Evidence

工程科学与实践
Evidence in Engineering Science and Practice

REVIEW ARTICLE

DOI: 10.63221/eesp. v1i01-04.17-23

Highlights:

- Rescuers in disaster scenarios are exposed to various hazards like asbestos being a significant concern.
- Rescuers continue to face health risks even after leaving the disaster scene and returning to their home base.
- Practical tactics and recommendations are proposed to safeguard rescuers from asbestos exposure during and after missions.

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Citation: Wong Siu-fung, 2025. Review on the Recommendations on Decontamination of Equipment of International USAR Deployment. Evidence in Engineering Science and Practice, 1(01), 17-23.

Manuscript Timeline:

Received	November 25, 2025
Revised	November 27, 2025
Accepted	November 27, 2025
Published	December 1, 2025

Fundings:

This research work is supported by self-funded.

Review on the Recommendations on Decontamination of Equipment of International USAR Deployment

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Abstract. It is unavoidable that the rescuers need to face potential hazards in the disaster, including environmental hazards, chemical hazards, and biological hazards, etc. Carcinogens are present in these hazards, such as asbestos. In general, safety prevention focuses on the operational phase. However, the rescuers also face the same risks as the disaster scene when they return to home base, as per previous experiences. There are not many literature or guidance documents discussing measures for the post-mission phase. This paper ventures into practical tactics to shield rescuers from asbestosis, casting a vital spotlight on prevention that extends beyond the immediate crisis, aiming to become a cornerstone reference for international urban search and rescue operations.

Keywords: Urban Search and Rescue, decontamination, occupational safety, INSARAG

1. Introduction

In February 2023, a significant earthquake with a magnitude of 7.8 heavily affected Southeastern Turkey. Approximately 130 international Urban Search and Rescue (USAR) teams were deployed to save the victims trapped by collapsed structures. After the demobilization, the United Nations International Search and Rescue Advisory Group (INSARAG) announced that asbestos contamination was found on the equipment of a Dutch USAR team (INSARAG, 2023).

The USAR team is a specialized team that locates, extricates, and initially stabilizes people trapped in a confined space or under debris in large-scale structural collapse incidents, such as earthquakes and landslides (UN OCHA, 2020) . They are not only tasked with carrying out USAR operations in their home country, but some of them will also be deployed to countries affected by major disasters under the coordination of INSARAG.

During life-saving activities (often referred to as the "operation phase"), the USAR teams typically apply their techniques to breach, break, and cut through concrete structures to gain access to heavy floors, heavy walls, or debris. A large amount of dust can be generated during the process. The inhalation of dust may trigger various reactions in the lungs, such as airway irritation, exacerbation of asthma, inflammatory reactions, and fibrosis (Habybabady, et al., 2018),

The occupational safety and health of all USAR personnel is the top priority in operations. To achieve the goal, all USAR teams attach great importance to assessing the risks they may encounter and providing personal protective equipment (PPE) to USAR personnel as safety measures, especially considering the high risk of spreading dust (Health and Safety Laboratory, 2010).

However, the dust produced during concrete removal may adhere to equipment at the scene. When the equipment is brought back to their home country for decontamination, maintenance, and storage, the workers involved also face the risk of being exposed to dust. In the worst scenario, the dust may contains asbestos, a proven carcinogen (National Toxicology Program, 2016) . It was a material widely used in construction in the last century for shading and heat insulation purposes. It may be found in roofing felt, steam pipes, and some vinyl floor tiles of old buildings (Michelle Whitmer, 2024) . When these areas are broken or damaged, it is possible for asbestos fibers to be released into the air (Hong Kong Housing Authority, 2016) . In other words, USAR personnel face the risk of asbestos exposure even when they return home to the base to handle the equipment after deployment.

Asbestos can split into very thin fibres (commonly known as asbestos-containing dust) and be released into the air when materials containing asbestos are damaged. When inhaled, asbestos fibres can cause serious lung diseases such as Mesothelioma and Asbestosis (Health and Safety Executive, 2012).

However, many USAR teams mainly focus on the operational phase rather than the post-mission phase. The deployment in Turkey highlights the fact that the risk of exposing contaminants at the home base after deployment is the same as at the disaster scene. Thus, this study was conducted to assess the decontamination practices of various USAR teams following international deployments and to compare them. The practical solutions were also evaluated.

In this research, the definition of decontamination is a combination of processes that removes or destroys contamination so that infectious agents or other contaminants cannot reach a susceptible site in sufficient quantities to initiate infection, or other harmful response. (Health & Safety Executive, 2013)

2. Methodology

2.1. Structured Questionnaire for the USAR Team Leaders

The team has conducted a survey by distributing it to the USAR teams to collect quantitative data. The surveys were completed by the USAR team leaders or their representatives. All responses collected through this survey were anonymous. In order to minimize duplications, the interviewees were required to input their team's name, but it would be treated with the strictest confidence. The questionnaire examined the common practice of the USAR teams for handling their equipment after USAR deployment.

2.2. Literature Review

The literature review was conducted to identify practical decontamination practices that meet international standards, common practices, and actual circumstances. It included the INSARAG Guidelines, NFPA Standard as well as publications from health and safety organizations.

The INSARAG is a global network under the United Nations Office for the Coordination of Humanitarian Affairs (OCHA). It develops the INSARAG Guidelines as international standards for USAR teams, focusing on capacity building and methodology for international coordination in USAR response. Furthermore, the INSARAG also issues Technical Guidance Notes that offer non-binding guidance to USAR teams as good practices and recommendations. At the time of writing, the INSARAG has not provided recommendations for decontamination after deployment (INSARAG Steering Group, 2023).

The Health and Safety Executive (HSE) is Britain's national regulator for workplace health and safety. They have also conducted research into occupational risks to improve workplace health and safety performance (Health and Safety Executive, 2021).

3. Result

3.1. Background of the respondents

The survey for this study was distributed to USAR team leaders or their representatives through social media and personal invitations. A total of 27 teams were surveyed. Most of the respondents' home base was in the Asia Pacific, 44% (12), followed by Africa-Europe-Middle East, 37% (10), while 19% (5) were in the Americas. The figures on the background of the USAR teams are presented in Table 1.

Table 1. (Statistics of the study respondent' background)

Sample number	N = 27	%
Region of Home Country	/	/
Americas	5	19%
Asia Pacific	12	44%
Africa-Europe-Middle East	10	37%
Capacity of USAR*	/	/
Light	7	26%
Medium	9	33%
Heavy	11	41%
Recognition of INSARAG #	/	/
IEC/IER	17	63%
IRNAP	1	4%
NAP	3	11%
None	6	22%

The INSARAG has established an independent classification system named INSARAG External Classification (IEC) and INSARAG Re-external Classification (IER). All USAR teams must undergo IEC/ IER in one of the three classification levels: Light, Medium, or Heavy, according to their operational capabilities (Okita & Shaw, 2020) . A Light Team consists of at least 17 personnel, a Medium Team requires at least 40, and a Heavy Team requires at least 59 personnel.

Except for IEC/IER, INSARAG has also launched the INSARAG Recognized National Accreditation Process (IRNAP) and National Accreditation Process (NAP). Both accreditations require the national teams to align with the INSARAG methodology, but the latter is only certified by national authorities.

Table 2. Statistics of the study respondents' feedback

Sensor name	VNIR-1024	SWIR-384i
	N = 27	%
SOP for decontaminate after deployment	/	/
Yes	22	81%
No	5	19%
Implementation of Decontaminate after Deployment	/	/
Immediately	12	44%
1-2 days after back to home country	9	33%

3-4 days after back to home country	4	15%
5 days after back to home country	2	7%
Method of removing contaminant on equipment's surface	/	/
Rinsing / wiping with water	15	29%
Rinsing / wiping with cleaning solutions	23	45%
Evaporation	6	12%
Moisture removal with absorbents	4	8%
Responsible person	/	/
USAR team members	23	70%
Professional cleaners (In-house or External service provider)	10	30%
Wearing additional PPE for decontamination (except rescue suit)	/	/
Yes	17	63%
No	10	37%
PPE for responsible person		
Respirator	12	31%
Face shield	14	36%
Gown	13	33%
Decontamination method is subject to the types of the contaminants	/	/
Yes	22	81%
No	5	19%
Method of detection of contaminant	/	/
CBRN hazmat device	3	13%
Based on local information	4	17%
Not mentioned	16	70%

4. Limitation

There are many effective decontamination guidelines for decontamination worldwide. In fact, the implementation is relatively limited.

Firstly, due to weight limits and restrictions on baggage carriage, the cleaning substances may not be easily transported during domestic operations under such circumstances. Secondly, even the USAR teams rely on water. The lack of water supply has become a major obstacle as earthquakes often damage critical infrastructure (Lam & Shimizu, 2021) . Thirdly, the USAR teams intend to spend as much time as they can carrying out life-saving activities in the affected country. Then they only have a short period for the preparation of demobilization, especially when the supply of departure flights is limited, not to mention decontaminating the equipment at the scene. Fourthly, some USAR teams are managed by voluntary organizations. Their resources cannot be compared with those of the career USAR teams.

5. Discussion and Suggestion

5.1. Review Common Practice and International Accepted Practice for Decontamin

81% of respondents have the Standard Operating Procedure (SOP) for decontamination after deployment. The figures in Table 2 also show that most of the respondents remove contaminants from equipment surfaces by rinsing or wiping with cleaning solutions, followed by rinsing or wiping with water. Only a small number of respondents use evaporation and moisture removal with absorbents. Besides, 68% of respondents expressed that their USAR personnel have shouldered

the role of decontamination. 63% of respondents also provide additional PPE such as a respirator, face shield, and gown while carrying out the decontamination process.

In the industrial sector, it is recommended to have trained personnel remove absorbents using wetting agents, applying compounds, or vacuum cleaners. Decontamination zones should be set up to prevent the spread of asbestos to other areas. The asbestos waste should be collected and stored into a suitable container immediately. The cleaners are required to wear suitable PPE such as protective clothing, footwear, and a respirator.

5.2. Effective Decontamination Method for USAR teams

Based on the aforesaid findings, a simple decontamination method is critical. USAR personnel specialize in life-saving mission, not decontamination. So, the decontamination method must be simple and efficient. At the same time, it is also required to comply with internationally recognized safety and health standards.The recommendations are as follows:

5.2.1 Mobilization Phase

The Safety Officer collaborates closely with the HazMat Technician (for Medium and Heavy USAR teams) to gather and analyze information about the contaminants at the disaster scene. It helps to develop tactics for decontamination and safety considerations through hazard identification and mitigation procedures. (INSARAG, 2020). For example, the risk is increased if the affected country is a developing country because asbestos, especially in older buildings, was commonly used and may not be removed due to resource constraints. Additionally, the Safety Officer should also prepare the appropriate PPE for the operation based on the information.

5.2.2 Operations Phase

It is very difficult to identify a material that contains asbestos by its appearance or color. It is recommended to treat all suspect materials as asbestos containing due to limitations of insufficient information. The risk is increased if the following factor is found:

After the search and rescue mission, the equipment should be returned to the Base of Operations (BoO). The USAR team members can simply rinse the equipment at the entrance outside of BoO on plastic sheeting. Asbestos could be removed by a cotton rag. Personnel can soak a cotton rag in water first and then wipe the contaminated surface. Repeat the step until the surface is cleaned. However, never resoak contaminated rags, as this can further contaminate the water (Health and Safety Executive, 2017).

After that, they can place the used rag and plastic sheet into the designated asbestos waste bag or double bag them in an impermeable heavy-duty plastic bag for further follow up (Labour Department of Hong Kong, 2014). Warning labels in the local language and English should be attached to the outside of the waste bag (SafeWork NSW, 2022). In any event, the decontamination area should be isolated to prevent the spread of asbestos dust to other areas during the decontamination process. The responsible personnel should wear a respirator and gloves that are not used for USAR operations and dispose of them after use.

Base of Operations (BoO) is the USAR team's mobile headquarters at a disaster scene. It covers communication hub, equipment store, medical tent, accommodation, etc. (Wong, 2023).

5.2.3 Demobilization Phase

After the operations phase, the USAR teams will return to their home base. Given the tight schedule, there is insufficient time for final decontamination before departure. Without any safety measures, asbestos dust can potentially contaminate other clean equipment and adhere to personnels' clothing. The practical approach is to wrap the equipment with a contaminated surface and then deliver it back to the home base for further decontamination (Occupational Safety and Health Administration, 1995). It helps to minimize personnel's contact with asbestos.

Cutting equipment has many parts that are challenging to clean. The USAR teams may consider disposing of this equipment in the affected country if no better options are available. However, it is important to note that communication with the affected country must be maintained.

5.2.4 Post-mission Phase

After the completion of the deployment, the equipment should be decontaminated. 77% of respondents decontaminate their equipment within 2 days. Despite being insignificant in most circumstances, the timing of decontamination can have an impact. However, it is important to decontaminate the

equipment within 2 days. This measure aims to reduce the potential risks associated with the use of equipment contaminated with asbestos dust during subsequent deployments within a short time frame.

Although the timing and location limitations of the operations phase and post-mission phase are different, the decontamination procedures are the same. As far as available resources, the USAR teams should seek assistance from HazMat technicians or a professional cleaning agency for decontamination. In general, they have better equipment and techniques for comprehensive decontamination.

5.3. Safety Promotion

Drawing from experiences in other industries, effective safety promotion helps enhance safety and health awareness and performance among USAR personnel, leading to a direct reduction in work-related injuries and diseases. It covers safety training and safety communication (Civil Aviation Safety Authority of Australia, 2022).

5.3.1 Safety Training

Safety training should be provided to all USAR teams members, covering information on contaminants and the correct procedures for handling (International Labour Organization , 2004). In fact, many respondents look forward to having such technical references. In order to support their suggestion, the aforementioned decontamination procedure could be disseminated through the INSARAG network as outlined in Chapter 2.2. It is also the main goal of this study.

The training program should encompass two distinct components: General and Specialist. The primary audience for the general training should include all members of the Urban Search and Rescue (USAR) teams, as each member may potentially be exposed to asbestos during search and rescue operations. Enhancing their awareness is crucial for ensuring their personal protection while performing life-saving tasks. The specialist training, on the other hand, is particularly relevant for Safety Officers and Logistics Team members. Safety Officers are required to provide expert guidance to the teams, making comprehensive knowledge of asbestos exposure essential. Similarly, Logistics Team members, who are responsible for managing equipment, benefit from advanced training to minimize the risk of asbestos exposure during their duties.

5.3.2 Safety Communication

Due to resource constraints, some USAR teams do not have detection devices for identifying containments. 18% of respondents rely on information from the affected country and their own experience to choose the appropriate method for decontamination.

In the international deployment, information will be shared through the Virtual On-Site Operations Coordination Centre (VOSOCC), which is a real-time online coordination platform that facilitates information exchange between the affected country and the USAR teams (INSARAG, 2022). It is recommended to include contaminants as must-report items in the reporting. If the affected country or other stakeholders discover any structures containing asbestos at the disaster scene, they can share this information through VOSOCC. They should also provide arrangements for the disposal of asbestos waste. Different cells within the INSARAG Coordination Mechanism can also provide guidance to the USAR teams in various phase. It helps save time and identify contaminants.

5.4. Resources

As outlined in Chapter 4, the voluntary USAR teams face the challenge of limited resources. However, all lives are priceless, including USAR personnel themselves. Every USAR team at every level shall have a minimum requirement for decontamination. The best measures are equipped with decontamination devices. However, some USAR teams that cannot afford related expenses also need demonstrate their ability to conduct decontamination processes for deployments. This may involve establishing partnerships with local fire and rescue services or private cleaning corporations.

6. Conclusion

Saving lives is the responsibility of every USAR personnel. The selfless devotion of international deployments that have taken part is exemplary. Their health and safety shall be ensured. Over the past period, the USAR teams have been striving to find the most suitable method for conducting decontamination following international deployments, by drawing inspiration from industrial sector practices. Decontamination of contaminants is a complex and high-risk process in industrial environments because workers often have limited time and space for their tasks, which is not applicable to search and rescue missions. In a life-or-death situation, every second counts. The

USAR personnel are also required to work under challenging circumstances. With a view to meeting the actual needs, USAR teams can achieve a balance between health and safety and operational effectiveness by adopting a simplified procedure at the scene and home base.

We hope that the study will improve the safety awareness of USAR personnel and enhance the efficiency of decontamination to align with international standards..

Conflict of Interest: The author(s) confirm(s) that there is no conflict of interest related to the manuscript.

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