



Operational Guides and Best Practices

SUBJECT: RESPIRATORY & DERMAL PROTECTION DURING FIRE ATTACK, OVERHAUL, AND INVESTIGATION

PURPOSE: To provide best practices for respiratory and dermal protection during the extinguishment, overhaul, and investigation phases of a fire

SCOPE: These recommendations were derived by consensus from studies presented Oregon State Fire Marshal Regional Hazardous Materials Team 9 during a Respiratory Protection Summit held January 18, 2012 at the Oregon Public Safety Academy in Salem, Oregon. For further information on study material, or to obtain a copy, contact the Oregon Office of State Fire Marshal.

RECOMMENDATIONS:

The intent of these recommendations is to provide fire departments with a multitude of options to better protect their personnel from the acute and latent effects of the products of combustion during extinguishment and post fire knock-down. Many factors may limit a fire department's ability to implement all of the best practices. End note numbering signifies that there is additional information in the back of this document.

LIMIT TIME RESPONDERS ARE EXPOSED TO TOXICANTS

- Consider rotating crews out of smoke and toxicant atmospheres¹
 - If staffing levels allow, frequent rotation of fire attack crews will limit time of exposure.
 - Limit the number of personnel assigned to overhaul operations or rotate crews.
- Limit overhaul activities to confirmation of extinguishment

UTILIZE VENTILATION AND COOLING TO REDUCE EXPOSURE

- Ventilation, post fire knock-down, will dilute the toxicants or transport them away from the fire structure
 - Gas powered fans may introduce Carbon Monoxide to the fire structure
 - Be aware of where the air tract may potentially transport the toxicants and adjust the overhaul zone accordingly
 - Consider the use of electric fans or natural ventilation during overhaul operations

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- Ventilation will not stop the production of toxicants by itself
- Allowing contents and structure to cool reduces the production of toxicants
 - Remote application of water reduces exposure to responders while cooling the materials
 - Use of foam may improve penetration and increase cooling
 - Utilize thermal imagers to confirm that the debris pile and structure have cooled
- Establish a 45min to 1hr window of time post knock-down to allow the contents to cool
 - Study demonstrated that toxicant levels were significantly reduced or were eliminated after 1 hour
 - Time away from the fire scene reduces the potential for evidence disturbance

IMPROVE ATMOSPHERIC MONITORING POLICY ON THE FIRE GROUND ⁱⁱ

- Do not rely on a Carbon Monoxide monitor as the determinate for safe breathing atmospheres
 - If possible, utilize advanced portable real-time monitors that can detect and quantify as many of the following toxicants:
 - Mercury
 - Ozone
 - Nitrogen Dioxide
 - Acrolein
 - Aldehydes
 - Particulate
- Monitor to establish Warm Zone and Cold Zone
 - Unhealthy toxicant levels can exist 75'-100' from the fire structure
 - In the absence of advanced monitors, the zones should be established based on wind direction, smoke levels, and contents involved
 - Responders may need to be on air at greater distances from the fire structure and out of visible smoke
 - Where possible, stage companies, command staff, and rehab upwind
- Utilize advanced monitoring to further identify the toxicants encountered
 - Establish decontamination practices for specific toxicants
 - Document exposures to known toxicants

IMPROVE PRACTICES ON THE FIREGROUND TO LIMIT FIREFIGHTER EXPOSURE

- Establish zones at a structure fire similar to that of a hazardous materials incident with airway protection determined by the Incident Commander/Safety Officer for each:ⁱⁱⁱ
 - Hot Zone- Area defined by active fire involvement
 - Warm Zone- Area immediately adjacent to hot zone typically outside the structure.
 - Cold Zone- Area outside of the reasonable tract of toxicant travel. Rehab should be located in this zone.^{iv}
 - Overhaul Zone- Area where active fire involvement occurred and where fire fighters will be working to ensure fire is extinguished.^v

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- Incident Command or Incident Safety Officer to determine safe doffing of SCBA based on conditions that should include:^{vi}
 - Time
 - Cooling
 - Monitoring
 - Size-up of contents
 - Wind direction
 - Location
- Crews should not exit the structure and immediately doff regulator or SCBA
- Emphasis should be placed on the importance of apparatus operators using SCBA's if unable to position upwind or out of Warm Zone
- Standby and Rapid Intervention Team placement
 - Standby away from the smoke if possible or on air
- Ensure use of SCBA for all crews working in the Warm Zone and Hot Zone who are unable to position upwind
- Incident Command should size-up the content pile
 - Chromated Copper Arsenate (CCA) pressure treated lumber is an extreme skin and respiratory hazard. Remote water application, crews to be upwind from this product when burning^{vii}
 - Fluorescent energy efficient bulbs, commercial sodium lamps, neon signs, and some thermostats and electric switches contain mercury. This extremely hazardous chemical is released as a vapor when these products are broken or are involved in fire.
- Air Purifying Respirators and SCBA mounted cartridges should not be utilized unless the toxicants can be identified
- Define salvage vs. overhaul within the context of this new set of recommendations
 - Responders are not a clean-up company
 - Incident Command will determine the extent of salvage and overhaul operations
- Develop decontamination procedures for PPE^{viii}
 - All companies working in the Hot Zone should have a gross decon of PPE prior to demobilization
 - Washing and/or scrubbing of PPE with water
 - Specific decon methods and equipment can be used if the toxicants can be identified
 - Bags for contaminated PPE should be provided to responders for transport back to quarters
 - PPE should be taken out of service and washed
- Develop decontamination procedures for personnel
 - Cleansing wipes such as “Hype-Wipes” should be provided to personnel on scene
 - All companies working in the Hot Zone should shower upon returning to quarters

Respiratory & Dermal Protection During Fire Attack, Overhaul, and Investigation**IMPROVE DEPARTMENT POLICIES, PROGRAMS, AND DOCUMENTATION**

- Health, Safety, and Wellness programs should be established, if not already^x
 - Personnel should have a baseline medical evaluation
 - Personnel should be evaluated during rehab for acute exposure
 - Document potential exposures or identified exposure if advanced portable detection is utilized
 - Education should be given on the toxicants found during overhaul and best practices for reducing the exposure
- Structure fires should be documented ^x
 - Construction type
 - Materials involved
 - Conditions
 - Personnel
 - Location
 - Actions
 - Use of airway protection
 - Toxicants found by air monitoring
- Procedure established for follow-up healthcare, if acute exposure suspected
- NFPA 1851 followed for PPE care
- Consideration of document provided to structure owner^{xi}
 - “after the fire disclaimer”
 - Inform owner of hazards potentially present

INVESTIGATION SPECIFIC RECOMMENDATIONS

- Create policy that outlines respiratory protection specific to investigators^{xii}
 - Issue, train, and reinforce the use of SCBA
 - Provide alternate respiratory protection and establish use guidelines
 - Air Purifying Respirators
 - Supplied Air Respirators
- Provide lightweight disposable PPE such as Tyvek® or Saranex® that can be worn over duty clothing
 - Supply disposable over-boots
- Improve existing air monitoring capabilities
 - Consider advanced portable detectors
 - Consider particulate monitors
- Follow firefighter decontamination procedures for PPE and personnel outlined above
- Document fires and suspected exposures

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ⁱ If staffing levels permit, rotate fire attack crews out of the structure. Not only do crews get tired, but there prolonged exposure to chemicals, compounds, and toxicants within these environments may constitute a greater threat than if exposure time were reduced and spread over a greater number of people. Additionally some chemicals can have a cumulative exposure effect.

ⁱⁱ It is no longer acceptable to simply monitor levels of Carbon Monoxide (CO) and to use levels of CO as an indicator of other chemicals. While it is recommended that fire service agencies monitor the air for the presence of aldehydes, mercury, ozone, nitrogen dioxide, and acrolein, it may not be financially possible to acquire equipment that allows this to occur. If possible utilize gas monitors you may have available to you, but again it is no longer acceptable to simply doff SCBA once CO levels fall to acceptable levels.

If gas monitors are not available (or the monitors available do not detect all of the above listed chemicals and compounds) it is recommended that once knockdown is achieved and the fire is believed to be extinguished wait an hour to allow the building and its contents to cool. During this time, consider the application of foam to penetrate and cool objects, or the use of exterior defensive operations, also attempt to minimize damage to potential evidence that may still exist. An inexpensive handheld infrared thermometer can be utilized to check the temperature of the room and its contents. . If the room and its contents are allowed to cool in this manner, it is acceptable to overhaul the fire without SCBA unless there is a specific known hazard (for example CO from gas powered ventilation fans, or airborne particulates released when walls or ceilings are opened to check for extension). Once operational needs allow, it is recommended that electric fans be utilized as often as possible to reduce levels of CO.

ⁱⁱⁱ Long used in hazardous materials incidents the fire service should implement a hot zone concept during all phases of fire operations. The size of the hot zone is not necessarily a circle, and is not necessarily limited to the walls of the structure. Wind conditions or other weather factors may cause harmful particulates and chemicals to remain in the ambient air up to 100 feet or further away (usually downwind) from the structure that is on fire. It was emphasized that simply reaching an exit point of the burning structure is not grounds for discontinuing the use of SCBA. Different fire service agencies may have different ways to identify a hot zone; including the use of cones, survey tape, glow sticks, or landmarks. Whatever system is utilized should become as interregal a part of operations as a scene size up, and should be communicated to mutual and auto-aid partners. Apparatus should not be parked in the hot zone. In the event it is unavoidable, operators should be wearing full PPE and SCBA. Standby crews, RIT, command personnel, rehab, non-operations personnel, and staged apparatus should be kept out of the hot zone unless an operational need exists, and even then they too should be in full PPE with SCBA. The SO and ASO(s) are not removed from this recommendation.

^{iv} It was discussed at the summit that many times rehabilitation areas are set up far too close to the fire scene. Rehabilitation areas by definition are areas in which no PPE is required, and should be located well away from the building or fire, a minimum of twice the distance of the hot zone. Two-hundred feet from the involved structure would not be unreasonable in many situations. This area should be upwind, but in environments in which the weather or wind conditions may change,

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this area may need to be evacuated or relocated to provide for the safety of the persons assigned to the rehabilitation area.

^v While conducting overhaul operations, care should be taken not to abandon respiratory protection simply because fire is believed to be extinguished. SCBA use should be continued (or room should be permitted to cool) for at least an hour after the fire has been knocked down. It is also important to note that simply because the room has been permitted to cool, if ceilings or walls are opened up to check for fire extension – there may be contaminants introduced to the air (insulation for example) the SO or IC should determine if a particulate filter will be adequate, or if SCBA use should continue to protect firefighters from airborne particles. Air monitoring should also continue, and appropriate actions should be taken based on the air quality readings

^{vi} The Safety and Health Section recommends the use of a qualified safety officer (SO) at all incidents that are large enough to justify one. Remember, if a SO is not specifically identified by the incident commander (IC), the IC retains the responsibility to act as the SO. It should also be noted that larger incidents may require the SO to have Assistant Safety Officers (ASO), and that one cannot be a SO without knowledge of the activity that is being overseen, and the hazards associated with it.

^{vii} At the summit it was discussed that treated lumber (typically used for decks) can release hazardous chemicals when exposed to fire. In particular, the treated lumber that appears as though it is coated with a green powder or liquid.

^{viii} Also lending itself from hazardous materials teams, the concept of a decontamination corridor or area as a gateway between the hot zone and the cold zone should also be implemented. Within this corridor Firefighter should be washed down with water, or with water and mild soap. The purpose is simply to remove solid particles such as wood, insulation, dirt, and other fire debris that would otherwise be carried into the cold zone, into the apparatus, and back into the station. All tools, equipment, turnouts, and SCBA should be washed in the decontamination zone.

Under no circumstances should contaminated items (ie tools, equipment, or PPE that has been in the hot zone) come in contact with interior surfaces or upholstery of fire apparatus before at least a gross decontamination has taken place. If this is simply not an option, then the interior surfaces of the apparatus should also be decontaminated. Fire attack hose should never be handled without gloves as the very nature of this hose (being dragged through fire debris, pools of contaminated water) could cause cuts or other dermal injuries allowing a higher level exposure to unknown contaminants.

Bunker gear should be doffed in the decontamination area, and placed into a plastic bag for transport back to the fire station and immediate washing. Station uniforms are usually adequate for individuals to be transported back to the station, but some jurisdictions have personnel transport spare or replacement turnouts for firefighters to wear while contaminated gear is cleaned. Tyvek suits (level B hazmat suits), painter's suits, or other similar garments add a layer of inexpensive protection to the individual (and the interior of the apparatus) while they are returning to the station if necessary.

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Once the apparatus has returned to quarters, all personnel that performed activities within the hot zone should shower. It is recommended that the shower start with cold water to minimize pores from opening and allowing potential contaminants into the dermal layers. Do not wear clothing again until it has been laundered. Cuts should be properly cleaned. While no specific studies are known to exist, simple machine washing was generally regarded as acceptable. If no showering facilities are available, cleaning wipes can be utilized to provide a minimum level of decontamination, and can be used to clean interior surfaces of apparatus that may have been cross contaminated.

Turnouts on the other hand, should be washed in a machine dedicated for the purpose, or sent out to a third party cleaning company. Generally speaking any agency that performs interior firefighting operations either issues a “backup set” of bunker gear for firefighters to use while the primary gear is being washed, or they have a minimal amount of gear for firefighters to utilize while gear is being washed. An inability to obtain alternate PPE should not be used as an excuse to not adequately wash or decontaminate PPE.

Having clean PPE may require a culture change. PPE (specifically turnouts and helmets) that are contaminated with cancer causing chemicals and fire debris are deemed in some fire service agencies as desirable. Emphasis should be placed on company officers and firefighters that the use of contaminated PPE carries with it an increased risk of dermal and respiratory harm, and can also negatively impact fire investigations by cross contaminating fire scenes.

^{ix} Health and wellness trending over time can only be trended over time if data is available. Agencies should already have health and wellness programs in place. If your agency does not and would like to start one, NFPA 1500 can be used as a starting point.

^x Company officers working in coordination with the IC or SO should determine if an exposure has occurred and the level of report that is necessary. Of course the maximum level of exposure requires the implementation of the exposure control plan for your agency. A minimum level can utilize the “firefighter casualty module” in an National Fire Incident Reporting System (NFIRS) compliant reporting system (required by all agencies that report incidents to the Oregon Office of State Fire Marshal) this module can be used with the level of severity indicating a “report only”. Provide construction type, materials being burned, and actions taken by the individual, and conditions that led to the exposure.

^{xi} While this document is not intended for property owners, fire service agencies should consider providing property owners with a generic form similar (or in combination with) the “permission to enter” for utilized by fire investigators to inform them of the potential risks associated with exposure to chemicals, compounds, particulates, and gasses.

^{xiii} Assure that all members who wear SCBA or any other respiratory protection have the appropriate medical clearance outlined in NFPA 1582 and are fit tested per OR-OSHA Respiratory Protection requirements.

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Fire investigators should also be equipped with air monitors and be properly trained in their operation; to know what readings mean; and what actions to take when various readings are reported.

Fire investigators should be provided with lightweight disposable clothing. There are several fire service agencies that utilize disposable level B hazardous materials suits to prevent cross contamination from one fire scene to another – and the reduce the need to decontaminate clothing. Fire investigators not utilizing disposable clothing should decontaminate their clothing in a manor similar to firefighters (reference item 3 listed earlier). Fire investigators should also shower upon returning from a fire investigation as quickly as practical.