An Roinn Tithíochta,
Rialtais Áitiúil agus Oidhreachta
Department of Housing,
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Good Practice Note 5.1

Protecting Firefighters from the Products of Combustion

Working at Operational Incidents

Prepared by the National Directorate for Fire & Emergency Management

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Section 1. Introduction

1. This document reviews the hazards and risks associated with the exposure of firefighting personnel, to potentially harmful airborne contaminants from the products of combustion, when working at operational incidents. It sets out good practice for fire services to mitigate the toxic impacts, for firefighters when working at fire related operational incidents.

2. Potentially harmful contaminants present themselves to firefighters working at operational incidents, primarily via airborne in the products of combustion. Over recent decades newer materials, particularly synthetic and petro-chemical based ones, are used in the construction of various types of buildings, and their contents, such as furnishings, fittings, linings and electronics, have followed a similar trend. These materials tend to ignite and burn hotter and faster than conventional materials and expose firefighters to increased concentrations of toxins.

3. Products of combustion or smoke consists of a mixture of particulate matter, heated gases, irritants, asphyxiants and toxins. The constituents of smoke vary from fire to fire and from one location to another, depending on such factors as the composition of the burning material, the rate of burning, the temperature and the oxygen levels.

4. It is important to recognise the potential harmful effects that firefighting can have on firefighters themselves. Exposure to the unique hazards present from toxic smoke inhalation in firefighting can lead to both immediate and long-term health consequences. Understanding and addressing these harmful effects is crucial to ensuring the health and safety of our operational firefighters.

5. Research[1] highlights that fire contaminants are directly linked to and can increase the risk of cancer and other diseases. This guidance provides advice to fire services in the pre-planning, the provision of suitable equipment/PPE and operating principles and practice, that will protect firefighters from the products of combustion. It highlights the importance and benefits of bagging, washing and decontaminating firefighter personal protective equipment (PPE) and fire service equipment, to mitigate the risks posed by smoke and other combustion products.

6. The NDFEM acknowledges that there are differing levels of activity, equipment and infrastructure in the various fire services in Ireland. This guidance is based on what is reasonably practicable, taking-into- account the number of personnel and local risks, knowledge and experience. The guidance is predicated on the expectation that it will ensure consistency in mitigating the risk in fire services.

7. Fire Authorities should review this guidance, and the associated training materials, to develop a policy that is specific to their needs, available resources and current infrastructure with the ultimate goal of mitigating the risks. It is suggested that a local implementation group be tasked with the development of the policy and subsequent implementation. It is further recommended that the developed system be monitored for learning opportunities and adaption.

8. This guidance does not cover contaminants caused as a result of exposure to general hazardous materials and the relevant standard operational guidance (SOG) should be consulted for further advice and information. This practice note focuses on operational fire services work and an additional guide will be prepared for managing the products of combustion in fire services training environments (training centres).

Section 2. Products of Combustion

1. The role of firefighters will inevitably bring them into direct contact with fires and the products of combustion, which contain many toxins. Fires produce a cocktail of toxic, irritant and carcinogenic chemicals – the composition of which varies depending on the specific materials burning and the fire conditions. They can be released in the form of particulates which will include aerosols, dusts, fibres, smoke and fumes or gases and vapours.

2. Some of the materials produced in fire (e.g. carbon monoxide, hydrogen cyanide and acid gases) have immediate adverse effects on health after only a single or short exposure (e.g. asphyxiation). This is known as acute toxicity.

3. The toxins that derive from the pyrolysis of fuels and the complex combustion process (e.g. polycyclic aromatic hydrocarbons, volatile organic compounds) have much longer-term adverse effects on health, causing conditions which are more complex and can develop more slowly e.g. cancer, cardiovascular (related to the circulatory system which comprises the heart and blood vessels) and neurological (nervous system) diseases. This is known as chronic toxicity. Repeated exposure to even very small amounts of chronic toxicants over time increases the likelihood of developing long-term health conditions.

4. Breathing apparatus training delivered to firefighters has to date focused very much on essential skills such as pathfinding, search procedures and casualty retrieval. Compartment fire behavior training has further complemented these basic skills and enabled firefighters to manage their work environment within a structure on fire. While the physical behaviour of smoke is now understood and managed by firefighters at incidents, research[1] indicates a link between exposure to the toxins contained in smoke and certain illnesses. They are present as airborne gases or condense onto surfaces (including firefighter PPE) as particulates or other deposits and resins.

5. Developments in breathing apparatus technology over the years have given firefighters a high standard of respiratory protection, when exposed to harmful airborne substances across the variety of incident types they attend. Research[1] has in recent years indicates that skin absorption rather than inhalation is now the leading cause of firefighter exposure to the harmful substances encountered. This highlights the importance of firefighter awareness and managing this exposure through managed work practices, including bagging of equipment/PPE at scene and decontamination of firefighters & PPE, equipment, and workspaces.

Section 3. Routes of Exposure

3.1 Direct Inhalation

1. Considered the traditional route of entry for toxins, the frequent use of modern breathing apparatus has greatly reduced the incidents of lung related illnesses among firefighters. Breathing apparatus is now commonly used not just for structural fires but also for vehicle fires, skip fires and many other types of incidents where combustion takes place in open spaces.

2. Breathing in toxic substances or harmful agents present in the air is a common route of entry. The respiratory system allows these substances to enter the lungs and eventually reach the bloodstream. Exposure happens when firefighters do not wear, incorrectly wear or prematurely remove respiratory protection.

3.2 Dermal Absorption

1. Toxic substances can be absorbed through the skin, especially if they come into direct contact with open wounds, cuts, or through prolonged skin exposure. Soot, or other harmful substances present in the smoke can be absorbed through the skin and enter the bloodstream.

2. The skin is the largest organ in the body and recent research has focused on it, as a pathway for toxins to enter the body. While it provides a barrier to many substances entering the body, it is not impervious. Research[1] indicates that increasing skin temperature leads to an increase in skin permeability and hence greater absorption of contaminants, via enhanced blood flow to the surface of the skin, increased skin hydration due to sweating, and the opening of skin pores.

3. The combination of boots, base layers and well-fitted structural firefighting kit provides a level of protection to the majority of the body. Research[1] has indicated that the face, jaw, neck, throat and hands are vulnerable to direct absorption and are areas of the body that require cleaning post exposure.

4. First generation anti-flash hoods were designed to limit the effects of elevated temperatures on exposed skin in the head and neck. Designs have now evolved into what are known as ‘particulate blocking’ anti-flash hoods, that while unable to be completely gas tight, have reduced the amount of toxins that can pass through, yet still fulfill the requirement to protect against elevated temperatures.

3.3 Ingestion

1. Ingestion through the gastro-intestinal tract occurs when a toxicant is swallowed.

Exposure to contaminants via ingestion may occur when food or drink is contaminated with fire effluents, e.g. if eating/drinking with soiled hands. In addition, when fire gases or particulates have entered the upper respiratory tract via inhalation, they may be carried via mucous and saliva into the digestive system and absorbed into the body.

3.4 EXPOSURE ENVIRONMENTS

1. A non-exhaustive list of examples where firefighters *are at increased risk of exposure to harmful contaminants* as a result of working at fires are as follows;

   (a) Firefighters working in smoky environments, internally or externally
   (b) Overhaul or damping down activity after extinguishing a fire
   (c) Not cleaning exposed areas with decontamination wipes at an incident
   (d) Carrying unbagged contaminated fire kit in own vehicle or in appliance cab
   (e) Cab seats or lockers not being cleaned after incidents
   (f) Cab or vehicle seat surfaces that are absorbent to contaminants
   (g) Eating, drinking or smoking/vaping with unwashed hands whilst wearing, or after de-robing PPE, that may be contaminated
   (h) Inadequate wearing or use of PPE while handling or servicing contaminated BA equipment
   (i) Inadequate wearing or use of PPE while undertaking cleaning of contaminated PPE and other equipment
   (j) Not changing out of dirty PPE or station wear
   (k) Not showering in the station after being exposed at a fire

Section 4. Contamination

1. This guidance focuses on the presence of harmful substances firefighters encounter during and after operational incidents. The broader contamination risks for firefighters include exposure to various hazardous materials such as:

   (a) Smoke and Combustion Byproducts

   Toxic gases and particulates, such as carbon monoxide, hydrogen cyanide, and formaldehyde, are present in smoke from burning materials.

   (b) Hazardous Chemicals

   Chemical spills or leaks from industrial facilities, vehicles, or storage units can expose firefighters to hazardous substances.

   (c) Biological Agents

   Exposure to pathogens or biohazards at medical emergencies, road traffic collisions, domestic house fires and waste-related facilities. This list is not exhaustive.

   (d) Asbestos and Heavy Metals

   Older Structures, particularly older roofing, which may release asbestos particles and/or other hazardous materials such as heavy metals like lead, zinc and cadmium (to name but a few) when damaged by fire ground activities or fires.

   (e) Waterborne Contaminants

   Contaminated firefighting runoff water may pose health and environmental threats particularly when working close to water embankments or flooded areas.

2. The types of contamination outlined above, outside of the products of combustion, are covered in the various SOGs, already issued by the NDFEM in areas such as Rescues and Attendance at Flooding (SOG 2.08), Rescues from Water (SOG 2.11), Hazardous Materials Incidents (SOG 7.00 – 7.09), Asbestos Incidents (SOG 5.11) and Working on, in or Near Water (SOG 5.16).

4.1 Direct Contamination:

1. When firefighters come into direct contact with hazardous products of combustion during an incident. Such exposure can happen through:

   (a) Contact with toxic smoke and other airborne particles while attending fire related incidents.

   Without proper protection, the permeation of contaminants occurs when these

substances penetrate structural fire kit or dermal absorption to exposed skin.

(b) Breathing Contaminated Air

Inhaling smoke or airborne particles that contain harmful substances can lead to respiratory contamination.

4.2 INDIRECT (CROSS) CONTAMINATION:

This takes place when contaminants are transferred from one surface or individual to another. Examples include:

(a) Personal Contact

Without proper decontamination firefighters can transfer contaminants through touch e.g. touching their face, communicating with others, or handling equipment, increases the risk of spreading harmful substances.

(b) Contaminated PPE and Equipment

If firefighters do not follow proper decontamination protocols, they are at risk of transferring contaminants to themselves or others.

(c) Fire Service Vehicles

Firefighters often bring contaminated PPE back to the fire station inside an enclosed vehicle cab. If the PPE is not decontaminated or isolated from crew, this can lead to contamination of the cab environment impacting the health of all personnel.

(d) Fire Station Areas

Dirty PPE which is not isolated can lead to contamination of communal areas such as muster area and appliance bays.

4.3 LEVELS OF CONTAMINATION

The levels of contamination from combustion products on the fire ground are affected by several factors:

(a) Fire Size and Duration

Larger and longer-duration fires typically produce more smoke and byproducts, increasing the potential levels of contamination.

(b) Materials Being Burned

Different materials release various toxic substances when they burn. Synthetic materials, plastics, and other chemical-based products can produce more hazardous smoke than natural materials like wood.

(c) Temperature

Increase temperature increases the levels of permeation.

(d) Proximity and Exposure Time

Firefighters working close to the fire source or staying longer in affected areas are more likely to experience higher contamination levels.

(e) PPE

Proper use of personal protective equipment, including breathing apparatus, reduces direct exposure to smoke and particulates.

(f) Ventilation

Controlled ventilation can help disperse contaminants, however, little or no ventilation will lead to higher concentrations of toxic smoke and gases.

(g) Weather Conditions

Wind speed and direction can disperse or concentrate smoke in particular areas, affecting contamination levels nearby and downwind affecting firefighters and other emergency service personnel not directly involved in the fire.

4.4 PERSONAL PROTECTIVE EQUIPMENT

1. PPE is a combination of garments and equipment designed to protect firefighters from the hazards which they may encounter at operational incidents and includes:

(a) Firefighting Structural PPE

This current standard is EN 469 (2020)[2], which focuses on thermal and physical protection, while working inside buildings. Features like pockets and loops, while functional, can accumulate contaminants, and without an effective inspection and cleaning routine, these harmful substances may persist on the gear. Additionally, as PPE ages, it's protective abilities diminish, making it easier for contaminants to penetrate the materials. Regular maintenance and updates to firefighting PPE are essential to ensure safety and effectiveness.

(b) Fire Helmet

The current standard is EN 443 (2008)[3], which considers criteria such as impact, thermal, electrical, head and face protection. The design of helmets allows for contamination to accumulate on both the outside and inside surfaces. Consideration should be given post fire to decontaminate helmets by thoroughly cleaning the inside cradle and outside shell.

(c) Anti-Flash Hood

The current standard is EN 13911 (2017)[4] and may also conform to NFPA 1971 (2018)[5], which considers the effect of severe heat posed by fire gases. Anti-flash hoods are in direct contact with the skin and dermal absorption around the skin/neck area is considered much quicker than absorption in other areas of the body. Particulate blocking flash hoods should be worn with the fire kit ensemble. They are not required to be worn on the fireground unless the firefighters are wearing breathing apparatus (BA) or a risk assessment requires their need. When they are worn and not under air they should be '*pulled down*' round the neck (rather than the traditional 'rolled down'), thus minimising contamination of the inside of the flash hood, prior to it being pulled up on to the head.

(d) Firefighting Gloves

The current standard is EN 659 (2003)[6], which considers thermal and physical protection. Gloves are subjected to the most regular wear and tear thus allowing for contaminants to be easily transmitted by direct contact or indirect (cross) contamination. Poor habits such as placing gloves inside of helmets post operational attendance allow for cross contamination from hand to head. Additional consideration should be given to wearing undergloves or applying barrier cream.

(e) Firefighting Boots

The current standard is EN 15090 (2012)[7], which consider thermal, impact and physical protection. Boots are often overlooked but are the greatest source of cross contamination from fireground to fire service vehicles and onto fire station communal areas. Most boots are leather in design and as such tears in boots will contain contaminants. On-site decontamination of boots should be always considered before entering a fire service vehicle.

(f) Base Layers

The base layer's (i.e. any clothing beneath structural PPE), primary function is to wick moisture away from the skin, regulate body temperature, and provide an additional layer against heat and friction from outer garments. Fabrics that should be considered include inherently flame-resistant fibres which maintain comfort, manage sweat, and resist ignition. Materials to avoid are common synthetics (polyester, nylon, polypropylene) since they can melt or drip under extreme heat, causing burns. Consideration should be given to garments certified to EN ISO 11612:2015[8] for heat & flame resistance and EN 1149-5:2015[9] for antistatic protection.

4.5 FIREFIGHTING EQUIPMENT

There are numerous pieces of equipment used at operational incidents, particularly in the areas and structures where firefighting activities are undertaken. This primarily includes hose, branches, thermal imaging cameras, radios and breathing apparatus. The main visible contamination should be cleaned thoroughly at scene using water and any brushes etc. The more significantly contaminated equipment, mainly BA sets should be initially cleaned wearing suitable PPE and then bagged/boxed for transport back to the station.

Section 5. Mitigating the Risk

Firefighters face significant health risks due to the byproducts of smoke and combustion encountered during firefighting operations. These byproducts contain toxic substances that, if not adequately decontaminated, can continue to adhere to PPE and fire ground equipment, persisting for extended periods and posing a continuous threat to firefighters' health. This guidance reflects a structured approach to mitigating the risk as much as is reasonably practicable.

5.1 Minimising Firefighter Exposure

The initial management of contamination at an incident site is critical, to limiting the exposure of contaminants to firefighters. There are practical control measures which can be followed to reduce exposure levels such as:

(a) Personal Protective Equipment (PPE)

(i) Undamaged, well-fitted PPE, including helmets, gloves, fire-resistant clothing, and boots.

(ii) Ensure that BA is worn during firefighting operations to prevent inhalation of toxic gases and particles.

(b) Decontamination Procedures

(i) Implement on-site decontamination protocols to remove soot and debris from PPE and equipment. Isolate and bag contaminated PPE on-site.

(ii) Use decontamination wipes or wet cloths to clean skin and exposed areas as soon as possible.

(iii) Develop a recordable maintenance, inspection and cleaning process of PPE and equipment after each incident, where contamination is believed to have occurred.

(c) Washing and Hygiene Practices

(i) Provide on-site handwashing facilities, especially before eating or drinking.

(ii) Provide facilities for showering and changing clothes immediately after firefighting, in order to minimise the spread of contaminants beyond the operational service.

(d) Length of Exposure

(i) It is advised that there is some management and recording of firefighters who don BA at incidents over the course of their operational work.

(ii) IC should consider the rotation of crews to minimise the amount of time spent in hazardous environments.

(e) Ventilation Systems

(i) Consider the installation of cab ventilation systems to limit airborne contaminants on returning from operational turnouts.

(f) Training and Education

(i) BA and CFB training programmes to focus on decontamination procedures post incident.

(ii) The structured approach is to minimise firefighter exposure to contaminants through appropriate pre-planning, considering the actions before, during and after an incident and for when the firefighters return to the fire station.

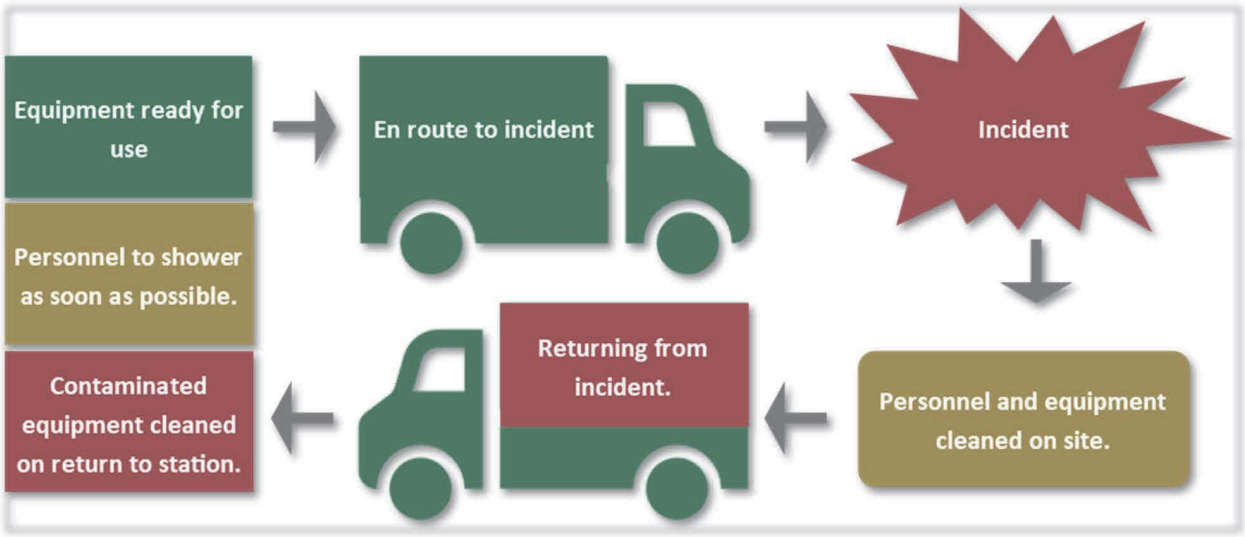


Diagram 1. Decontamination Cycle (Adapted from UCLan Document[1])

5.2 PRE-PLANNING

5.2.1 Fire Station Layout

1. The layout of the fire station should be clearly delineated with appropriate signage, as much as practicable, for the areas where dirty or contaminated equipment or PPE is permitted. All fire stations should progress to clearly indicating the clean and contaminated areas and consider external washing facilities in station yards for clean down of PPE and equipment.

2. Fire stations should have appropriate separation and signs/colour coding of areas with traffic light system to clearly denote contaminated (red), transition (yellow), and clean (green) spaces within the building. The Red Zone contains spaces most likely to be contaminated such as apparatus bays. The Yellow Zone creates transition spaces between red and green zones where contamination control takes place. The Green Zone

houses clean spaces such as living, administrative and public areas.

3. The Yellow Zone acts as a “filter” between the Red Zones, where contaminants can be found, and the Green Zone. This transition zone provides a place for personnel and gear to be decontaminated while providing a buffer to keep the contaminants from crossing over into where firefighters eat, live and sleep, thus minimising exposure. It is recommended to divide the fire station in to three hazard zones. It is acknowledged that the layout of stations varies significantly across the country and any guidance on zoning will have to be tailored locally. Notwithstanding this the following may provide some assistance when ‘mapping’ stations.

Hot (Red) Zone:

4. These are designated for everything contaminated that needs to be decontaminated and are primarily operational areas. Ideally, there should be a decontamination at source policy, but the red area has a medium risk of cross contamination or exposure to carcinogens. If leaving a red area, firefighters should ideally not be able to enter a green area without passing through a transitional zone (yellow) with the opportunity to wash and change clothes. Example of areas* that may be considered for inclusion in the red areas are as follows:

(a) Appliance bay
(b) Appliance washdown
(c) Operational washdown
(d) Workshop
(e) Operational equipment store
(f) Compressor room
(g) Dirty kit collection
(h) Briefing/debrief room

* **Note:** The designated areas detailed above may vary from those outlined in the developed fire authority's policy as a result of station layout or decontamination procedures conducted external to the station.

Warm (Yellow) Zone

5. This is the transitional space between red zones and green areas where firefighters and staff can clean and remove contamination. The risk of exposure to contamination or carcinogens is low. Firefighting kit can be worn in this area if suitably clean. Example of areas that may be considered for inclusion in the yellow areas are as follows:

(a) WC/showers

(b) Lockers
(c) Laundry
(d) In-use kit room
(e) Drying room / cabinet
(f) BA servicing / wash area
(g) General equipment store
(h) Cleaners' store

Cold (Green) Zone

6. This is the clean areas within a station where food is prepared or consumed or the living areas of the fire station, where clean only tasks are carried out. I.e. office tasks. No firefighting kit is to be worn and there should be no risk of exposure to contamination from carcinogens. Contaminated PPE and equipment should never enter this zone. Example of areas that may be considered for inclusion in the green areas are as follows:

(a) Public entrance
(b) Reception
(c) Community room
(d) Public WC
(e) Personnel main entrance
(f) Meeting rooms and offices
(g) Quiet rooms / prayer rooms
(h) Briefing / training room
(i) Recreational rooms
(j) Mess area / kitchens
(k) Bedrooms / Dormitories
(l) Gym
(m) IT Comms rooms

7. Fire stations should be equipped with adequate welfare facilities such as showers and washing machines, to assist in decontamination procedures. Vehicle exhaust ventilation systems should also be installed in fire stations to remove harmful contaminants which may enter the ambient air once a fire appliance engine is turned on. Fire appliances may be provided with internal clean air technology to internal cabs which may become contaminated due to off gassing of PPE and equipment. This does not negate the rationale for the isolation of contaminated PPE or equipment from the cab.

8. This guidance advocates the principle of eliminating contamination as close to the source

and keeping it outside the fire station, as far as practicable. Hence, the layout of the station should keep the red (contaminated) areas to an absolute minimum.

9. Where some existing station layouts may not currently facilitate physical separation internally, they should adhere to the important principles of segregation of contaminated equipment and PPE. This further highlights the need for the bagging of any contaminated equipment before entering the fire station. In fire stations with limited internal space, the principle of keeping the entire station as a clean area should be considered. This would require putting decontamination arrangements externally or rooms not internally accessible within the station.

10. Zoning within stations should be carried out in consultation with the local implementation committee to ensure consistency across all fire authority brigades and the relevant station officers who will ultimately be responsible for implementing and managing the developed policy.

5.2.2 Equipment

11. There should be a regular PPE maintenance regime in place to ensure that it is clean and in a satisfactory condition. All PPE should fit correctly and not be excessively loose, ensuring an overlap between the tunic and the bunker pants when worn. Periodic inspection should be carried out of all PPE and all defects remedied and recorded.

12. Clean turnout kit should be stored in the designated muster area. When stored in the appliance bay, it must not be in close contact with vehicle exhausts. Where smoke extract systems are provided they should be enabled at all times and coupled to vehicle exhausts when parked. Where extract systems are not provided, vehicle engines must not be allowed run indoors for longer than is necessary. Do not store contaminated PPE in muster areas, personal lockers or dormitories and never with clean PPE or clothing.

13. Initial decontamination of all equipment should be carried out on the fire ground and then completed back at the fire station. This will require provision for BA wearers doffing PPE and base layers on the fire ground, prior to returning to the fire station, and considering how to transport contaminated equipment. Hence, necessary arrangements need to be in place to facilitate the return of PPE, equipment & personnel to the station.

14. The following should be planned for:

    (a) Have the necessary equipment at station and on appliances for cleaning equipment and PPE with appropriate procedures for their use, maintenance and decontamination, where necessary.

(b) Regularly check washing machines (where installed) and showers to confirm they are in good working order. Where washing machines are not installed at station or available, firefighters should be provided with suitable facilities to store and transport PPE to a suitable location off-site.

(c) Firefighters shall have two sets of structural PPE (including gloves) and sufficient spare clothing (uniform/work or normal wear) on station, in case clothing has to be bagged for return from an incident.

(d) Consideration should be given to the provision of clean anti flash hoods (not personal issue) stored in a clean sealed container on front line appliances.

(e) Plan how to bag, store and transport contaminated equipment/PPE to the fire station.

(f) Have planned PPE laundry/equipment cleaning procedures in place.

(g) All fire fighters are trained and familiar with decontamination guidance and are able to implement decontamination procedures.

(h) Appliances should be stocked for dealing with contamination at incidents, with the following suggested level of equipment (non-exhaustive):

(i) Soft head brushes

(ii) Decontamination skin wipes

(iii) P3 respirator masks

(iv) Disposable nitrile gloves (or similar)

(v) Disposable Tyvek® aprons or suits (or similar)

(vi) Roll of soluble large laundry bags (may not be suitable for damp/ wet PPE)

(vii) Roll of large clear plastic bags for bagging equipment & PPE

(viii) Heavy duty industrial wipes

(ix) Spare flash hoods & firefighting gloves

(x) 2 to 4 pairs of long-sleeved tops, bottoms & slippers (consider alternative PPE)

5.3 DURING THE INCIDENT

1. On approaching incidents, where possible, park appliances upwind of smoke and close cab windows and doors. All firefighters should wear PPE that is suited to the incident type and wear it correctly and not stepdown gear until a dynamic risk assessment has ascertained that it is safe to do so.

2. Certain incidents may require BA crews to change cylinders and recommit to a structure to complete further tasks. This will very much be dictated by the scale and urgency of the incident and the resources available at the time. Where re-committing to the fire risk area is likely, then hydration and decontamination of the head, neck and hands with wipes is recommended beforehand.

3. For incidents involving fires:

   (a) Incident commanders should consider defensive firefighting in the first instance, depending on the dynamic needs of the incident, in particular where there are no persons reported.
   (b) When deciding on BA at an incident, the Incident Commander should consider minimising the number of personnel wearing in the danger area, relative to the needs for effectively resolving the incident.
   (c) BA entry control and incident command points should be sited out of smoke.
   (d) Firefighters that are not actively involved in firefighting should avoid contact with smoke.
   (e) Dealing with outdoor fires such as gorse/bog/forestry should consider airbourne contamination and appropriate mitigation agreed and communicated to all. The challenges of maintaining full PPE/SCBA when working in hotter weather needs to be considered, in terms of suitable protection from contaminants, whilst also protecting from the effects of heat and sun.
   (f) Consider cordons, and non-fire service personnel operating at the incident i.e. Gardai, Paramedics, etc, should be advised of the hazard.
   (g) Firefighters need to be aware of the limitations of P3 respirator masks, as they are designed only for blocking particles and will not provide adequate protection against airborne toxic gases.
   (h) Personnel in the area where damping or overhauling at a fire, must always wear SCBA.
   (i) If you have to eat, go to the toilet or smoke, firefighters must ensure that they thoroughly clean hands and face beforehand and out of area where the risk of contamination exists.
   (j) For longer duration calls, considerations around the provision for welfare must have regard to decontamination requirements and suitable resources provided (including access to sanitary facilities for all)

5.4 AFTER THE INCIDENT

1. The Incident Commander will carry out a risk assessment to determine the level of decontamination required, as well as requesting additional resources including appropriate decontamination and welfare support, if deemed necessary. To reduce prolonged exposure to these hazards, all PPE, equipment and vehicles assessed as contaminated, should be cleaned and decontaminated at the incident.

2. The key principle in minimising the level of personal exposure, is the undertaking of

cleaning and bagging of equipment/PPE (as much as is practical) at the incident location, before travelling back to the fire station. At the majority of fire incidents, the exposure to contaminants should be for a relatively short period of time. Tasks such as firefighting, search and rescue or damping down should be for the most part achievable on one cylinder. Research[1] has shown that the release of toxins (known as off-gassing) continues for some time after a fire has been considered extinguished.

3. Where it is determined that decontamination is required, the Incident Commander will arrange for a defined doffing area to be established. This can be achieved by laying down a ground sheet and the necessary equipment to facilitate decontamination readied and firefighters allocated the task of assisting where necessary. The Incident Commander should consider appointment of Decontamination Officer/Safety Officer to manage depending on the scale of the incident. The process at incident should include the following:

   (a) Establish the doffing area using a ground sheet.
   (b) Firefighters and assistants should don P3 respirators, disposable gloves and safety glasses.
   (c) Equipment can be washed/wiped down to remove any obvious heavy soiling from BA, PPE & Boots using a combination of dampened heavy-duty wipes, soft bristle brushing and/or hose reel (‘garden hose’ pressure). This should remove a significant level of the contaminants and reduce off-gassing.
   (d) Flash hoods and gloves should be doffed and bagged in appropriate laundry bag.
   (e) Head, face, neck, jaw, throat and hands to be thoroughly cleaned using decontamination wipes.
   (f) Tunics & leggings should be doffed and bagged in appropriate laundry bag.
   (g) Respiratory protective equipment should be one of the last items of PPE removed during de-robing (after decontamination).
   (h) BA sets should be fully shut down and bagged in clear plastic bags and stored in a sealed bag/container.
   (i) Provide Tyvek suits for wearing over base layers before getting back into the appliance. Where base layers are considered to be contaminated, additional options including provision of dry suitable change of clothing, and doffing of base layers to a laundry bag.

5.5 Return to Fire Station

1. Unbagged contaminated PPE/equipment (including contaminated BA Sets) should not be brought back to the station in the crew cab. Pre-planning should have accounted for

available space that may be used for transporting equipment back to the station. This should include consideration of lockers and pump bay on the appliance or support vehicles, as viable transport storage spaces. PPE that is suspected of being contaminated should preferably be transported in an air-tight suitably labelled container, where practicable, to prevent cross-contamination.

2. In the event of a running call, a decision will be made by the Incident Commander in relation to the mobilisation to an incident. The factors include the nature of the incident information, and the level of depletion of crew, PPE and equipment from the previous call. While it is always preferable that the crew be fully readied before becoming available, the nature or level of urgency of the running call will influence the requirement to respond e.g. persons reported. Where the Incident Commander assesses that the crew does not attend, this will be conveyed to the communications centre and the next appliance on the PDA should be mobilised. Where the decision is made to attend, priority should be given to selecting other firefighters for any necessary BA work at the subsequent incident. The firefighters with bagged gear may have to unbag this fire kit and spare gloves and flash hoods should be distributed.

3. The process on arrival back at the fire station should include the following:

   (a) Arrangements should be made to complete the cleaning process and priority given to undertaking as much of this work in open air.
   (b) It is important to protect areas of exposed skin and airways when cleaning soiled PPE/equipment. Those carrying out this work should wear disposable gloves and P3 respirator masks as a minimum.
   (c) Where cleaning takes place at sinks or work tops, clean them down afterwards.
   (d) Cab seats, floors and lockers that may have become contaminated during the incident shall be cleaned.
   (e) It is essential that firefighters shower as soon as possible on returning to the station and in all instances within an hour (‘Shower within the hour’). Firefighters should shower at the station to minimise the spread of contaminants beyond the operational service.
   (f) Base layers requiring laundering to be replaced and arrangements made for washing same.
   (g) Do not return to canteens, dormitories etc. (clean areas) in dirty clothing.
   (h) PPE and equipment such as BA should be replaced to ensure readiness for the next incident.
   (i) PPE and equipment (particularly BA) should be deep cleaned and thoroughly

decontaminated after every incident involving fire gases, to avoid a build-up of toxic contaminants.

(j) Consider rotation of BA wearer duties for follow-on calls, depending on resources.

(k) Regular rehydration should continue for 24 hours after the incident.

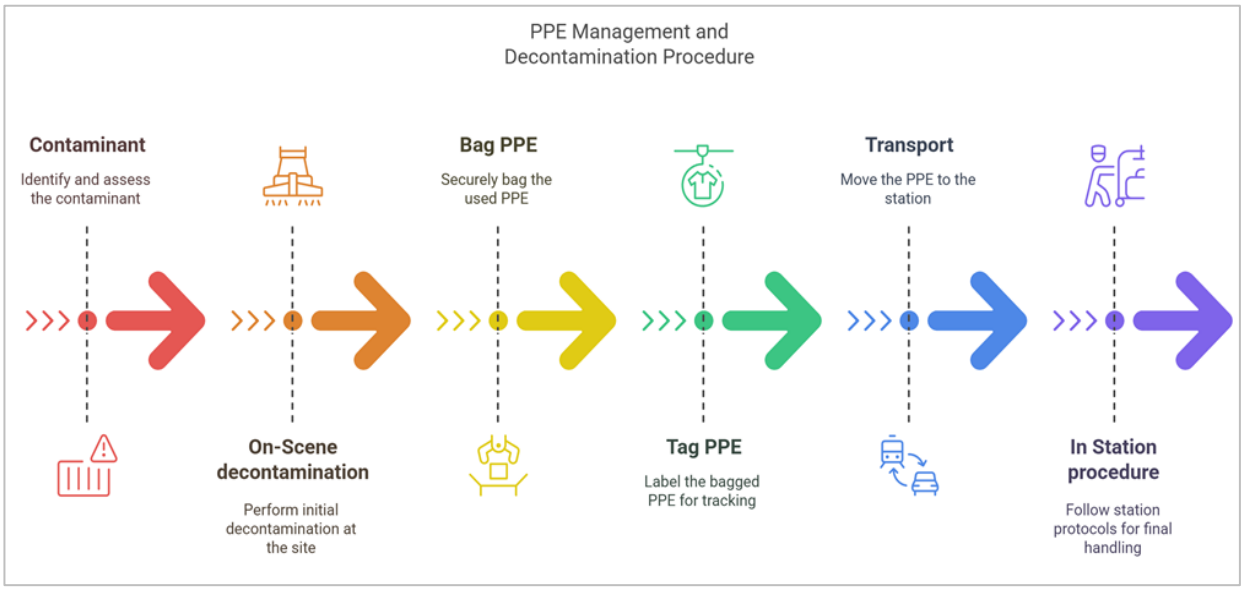


Diagram 2. PPE Management and Decontamination Procedure

4. The decision process around the actions to take in relation to the various modes of decontamination are outlined in Appendix 1 and Appendix 2.

5. It is important that every fire service puts in place a procedure for the appropriate cleaning of PPE. The general considerations for the decontamination of PPE/clothing at the fire station as follows:

(a) All articles of clothing and/or equipment that were exposed to contaminants should be properly cleaned as specified in the appropriate standard e.g. ISO 23616[10] (2024).

(b) Thorough, routine cleaning should include the PPE interiors. Thus until the interior of PPE has also been cleaned and dried, the gear should be considered out of service.

(c) Slightly contaminated PPE e.g. with a slight smell of smoke* but with no visible soiling, should hung in a well-ventilated area away from clean PPE e.g. an outdoor covered area, or well-ventilated outhouse.

(d) Following fire incidents, cleaned PPE ensembles should be hung on racks to reduce drying times and to allow for continued gassing-off. Fans may facilitate this process.

* **Note:** Smell of smoke can to some degree be subjective but is a broad indicator of some contamination.

6. The overall control measures to mitigate exposure for firefighters is provided in Appendix 3, which details the various considerations in fire services for the various stages of an incident.

Section 6. Post Incident Decontamination

1. Regular decontamination practices aid in preventing the transfer of harmful substances to other areas within the fire station or vehicles, reducing the risk of secondary exposure for firefighters, support staff, and the public. Regular washing and decontamination of PPE and fire ground equipment significantly reduces the potential for long-term health problems associated with exposure to smoke byproducts, thus improving overall firefighter health and well-being.

2. Effective decontamination procedures will extend the life cycle of PPE and fire ground equipment by preventing the buildup of corrosive and damaging substances. This results in cost savings for the fire service in the long run and ensures better functionality and performance, allowing firefighters to carry out their duties effectively and efficiently during emergency situations.

6.2 Personal Protective Equipment

1. The fire authority should have arrangements in place for the cleaning and decontamination of PPE, which can be self-managed or contracted to a specialist third party. The maintenance/care program should ensure that all firefighter PPE is maintained, repaired when necessary and decontaminated according to the manufacturer's specification. The system should include the following principles:

   (a) Full inspection of PPE for any wear or damage and if required sent for repair.
   (b) Each laundering process is logged for each item of PPE, to allow for tracking of care/maintenance for each fire-fighter.
   (c) Professionally decontaminated from harmful agents including a facility to remove heavily soiled garments.
   (d) Use laundering practices that are recommended by the manufacturer, to remove as much contamination as is reasonably practicable.
   (e) Prevent cross-contamination in the local cleaning and professional decontamination processes, to have regard to environmental protection (e.g. wastewater and air).
   (f) Reproofing agent used, as specified by the manufacturer after the designated number of washes.

6.3 Firefighting Equipment

1. The fire authority should have arrangements in place for the cleaning and decontamination of fire services equipment. The maintenance/care program should ensure that all firefighting equipment, in particular breathing apparatus sets, is maintained, repaired when necessary and decontaminated according to the

manufacturer’s specification. The system should include the following principles:

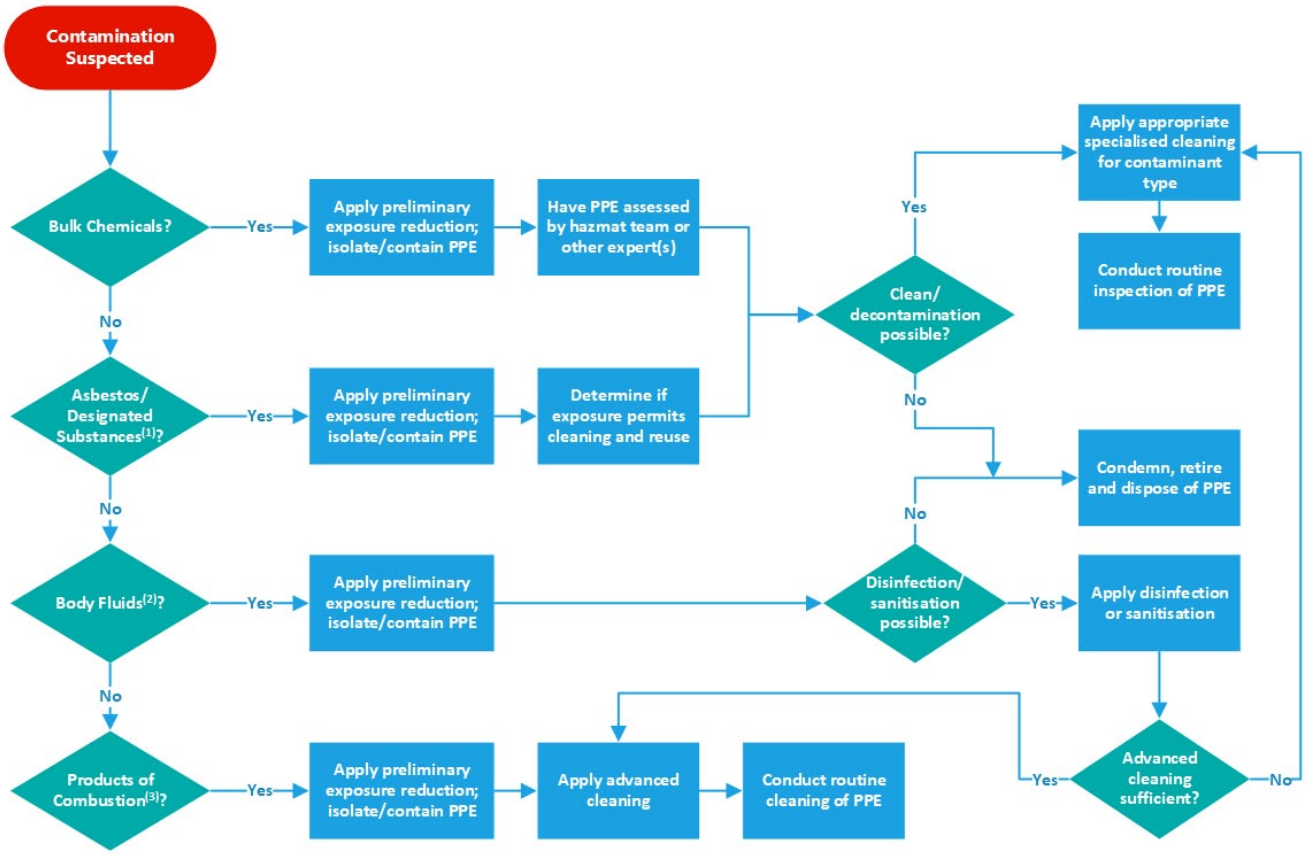
(a) Full inspection of equipment for any wear or damage and if required sent for repair.
(b) The laundering process is logged for each piece of equipment, to allow for appropriate tracking of care/maintenance.
(c) Decontaminated from harmful agents including a facility to remove heavily soiled materials.
(d) Firefighting equipment should be decontaminated before return to operational service.

Section 7. References

1. University of Central Lancashire (2020) Interim Best Practice Report - Minimising firefighters' exposure to toxic fire effluents.
2. EN 469 (2020) Protective clothing for firefighters - Performance requirements for protective clothing for firefighting activities.
3. EN 443 (2008) Helmets for firefighting in buildings and other structures
4. EN 13911 (2017) Protective clothing for firefighters - Requirements and test methods for fire hoods for firefighters.
5. NFPA 1971 (2018) Standard on Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting.
6. EN 659 (2003) +A1:2008 (Main) Protective gloves for firefighters
7. EN 15090 (2012) Footwear for firefighters
8. EN ISO 11612 (2015) Protective clothing — Clothing to protect against heat and flame — Minimum performance requirements
9. EN 1149-5 (2018) Protective clothing. Electrostatic properties Material performance and design requirements
10. ISO 23616 (2024) Cleaning, inspection and repair of firefighters' personal protective equipment (PPE)
11. NFPA 1851 (2020) Standard on Selection, Care, and Maintenance of Protective Ensembles for Structural Fire Fighting and Proximity Fire Fighting

Section 8. Appendices

Appendix 1. Contaminated PPE Process Flowchart



Notes:
1. And other designated substances
2. Includes other microbial contamination
3. Includes any significant structural fire exposure

Diagram 3. Approach for Deciding Handling, Cleaning, and Disposition of Ensemble Elements (Figure A1 NFPA 1851[11])

Appendix 2. Addressing Specific Types of Contamination

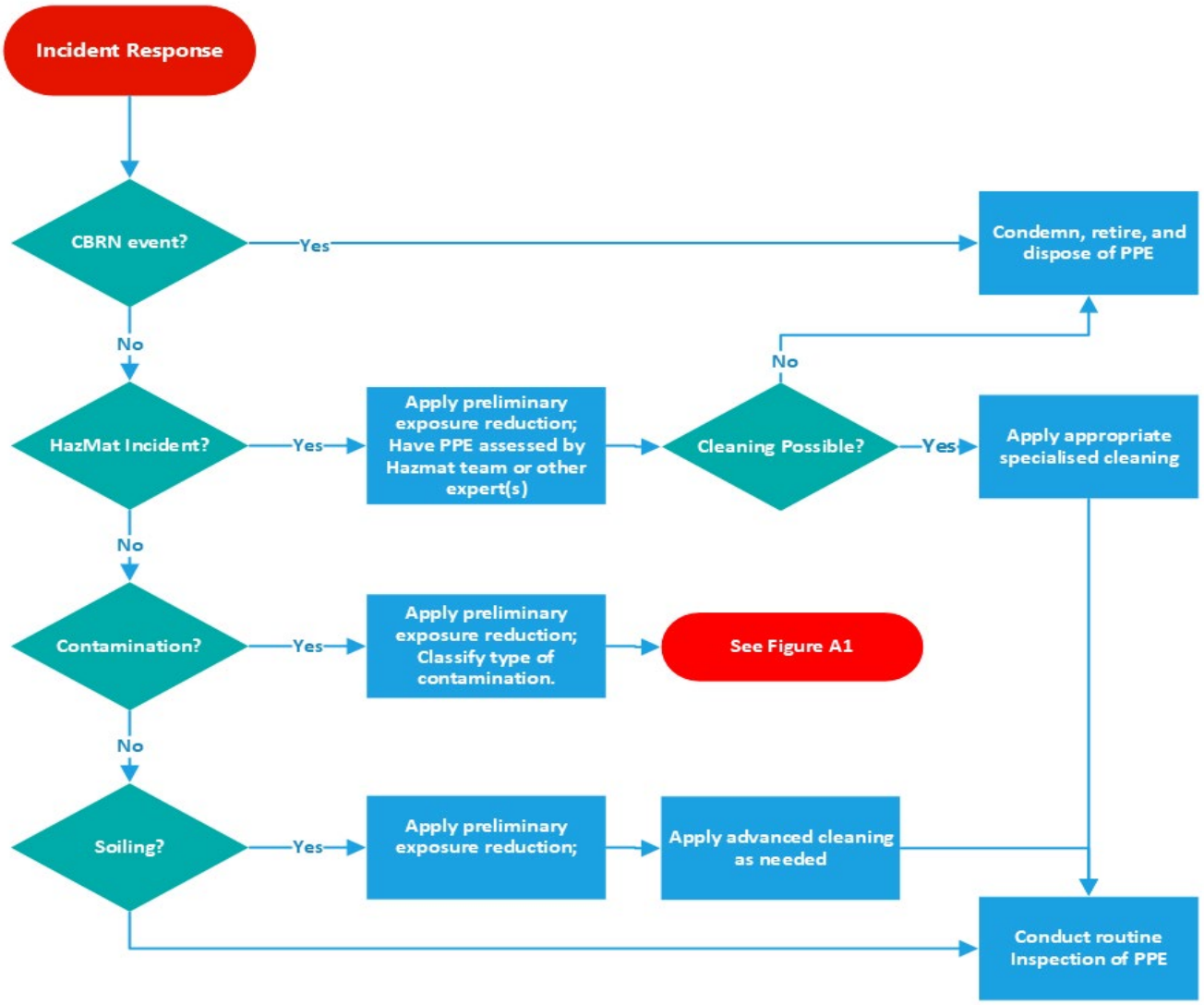


Diagram 4. Approach for Addressing Specific Types of Contamination (Figure A2 NFPA 1851[11])

Appendix 3. Primary Control Measures

Controls Measures for Migating the effects of Products of Combustion



PREPLANNING

- Fire station should be clearly delineated with appropriate signage
- Fire stations should be equipped with adequate welfare facilities
- Vehicle exhaust ventilation systems should also be installed in fire stations
- Regular PPE maintenance regime should in place
- Clean turnout kit should be stored in the designated muster area
- Have the necessary equipment at station and on appliances for cleaning equipment and PPE
- Plan how to bag, store and transport contaminated equipment/PPE to the fire station



- Appliances should be stocked for dealing with contamination at incidents,
  - ✓ Soft head brushes
  - ✓ Decontamination skin wipes
  - ✓ P3 respirator masks
  - ✓ Disposable nitrile gloves (or similar)
  - ✓ Disposable Tyvek® aprons or suits (or similar)
  - ✓ Roll of soluble large laundry bags (may not be suitable for damp/wet PPE)
  - ✓ Roll of large clear plastic bags for bagging equipment & PPE
  - ✓ Heavy duty industrial wipes
  - ✓ Spare flash hoods & firefighting gloves
  - ✓ Roll of asbestos waste bags
  - ✓ 2 to 4 pairs of long-sleeved tops, bottoms & slippers (consider alternative PPE)

DURING THE INCIDENT



- Incident commanders should consider defensive firefighting in the first instance
- Minimise the number of personnel wearing BA in the danger area
- BA entry and incident command points should be sited out of smoke
- Firefighters that are not actively involved in firefighting should avoid contact with smoke
- Consider cordons, and non-fire service personnel operating at the incident
- Be aware of the limitations of P3 respirator masks
- wear BA when damping down or overhauling at a fire
- If you have to eat, drink, vape or smoke, ensure that you thoroughly clean your hands and face beforehand



AFTER THE INCIENT

- Risk assessment to determine the level of decontamination required
- Cleaned and decontaminate at the incident where possible
- Where re-commitment of BA crews is likely, hydration and decontamination of the head, neck and hands with wipes is recommended beforehand



- Firefighters and assistants should don P3 respirators and disposable gloves
- Flash hoods and gloves should be doffed and bagged in a water soluble laundry bag.
- Head, face, neck, jaw, throat and hands to be thoroughly cleaned using decontamination wipes.
- Tunics & leggings should be doffed and bagged in a water soluble laundry bag.
- Respiratory protective equipment should be one of the last items of PPE removed

RETURN TO STATION

- Unbagged equipment (including contaminated BA Sets) should not to be brought back to the station in the crew cab
- Incident Commander to assess mobilisation to running call
- Priority should be given to selecting other firefighters for any necessary BA work at the subsequent incident
- PPE and equipment (particularly BA) should be cleaned and thoroughly decontaminated after every incident to avoid a build-up of toxic contaminants.



- Arrangements should be made to complete the cleaning process and priority given to undertaking as much of this work in open air.
- It is important to protect areas of exposed skin and airways when cleaning soiled PPE/equipment.
- It is essential that firefighters shower as soon as possible on returning to the station.
- Do not return to canteens, dormitories etc. (clean areas) in dirty clothing.

Regular rehydration should continue for 24 hours after the incident.

Controls Measures for Migating the effects of Products of Combustion



POST INCIDENT

- Regular decontamination practices aid in preventing the transfer of harmful substances.
- Regular washing and decontamination of PPE and fire ground equipment significantly reduces the potential for long-term health problems
- Effective decontamination procedures will extend the life cycle of PPE and fire ground equipment



PPE MANAGEMENT

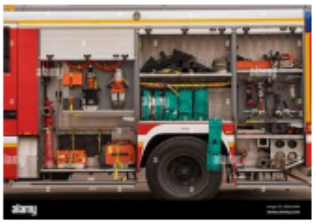


- Full inspection of PPE for any wear or damage and if required sent for repair.
- Each laundering process is logged for each item of PPE, to allow for tracking of care/maintenance for each fire-fighter.

- Professionally decontaminated from harmful agents including a facility to remove heavily soiled garments.
- Use laundering practices that are as per manufacture's recommendations to fully remove all contaminants
- Reproofing agent used, as specified by the manufacturer after designated number of washes

FIREFIGHTING EQUIPMENT

- Full inspection of equipment for any wear or damage and if required sent for repair.
- The laundering process is logged for each piece of equipment, to allow for appropriate tracking of care/ maintenance



- Professionally decontaminated from harmful agents including a facility to remove heavily soiled materials.
- Firefighting equipment should be decontaminated before return to operational service.

MINIMUM PPE






Appendix 4. Station Signage

Appendix 4.1. Floor Mats



Diagram 5. Station Signage (Entrance Mats)

Appendix 4.2. Door Signage

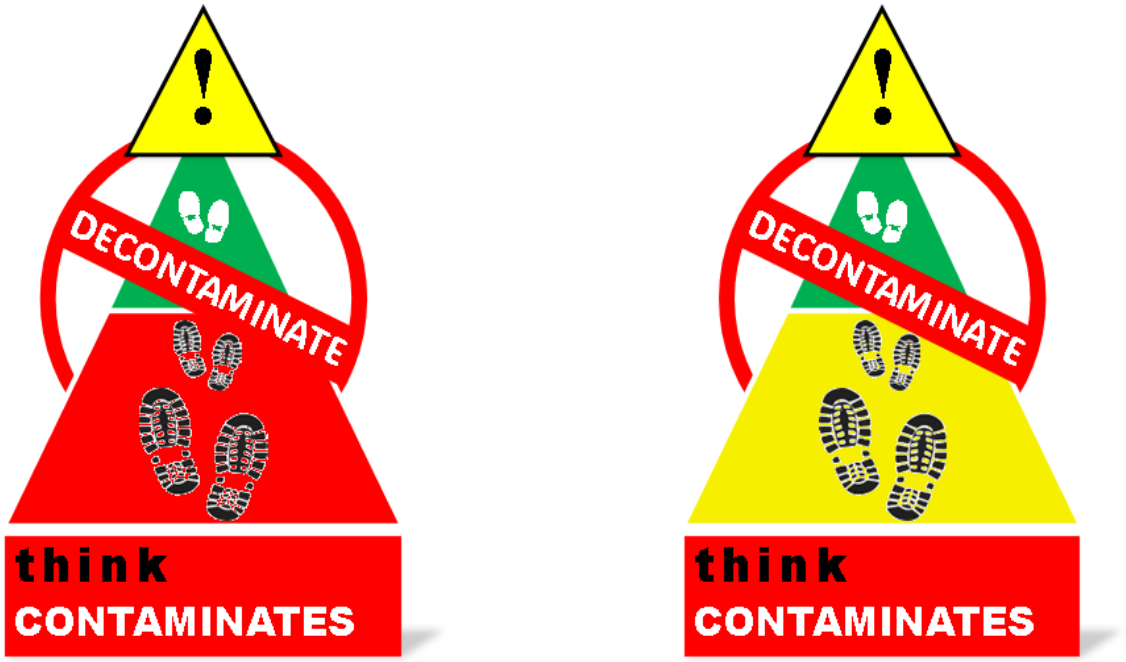


Diagram 6. Door Signage - 140mm Tall

Appendix 5. Risk Assessments

Risk Assessment Summary Sheet							
Title:	**GPN 5.1 - Protecting Firefighters from the Products of Combustion - *Working at Operational Incidents***						
Doc. Code:	GPN5.1-RA-01	**Issue Date:**	Sept 2025	**Version:**	1.0	**Developed by:**	Project Implementation Group

Activity	Hazard	Risk Group	CONTROL MEASURES	Responsible Person(s)
Fire Ground Activity	Contamination on the Fire Ground	A **Likelihood** 2 / **Severity** 4 **Risk Rating BEFORE Controls** **8 (Med)**	• Wear PPE & respiratory protection appropriate to the risk • Park appliances upwind and close cab windows • BA Entry Control & IC Command points to be located outside of smoke • Exercise caution during damping down – do not reduce full respiratory protection • Eat, drink only after thoroughly cleaning hands/mouth • Carry out doffing and decontamination as appropriate and in a controlled manner • Decontamination to be carried out using appropriate PPE i.e. P3 masks and gloves • Decontaminate vulnerable areas of the body as soon as possible • Shower as soon as possible, back at station • Do not carry contaminated or bagged equipment in the crew cab	All **Likelihood** 1 / **Severity** 4 **Risk Rating AFTER Controls** **4 (Low)**

Activity	Hazard	Risk Group	CONTROL MEASURES	Responsible Person(s)
Fire Ground Activity	Running Calls	A **Likelihood** 2 / **Severity** 4 **Risk Rating BEFORE Controls** **8 (Med)**	• Running calls to be attended following a DRA by IC as to the operational capability of the crew • Where decontamination a concern on the previous call crew to remain unavailable until PPE & equipment are replenished/ cleaned	IC **Likelihood** 1 / **Severity** 4 **Risk Rating AFTER Controls** **4 (Low)**

Activity	Hazard	Risk Group	CONTROL MEASURES	Responsible Person(s)
Fire Ground Activity	Contamination on Station	A **Likelihood** | **Severity** 2 | 4 **Risk Rating BEFORE Controls** **8 (Med)**	• Ensure PPE is not stored close to vehicle exhausts • Enable & couple vehicle exhaust extract hoses • Dirty & clean PPE/ Clothing not to be stored together • Dirty PPE or clothing not to be worn in canteens, dormitories etc • Decontamination to be carried out using appropriate PPE i.e. P3 mask and gloves • Decontaminate PPE, equipment & surfaces • Decontaminate lockers and cabs • Shower as soon as practicable in the fire station • Re-hydrate for 24hrs	All **Likelihood** | **Severity** 1 | 4 **Risk Rating AFTER Controls** **4 (Low)**

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