

# Medical Technical Reference Note

Particulate Exposure to Rescuers

Particulate exposure for rescuers and canines in the collapsed structure environment

Technical Reference Note

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- **Introduction**

- The collapsed structure environment poses many risks to responders.<sup>1</sup> Of these, the exposure to particulates<sup>2</sup>, such as concrete and wood dust, and fibres from other construction materials, has not been as well explored as other hazards. One particulate, asbestos, is frequently found in structures around the world despite some attempts to regulate its use. There are potential short-term and long-term health and well-being implications with exposures to particulates, especially respiratory disease.
- Little guidance exists addressing the specific requirements about protection of responders from particulates in the collapsed structure environment. The activities involved in rescue operations often generates hazardous particulates. In widespread incidents such as earthquakes, resources (e.g., easy access to water) that can help mitigate particulate exposure, may not be available. Many particulates that pose a risk are not visible. Therefore, teams should assume the presence of these particulates at all worksites.
- The International Search and Rescue Advisory Group (INSARAG) helps to coordinate search and rescue organisations globally that work in the collapsed structure environment. The INSARAG Steering Group (ISG) recently approached its Medical Working Group (INSARAG MWG) with a request to examine particulate exposure and risk reduction in the unique collapsed structure environment. This document provides a response to this request.

- **Purpose**

- This document provides basic field and home base procedures that can help reduce the risk of exposure to particulates by responders involved in response activities to collapsed structure incidents. It has been designed as an informative tool for USAR teams but does not provide any mandates. It therefore is maintained in the technical reference library of the INSARAG catalogue of documents.
- The document discusses particulates as a wide group of materials that responders can be exposed to with a particular emphasis on asbestos.
- It is important to note that any Local Emergency Management Authority (LEMA) may impose additional requirements beyond what is discussed in this document.

- **Scope**

- This document focuses on the hazard posed by particulates in the collapsed structure environment to responders. As such, it:

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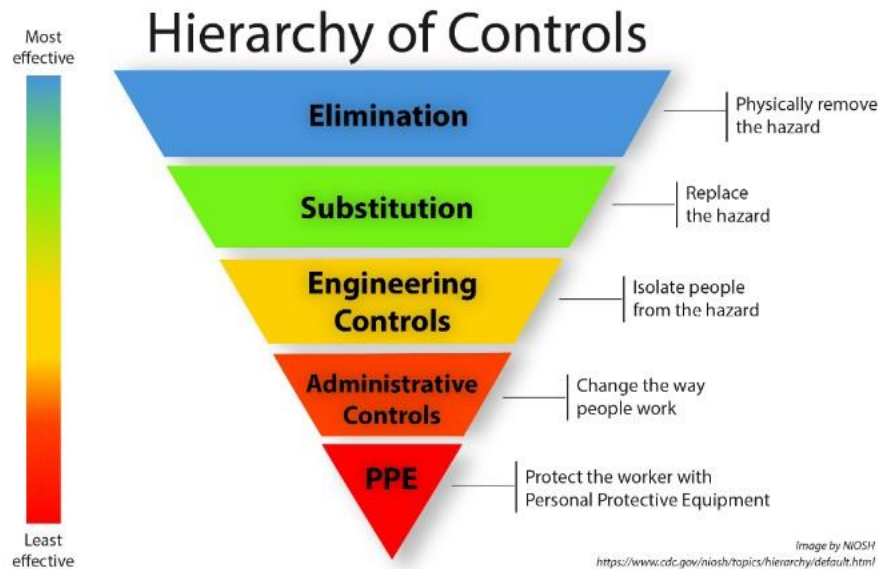
<sup>1</sup> In this document, the term 'responders' is used in reference to both human and canines.

<sup>2</sup> The terms 'dusts' or 'fibres' are also used to describe particulates.

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- Provides a particular focus on asbestos while mentioning other particulates that regularly pose a risk.
  - *Is intended for application in the collapsed structure rescue environment and not in regular industry, or in post impact demolition or debris disposal environments.*
  - Is not a discussion of the following, all of which may necessitate different guidance and response procedures:
    - Aerosols or gasses
    - Oxygen deficient environments
    - Radiological or biological particulates
  - Is not focused on the science behind particulates but instead emphasises practical solutions.
- The hierarchy of controls, depicted below, outlines methods of risk reduction, the most effective being elimination or physical removal of the hazard. As these may not be possible in the collapsed structure environment, and there is time urgency in effecting search and rescue, less effective control methodologies are available to reduce risk such as the use of PPE.



- **Background**

- What are particulates?
  - Terminology matters: This paper uses the term “particulates” to refer to suspended solid particles in air that are generated in the collapsed structure environment and pose a hazard to responders. Other communities may use the term in different

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contexts. For example, the term “particulates” is also used when studying health effects of general air pollution.

- Size matters: Particulates of any size that can be inhaled have the potential to cause harm. Smaller particles can be breathed deep into the lungs and cause lung damage. Some have the potential of being absorbed into the blood stream from the lungs. Particulates may also be ingested or absorbed through the skin.
- Location does not matter: Particulates of different types are always present as a result of structural collapse and rescue work. Imagine buildings being imploded for demolition and the massive amount of dust that results. Though some countries have taken efforts to limit the use of certain particulates, such as asbestos, in modern construction, there are plenty of older buildings still in use with these materials in them. They become problematic when the structure fails or is being disturbed during search and rescue operations.



*Collapsed building in Sarmada, north-west Syria. 6 February 2023. Credit: OCHA/Ali Haj Suleiman*

- What types of particulates exist in the collapsed structure environment?
  - There are hundreds of particulates with potential health effects that could exist in the collapsed structure environment. A comprehensive list is beyond the scope of this document.
  - Even if a specific particulate has no specifically known health effect, it may still cause a problem by simply irritating the upper or lower respiratory airways of a rescuer.
  - Even if a country has enacted bans or regulation of a specific particulate such as asbestos, older structures may exist with these hazards still present.
  - Rescuers typically conduct operations in multiple different structures and so testing to rule out the presence of an individual particulate in any single building is rarely helpful.

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- Examples of common particulates:
  - Silica: *Silica is the the most frequently encountered particulate in the collapsed structure environment.* The most common form of silica is quartz which can be found in numerous materials such as soil, sand, concrete, and artificial stone.
    - Silica can become trapped in lung tissue leading to inflammation and scarring with subsequent breathing difficulty (silicosis).
    - Health effects usually require repeated exposure that manifests later in life but very high-level exposures can lead to acute disease in a matter of weeks.
    - Repeated or large doses can increase the risk for lung cancer.
    - Smoking increases risks of the health effects.
  - Asbestos: Asbestos is a defined group of naturally occurring minerals that form long thin fibres that are hair-like or needle-like. Key commercial applications include fireproofing building materials, insulation and textiles.
    - Though the application of commercial asbestos in industry is heavily regulated or banned in some countries, it still can be found in older structures.
    - Two main forms exist:
      - Serpentine (includes chrysotile)
      - Amphiboles (includes crocidolite, amosite, anthophyllite, actinolite, and tremolite)
    - Asbestos usually causes health effects through repeated (chronic) exposure but one-time (acute) very high dose exposure may also have long term effects.
    - Two main health effects are known:
      - Asbestosis: A pulmonary disease in which the lung is scarred, causing shortness of breath and difficulty oxygenating.
      - Cancer:
        - Lung cancer
        - Mesothelioma: a cancer of the pleural lining around lungs that is almost uniformly fatal.
    - Other potential health effects:
      - Cerebrovascular disease
      - COPD
      - Chronic bronchitis
      - Autoimmune disease
      - Multiple myeloma
      - Gastrointestinal cancer
      - Skin symptoms

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- It is important to realise that cigarette smoking can significantly increase the severity of some of these health effects.
- Concrete dust: Can contain high levels of silica but is also alkaline and corrosive. It can be a potent irritant to the airways and in severe cases of high dose exposure, can cause concrete impactions in the sinuses, upper and lower airways.
- Synthetic fibres: Asbestos has been replaced in many industries by synthetic fibres (e.g., insulating glass wool) which are generally less hazardous or have lower risk of long-term effects. They may still have short-term effects like airway and skin irritation.
- Gypsum: Found in some drywall and other substances, gypsum can be a potent irritant to the airways. It may also contain silica.
- Wood dust: Can be a strong irritant of airways. There is a potential lung cancer link, especially in chemically treated wood.
- Lead dust: Lead, though heavily regulated in some countries, can still be found in some paints, pipes and stained-glass windows. Some studies have demonstrated lead dust can be absorbed through the skin. Repeated inhalation is particularly toxic to children and their neurological development. In adults, exposure can lead to:
  - Short term exposure:
    - Abdominal pain
    - Diarrhoea
    - Dehydration
    - Memory loss
    - Tingling in hands and feet
  - Very high doses or longer-term exposures:
    - Anaemia
    - Bone or tooth loss
    - Fertility problems in both men and women
    - Kidney and brain damage
    - Adverse effects on the developing foetus in pregnant women
    - Death
- Are there regulations regarding rescue work done in the collapsed structure environment?
  - Some governments have very specific regulations in place to protect workers against particulates. These are usually designed for general industry such as construction, manufacturing, and demolition (e.g., EU-OSHA, US-EPA, SAWS-China). Fewer countries have regulations for fire fighters and even less speak directly to the post impact rescuer in the disaster/ collapsed structure environment.
  - Rescue work in the disaster environment can be differentiated from general industry in many ways. Examples include:

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- Time critical activity:
  - The most critical factor in rescue work is the limited time available to locate and rescue entrapped individuals.
  - Once located, operations may still involve extended periods working in a collapsed structure to disentangle and extricate a victim(s).
- Limitations of PPE: Certain types of PPE can restrict or make working in collapsed structure environments dangerous. Rescuers operate in complex environments which can require walking on uneven surfaces, rope work, and crawling. Some conditions may necessitate unrestricted fields of vision.
- Lack of supporting infrastructure: Containment and other mitigation measures required for some regulated activities may not be available or practical in the austere collapsed environment.
- Use of water: Mitigation of particulates, in many ways, is dependent on easy access to large amounts of water, used to dampen down and prevent suspension in air, which may be scarce in the disaster environment. Also, large volumes of water used to suppress dust could destabilise a partially collapsed structure and cause slip hazards.
- Lack of resupply: Relevant resources, such as supplied air or protective garments, carried by deployed teams are limited and resupply options restricted.
  - The hierarchy of controls for particulates in the collapsed structure environment is difficult to apply because of the above factors.
  - The potential exposure to particulates is unavoidable but teams can still mitigate harm.
  - In addition, Local Emergency Management Authorities (LEMA) may establish their own requirements.
- **Team recommendations (best practices)**
  - Pre-deployment: Activities to be conducted during times of pre-deployment in an on-going fashion.
    - Resources: Teams should acquire any resources they expect to utilise in mitigating particulate exposure in the field. By far, the most important to consider is respiratory protection but other resources may be relevant as well (see below concepts).
      - For resources purchased:
        - Ensure adequate numbers for anticipated operations and reserves.
        - Ensure adequate types and sizes for anticipated operations.
        - For respiratory protection, establish a mask/respirator fit-testing program for rescuers. Fit-testing is a standardised process in which the fit of a mask/respirator is evaluated to ensure it provides maximum protection to the wearer against particulates.



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- For items with expiration dates, ensure rotation of stock.
- If practical, consider acquisition of tools that facilitate dust suppression.
- **Health monitoring:** Establishing a comprehensive program to monitor the health of rescuers will help in the detection and/or monitoring of potential particulate exposure. Industrial hygienists can be helpful in this regard. Robust programs can include chest radiography and pulmonary function tests (PFTs) to screen for and monitor potential impacts. They may also highlight the risks of smoking and particulate exposure while offering support for rescuers that seek to cease smoking. In some teams' countries, health monitoring may be mandatory for potential occupational exposures.
- **Develop protocols:** Establish protocols for how personnel will mitigate particulate exposure in the field.
- **Training and Exercising:** Once protocols have been written and resourced, they should be trained and exercised. This can increase awareness of the risks of particulate exposure and will provide evaluation of how these procedures will perform in the field.
- **Team deployment:**
  - **Assessment during mobilisation:** It may be possible to remotely identify common construction methods and materials in the impact area for the presence of certain particulates.
  - **Assessments while in field:** Common or individual structure types and non-structural elements can be evaluated while in the impact area. The teams' structural engineers can be helpful in these evaluations.
    - **Note:** There is generally a very limited role for particulate testing in the collapsed structure environment. As an example, testing for asbestos usually requires some form of specialised microscopy. It is more advisable to assume particulates exist that have potential health impacts in all USAR operations, especially cutting, breaking, breaching and simpler activities such as movement in a tunnel which can cause resuspension of particulates.
- **Respiratory protection:** The most critical element for protection of rescuers in the collapsed structure environment is properly fitted respiratory protection:
  - In oxygen sufficient environments, the recommended minimum is either a full face or half face air purifying respirator with high efficiency particulate cartridges/filters. The half mask variety should be used in conjunction with adequate eye protection (e.g., sealed goggles).
  - Selection of respiratory protection and filters should consider the likely levels of exposure and the protection factor for the type of respiratory protection.
  - Some countries may select to use textile-based respiratory protection (e.g., FFP3, N99/N100, KN100/KP100). These should be regularly replaced during operations on the rubble pile according to manufacturer's guidelines and level of contamination.

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- Dust masks that are not fit-tested, surgical masks, and improvised protection such as bandannas are not considered adequate for respiratory protection from most particulates.
- Supplied air systems (e.g., SCBA) or powered air purifying systems (e.g., PAPRs) provide the highest levels of respiratory protection against particulates but are generally not practical in the post-impact, collapsed structure environment with extended operations.
- Respirators should be worn during all stages of response operations while in the collapsed structure environment.
  - Resuspension of particulates can cause exposure when in proximity to collapsed structures. Resuspension can be caused in multiple ways such as wind, vehicle traffic, or heavy machinery moving debris.
- Even well-designed respirators can increase the effort of breathing, adding to the exertional toll on rescuers. Medical personnel should provide health monitoring during rescue operations to ensure adequate hydration and rest.
- Other Personal Protective Equipment: Other elements of the protective ensemble can also be important in protection against particulates.
  - Eye protection
  - Helmet
  - Gloves: Can help prevent contamination of hands
  - Clothing: Clothing helps prevent contamination of the skin.
    - Disposable coveralls and other forms of temporary protection have been tried in the collapsed structure environment and are generally not sturdy enough to withstand the environment. Their use may also cause heat exhaustion in extended operations.
    - Rescuers should doff clothing utilised in the collapsed structure as soon as practicable but definitely before returning to the base of operations (see below).
- Skin contamination: Rescuers can consider the use of skin wipes to remove visible dust/particulates from face (especially nose and around mouth), neck, and hands as an intermediate measure when exiting a structure. This is most important before eating or drinking.
- Management of environment: Various risk control methods can be considered in the collapsed structure to reduce the exposure to particulates.
  - “Wetting” the area of the structure being broken or breached can help to reduce the particulate burden. Small hand pump sprayers can be helpful in this regard. However, this is not always practical, and the creation of slip hazards should be monitored. In addition, copious amounts of water are not always available. Creation of ice during operations in cold environments is possible as well.



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- Ventilation of confined spaces assists with the prevention of build-up of multiple hazards beyond just particulates. Consideration should be taken as to where ventilation is being exhausted.
- Certain operations that are expected to generate significant amounts of particulates can be delayed until weather changes (e.g., avoiding night-time inversions) but this is not often practical when conducting rescue operations.
- Decontamination: All efforts should be made to prevent carrying particulates into vehicles or into the base of operations (BOO).
  - Remove dry contaminant from responders or equipment (e.g. brush, high efficiency particulate filter vacuums, etc.) while wearing suitable respiratory protection
  - Use skin wipes prior to entry into a vehicle
  - Remove outer clothes prior to entry into the BOO
  - Utilise the BOO decontamination process upon entering:
    - Showering or skin wipes before entry into the camp (including efforts to clean hair)
    - Some teams have established dedicated entryways into the camp to ensure compliance with these steps
  - Cleaning of uniforms before reuse (which may pose a resuspension risk) is often challenging if not impossible in water restricted environments:
    - When water is available, crude efforts can be made to wash clothing to debulk the particulates and can be done while wearing gloves and a respirator
    - “Misting” of clothes may also be an option
    - An alternative is the use of an industrial HEPA vacuum
    - At a minimum, rescuers should reserve a clean set of clothing for inhabiting the BOO communal and sleeping areas and for demobilisation
- Demobilisation: Several steps can help reduce risk during demobilisation.
  - Documenting the names of rescuers involved in operations at the conclusion of a mission can be helpful for exposure reporting. As many of the particulates are so frequently encountered, it is reasonable to assume that a health issue can be associated with exposure on the mission.
  - Equipment and clothing that has been heavily contaminated with particulates can be bagged and returned separately. These items may require specialised cleaning (i.e., not in a personal washing machine).
  - Post-deployment health surveillance is an important consideration when responders may have been exposed to particulates.
- Special note on canines: The following protocol is a recommendation from procedures utilised at the 2021 Champlain Tower collapse. It should be considered for the canines’ health as well as potential further exposure to other responders.
  - The handler should use appropriate PPE during decontamination efforts of the canines (eye protection, gloves, respiratory protection).

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- As canines may be exposed to human remains as well as particulates, it is recommended that a dilute solution of non-alcoholic chlorhexidine scrub (preferred over full strength) is used to wash animals down. If chlorhexidine is not available, plain water should be used. Dish soap should be avoided due to its negative effects on canine skin.
- When non-alcoholic chlorhexidine is available:
  - Canines just coming off the rubble pile should receive a wipe-down in the designated area with disposable towels saturated with dilute 2% chlorhexidine (1:4 dilution) and use an appropriate foot bath containing dilute chlorhexidine solution. Before wiping-down, canines can be treated to remove dry contaminant (e.g. brush, high efficiency particulate filter vacuums, etc.).
  - All crates should be thoroughly wiped down with disposable towels saturated with dilute chlorhexidine between each canine.
  - Canines should receive a full decontamination bath (using dilute chlorhexidine scrub) prior to travel home.
- Leash/collars should be changed out at the end of the shift. Contaminated set should be decontaminated and held for use in the field (recommend storage in resealable plastic bag). A clean set should be held for use in the BOO and for demobilisation.

### References (to be further developed after input from other WGs)

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#### [Structural Collapse Guide | Occupational Safety and Health Administration \(osha.gov\)](#)

#### [Crystalline Silica: Health Risks | NIOSH | CDC](#)

#### [Wood Dust - Overview | Occupational Safety and Health Administration \(osha.gov\)](#)

#### [Lead: Information for Workers | NIOSH | CDC](#)

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