 deaths directly attributed to asphyxiation between 1996 and 2003 (Jose, Phillips, Gagliano, & Bernocco, 2006, p. 9). The need for an air management program is carved on fallen firefighter memorials across the world and we need to learn from their misfortunes.

Around the world many progressive and professional fire departments are now mandating air management programs that direct the use of a SCBA before, during, and after fire ground operations in accordance with NFPA 1404. In 2007, NFPA 1404 was revised and one of the main standards revised was 1404 A5.1.4(2) titled the Individual Air Management Program (NFPA 1404, 2006). “This program will develop the ability of an individual to manage his or her air consumption as part of a team during a work period and should include these directives; exit the IDLH prior to low air alarm activation, the low air alarm activation signifies the use of the reserve air, and activation of the low air alarm is an immediate action response for the individual as well as the crew” (Farmer, 2007). The solution for air management does not require the acquisition of expensive equipment, the accumulation of more personnel, or the execution of the normal aggressive fire ground activities to accomplish a good air management policy. However, the implementation of an air management policy can greatly alleviate legal

and liability issues, make the fire ground or area a safer workplace, and minimized exposure to toxic fumes and atmospheres (Gagliano et al., 2008). The mistakes in past practices on respiratory protection must now become the future for air management in the fire service.

Many different items can contribute to becoming low on air. Equipment failure or malfunction is extremely important therefore checking the equipment at the beginning of every shift can alleviate most of the low air problems. Improper maintenance on old and new equipment can lead to damaged components and leaks. Checking for stripped threads, damaged or missing O rings, and poor connections can alleviate devastating problems when duty calls while working in the IDLH. The physical fitness and aerobic capacity of the firefighter can contribute to consuming more air and creating less time inside the IDLH. The higher the aerobic capacity that enhances the use of oxygen the longer length and time between breaths can allow the individual a quicker the recovery time and a longer duration of air left in the cylinder. The higher the endurance of physical fitness of the firefighter requires less oxygen absorption into the muscles to yield the same work. The body's response to environmental factors can affect how fast the firefighter consumes air. The heat from working in a fire can cause rapid fatigue, increase stress on the body and heart, and make the individual increase their effort to do more work. The cold can cause the body to exert more energy and consume more oxygen to maintain body temperature. The psychological responses and mental stress from different types of emergencies, crew interactions, and personal problems can directly make the body consume more air during fire workloads. The "fight or flight syndrome" from falling through a ceiling for example causes a massive dump of adrenaline into the body increasing the heart and respiratory rates causing the individual to consume more air even though no physical activity has taken

place (Gagliano et al., 2008). Being familiar with the equipment can extend the firefighters air duration during stressful situations.

The best training for firefighters is hands-on training that is scenario based. “Firefighting is a hands-on job,” said Chris Delisio, founder of the training program and retired Fire Department City of New York firefighter. “If you want a better firefighter, a safer firefighter, you have to train the way you’re going to fight. That’s what we do here. We train them the way we want them to fight” (Powers, 2010, para. 4). Scenario based training is training that is similar to a situation the firefighter may encounter on the fire ground. Using acquired structures, commercial buildings, and high rise structures can bring a sense of reality to any hands on situation. If there is a carpenter working in the fire department, this great resource can supply any fire department with many different obstacles and situations a firefighter can use to train on. Firefighters want any training to be as realistic as possible. The more realistic the training or situation specified the better the outcome of the firefighters retaining the skills and information given. If the hands-on training lacks realism or purpose the firefighters will either discount the training entirely or minimize the importance of such training. Firefighters must practice like they are expected to play: they must train the way they are expected to fight (Gagliano et al., 2008, p. 389).

This literature review showed many different ways that other agencies could impact or have impacted on having an air management and training policy in place. The question remains, why don’t fire departments, especially OCFRD, have an air management policy in place? Are firefighters not as important as SCUBA divers, miners, and pilots? This literature review has great strength in supporting the need to implement a rule of air management for OCFRD.

Procedures

This applied research project was created by using the action research method with the purpose of defining the problem, exploring what other intuitions have placed into action for air management, and generating a standard operating procedure to institutionalize the rules of air management for OCFRD.

Many resources were used to examine the importance of an air management program for OCFRD. The Learning Resource Center (LRC) at the National Fire Academy (NFA) provided many resources toward relevant materials on the SCBA, RIT functions, confined space hazards, and the like for this particular subject both on site and on the internet particularly with several articles, journals and very few books. Relative information from past Executive Fire Officer ARP's was reviewed and evaluated on this subject matter. However, the lack of information on air management as a whole was unsuccessful due to lack of researched information on this extremely life saving subject. Through reviewing the research materials, it is relatively safe to declare that, due to a lack of a suitable air management program and proper training objectives for managing the firefighter's air while in an IDLH is the common denominator for all the near misses, close calls, and unfortunately fatal injuries

. In February of 2009, the Orange County Fire Rescue Training Division (OCFRD), in compliance with OCFRD General Order (GO) 09-07, ROAM – Rule of Air Management (see Appendix D) and NFPA 1404, the Standard on Fire Service Respiratory Protection Training, which mandates yearly training on individual air management, developed a multi-company drill implementing the first rule of air management training for the department. Drills were constructed for fire department personnel to practice training with their Self Contained Breathing Apparatus (SCBA) in a learning safe environment. The drill consisted of an annual SCBA

inspection drill compliant with OSHA 29 CFR 1910.134 , a timed 60 second air-pack donning drill in full bunker gear, and successful demonstration of buddy breathing techniques in a lighted and dark environment. Additionally, a presentation on the Rule of Air Management (ROAM), an Air Consumption Drill (ACD), and a search and rescue scenario concentrating on traditional search techniques was performed. The preliminary drill, consisting of search and rescue, was used as a training tool to find a victim in a smoke filled environment with an underlying training tool of air management. Personnel were directed to run their crews through the drill as they would perform on a real emergency scene using the procedures stated before the start of the drill. Instructors evaluated the drill's use of the rule of air management and the outcome was implemented into the training. In the past, crews waited for the low alarm bell or vibralert to activate before exiting the structure. With the implementation of air management into the drill, crews were now accountable for exiting the structure when the amber light was activated inside their heads up display (HUD) signifying 50% of air consumption was remaining in the cylinder. The HUD, located in the respiratory mask, is another tool used by a firefighter that allows the individual to look at a display just above the brim of their nose indicating lights that signify what stage of air is left in the cylinder. For example, two green lights mean the tank is full, one green light means the cylinder has reached $\frac{3}{4}$ air supply left, amber means there is a half of tank of air left, and red means there is $\frac{1}{4}$ air left in the cylinder and is considered the firefighter's emergency air (see Appendix E).

An air consumption drill was given to 915 OCFRD firefighters to determine their air consumption rate for 10 minutes. The intent of the drill was to introduce the proposal of air management to firefighters and offer them the opportunity to perform air management techniques while performing the drill. The drill consisted of the firefighter in full bunker gear

and SCBA. The cylinder was filled to capacity with 4500 psi. and recorded for each individual. This drill will establish a baseline for the firefighter's air consumption duration while performing diverse tasks that a firefighter would encounter on a true fire ground. The individuals were advised that the drill did not require them to finish every task in 10 minutes but to work on consuming air in case of an emergency. The tasks included:

- search and rescue off a hoseline [*sic*]
- stair climb
- hoisting tools to the second floor
- secondary search with victim removal
- taking a 24 ft ladder off an engine and raising the ladder to the proper climbing angle and securing the halyard
- chopping wood that simulates opening a roof
- opening and closing a hydrant
- hoseline deployment to a specified area 100 feet away
- moving equipment from one area to another area approximately 50 feet away
- taking the ladder down and placing it back on the engine
- Using the Molitor, a machine that simulates breaching a ceiling

After the drill, the ending psi on the cylinder gauge was recorded and placed into an air consumption formula. The results revealed how many minutes the firefighter would have left in the cylinder after strenuous work for 10 minutes. This time would also include the 5 minutes of emergency air left for unforeseen circumstances (see Appendix F).

Results

In the past and demonstrated during the drills in 2009 (personal observation), OCFRD personnel have relied on the sound of the vibralert to signal exit the from IDLH environments. Many problems arose from the practice of relying on the bell or vibralert to activate. For example, many crews were so far into the scenario that they became lost and ran out of air, while some became separated from their crew, became disoriented, and/or ran out of air. Others misjudged how far into the structure they actually were and even though knew where they were in the structure and found their way out, ran out of air before they exited. All this happened because the crews waited on the vibralert activation to signal when to exit the building. Instructors confirmed that 80% of the time crews were exiting the structure with their vibralerts activated consuming their emergency air and/or exiting the structure with no air left in the cylinder and the mask pulled from their face.

The results of this action research project are based on the evaluation of the literature reviewed and the ACR drill exercise results. All data from the ACR drill exercise was placed on a spreadsheet per individual per shift day worked. Approximately 915 individuals completed the drill. The results can be found in the appendix portion of this paper (see Appendix G). The answers to the questions in the beginning of this ARP are provided in a narrative format.

- (1.) How does the department's General Order (GO) of air management comply with the Occupational Safety and Health Administration Standards of Respiratory Protection (OSHA)? The department's general order does not comply with 29 CFR OSHA 1910.134 because the OSHA standard is not addressed in the literature of the GO; however, OCFRD does have many SOP's addressing the subject of respiratory protection. The current GO has expired but does comply with NFPA 1404 in the following ways: (1) Exiting the

IDLH atmosphere before consumption of the reserve air supply begins by inspecting the HUD for the amber light, (2) The low-air alarm is notification that the individual is consuming the reserve air supply and should notify command at once for an immediate exit, (3) Activation of the low-air warning alarm is an immediate action item for the individual and/or team and will be assessed by the Incident Commander (NFPA 1404, 2006). Upon completion of this research and approval of the fire chief, the GO will be reinstated and/or a SOP will be established for the department.

(2.) What standards or guidelines for air management have other departments implemented?

Many departments have written guidelines, standards, or procedures that pertain to the compliance of OSHA regulations. OCFRD established a Standard Operating Procedure (SOP) for a respiratory protection program in March of 2005 that specifically complies with OSHA regulation 29 CFR 1910.134. That same year in June a SOP was initiated specifically to provide guidelines for maintaining and using the SCBA properly. Both of these were revised in March of 2008. After reviewing the SOP's of the following Florida surrounding fire departments, Longwood Fire Rescue, Seminole County Fire Rescue, Osceola Fire Rescue, Lake County Fire Rescue, and Orlando Fire Department, very few have complied with the new standards of NFPA 1404 that require the firefighter to be out of the IDLH before the low air alarm activates or has a respiratory protection program. However, in January of 2009, OCFRD took their first step towards this new compliance by creating a General Order (GO) that required all firefighters to account for their air supply and notify Command when the cylinder reached 50% capacity.

(3.) What elements are needed to create a successful air management program? Compliance with OSHA regulations and NFPA 1404 is a great start. OSHA mandates all the

individuals' health requirements, annual physicals and SCBA mask fit test pertaining to oxygen deficit situations. NFPA 1404 underwent a revision in 2006 that mandates firefighters to be out of the IDLH atmosphere before the low-air warning alarm activates. And, if their low-air warning alarm activates while they are inside the hazardous environment, then this is an immediate action item and should be treated as a Mayday situation. All firefighters should be out of an IDLH atmosphere prior to the low air alarm activating with no excuses. The reason NFPA 1404 mandates this exit is in case something unexpected could go wrong and the emergency air is needed to escape.

- (4.) What factors can contribute to a firefighter becoming low on air? Numerous factors can affect the air supply of an SCBA. For example, being familiar with the equipment and what it can do will formulate a more comfortable and confident feeling for the individual that uses the equipment during stressful situation. Becoming physically fit to execute the work will allow the firefighter to consume less air while performing the tasks involved because the body can recover faster under stress. The body's response to the environment such as heat and cold uses more energy and oxygen to maintain body temperature. The psychological responses such as the type of emergency, personal problems, stress of being the rookie or on probation, and the overall mental stress that is acquired whenever the station alarm sounds indicating it's time to get on the rig and go. OCFRD requires in the respiratory protection program to have annual recertification training on the SCBA. The department also encompasses a safety and wellness program that specializes in nutrition, physical workouts with weight and gym sets in each station, candidate and recruit entrance testing, wellness screening with the fit van, and strength conditioning. Repetitive education on the SCBA from daily checkouts to physical training scenarios in stressful

environments can alleviate most firefighter's fear of becoming the statistic when faced in a situation that could mean life or death. The more repetitive a situation becomes the less you think about how to perform the task, but rather it comes naturally and without hesitation. A certain level of stress can be relieved if training is sufficient to make firefighters more comfortable and confident with their equipment.

- (5.) What elements of training during mock scenarios can be improved to enhance the implementation of air management? The importance of extending one's air supply is irrefutable. The 1000 pound drill can be a starting point in determining air consumption while at rest. The drill requires the individual to don a SCBA with the tank reading 1000 psi or in a sense your emergency air. While absolutely doing nothing use different air saving techniques to see how long the tank will last. Once the firefighter has a baseline at rest, try walking on a treadmill to establish a baseline at moderate activity and so on. This drill can also alleviate any fears associated with the equipment while making the firefighter feel more comfortable and confident with the equipment and its limitations. Another element, such as the air consumption drill, is repetitive training on the SCBA during any and all training evolutions. The more you hear, see, and touch an object can cause the brain to create a folder much like a computer that stores repetitive situations and relays this to the individual when needed or placed in a situation that warrants this information. Albert Einstein states ingeniously, "the definition of insanity is doing the same thing over and over again and expecting different results".

Discussion

Based on the literature review, personal observations as a company officer/instructor, and a review of pertinent data, several observations can be made. First, the fire service has grossly underestimated both the resources and the time required to enter a building on fire, find the fire

fighter and remove the fire fighter to safety. Four members of a rapid intervention team didn't do it; neither did six, nor eight, nor 10! The average number of fire fighters required in the Seattle study to affect a rescue was 11; Phoenix determined 12 were needed ("IAFC Rapid Intervention", 2004, para. 5).

The time required to enter the structure, find the firefighter and exit to a safe place was even more disturbing. Seattle's research indicated 20 minutes was average and Phoenix came in at 21 minutes. This is a very long period of time and certainly a fatal period if the fire fighter is out of air! Think about it. We barely get 20 minutes of work time out of the typical "30 minute" SCBA cylinder and the emergency reserve air will only last approximately five minutes. Additionally, the Phoenix study also determined that one in five rescuers got in trouble and required assistance or rescue ("IAFC Rapid Intervention", 2004, para. 6)!

Clearly, the lesson learned from the Phoenix and Seattle study is to ensure the firefighter does not get in trouble in the first place in order to rely on the RIT team for survival. This will inquire that the firefighter has the proper equipment, training, procedures, and effective fire ground command and accountability operations ("IAFC Rapid Intervention", 2004).

With a solid rule of air management, the survivability of the firefighter increases significantly giving the RIT team more time to locate and place the firefighter on air before reaching the point of no return (Gagliano et al., 2008). Air management accountability is critical any time firefighters enter a burning structure, whether it is for fire control or to rescue another firefighter. Chief Brunacini once said in an informal meeting of the minds, "our life expectancy inside a structure fire is limited to the air we carry on our backs" (Kreis, 2003).

For many years the concept of air management has been taken for granted. Today's fire departments know the toxic elements that are released from the smoke and gases can infect the

individual's health ultimately ending the firefighter's career for early retirement or worse a line of duty death. Because of these resulting issues, NFPA and OSHA have integrated laws and standards that must be followed in order to have a quality air management program. NFPA discusses that the SCBA should be an integral part of the firefighters personal protection equipment and requires the firefighter to check this equipment out on a regular basis. OSHA affirms that the SCBA should be trained upon annually including realistic and timed evolutions to make sure the individual is familiar with the safety equipment presented to each one of them.

In order for this to happen, fire departments must retrain the minds of the firefighters from past practices of listening for the bell and exiting on the reserve air to managing their air appropriately while still performing their task at hand and exiting before the low air alarm activates. The mistakes in past practices on respiratory protection must now become the future for air management in the fire service. If a firefighter does not inspect or train on the SCBA regularly for proper functional operation and confidence in the equipment, it will only hinder the individual during stressful situations and take more time to figure out systematically how to save their life while consuming more air and becoming the next statistic on the firefighter fatality report. Regular training with the SCBA can only increase the confidence of the firefighter with their equipment and skills. The SCBA is a firefighter's best friend in the fire service and ultimately should be treated like one. Knowing the layout of the building before a firefighter enters the IDLH can increase situational awareness for the firefighter while decreasing their stress level. Locating the entrances and exits of the structure, finding the outside stairways and garages, observing building construction type, knowing where the fire is located can all be stress relievers upon entering the IDLH and possibly becoming that individual that is low on air or maybe even another crew member.

Numerous factors can affect the air supply of an SCBA. In order to maximize a firefighter's effectiveness on the fire ground, the individual should consider familiarization with the equipment, becoming physically fit to do the work, develop, seek, and train on stress relievers to reduce physiological considerations and psychological responses.

All firefighters should evaluate their air conservation abilities and train to improve their comfort and proficiency while wearing SCBA. Each firefighter should know how he or she reacts to stress when wearing an SCBA. These reactions affect the duration of the air supply. A certain level of stress can be relieved if training is sufficient to make firefighters more comfortable and confident with their equipment. The OSHA Respiratory Protection Plan requires anyone who uses an SCBA to train annually on the SCBA components and their delivery while also receiving a fit test on the mask to make sure that it fits properly with no leaks during an IDLH situation ("OSHA 1910.134", 2009). Even though air management is extremely new and there is not much data found in the libraries and learning institutions, fire departments across the nation will have to change the mind set of exiting an IDLH when the low alarm activates or the red light begins to blink. If not, the fatality rate from asphyxiated firefighters from running out of air will continue to appear in the fire service for many years to come.

The adoption of this program will require strict discipline from all players that can result in a movement that can be infectious to an entire department. There is no expense to comprise and utilize the rule of air management. This essential safety mission only requires acceptance, execution, and practice, practice, practice

During OCFRD's air consumption drill, the results clearly revealed that the firefighter was ultimately not aware of how much air they consumed in just 10 minutes of strenuous work on a 45 minute bottle. The average of the 915 firefighters that participated in the ACR drill revealed

that a 45 minute cylinder would last the firefighter approximately 20 minutes total. Therefore, taking the emergency reserve 5 minutes from the 20 minutes and consequently leaving 15 minutes of total air left in the cylinder gives the firefighter 7 ½ minutes of working time and 7 ½ minutes to exit. Even though the firefighters low air alarm did not activated during these drills it is safe to say that the activation of the low air alarm is not a signal for the firefighter to leave the IDLH but a warning sign to inform the firefighter that they are now running out of air.

Recommendations

Based on the research in this study, the author is recommending that OCFRD establish and implement an Emergency Operating Procedure (EOP) on proper air management before, during and after an emergency incident (see Appendix H). A committee should be formed between the Operation and Training Division to establish and ensure every policy and procedure created meet all mandated regulations and standards regarding air management while reviewing any existing policies from the past. The implementation of this EOP should incorporate the rule of air management, all legal mandates, policies, standards, and procedures, case studies pertaining to air management from other departments, and quarterly SCBA training evolutions given by the field lieutenants for annual reviews.

The author is an advocate for the subject of air management and recommends that anyone researching this topic should advise their colleagues of the tremendous importance and focus on dealing with firefighters running out of air. The belief that every firefighter will gain all the knowledge and experience in the course of time and service cannot be justified when firefighters are still dying in the line of duty. The errors in past practices on respiratory protection must now become the future for air management in the fire service.

Retrain your mind and become an advocate for your department as well as other departments in adopting and implementing an air management policy. OCFRD stands behind its training motto:

Train as if your life depends on it, because it does. Your life does too!

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Appendix A

Time In A Bottle - 25% EOSTI

Rated Service Life	Total Volume	HZ Volume	HZ Time	Exit Volume	Exit Time
30 Min.	45 ft ³ (1274 L)	33.75 ft ³ (955 L)	9.50 Min.	11.25 ft ³ (318 L)	3 Min.
30 Min.	60 ft ³ (1698 L)	45 ft ³ (1274 L)	12.75 Min.	15 ft ³ (425 L)	4.25 Min.
45 Min.	66 ft ³ (1868 L)	49.5 ft ³ (1401 L)	14 Min.	16.5 ft ³ (467 L)	4.67 Min.
60 Min.	88 ft ³ (2490 L)	66 ft ³ (1868 L)	18.7 Min.	22 ft ³ (623 L)	6.25 Min.



Times are based on 100 liter/minute breathing rate




Appendix B

Table 1. Tarver Rescue Timetable

<i>Time</i>	<i>Task</i>	<i>Lapsed Time</i>
17:26	Tarver calls for help	
17:27	RIC deployed	1 minute
17:36	Company locates Tarver	9 minutes
18:19	Tarver out of structure	43 minutes
Total Lapsed Time		53 minutes

Appendix C

	Orange County Fire Rescue Department Standard Operating Procedures		
Division:	Administration	Issue Number:	Admin 28
Initiated:	T. J. Lyon, Division Chief	Effective Date:	03/01/2005
Approved:	Carl L. Plaughter, Fire Chief	Revision Date:	03/01/2008
Subject:	Respiratory Protection Program		Page 1 of 5

1 PURPOSE:


- 1.1 To establish a procedure to prevent injury as a result of acute or chronic exposure to airborne toxic substances or other respiratory hazards such as oxygen deficient atmospheres.
- 1.2 To comply with OSHA Regulation 29 CFR 1910.134.

2 RESPONSIBILITY:

- 2.1 These procedures apply to all personnel identified as a user of any Respiratory Protective Unit (S.C.B.A.).


3 PROCEDURES:

- 3.1 Parts of the Respiratory Protection Program
 - a. SECTION 1 – Purpose of the program
 - b. SECTION 2 – Responsibility (Individual)
 - c. SECTION 3 – Positions designated to wear Respiratory Protection Equipment
 - d. SECTION 4 – Employee Training
 - e. SECTION 5 – Medical Examinations
 - f. SECTION 6 – Equipment Selection
 - g. SECTION 7 – Air Quality
 - h. SECTION 8 – Respirator Care
 - i. SECTION 9 – Appendix
- 3.2 Inspections
 - a. Users are responsible for the Daily Inspection of their assigned respirator.

	Orange County Fire Rescue Department Standard Operating Procedures		
Division:	Administration	Issue Number:	Admin 26
Subject:	Respiratory Protection Program		
Effective Date:	03/01/2005	Revision Date:	03/01/2008 Page 2 of 5

- b. Regular inspection and maintenance of respirators in accordance with the manufacture's instructions will ensure that these respirators, when properly used, will give the wearer the best possible protection.
- c. Inspection of SCBA:
- Personnel shall, at the start of their duty tour, thoroughly check the SCBA to ensure its full serviceability and properly complete the SCBA check sheet in the truck check book.
 - Check regulator and low-air alarm for proper operation
 - Check tightness of connections
 - Check condition of the face piece and harness assembly
 - Check that the cylinder hydrostatic test date is less than five years old
 - Check that cylinder has at least 4000 psi pressure
- d. Monthly inspections of respirators are to be performed on the first day of the month.
- Completion of the "Daily Air Pack Inspection Sheet" is required and will be filled out at the station
- e. If during the inspections any unit is found to be unserviceable, the deficiency will be noted on the "Daily Air Pack Inspection Sheet" and the unit "RED TAGGED" (placed out of service).
- A copy of the "Daily Air Pack Inspection Sheet" will accompany the out-of-service unit to the SCBA repair shop
- f. If during the inspection no damage or deficiencies are found with the unit, then the "Daily Air Pack Inspection Sheet" is to be maintained in the Company Officer or Supervisor's office file.

3.3 Maintenance

	Orange County Fire Rescue Department Standard Operating Procedures		
Division:	Administration	Issue Number:	Admin 26
Subject:	Respiratory Protection Program		
Effective Date:	03/01/2005	Revision Date:	03/01/2008 Page 3 of 5

- a. Respirator Repair i.e., replacement of lens, hoses, shoulder harness, cylinder hydrostatic tests and regulator repairs are handled by the SCBA repair shop.

3.4 Cleaning The Mask For SCBA's

- a. Acceptable cleaning procedure is as follows:
- Using cleaner – sanitizer, create a warm water solution of no more than 110 degrees F
 - Immerse the mask in the solution and wash
 - Rinse the assembly with clean, warm water
 - Drain all water and air-dry the assembly
 - Hand wipe the assembly, valve and other parts with damp cloth as needed to remove residue and all foreign materials

3.5 Storage of Respirator

- a. After cleaning and inspection all respiratory units will be stored to protect against dust, sunlight, heat, extreme cold, excessive moisture or damaging chemicals.

3.6 Medical Examinations


- a. A mandatory employee physical shall be done on an annual basis.

3.7 Training

- a. All training will be conducted according to the OCFRD Self Contained Breathing Apparatus Training Package and Standards 4201-4204.
- b. All personnel that are expected to, or likely to, respond to and function in areas of atmospheric contamination shall be trained in the proper use and maintenance of SCBA's.

3.8 Responsibilities


- a. SCBA's will be worn at emergencies involving the presence or possibility of contaminated (toxic) atmospheres.

	Orange County Fire Rescue Department Standard Operating Procedures		
Division:	Administration	Issue Number:	Admin 26
Subject:	Respiratory Protection Program		
Effective Date:	03/01/2005	Revision Date:	03/01/2008 Page 4 of 5

- b. Company Officers shall assign a specific SCBA to each member under his/her command.
- c. SCBA's shall not be prematurely removed during an incident. Respiratory hazards exist at fire situations as well as hazardous materials incidents involving toxic materials.
- d. SCBA's shall not be removed until the atmosphere has been determined to be safe to operate within. A safe atmosphere at structure fires is determined by the following parameters.
 - CO = less than 35 ppm
 - O2 = greater than 19.5%
 - Authorization for the removal of the SCBA shall only be by the Incident Commander (OSHA 29 CFR 1910.134)
- e. All personnel are responsible for donning a properly functioning SCBA and properly operating the apparatus.
- f. All personnel must complete an annual respiratory fit test at the time of their annual physical in accordance with OSHA 1910.134.
 - Personnel must bring their assigned SCBA mask and Nomex hood to the scheduled annual physical
 - The SCBA mask and Nomex hood shall be clean and contaminate free
 - Personnel shall be clean shaven for the fit test
 - Only minimal make-up can be worn for the fit test
 - Smoking prior to the respiratory fit test is discouraged (hired prior to October 1, 1989)

4 REFERENCES:

- 4.1 OCFRD Respiratory Protection Program Booklet
- 4.2 OCFRD Self-Contained Breathing Apparatus Training Program

		Orange County Fire Rescue Department Standard Operating Procedures		
Division:	Administration	Issue Number:	Admin 26	
Subject:	Respiratory Protection Program			
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- 4.3 OCFRD Self-Contained Breathing Apparatus Performance Standards 4201-4204
- 4.4 Departmental SOP's
- 4.5 Forms Manual
- 4.6 OSHA Regulations 29 CFR 1910.134

Appendix D



ORANGE COUNTY FIRE RESCUE DEPARTMENT GENERAL ORDER

	ISSUE: GO-09-07	
DIVISION: Operations	POSTED DATE: 1/28/09	Revised: 1/29/09
INITIATED: Mark Rhame, Division Chief, Operations APPROVED: Carl L. Plaughner, Fire Chief	<i>MR</i>	INITIALS: <i>CP</i>
SUBJECT: ROAM – Rule of Air Management		PAGE: 1 of 1

Effective January 28, 2009 OCFRD will be implementing the use of ROAM. ROAM stands for Rule of Air Management and is the practice of consciously keeping track of the amount of air available in your SCBA. This is seen as the next basic firefighter skill along with forcible entry, ladders, hoseline management, etc. In the past we have practiced exiting the fire structure IDLH when our Vibra-Alert activates at **1100** psi remaining. This practice is now seen as hazardous as the air consumed after Vibra-Alert activation is considered reserve air and should be available for emergent use only.

Initial implementation of ROAM requires the following:

- Each member checks out their own SCBA at the beginning of each shift and throughout the shift as necessary due to alarms
- Each member must ensure that their SCBA cylinder has a minimum of 4000 psi. If the cylinder is below this level, it must immediately be changed out or filled
- Each member operating at an IDLH scene involving the use of SCBA must make a conscious effort to know exactly how much air they have remaining in their SCBA at all times
- When a PAR is conducted, each officer or lead firefighter must announce the crew member with the lowest air level by using the color of their heads up display (HUD) reading along with their current location and assignment
Example: "E30 is PAR with three, side C/quadrant C, fire attack, "green" or "E30 is PAR with three, side C/quadrant C, fire attack, "yellow"
- Decisions to rotate crews will be based on the member with the lowest air reading on a crew
- Incident command must maintain crew air levels and coordinate appropriate relief for crews needing to exit the IDLH atmosphere
- A yellow bar on the heads up display means that reserve air is near being utilized and Incident Command should be notified immediately. Command will evaluate conditions and direct the interior crew of the appropriate action to take
- A Red HUD light and Vibra-Alert requires immediate notification of command and egress from the structure

Implementation of ROAM will require training, SOP/EOP revision, and an overall cultural change in our organization. The training division will be implementing ROAM during 2009 multi-company fire drills and as part of our annual SCBA recertification drills. SOP/EOP revisions that encompass this new practice will be taking place in the near future.

Remember...."THE SAME AMOUNT OF AIR IT TAKES YOU TO GET INTO A STRUCTURE WILL BE REQUIRED TO EXIT A STRUCTURE; ENTRY AIR – EXIT AIR = ACTUAL WORKING TIME AIR"

Appendix E

Two (2) Green lights- full cylinder (4500 psi)



One (1) Green light- $\frac{3}{4}$ cylinder (approx: 3400 psi)



One (1) Amber/Yellow light- $\frac{1}{2}$ cylinder (approx: 2200 psi)



One (1) Red light – $\frac{1}{4}$ cylinder (approx: 1000 psi)



Appendix F

AIR AWARE

ACR = Air Consumption Rate
(FORMULA: 45 min SCBA)

- a) Amt/bottle(beginning) *minus* Amt/left(after drill) = _____psi air remaining.
- b) Air remaining ____ psi *divided by* TIME (10 minutes) = ____ACR/min
- c) Amt/bottle(originally) *divided by* ACR/min = _____ min(s) the SCBA will last for work and survival.

EXAMPLE:

- a) 4000psi – 2000psi = 2000psi (air remaining)
- b) 2000psi divided by 10 minutes (time on air) = 200psi ACR/min
- c) 4000psi divided by 200psi (ACR/min) = 20 minutes

Conclusion:

At the rate the FF was consuming air he/she would have 20 more minutes left in the SCBA for work and/or survival.

When the red light on the HUD is displayed or the Vibralert is activated, you are now consuming your reserve/emergency air.

If you come out of the IDLH in survival mode it may be too late, you are already using your reserve/emergency air. This air will only last approximately 5 minutes depending on how fast you are consuming your air.

Rule of Air Management

“Know how much air you have, and manage that air, so that you leave the hazard area before your low-air alarm activates.”

Appendix G

Air Consumption Drill 2009								
Battalion 1			Battalion 2			Battalion 3		
A Shift	B Shift	C Shift	A Shift	B Shift	C Shift	A Shift	B Shift	C Shift
22	20	20	22	25	26	20	10	23
20	21	21	27	14	22	21	16	15
20	22	20	18	19	20	16	14	15
18	27	23	20	23	20	21	21	20
31	18	22	23	20	20	23	15	19
14	20	20	26	17	28	20	20	19
20	23	45	23	20	25	20	21	18
28	20	30	23	25	24	22	19	19
21	20	32	16	23	28	20	20	19
14	21	20	13	23	32	19	14	14
12	24	24	24	17	21	20	18	21
21	20	15	24	23	23	14	19	20
26	21	15	19	18	29	18	18	23
28	30	25	24	20	40	22	24	18
38	17	24	26	22	23	20	21	20
18	21	20	15	26	20	20	19	19
21	22	20	20	25	21	18	25	19
20	15	16	20	19	20	31	19	20
14	21	20	21	24	23	14	24	22
17	31	20	22	26	22	20	26	20
21	30	23	24	15	20	28	15	20
22	17	25	19	20	45	21	20	18
15	28	15	24	20	30	14	20	31
21	23	15	26	15	32	40	21	14
31	20	19	15	21	20	30	22	20
30	17	20	20	31	24	30	27	28
17	20	16	22	30	20	30	18	21
28	25	20	20	17	28	25	20	14
12	20	15	20	28	25	19	23	24
24	22	15	18	21	24	20	20	26
24	13	26	31	22	28	20	20	15
19	15	22	14	19	32	19	21	20
24	12	20	20	19	21	20	24	20
26	15	20	28	20	15	22	20	21
15	24	20	21	22	22	13	21	22
20	36	28	14	13	25	15	20	27
20	18	25	20	15	24	12	23	22
21	23	24	19	12	20	15	22	21
22	30	28	20	15	20	24	20	20
27	23	32	14	24	16	20	45	24
18	30	21	18	22	20	28	30	20
20	25	23	19	27	20	25	32	14

23	28	29	24	18	23	24	20	28
26	37	40	26	20	25	28	24	28
23	23	23	15	23	17	32	25	18
23	20	15	20	20	28	21	28	22
	22	15	17	20	23	23	25	15
	13		20	21	20		24	21
			28	24	17		18	
995	1063	1046	1022	1023	1171	1171	1051	977
21.6304	22.1458	22.2553	20.8571	20.8775	23.8979	21.63829	21.4489	20.35416

Air Consumption Drill 2009								
Battalion 4			Battalion 5			Battalion 6		
A Shift	B Shift	C Shift	A Shift	B Shift	C Shift	A Shift	B Shift	C Shift
18	14	20	24	24	38	25	24	20
23	22	15	19	26	25	20	23	26
16	18	21	23	36	20	25	20	28
18	25	20	23	18	26	15	26	25
21	19	21	23	23	18	22	33	15
23	25	20	24	30	20	22	45	26
14	14	22	24	23	16	27	40	20
20	19	20	19	30	18	18	30	24
19	23	20	24	25	23	20	30	20
20	20	14	26	28	23	23	30	20
14	17	14	15	37	17	26	25	20
22	20	16	20	23	23	23	19	21
16	25	21	20	17	18	23	20	24
21	14	19	21	21	20	26	20	20
0	23	20	22	22	22	16	19	21
27	21	16	24	15	26	30	20	20
14	30	20	14	21	22	25	22	23
14	17	25	15	31	20	23	13	22
18	21	19	22	30	20	32	15	20
23	22	24	22	17	20	28	12	45
20	15	26	32	28	28	25	15	30
19	21	15	22	21	25	25	24	32
11	31	20	25	22	24	22	22	20
20	30	20	18	19	28	25	20	24
21	17	15	24	19	32	21	26	25
26	28	21	21	22	21	20	14	28
28	31	31	25	22	23	21	27	25
38	30	30	28	21	29	21	22	24
18	17	17	24	26	40	21	24	18
21	28	28	20	25	23	26	24	28
20	21	21	21	26	21	28	30	22
14	22	22	20	24	20	38	17	20

17	19	19	28	31	26	18	21	22
21	19	19	21	20	23	21	22	23
22	24	20	21	23	23	20	15	22
15	21	22	16	21	22	28	21	21
21	25	13	27	21	19	20	31	20
31	28	15	20	17	20	30	30	24
21	24	12	20	19	21	20	17	20
22	20	21	26	20	25	26	28	14
19	22	20	25	22	24	22	21	28
19	15	14	15	13	20	17	22	28
22	21	17	22	15	20	28	19	18
22	31	21	24	12	16	12	19	22
21	30	22	19	15	20	24	14	15
26	17	15	24	24	20	24	23	21
25	28	21	26	22	23	19	16	21
	21		15		25			22
	22		20					
941	1087	924	1073	1067	1096	1091	1070	1097
20.0212	22.1836	19.6595	21.8979	22.7021	22.8333	23.2127	22.76595	22.85416

18965	TOTAL
21.84647	**Average Total

Results of Air Consumption Drill (ACR)						
	Battalion 1	Battalion 2	Battalion 3	Battalion 4	Battalion 5	Battalion 6
A Shift	22	22	21	20	21	23
B Shift	22	22	21	21	22	23
C Shift	22	24	20	20	23	23
Mean	22	22	21	21	22	23
Average Mean: 21.8						
Results of Air Consumption Drill- mean = 21.8 (22) minutes of air remaining after completion of drill and includes approximately 5 minutes of emergency air.						
[915] personnel						

Appendix H

Orange County Fire Rescue Department Standard Operating Procedures

Division: Administration	Issue Number:
Initiated: Division Chief	Effective Date:
Approved: Fire Chief	Revision Date:
Subject: Air Management	

1. PURPOSE:

- 1.1. To establish a procedure to require members to maintain an awareness of their Self-Contained Breathing Apparatus (SCBA) air pressure at all times while working within an IDLH and provide an early notification of low air situations prior to the activation of the SCBA low air alarm and/or vibralert.

2. RESPONSIBILITY:

These procedures apply to all personnel identified as a user of the SCBA.

3. DEFINITIONS:

3.1 Glossary of Terms

- a. **Rule of Air Management (ROAM)** – Know how much air you have in your SCBA and manage the amount of air you have so that you leave the hazardous environment before your SCBA low-air warning alarm activates.
- b. **IDLH** – an atmosphere that poses an immediate threat to life, would cause irreversible adverse health effects, or would impair an individual's ability to escape from a dangerous atmosphere
- c. **READY Checks** – a mnemonic device used to remember the key elements of checking the crews PPE and readiness prior to entering a hazardous atmosphere.
- d. **Point of No Return** – Is not the point where you die, but rather that point at which you or your team stops becoming part of the solution and starts to become part of the problem.
- e. **SCBA** – Self Contained Breathing Apparatus; a device worn by rescue workers, firefighters, and others to provide breathable air in an IDLH (Immediate Danger to Life and Health) atmosphere.

4. RESPONSIBILITIES:

4.1 SCBA Readiness Check

- a. Individuals shall perform a daily check of their SCBA upon arrival for duty and the results of the inspection shall be noted on the SCBA check-off sheet.
- b. Crew team members shall check air pressure with their crew prior to entry into the IDLH environment.
 - Air pressure upon initial entry of an IDLH situation shall be 4050 psi or greater
 - Entry into an IDLH with less than 4050 psi will be at the discretion of Command and type of job function involved. EX: Setting up for PPV and returning to safe zone
- c. Prior to entering and IDLH, crewmembers shall perform a R.E.A.D.Y check to determine if the crew is ready to enter the structure or hazard.
 - **Radio** – Each member will verify radios are turned on and working; are switched to the correct channel; and everybody knows who they are reporting too.
 - **Equipment** – Each member has the equipment needed for the assignment and knows how to use it. Every member will verify proper application of PPE.
 - **Air** – Each member will do a pre-entry air check and verify they have enough air to begin the assignment.
 - **Duties** – Each member will be advised of their duties within the team's assignment.
 - **Yes** – If all of the above are affirmative, the team will contact the Incident commander and advise him/her that the R.E.A.D.Y check is complete and the team is entering the hazard area.

4.2 SCBA air management while inside an IDLH

- a. Continually monitor air consumption and pressure as an individual and/or a crew at
 - Regular time intervals (5 minutes)
 - 10 minute CAD safety time notification from dispatch

- Change of work area (floor level change, area or room searched)
 - Passing of major landmarks inside the structure
 - Completion of assignment and prior to accepting another assignment
- b. Crew members will give an automatic air status report to the crew leader when the first member of the crew reaches and air pressure of 2000 psi.
- The Heads-Up Display (HUD) will show one amber light indicating the cylinder is at 50% capacity or $\frac{1}{2}$ a tank left.
 - The crew leader will notify command and request relief so that egress from the IDLH area occurs prior to activation of the low air alarm.
 - Command will decide to replace the crew depending on time of alarm, structural stability, and location of crews to exits and egress.
 - The IC may allow the team to continue working below $\frac{1}{4}$ of cylinder pressure under the following conditions:
 - the fire is under control
 - structural evaluation is made by the IC and concurred by the Safety Officer to determine that there is no structural collapse or entanglement hazards, the crew's visibility is not impaired, and a PAR indicates that the crew is intact and able to continue.

4.3 SCBA Low Air Notification

- a. If a low air alarm activates within the IDLH environment, the user shall call for an immediate radio transmission to Command specifying:
- Who you are?
 - What is your status?
 - Where are you located?
 - What is your current air supply?

EXAMPLE: E38 to Command, this is FF Jones. I am located on the first floor in the Bravo-Charlie corner. I have 900 psi left in my tank. I can see the door on the Bravo side and will exiting.

NOTE: Always address this radio transmission to the proper supervisory level. If you are part of a Division or group, the transmissions shall be addressed to that that level and not to Command

- b. Command shall confirm the message and verify that the Rapid Intervention Team (RIT) Leader has received the same information of status of the individual.
 - c. The RIT Team shall evaluate the need to reposition to confirm the members exit.
 - The RIT Leader shall continue to evaluate the member's air supply in the IDLH and will notify Command if the member has not exited the structure within one minute of the low air alarm notification to Command.
 - Command will evaluate the need to for an immediate RIT activation.
 - d. Members shall notify Command immediately upon exiting the structure or hazard area.
 - e. A low air alarm activation without notification to Command shall produce a call to Command from any crew member in close proximity of the alarm and report the activation and possible location.
- 4.4 The following conditions are automatic criteria for calling a "MAYDAY"
- Low air alarm activation
 - Disoriented and/or unsure of your location
 - SCBA failure within the IDLH
 - Trapped, entangled, or unable to self extricate within approximately one (1) minute
 - Unable to find an exit within approximately on (1) minute
 - Finding another firefighter in distress
- 4.5 Point of No Return
- a. Is not the point where you die but rather that point at which you or your team stops becoming part of the solution and starts to become part of the problem.

5 REFERENCES:

- 5.1 OSHA Regulations 29 CFR 1910.134
- 5.2 Departmental SOP's
- 5.3 SCBA Daily Check-off Sheet
- 5.4 EOP Mayday Event
- 5.5 OCFRD Self Contained Breathing Apparatus Standards 4201-4204
- 5.6 OCFRD Respiratory Protection Plan
- 5.7 Air Management for the Fire Service, (Gagliano, M., Phillips, C., Jose, P., & Bernocco, S. (2008).