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SHARP

Strengthened International HeAlth Regulations & Preparedness in the EU

WP9 – Chemical safety and chemical threats

D4: Report on Standard Operating Procedures (SOPs) for responding to chemical threats

Tom Gaulton[1], Matej Ivartnik[2], Arjen Gootzen[3], Katarina Bitenc[2], Viviana Golja[2] Werner Hagens[3] and Lisbeth Hall[3]

[1]UKHSA, UK, [2]NIJZ, Slovenia, [3]RIVM, Netherlands

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Contents

1. Introduction

The Strengthened International HeAlth Regulations and Preparedness in the EU (SHARP) Joint Action aims to strengthen preparedness in the EU against serious cross-border threats to health, and to support the implementation of the International Health Regulations (2005). The EU SHARP Joint Action has received funding from the European Union, in the framework of the Third Health Programme (2014-2020).

As part of the chemical safety and chemical threats Work Package 9 (WP9) of the SHARP Joint Action (JA), previous work and outputs were built upon to draft Standard Operating Procedures (SOPs), which guide users on carrying out a process related to chemical incident response. The SOPs can be used as background documents to provide guidance to readers with little experience in the topic areas, which should be built upon with further research. A suggested sequence or stepwise procedure is included in each SOP, that can be adapted and used in accordance with local/regional plans

This report has been prepared as Deliverable 9.4 of Work Package 9: Chemical Safety and Chemical Threats of the EU SHARP Joint Action, as set out in the Grant Agreement. The objectives of this report are to explain how the topics were selected and present the SOPs and explain how they are intended to be used.

2. SOPs

2.1 Purpose of the SOPs

SOPs aim to provide clear instructions to guide users on how to carry out a process and should represent good or best practice in carrying out the procedure. SOPs can play a vital role in maintaining consistency, quality, safety, and compliance within organisations. They provide a structured approach to tasks and processes, enhancing overall operational effectiveness and minimizing risks.

The SOPs in this report could also be used as guidance documents to facilitate learning and training around the topic areas, with references for further reading and exploration. In this way, the SOPs could improve knowledge of chemical health threats and some areas of the management of chemical incidents and to contribute to improved IHR core capacities for chemicals. These documents are intended to suggest a procedure which could be integrated or adapted to existing local procedures. The SOPs are also meant to be used in combination with existing local processes and protocols, to complement and not to replace them.

2.2 SOP Topics

The topics for SOP development were chosen based on the results of the SHARP WP9 gap analysis questionnaire and D9.1 fact-finding report, where participants were asked to rate topics which were most relevant and required further training in their country and feedback from the WP9 chemical workshops which were delivered.

In the WP9 fact-finding questionnaire, respondents were asked which chemical topics they would like to receive training materials for, the answers provided included:

- Detection of chemicals,
- Decontamination of exposed persons,
- Strengthening collaboration,
- Sampling strategies
- Risk assessment practices

In the WP9 Training and exercise report (which details the training materials produced for the two chemical workshops delivered by WP9), participants who evaluated the workshops were asked what areas they would want to receive more information on. Responses included:

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- More details on intersectoral communication between the public and private sector
- Risk assessment
- More technical insights on specific chemical incident management aspects: decontamination, sampling

Based on the expertise in the WP9 team, from the responses received from the fact-finding questionnaire and workshop feedback, the topics selected for these SOPs were as follows:

- Surveillance (Event-Based Surveillance) of chemical incidents
- Multisectoral collaboration in the event of a chemical incident
- Risk analysis process of chemical incidents
- Decontamination during a chemical incident
- Sampling and monitoring during a chemical incident
- Recovery from a chemical incident

3. Discussion

Six SOPs have been produced, which provide some background information on the selected topic (selected through stakeholder feedback from the questionnaire and chemical workshops), resources/references for further reading and a suggested stepwise process for implementing the topic. The topics were selected based upon the expertise in the WP9 working group and feedback received from the WP9 questionnaire and feedback from chemical workshops.

The SOPs are not intended to replace existing procedures or be definitive documents on the topic. They are designed to provide background information, some good practices from the project team's countries and signpost to further reading or learning. The suggested steps to take are intended to be adapted and used in-line with existing information and procedures in-country and serve as a guide for those who do not currently have existing procedures or

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lack training and knowledge around the topics. They could also be used to aid training, exercises and other learning activities in country.

SOPs are dynamic documents that not only guide actions but also contribute to the collective knowledge and expertise of those responsible for chemical incident management. Below is a brief description of each SOP:

- **Surveillance (Event-Based Surveillance) of chemical incidents**
  SOP for Event-Based Surveillance of chemical incidents, which is crucial for ensuring rapid detection and response to potential hazards. It is a good place to start for a country/organisation that does not currently conduct regular surveillance for chemical incidents or exposures.
- **Multisectoral collaboration during a chemical incident**
  SOP for multisectoral collaboration during chemical incidents provides background and examples of multisectoral collaboration from the UK, Slovenia and the Netherlands, with key principles and references to established guidance on managing a response to chemical incidents with multiple sectors.
- **Risk assessment process of chemical incidents**
  SOP for risk assessment of chemical health threats provides guidance to ensure the human health effects from chemical incidents are minimised. This SOP provides an overview on the risk assessment process for chemical incidents, how risk assessments are undertaken, how they change as the incident progresses and how they are used in reducing human exposure to chemicals.
- **Decontamination during a chemical incident**
  SOP for decontamination of persons exposed to chemicals provides background and key concepts of decontamination, which is critical for ensuring the safety of personnel and the environment during chemical incidents.
- **Sampling and monitoring during a chemical incident**

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SOP for sampling and monitoring during a chemical incident provides an overview of these important functions in the context of fires. Guidance is included on assessing the extent of contamination, identifying potential health risks, and guiding response efforts accurately.

- **Recovery from a chemical incident**

  SOP for recovery from a chemical incident provides background and key references to provide a structured and coordinated approach to restoring areas affected by a chemical incident to normality.

4. Next steps/Recommendations

This report presents some SOPs which can aid in further strengthening chemical health threat preparedness and response capacities. While the SOPs in this report are suggestions, to keep SOPs current and relevant, it is recommended to conduct periodic reviews, to incorporate the latest research, regulatory changes, and best practices. The SOPs should then be updated accordingly and used regularly to train employees, ensuring staff are using up to date procedures in-line with local requirements.

To maximize the impact of SOPs in knowledge enhancement and readiness, the SOPs could be used in comprehensive training programs for all personnel involved in chemical incident management. Feedback should then be provided from personnel who have used the SOPs either in real situations or in training (such as incident scenarios or exercises) on the usability and effectiveness of SOPs, to ensure they are always fit for purpose and that those who will use them are familiar with their content.

To enhance the accessibility and usability of SOPs, digital versions of SOPs should be made available for easy access on mobile devices and real-time updates could then be implemented.

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Annexes

Annex 1: SOP - Event-Based Surveillance of chemical incidents

SHARP JA WP9 – SOPs

Event-Based Surveillance of chemical incidents

Tom Gaulton and Katarina Bitenc

The number of chemicals in our society and in our daily lives continues to increase. Accompanying this is an increasing risk of human exposure to and injury from hazardous substances. Performing regular, structured surveillance of chemical incidents allows a greater awareness of the types of chemical hazards causing injury and the frequency of their occurrence, as well as providing a better understanding of exposures. Surveillance is a key activity required under the International Health Regulations (2005) core capacities (1). As outlined in the IHR (2005), 'surveillance' refers to the systematic ongoing collection, collation and analysis of data for public health purposes and the timely dissemination of public health information for assessment and public health response as necessary (1).

Event-based surveillance (EBS) is a functional component of the early warning and response process and encompasses the organised collection, monitoring, assessment and interpretation of mainly unstructured information (from formal and informal sources, e.g. official news websites and social media) regarding chemical incidents or hazards, which may represent an acute risk to human health (2,3). EBS can be used to heighten situational awareness for current chemical incidents occurring globally (i.e., types of agents involved and the level of morbidity/mortality they cause). The method provides a rapid and simple means of detecting and identifying chemical incidents, it can be set up rapidly and with minimal cost, the outputs of which can be used to identify emerging risks and inform preparedness planning, response and training for chemical incidents (e.g., case studies and exercise scenarios).

For example, a set list of websites (see Table 1) is checked regularly to detect relevant chemical incidents. These are merely suggestions and those carrying out surveillance should seek their own sources based on their needs. Incidents which meet the criteria (for instance, the incident must have a public health impact: two or more members of the public injured, see Table 2 for more information) can be logged in a spreadsheet or database, which can then be forwarded to those with an interest in chemical incidents e.g., public health agencies, research scientists, toxicologists etc. The incidents can serve as lessons learned to improve preparedness and response to chemical incidents.

Table 1. List of websites used for chemical incident EBS (3).

Website	Link	Brief description
BBC News	https://www.bbc.co.uk/news	Search terms include: 'chemical', 'toxic', 'poison' and 'explosion'
MediSYS	https://medisys.newsbrief.eu/medisys/categoryedition/symptoms/en/chemical.html	Also check the following pages: 'chemical accident', chemical threat' and 'toxic'
ProMedMail	https://promedmail.org/	Search terms include: 'chemical', 'toxic' and 'poison'
RSOE EDIS	http://hisz.rsoe.hu/alertmap/index2.php?area=eu	Check map for all markers of HAZMAT, explosion, fires and CBRN incidents
HealthMap	https://www.healthmap.org/en/	Search using terms: 'poisoning' and 'environmental'
GPHIN	https://gphin.canada.ca/ *requires registration for access*	Search globally for events: within 48 hours; involving 'Environmental', 'Chemical', 'Product' and 'substance abuse' categories

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InformationAware	http://www.informationaware.com/special-project/search	Search for events involving: 'Chemical spill', 'Factory explosion' and 'Industrial explosion'
Twitter (now X)	https://twitter.com/search-advanced?lang=en-gb	Search terms: 'chemical', 'toxic' and 'poison'
Google News	https://www.google.co.uk	Perform google search for 'chemical', 'toxic' and 'poison', then select 'News' tab.
Google Alerts	https://www.google.co.uk/alerts	Create automated email updates using the search terms: 'chemical', 'toxic' and 'poison'

Detecting and logging chemical incidents of interest is essential for ensuring timely response and effective management of potential hazards. Criteria for detecting and logging chemical incidents of interest can be found in Table 2, below. These are just suggestions and should be modified for your own use.

Table 2. Suggested criteria for detecting incidents, logging them and reporting them

Number	Criteria for logging incidents of interest	Brief description
1	**Public health incidents**	Include incidents which cause a health effect (multiple injuries/death) to be considered a public health incident
2	**Incidents that may spread**	Include incidents which are likely to spread or continue to affect the public, as further injuries may occur
The additional criteria below are optional and should be considered for use in your country if applicable		
3	**Cross border determination:**	Is the event near rivers/ports, near borders? Is there a chance this incident could affect another country/countries?

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4	**Reportable diseases:**	Include incidents involving diseases or conditions that are reportable to public health authorities as per local requirements.
5	**Outbreaks:**	Log suspected or confirmed outbreaks of chemical exposure/unknown etiology, whether they are localized or spreading across multiple regions.
6	**Potential for transmission:**	Consider incidents involving agents with high transmissibility/dissemination potential, as they may pose broader public health risks.
7	**Environmental health hazards:**	Log incidents related to environmental hazards, such as air or water pollution, chemical spills, or hazardous material exposures.
8	**Notification from healthcare providers:**	Log incidents reported by healthcare providers or laboratories that suggest a potential public health concern.
9	**International health events:**	Consider logging incidents related to health events of international concern as defined by the World Health Organization (WHO) (Public Health Emergency of International Concern/PHEIC) or the European Union (Public Health Emergency at European Level/PHEUL).
10	**Notification from surveillance systems:**	Log incidents detected through public health surveillance systems, including syndromic surveillance, laboratory reporting, or electronic health records.

Event-based surveillance is a method of monitoring and detecting public health events, such as disease outbreaks or chemical incidents, by looking for specific indicators or events rather than relying solely on traditional surveillance systems. Table 3 suggests the steps which need to be taken to employ this method of surveillance.

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Table 3. Suggested steps to take for the EBS method.

Step	Action	Brief description
1	Check the sites in your EBS plan (use the ones listed in Table 1 as a starting point) either daily or a few times per week, use the suggested terms in Table 1 or your own specific terms	Frequency of checking these sites is up to the user
2	If any chemical incidents are detected, check them against the criteria (See Table 2 for example criteria)	
3	Log relevant incidents in a repository, for example, into a database/excel sheet for saving	
4	E-mail a summary of the incidents you have detected to colleagues	Include date/time of incident, link to the article, website the article was found, location of the incident, the chemical involved and any injuries/deaths which occurred
5	Send the incidents on to relevant stakeholders in your country (or international partners, for example the WHO) for information	For example, other health organisations/departments, poison centres, ministry/organisation of the environment
6	Maintain the repository and regularly analyse the data for trends, incidents to use as case studies/teaching aids, general awareness of the types of chemical incident you regularly detect. This information could also be used to inform policy	

While there are many benefits of using this method, there are also some drawbacks. While EBS rapidly picks up potential chemical incidents, it relies on using news websites and accuracy is sometimes questionable. It is often very difficult to follow up on the identified incidents, as sometimes information on the final numbers of casualties or the identity of the chemical agent is incomplete, inaccurate or unreliable and unverified. Nonetheless, this is a viable method to rapidly and cheaply detect chemical incidents and create a useful

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repository of incidents for future training, raising awareness and identifying trends in chemical incidents and exposure.

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Annex 2: SOP - Multisectoral collaboration in the event of a chemical incident

SHARP JA WP9 - SOPs

Multisectoral collaboration in the event of a chemical incident

Tom Gaulton, Matej Ivartnik, Werner Hagens and Lisbeth Hall

This SOP will give an overview of some of the tools and processes used to facilitate multisectoral collaboration for response to chemical incidents. It will also provide the perspectives from the United Kingdom (UK), Slovenia and the Netherlands and how these countries promote effective collaboration between sectors in the case of a chemical incident.

Responding to chemical incidents requires a multisectoral approach which requires input from a wide range of government and non-governmental bodies. Chemical incidents can be varied and complex, often requiring expertise from different organisations and sectors to provide an effective response. While the health sector is not always the lead agency managing a chemical incident, it often has the responsibility of ensuring capacity for the rapid and efficiently coordinated response to chemical incidents. Considerations must be given to the local environment which may be contaminated (including sources of drinking water, farmland and livestock) and effects on infrastructure such as transport and utilities.

Preparedness plans are key to establishing who should be involved in responding to chemical incidents, who should lead and the structure of command and responsibility to ensure efficient and coordinated response effort.

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UK perspective

Legislation

The Civil Contingencies Act (CCA, 2004) is a legal instrument that establishes a clear set of roles and responsibilities and emergency powers for those involved in emergency preparation and response at the local level. The CCA provides a coherent framework at local and national level, for emergency planning and response. Organisations listed in the CCA have legal responsibilities, including:

- assessing the risk of emergencies occurring and use this to inform contingency planning in the form of a Community Risk Register;
- Put in place emergency plans;
- Create business continuity plans to ensure that they can continue to exercise critical functions in the event of an emergency;
- Make information available to the public about civil protection matters, and maintain arrangements to warn, inform and advise the public in the event of an emergency;
- Share information with other local responders to enhance co-ordination;
- Co-operate with other local responders to enhance coordination and efficiency;
- Provide advice and assistance to businesses and voluntary organisations about business continuity management (Local Authorities only).

The CCA designates Category 1 responders and Category 2 responders: Category 1 responders include first responders (police/ambulance/fire service), the UK National Health Service (NHS), UK Health Security Agency, Environment Agency and the UK coastguard agency/port health authorities. These responders are responsible for risk assessment, carrying out emergency plans. Communicating with the public and coordinating category 2 responders.

Category 2 responders include Utility providers, public transport providers, port/airport operators and the Health and Safety Executive. Category 2 responders are co-operating bodies (they have little involvement in core work, but are involved in incidents that affect

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their sector). They are required to co-operate with other Category 1 and 2 responders for example, Transport for London, who operates the London Underground, played a key role in restoring the transport network in London restored quickly, efficiently and safely following the 2007 London bombings.

The CCA outlines the creation of Local Resilience Forums (LRFs), which are multi-agency partnerships of local Category 1 responders, with support from Category 2, military and voluntary sectors. The LRFs coordinate risk assessment through production of the local Community Risk Register – localised incidents and catastrophic national emergencies, Emergency plans to prevent, mitigate and respond to incidents, facilitate Category 1 & 2 responders in the delivery of their CCA duties and deliver government policy by coordinating responses to government initiatives

Preparedness or Emergency Plans are key to establishing who should be involved in responding to chemical incidents, who should lead and the structure of command and responsibility in the response effort. The aim of an Emergency Plan is to increase multi-agency and community resilience by ensuring that all responders:

- know their role;
- are competent to carry out the tasks assigned to them;
- have access to available resources and facilities; and
- have confidence that their partners in response are similarly prepared.

Category 1 responders have the responsibility to maintain plans for preventing the emergency; reducing, controlling or mitigating its effects; and taking other action in connection with the emergency.

In the UK, Control Of Major Accidental Hazard (COMAH) Regulations (2015) implement the majority of the Seveso III Directive to prevent and mitigate the effects of major accidents to the public and the environment, through demonstration of adequate safety. The regulations ensure that businesses take all necessary measures to prevent major accidents involving

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dangerous substances and limit the consequences to people and the environment of any major accidents which do occur. These sites must have and maintain plans (which contain an overview of what is stored on site and the risks in case of an emergency) in the case of emergencies, which are shared with (among others) the national public health authority (UKHSA) and emergency services. Within the plan are instructions on who to contact initially, where to seek advice from and measures to safeguard public health.

JESIP

In the UK, the Joint Emergency Services Interoperability Principles (2) aim to 'work together, save lives, reduce harm', in the case of CBRN incidents, from planning, through to response and recovery. The models and principles outlined by JESIP have become the standard for interoperability when responding to CBRN incidents in the UK, as such incidents need to consider multi-agency working to reduce the public from harm.

Whilst the initial focus was on improving the response to major incidents, JESIP is scalable, so much so, the principles for joint working and models can be applied to any type of multi-agency incident. Among the resources on the JESIP website, they have produced the document JESIP Joint Doctrine: the interoperability framework, which sets out a standard approach to multi-agency working, along with training and awareness products for responding organisations to train their staff (3).

The content of the Joint Doctrine aims to address (among others):

- Challenges with initial command, control and coordination activities on arrival at scene
- A requirement for common joint operational and command procedures
- Role of others, especially specialist resources and the reasons for their deployment, not well understood between services

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- Challenges in the identification of those in charge at the scene leading to delays in planning response activity
- Misunderstandings when sharing incident information and differing risk thresholds not understood

JESIP also outlines principles for joint working among emergency responders, which are particularly important in the early stages of an incident, when clear, robust decisions and actions need to be taken with minimum delay, often in a rapidly changing environment (2)

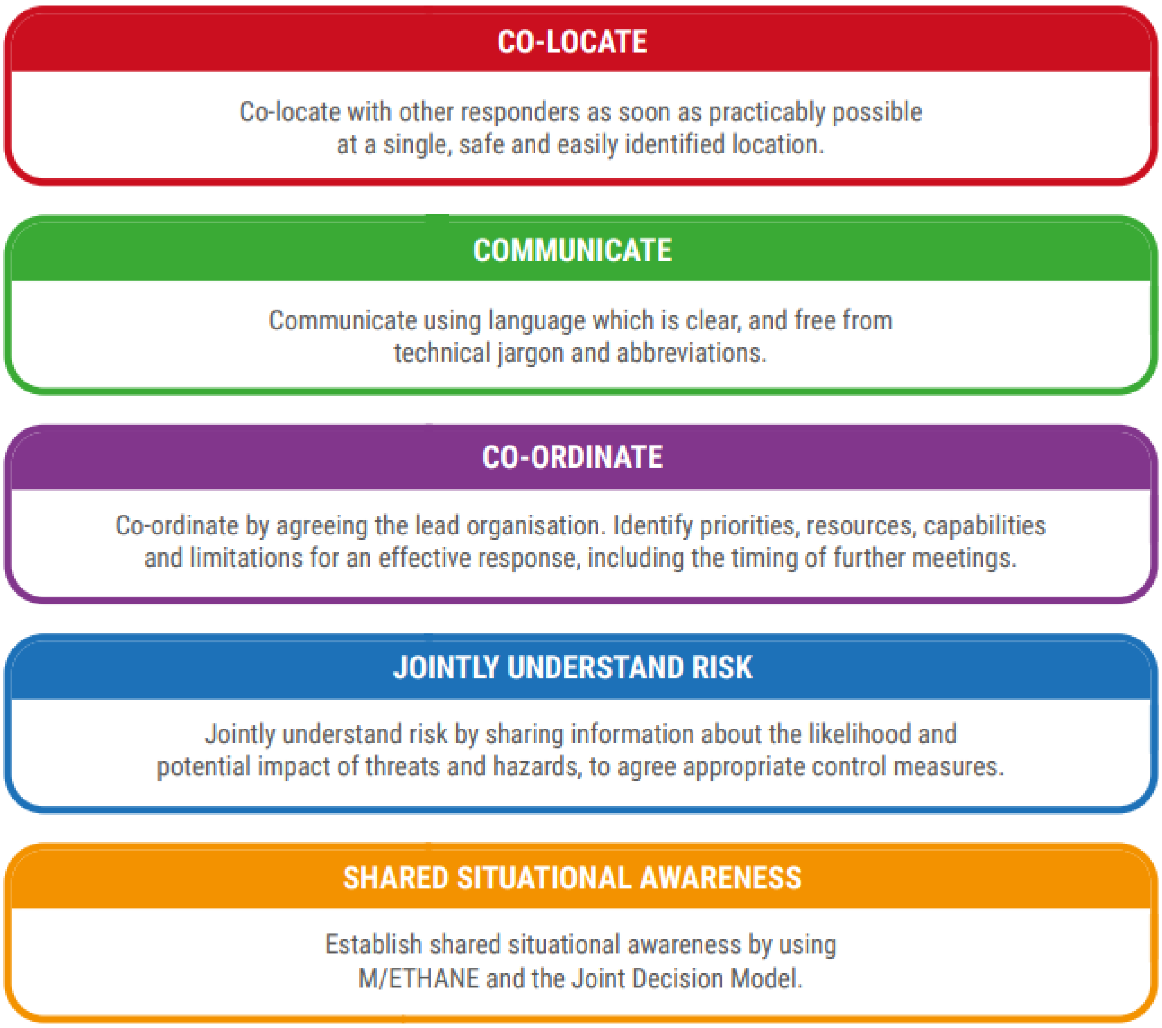

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Figure 1. Diagram showing the JESIP principles for joint working. (2)

METHANE

The M/ETHANE model is an established reporting framework used in the JESIP principles, which provides a common structure for responders and their control rooms to share incident information.

It is recommended that this format is used for all incidents and be updated as the incident develops. For incidents falling below the major incident threshold M/ETHANE becomes an 'ETHANE' message.

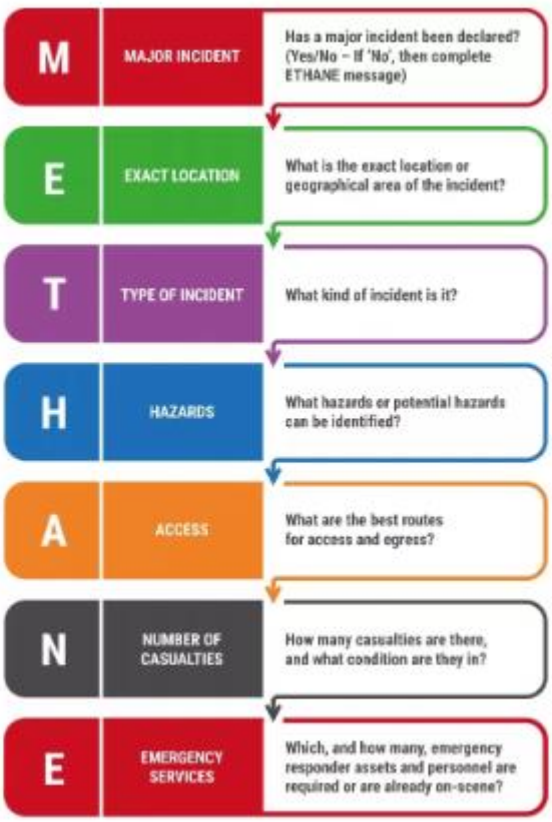

Figure 2. Overview of the METHANE model (2)

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Slovenian perspective

In Slovenia, the Protection against Natural and Other Disasters Act (Official Gazette of the Republic of Slovenia, No. 51/06 - official consolidated text, 97/10 and 21/18 - ZNOrg) provides a framework for emergency planning and response on all levels. In general, everyone in Slovenia participates in protection and rescue, where the law specifies three types of participation:

- Civil protection - is a purposefully organized part of the system of protection against natural and other disasters. It includes management bodies, units and services for protection, rescue and assistance, protection and rescue equipment, and facilities and devices for protection, rescue and assistance.
- Administration of the Republic of Slovenia for Civil Protection and Disaster Relief (ACPDR) is a constituent body of the Ministry of Defense and performs administrative and professional protection, rescue and relief tasks as well as other tasks regarding protection against natural and other disasters.
- Citizens - Everyone must inform the nearest information centres or the Police of any danger of a natural or other disaster as soon as they have noticed or learned of it. So, everyone in Slovenia is actually also a part of alarming system.

ACPDR includes notifications centres, which perform a 24-hour duty service. They are responsible for coordinating the response in the event of accidents, for data collection and to provide information for the public. In case of need, they **activate various experts** who cover different areas in response (health, environment etc.), among them public health experts, provided by the National Institute for Public Health (4).

Protection, Rescue and Relief Forces are organized on three levels: municipal, regional and national. The municipal and regional levels consist of organisations like Fire-Fighters, Emergency Medical Assistance and Technical Rescue Units. While the national level includes other public services, among them the environmental laboratory and public health service (5).

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ACPDR is also responsible for preparation of Protection and rescue plans. Plans should be prepared for organizations, municipal, regional and national level for different types of disaster (e.g. floods, earthquakes, fires).

While there are no regional or national plans for chemical incidents prepared, there are plans for organizations and municipalities.

Dutch Perspective

In the Netherlands, the response to a chemical incident is the responsibility of the safety regions (veiligheidsregio's). The safety regions have fully equipped fire-brigades, including standard measurement tools. The incident is assessed to categorise it according to a so-called GRIP structure. GRIP stands for Coordinated Regional Incident Response Procedure. The GRIP structure was created to organize the scaling up of emergency services in an orderly manner. GRIP relates to the organization of disaster response and crisis management by the emergency services of the security region.

The levels are:

GRIP 1: Source control

GRIP 2: Source control and effect area

GRIP 3: Threat to the well-being of the population

GRIP 4: Cross-municipal incident (more than 1 city involved)

GRIP 5: Cross-regional incident (More than 1 safety region involved: the safety region with the source of the incident is in charge.

The national government is never in charge of local/regional disaster response of chemical incidents. If needed, the safety region can ask the Crisis Expert Team Environment and

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Drinking Water (CET-md, governmental organization) for expertise, assistance and advice, see below. This activation of CET-md is independent of GRIP level.

Crisis Expert Team Environment and Drinking Water (CET-md)

In the case of complex incidents which can pose risks to public health, such as serious environmental pollution or disruptions to drinking water supplies, specialist knowledge is required. In the Netherlands, this can be provided by an expert advisory network of eight government and knowledge institutes, the Crisis Expert Team Environment and Drinking Water (CET-md) (4). This network, which encompasses a broad range of expertise in the fields of public health and the environment, provides 24/7 support on incidents involving the environment or drinking water. Together, the institutes in this network offer expert advice on possible risks and measures. The CET-md falls under the responsibility of the Departmental Crisis Management Coordination Centre of the Ministry of Infrastructure and Water Management.

The eight institutes in the network are:

- Ministry of Defence: Coordination Centre on Health and Safety Expertise (CEAG)
- Royal Netherlands Meteorological Institute (KNMI)
- Water Research Institute (KWR)
- National Information Centre on Accidents involving Hazardous Substances (LIOGS)
- National Institute for Public Health and the Environment: Environmental Incident Service (RIVM/MOD)
- University Medical Centre Utrecht: National Poisons Information Centre (NVIC)
- Wageningen Food Safety Research (WFSR)
- Water Management Centre of the Netherlands - National Coordination Committee on Environmental Pollution of Water (WMCN/LCM)

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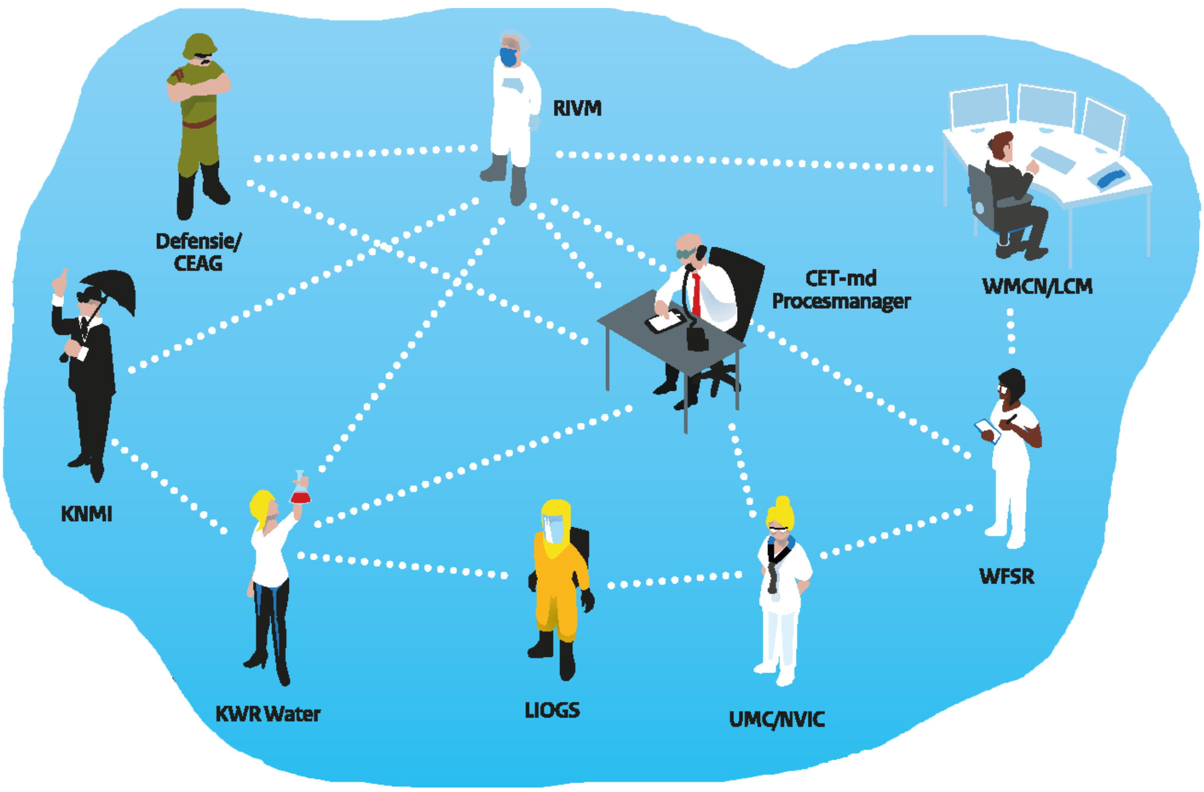

Figure 3. The institutes involved in the CET-md (7)

When can CET-md be called on?

CET-md can be called on, for example, if there is a major fire at a chemical plant and contaminated fire extinguishing water runs off into surface water. What are the dangers to humans, animals and the environment? Do the hazardous substances in the smoke pose a threat to public health? Can crops from the land be eaten or not? These are the types of questions that authorities at local, regional and national level can call on CET-md to answer. A phone call to one of the eight institutes gives immediate access to the network, with each institute having its own area of expertise.

Specialist knowledge integrated into one set of recommendations

When one of the institutes receives a request for advice, this institute sets to work answering it, as well as submitting the request to the other, relevant knowledge institutes. Based on, for example, measurement data, modelling, expert risk assessments and analyses (e.g. of

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chemical substances), the network analyses the situation. All knowledge and advice from the institutes involved are then combined into one set of recommendations. This allows the right measures to be taken immediately, to prevent serious consequences.

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Annex 3: SOP - Risk Assessment process of chemical incidents

SHARP JA WP9 - SOPs

Risk Assessment of cross-border chemical health threats

Matej Ivartnik and Viviana Golja

Background Information

Risk analysis is a process that incorporates risk assessment, risk management and risk communication. The first and the most important component is risk assessment. Risk assessment is a systematic process for gathering, assessing and documenting information to assign a level of risk to health (1, 5). Risk assessment provides the basis for taking action to manage and reduce the negative consequences of acute public health risks. Management of chemical incidents and emergencies require a multi-disciplinary and multi-sectoral approach, it includes all actions and activities to reduce health risk, arising from incidents (2). Risk communication is the real-time exchange of information, advice and opinions between experts or officials and people who face a hazard or threat to their survival, health, or economic or social wellbeing (3).

Topic Overview

A framework for coordinating the management of events that may constitute a public health emergency of international concern, and for strengthening the capacity of all countries to detect, assess, notify and respond to threats to public health, including chemicals, is provided in International Health Regulations (IHR).

More detailed instructions and obligations in this area for member states are set out in Regulation (EU) 2022/2371 of the European Parliament and of the Council of 23 November 2022 on serious cross-border threats to health and repealing Decision No 1082/2013/EU (7).

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Public health has an essential role to play in preventing the occurrence of chemical incidents and minimizing their negative impacts on both the exposed population and the environment should they occur. In reducing the negative effects of a chemical accident, a key task in the field of public health is the process of risk analysis, which is carried out in cooperation with other stakeholders. Risk analysis is a process that includes three components: a) human health risk assessment; b) risk management and c) risk communication (1).

Human health risk assessment

Health risk assessment is a process intended to estimate the risk to a given target organism, system or (sub)population, including the identification of uncertainties, following exposure to a particular agent, considering the inherent characteristics of the agent of concern as well as the characteristics of the specific target system. Human health risk assessment of chemicals refers to methods and techniques that apply to the evaluation of hazards, exposure and harm associated with chemicals (1).

The risk assessment process begins with problem formulation and includes four additional steps: (a) hazard identification, (b) hazard characterization, (c) exposure assessment and (d) risk characterization.

Hazard identification is generally the first step in a risk assessment (possibly at the same time as exposure assessment) and is used to determine whether exposure to this chemical has the potential to harm human health. Hazard identification involves determining whether the chemical is considered hazardous, based on existing knowledge. Therefore, this process reflects the inherent toxicology of the chemical(s) in question, without predicting the likelihood of an effect. In hazard characterization the relationship between exposure or dose and any toxic effects is analysed. By analysing the relationship between dose and effect, thresholds can be employed which describe what doses of the chemical causes no effects, mild, moderate, severe and very severe effects or even death.

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Exposure assessment is used to determine whether people are in contact with a potentially hazardous chemical and, if so, to how much, by what route, through what media and for how long. Exposure can occur from different segments of the wider (outdoor air, soil, water) and narrower (indoor air, house dust) environment, through consumption of food, water and through objects of general use. The most common routes of entry are through the respiratory tract, skin and ingestion, less often through the eyes. Depending on the duration, the exposure can be short-term, medium-term or long-term. There are a lot of factors which can influence exposure and should be considered by the assessor:

- location of the release (e.g. industrial, urban, rural, indoor/outdoor),
- are the conditions dry or wet (rainfall may increase the amount of a chemical removed through wet deposition from the atmosphere and subsequently deposited on various surfaces),
- wind speed and direction (how far a plume contaminated by chemicals will travel),
- physicochemical properties of the released chemicals (e.g. low or high volatility, how reactive they are, how mobile they are in water/soil etc.),
- what types of surfaces are present (some chemicals soak into absorbent surfaces).

The last step of a chemical risk assessment – the risk characterization – is typically a quantitative statement about the comparison of estimated exposure to the most appropriate health-based guidance value, media-specific quality guideline value or other hazard characterization value, such as the cancer slope factor or a point of departure (for example, a no-observed-adverse-effect-level or NOAEL, lowest-observed-adverse-effect level or LOAEL, or benchmark dose (lower confidence limit) or BMDL).

A necessary element of risk assessment is the definition of uncertainty. Better knowledge of hazards and more accurate assessment of exposure means less uncertainty. In the case of some chemical incidents, it will not be known at the outset what hazards are present. In the

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event of a chemical accident, time usually runs out and immediate action must be taken to protect health. Since risk is a product of hazard and exposure, to reduce risk, exposure must be reduced – shelters and evacuation are the usual options. Chemical risk assessment is a dynamic process, the situation may change over time and the risk assessment must be updated accordingly (1, 5, 6).

Risk management

Management of chemical incidents includes all measures and activities to reduce health risk arising from these incidents. Health systems play a significant role in reducing hazards, exposures and vulnerabilities, and in establishing capacities to prevent the occurrence or reduce the consequences of hazardous events that may lead to emergencies. Such capacities include primary care, disease surveillance, pre-hospital care, mass casualty management, chemical and radiological safety, mental health, and risk communication.

The risk assessment itself is completely irrelevant if measures are not introduced based on it, to reduce this risk. The measure always depends on the environment in which they are implemented, so the proposed measures must always be adapted to the conditions. It is very important to consider the vulnerability of the affected environment. Some already include this element in the risk assessment itself. Measures that are effective in the respective environment must be proposed. Shelter-in-place is an appropriate measure where the infrastructure allows for the prevention of outside air intrusion, evacuation of the area is also an option, as long as this does not cause confusion and chaos that could lead to a worse health outcome. The goal of public health is to prepare appropriate proposals for various target groups, from mediators, decision-makers to the affected population (2).

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Risk Communication

Risk communication is the real-time exchange of information, advice and opinions between experts or officials and people who face a hazard or threat to their survival, health, or economic or social wellbeing. The purpose of risk communication is to enable people at risk to make informed decisions to mitigate the effects of a threat (hazard). Accurate information provided early, and in languages and channels that people understand, trust and use, enables them to make choices and take actions to protect themselves, their families and communities from the health hazards threatening their lives and well-being. The most important task is ensuring coordination between different member states, authorities and agencies involved in the response and the media along with a uniform message. Establishing and maintaining trust is an important step in communication and is linked to community engagement and open acknowledgement of uncertainty. To build trust, risk communication must be linked to functioning and accessible services, must be transparent, timely, easy-to-understand and must acknowledge uncertainty, address and engage affected populations. Risk communication must be linked to self-efficacy and be disseminated using multiple platforms, methods and channels. In risk communication, risk perception and socioeconomic conditions must be taken into account as well for successful communication with target stakeholders. Countries are required to establish a set of core capacities to address all types of potential public health emergency of international concern including those that involve chemicals. Among the core capacities related to chemical incidents and emergencies, is established coordination and cooperation between all relevant stakeholders and national risk assessors, taking actions to reduce risks (3).

In the last decade, the EU project CERACI (Cross-border Exposure characterization for Risk Assessment in Chemical Incidents) was carried out, the aim of which was to improve exposure assessment at the EU level (8). Its conclusions regarding exposure assessment can be broadly applied to the overall risk analysis process. It is important that the performers of various tasks in the risk analyses process (risk assessment including exposure assessment, risk communication) are well connected with each other, as well as the countries affected by the

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chemical incident. These are people from different states and organizations, and their liaison during incident response may not be commonplace or formalised. There is limited exchange of good practices between countries because experts are rarely connected across borders and there are few opportunities for networking and sharing of expert knowledge. Member States are most likely to utilise mutual aid from neighbouring countries at the local responder level. There is a need for:

- National formal legal requirements within Member States for cooperation in risk analysis between responders (i.e. between exposure assessors - risk assessors, communicators, those involved in risk management)
- A common framework for semi-formal international collaboration between Member States (e.g. memoranda of understanding)
- An EU Crisis or Emergency Cooperation Centre for all stakeholders that need to share cross-border emergency preparedness information

The potential for cross-border chemical health threats will be reduced by timely and transparent notification of events, combined with a collaborative assessment of the risks by the concerned states and international health authorities and together with effective risk management and risk communication (8).

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Procedure/Instructions

Table 1: Risk analysis of cross-border chemical health threats

Phase	
Preparedness	*Step 1* Establish coordination and collaboration between all relevant stakeholders nationally and internationally.
	Step 2 Prepare general recommendations for health protection in case of various types of accidents.
	Step 3 Propose measures that will reduce the vulnerability of the nearby community and will reduce the risk of a specific hazard in case of an accident (prepare shelter-in-place or premises for evacuation of affected residents, advice on limiting the consumption of contaminated drinking water or food, advice on limiting access to contaminated area etc.)
	Step 4 Gain trust for easier communications, make connections with people and organizations that people value. Establish communication channels and introduce people to them.
Response	*Step 1* Activate a network of stakeholders designated for risk assessment and disaster response including communications.
	Step 2 Activate the established communication network. In first phase of accident communicate general recommendations.
	Step 3 Establish a dialogue with the affected community and find key stakeholders within it.
	Step 4 Gather all available data (from first responders and other with knowledge about incident). Collect and analyse relevant samples (e.g. air, soil, drinking water, crops). Gather data of population at risk – from responders to nearby inhabitants, random by-passers. Pay special attention to more sensitive groups of the population.
	Step 5 Start dynamic risk assessment by answering to the questions: *What is (are) substance(s) in question? Do they have hazardous properties?*

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	What are the possible consequences of exposure and at what level of exposure? *To how much, by what route, through what media is exposure possible?* *How long is expected duration of exposure?* *Is it a risk to human health? Which are the most vulnerable groups? What is the level of risk?* Repeat assessment with additional data.
	Step 6 Give advice on health protection measures (e.g. to leave the contaminated area, to stop consumption of drinking water or food which may be contaminated until the results of analysis are known).
	Step 7 Inform the affected population and public. Message should be uniform, transparent, timely, easy-to-understand, acknowledge uncertainty and be disseminated using multiple platforms, methods and channels.
Recovery	*Step 1* Perform risk assessment for delayed indirect risks. Collect additional environmental samples (crops, surface waters, soil). Collect health data from regional health centres. Collect biomonitoring data. Give advice on additional health protection measures (e.g. water supply flushing, cleaning the affected surfaces). Give advice on the environmental remediation measures.
	Step 2 Communicate with the affected population. Engage them in the assessment of health consequences, obtain information about their needs and provide them with support.

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Annex 4: SOP - Decontamination during a chemical incident

SHARP JA WP9 - SOPs

Decontamination of chemical exposure

Tom Gaulton and Katarina Bitenc

Introduction

The primary public health concern following a chemical incident will be to preserve life. To this end, the decontamination of exposed persons, defined as any action that reduces, removes, neutralizes or inactivates contamination is an immediate consideration. Decontamination not only limits the potential exposure (e.g., reducing contaminant absorption through the skin) but also reduces the uncontrolled spread of contamination to unexposed persons, emergency responders, equipment and health care facilities, a scenario highlighted by the 1995 Tokyo subway sarin attacks (1).

Mass casualty chemical decontamination protocols have been systematically developed, optimised and evaluated through a series of in vitro and human volunteer trials. These studies have improved our understanding of several critical areas of the decontamination process, ultimately leading to tested and efficient decontamination capabilities (1).

Guidance on the initial operational response (IOR) to CBRN (Chemical, Biological, Radiological, and Nuclear) incidents involves immediate actions to mitigate the threat and protect lives and the environment (available from here). Within this guidance are the main steps to take when members of the public have been exposed to a chemical agent. The guidance is also in-line with the JESIP principles (see SOP on multisectoral collaboration) and should be used in tandem.

The PRISM (Primary Response Incident Scene Management) incident response protocols are US Federal Guidelines fit for purpose for ambulatory casualties and are focused on the initial "disrobe and decontaminate" response to chemical incidents. PRISM introduces the "triple

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protocol” of dry, wet, and technical (specialist) decontamination. The PRISM series was written to provide authoritative, evidence-based guidance on mass patient disrobe and decontamination during a chemical incident. The PRISM documentation comprises three volumes: Strategic Guidance, Tactical Guidance, Operational Guidance. PRISM protocols for mass casualty decontamination are effective, but there is a need to develop better communication strategies for first responders to ensure that decontamination protocols are performed in an optimal manner (2, 3).

Initial Operational Response (IOR)

In the event of a chemical incident where members of the public have been exposed, the speed of the response is critical to saving lives. The initial Operational Response (IOR) describes the immediate actions to take upon arrival at the scene of chemical contamination of affected persons. Through the process of Evacuation, Disrobe and (Improvised) Decontamination, ideally within 15 minutes, the vast majority of skin contaminants can be removed and further injury or death avoided. It must be remembered that First Responders must ensure their own safety and carry out ongoing hazard assessments (4).

Evacuation - The removal of casualties away from the area or source of contamination should be carried out as a priority. Casualties should be moved to an area upwind and ideally uphill of the incident. It is important to clearly communicate with casualties and bystanders throughout the response, what is known about the incident; what is being done to help them and how they can help themselves.

Disrobe - Casualty disrobing/ undressing is a critical step in the decontamination process and is highly effective at reducing the effects of exposure to chemical contaminants. Disrobe procedures should be, where possible, conducted by the casualty themselves and should be systematic and consistent with the steps outlined in the Fire and Rescue Service (FRS) disrobe pack pictogram (Fig. 1 below). Consideration should be given to ensuring the welfare and, as far as is practicably possible, dignity of casualties.

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Figure 1. UK Fire and Rescue Service guidance on effective disrobing (4)

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Decontamination - DRY decontamination should be considered in the first instance where a non-caustic (i.e. no obvious burning or skin irritation) chemical agent is suspected. Dry decontamination consists of the use of dry absorbent material such as paper tissue or cloth to blot the affected body.

WET decontamination should be used if signs and symptoms of caustic chemical substance are apparent or the contaminant is known to be biological, radiological or nuclear. Improvised wet decontamination consists of the use of water (with 0.5% detergent) from any available source such as taps, showers, hose-reels, sprinklers, etc. to dilute and flush the contaminant away from the body surface, followed by wiping the area with a sponge or cloth, then rinsing the area again with water (the rinse-wipe-rinse method) (4).

Interim decontamination

Interim decontamination is the use of standard equipment to provide a planned and structured decontamination process for large numbers of the public as soon as possible, until purpose-designed decontamination equipment is available.

The benefits of establishing interim decontamination should be considered along with the risks; depending on the method used, there may be issues around maintaining systems for long periods, disrobe provision, re-robe provision, ability to use warm water, enclosures, ability to capture water run-off, limited personal protective equipment (PPE) for fore and rescue service personnel, contamination of appliances and equipment, etc. There is no national standard for interim decontamination; each fire and rescue service has established its own individual methods. However, interim decontamination has the advantage of being a more structured and controlled method than improvised decontamination. (6)

Interim decontamination consists of using fire service vehicles to create a shower corridor through which casualties are showered using fire hoses in a more controlled manner (also known as the 'Ladder Pipe' system in the US (1)).

These initial and interim steps significantly reduce the time between exposure and intervention. While IOR and interim procedures may not be as effective as those under the

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Specialist Operational Response (SOR), rapid chemical removal is preferable to no intervention and waiting for a specialist response.

Specialist Operational Response (SOR)

Mass casualty decontamination

Chemical incidents can occur which may affect large numbers of people. These so-called 'mass-casualty' incidents are defined by NHS England as 'an incident (or series of incidents) causing casualties on a scale that is beyond the normal resources of the emergency and healthcare services' ability to manage' (5).

SOR typically involves the use of mass decontamination units (MDUs) consisting of one-way system in which contaminated persons are guided through specialized tents in which they are sprayed with large volumes of water and responders in full personal protective equipment (PPE) aid the removal of contaminants through wiping the affected individuals. This system results in the decontamination of hundreds of people per hour and is essential for mass casualty events. (1)

Further reading

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Annex 5: SOP - Sampling and monitoring during a chemical incident

SHARP JA WP9 - SOPs

Sampling, monitoring and detection of chemical incidents

Arjen Gootzen

Background Information

When a chemical incident occurs, members of the public might be exposed (depending on the nature and location of the incident). Exposure to chemical hazards may be minor but in a worse case could have lethal consequences. A risk assessment (see the Risk Assessment SOP for more information) can give an indication of the health threats in the exposed population. However, to perform a reliable risk assessment, accurate and timely information about the exposure is required (1). Therefore, reliable sampling and monitoring at the place of the incident and its surroundings are essential to identify the hazards and to assess possible exposure. Furthermore, sampling, detection and monitoring are important during the acute phase of the incident to inform immediate decision making for mitigation purposes, dispersion modelling and risk assessment (2) and risk communication. Also, if the acute phase of an incident is under control and the (direct) health threats have diminished, there may still be health risks, for example through exposure to contaminated water, soil and crops. Monitoring and sampling of these media is therefore important in this phase as well. Since sampling and monitoring are highly important during and after an incident (and sometimes before, if continuous air quality monitoring is undertaken), it is recommended to have a ready-made strategy available which can be adjusted according to the characteristics of the chemical incident. This way a rapid evaluation of the threat and risks can be performed and proper countermeasures can be taken (3, 4).

In this guideline, procedures for sampling, monitoring and detection are summarised in a chronological way. It gives basic guidance on how to act and what to consider when a chemical health threat occurs, both during the acute phase and the monitoring thereafter. The focus in this guideline will be on fire threats (exposure mainly by contaminated air and/or smoke) because this is among the most commonly occurring chemical incidents.

Instructions

When a chemical incident does occur, many quick but well-considered actions have to be taken in short timeframes. The current phase of the incident determines which samples can be taken, what is useful to monitor and which information can be collected in the field.

Each fire incident can be roughly classified into 4 stages:

- Preparation phase
- Acute phase (during the fire)
- Smouldering phase
- Post-incident/monitoring phase

The next paragraphs will describe what to consider during the several phases of a fire.

1) Preparation phase

The preparation phase contains all preparations that can be taken before an incident occurs. This phase likely takes the most work. However, a good preparation for an incident saves a lot of time and effort during an incident and is therefore the most important phase. The CERACI report (5) gives some good examples of barriers and good practices in monitoring (see chapters 4.1.6.3 – 4.1.6.4).

a. Sampling and analysis strategy

A sampling strategy contains information about:

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- where to take samples
- sampling distance from the fire
- order of sampling
- sampling time
- substances to measure
- how many samples to take
- taking replicate and reference samples (upwind from the place of incident)
- which equipment/method/sampling procedure to use for which substances

The main purpose of a sampling strategy is to help enable an overview of the possible hazards, quantify them and evaluate the risk of exposure to people and the environment. A ready-made sampling strategy can save time during an incident (6).

An analysis strategy is important for fast and timely analysis of the samples taken. It would be useful to distinguish different types of sampling e.g. samples collected for lab analysis, field samples etc. The strategy contains information about which organisations are authorized for which tasks, which lab capabilities are available, which samples go to which labs and who is in charge of the risk assessment. If there is more than one potential lab, make a shortlist. Involve these labs in the development of the sampling and monitoring strategies.

These ready-made sampling and analysis strategies can be quickly adapted into tailor-made sampling and analysis plan during the acute phase, of which the details depend on the characteristics of the incident.

b. Supplies and equipment

Make sure that there are sufficient supplies and equipment for taking samples and keep a list of storage supplies. Make sure that supplies are within their expiration date. The distribution of supplies and equipment is important in order to have the right equipment and supplies at the correct place at the right time (e.g. fire fighters are often the first to reach a fire, and could therefore start with taking the first instantaneous monitoring samples). More accurate and time-consuming sampling and detection (according to the sampling plan) can follow as soon as possible thereafter.

Both the field equipment and lab equipment should be calibrated and ready for use. How samples are transported (e.g. chilled packaging) to the lab should already be considered in this phase to ensure timely analysis.

Supplies to consider are: personal protection equipment (PPE), equipment to take samples (from air, water, soil, deposited particles), immediate detection equipment (to detect organic and inorganic materials and dust particles in the air) and possibly (rapid) analysis equipment to determine which materials are released and/or in which quantities.

c. Up-to-date protocols and training

For fast sampling make sure protocols are up-to-date and that personnel are trained accordingly. Protocols should give detailed information about what steps to take, in which order and in which situation. Personnel should be trained on a regular basis both theoretically and though practice in the field.

2) Acute phase, (Golden Hour)

In the acute phase of an incident, it is important to collect information on the possible hazards and exposures for people, livestock, crops and/or the environment. This information can be used to take countermeasures and to estimate the possible health impact. During this phase, establish an indication of the possible hazards and exposures and determine whether monitoring or sampling is necessary and to what extent. What is the situation? Are there substances being released? Are there substances that might be released? Is there potential exposure to people, livestock and/or crops? Are there expected health risks?

The answers to these questions may depend on several factors such as:

- the source of the incident (e.g. a chemical factory)
- the size of the fire
- possible release of chemical substances, gasses or vapours to the surrounding area

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- weather conditions (e.g. wind speed and direction)
- inhabitants in the surrounding area
- distance to nearest inhabitants
- vulnerable populations nearby (e.g. elderly, young children)
- livestock or crops in the surrounding area
- a water catchment area nearby

This information is important for determining a sampling and analysis plan. Take into account that sampling results not only give information enabling hazard identification and but can also be used for hazard modelling.

Exposure from air and smoke are the most relevant in this phase of a fire incident. Therefore, samples from air and smoke should be taken first, at a later stage deposition samples from soil, grass and/or crops can be taken (see chapter 4: Post incident). If contamination of surface or drinking water is expected, samples of these matrices should also be taken. Samples of ash or debris can be taken to measure and look for specific possibly hazard substances.

There are 3 main aspects for setting up a sampling plan:

- Location
- Substances to measure
- Sample time

Location

Sample location is based on how the fire develops and how the hazardous substances spread in the surroundings. This can be visualised by a basic diffusion model or visual observation of the smoke. If needed, information about the weather conditions can be requested at the local or national weather forecast station. Quick handheld measurements can confirm the direction of dispersion of harmful substances. Samples should preferably be taken at the place where the highest concentration (often down-wind) is expected; as this

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way a worst-case measurement can be taken. At a height of 1.5 metres (breathing level), the highest inhalational exposure to people is expected. Therefore, if possible, sample at a height of 1.5 metres. Take into account that smoke can travel hundreds of metres or even kilometres from the place of the incident. Concentrations of substances at these distances are often diluted because of the distance and can fluctuate because of wind conditions. Taking representative samples at big distances can therefore be difficult. A recent analysis of 132 fires in the Netherlands showed that most harmful substances were measured within 300 meters of the fire. Harmful substances were rarely found more than one kilometre from the fire (7). Therefore, to get a good indication of the concentration and variety of substances in the smoke, if possible, take a sample close to the incident. If the location where the highest concentrations are expected is not available for sampling (e.g. because the position is above water, or it is too dangerous to reach) try to measure as close as possible to this position.

Substances to measure

Always measure as many hazardous chemical substances as possible. Besides substances such as polycyclic aromatic hydrocarbons (PAHs), carbon monoxide, nitrogen oxides, soot/particulate matter, volatile organic compounds (VOCs, such as benzene, toluene, ethylbenzene, xylene, styrene and naphthalene) which occur at almost all fires, analysing for specific substances such as dioxins, heavy metals, sulphur dioxide, can be done depending on the specific situation. Prioritising substances for analysis can be made based on their expected release and their hazard properties.

Sampling methods/monitoring time

There are 3 major ways of sampling and monitoring: instantaneous, continuous and time-average measurements. Depending on the phase of the fire and the purpose of the measurement (what information do you want to collect), one or more these ways can be used.

Instantaneous monitoring gives a rapid indication of the possible health threats. Monitoring instruments are often fast and easy to use and can be used by fire fighters who arrive at the place of the incident at an early stage. However, instantaneous measurements are less accurate than measurements with longer sample times.

Continuous and time-average measurements are used to calculate average concentrations over a certain time period. Time-average measurements are often taken on a medium like a filter, impinger or absorption tube. The sample time depends on the flow of the equipment that is used and the concentration of the substances to measure. Several samplers can be used simultaneously to get a better view on the distribution of the exposure.

Continuous measurements can detect concentration peaks and changes in concentrations, for example because of changing conditions of the fire or the wind. This can be useful when brief peaks of concentrations of toxic substances are expected. For more chronic exposures, a time-average sample should be used. Several sampling/monitoring methods can be used simultaneously to get a complete view of the possible hazards (such as safety monitoring e.g. the lower explosive limit of gases).

3) Smouldering Phase

Whereas in the acute phase, monitoring and sampling should be quick, simple and direct, in the smouldering phase (when the direct fire is under control but not necessarily extinguished), additional samples can be taken for more thorough analysis, if specific substances are expected to be released. During the smouldering phase, the amount of smoke ascending is often less. Furthermore, due to less oxygen supply and therefore worse burning conditions, high concentrations of hazardous compounds (at breathing level) can be expected (8). VOCs and inorganic substances can be measured with a handheld device. Deposition samples taken during the smouldering phase are analysed in the lab, results are available at a later date.

4) Post incident

Sampling can be stopped when either the fire has stopped, when sufficient data has been collected for a risk assessment or when there are no more health risks to be expected. However, during the last phase of a fire, dust samples, soil samples and samples from grass/crops can be taken to identify the amount and spread of deposition, for possible latent health risks. Results can give an indication about whether crops are safe for consumption or if grass is safe for consumption for livestock. In most cases, these samples are analysed for the same substances as the air samples. Sample time is less relevant for these monitoring samples. For more information see the SOP about Recovery.

Overview of different techniques

Table 1 gives a general overview of different techniques that can be used either for detection, sampling or analysis. Depending on the situation and the phase of the fire, the method that best fits the situation can be chosen.

Table 1: Overview of equipment

Detection equipment	Name	Components	Matrix	Phase	Remarks
1	Dosimeter	γ- and x-ray	air	Acute/ smouldering	PPE, not for detection
2	Detection meter	α-, β- en γ-radiation	air	Acute/ smouldering	Handheld for radiation detection
3	Detection paper	pH of hydrogen fluoride (HF)	liquid	Acute/ smouldering	Indicative measurement
4	Gas monitor	HF, hydrogen chloride (HCl)	air	Acute/ smouldering	
5	E-Nose	VOC`s, methane and inorganic odour	air	Acute/ smouldering	Indicative measurement

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		components like ammonia or hydrogen sulphide			
6	Photo Ionisation Detector (PID)	Total VOC, benzene	air	Acute/ smouldering	
7	Mercury monitor	Mercury	air/dust/ liquid	Acute/ smouldering	
8	Gas detector with electrochemical cells	carbon dioxide, carbon monoxide, nitrogen oxide, hydrogen sulphide, phosphine, sulphur dioxide, nitrogen dioxide, chlorine, hydrogen cyanide and ammonia	air	Acute/ smouldering	Different sensors available for different components
9	Chemical warfare agent (CWA) monitor	CWA agents	air	Acute/ smouldering	Handheld
10	Dust monitor	particulate matter	air	Acute/ smouldering	Handheld
11	Fourier-Transform Infa-red Spectroscopy (FTIR)	identificatio n	solids/ liquids		Handheld
12	Raman spectroscopy	identificatio n	Solids/ liquids		Handheld
Sample equipment					
1	Tedlar bags	VOC`s	air	Acute/ smouldering	short shelf life/requires lab analysis
2	Canister	VOC`s	air	Acute/ smouldering	used for timed sampling/requires lab analysis

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3	Thermal desorption tubes	VOC`s	air	Acute/ smouldering	used for low concentrations/ requires lab analysis
4	Carbon tubes	VOC`s	air	Acute/ smouldering	used for timed sampling/requires lab analysis
5	Badge/passive sampler	VOC`s	air	Acute/ smouldering	Less accurate
6	Medium/High volume sampler (MVS/HVS)	particulate matter, Cl, PAH`s, Dioxins, heavy metals	air/dust	Acute/ smouldering	Filter sampling/for dust samples/requires lab analysis
7	Cotton Wool	Elements, PAH`s, dioxins	dust	post incident	deposition samples
8	Scissors	Elements, PAH`s, dioxins	other	post incident	grass samples
9	auger	various components	soil	post incident	soil samples
10	Water sampler	various components	water	post incident	water samples
Analysing equipment					
1	spectrometer X-Ray Fluorescence (XRF)	Elements	solids/ liquids		
2	Gas Chromatopgraphy -Mass Spectrometry (GC-MS)	VOC`s	air/ liquids		

Table 2: Step by step guide for sampling and detection

Phase	Steps to take
Preparation phase	Compose a sampling strategy with relevant information
	Compose an analysis strategy with relevant information
	Make sure that there are sufficient supplies and equipment at the correct locations

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	Keep protocols up-to-date
	Make sure personnel is well trained
Acute phase (during the fire)	Collect information about the incident based on the expected environment and health risks
	Decide if sampling is required and to what extent
	If sampling is required use the sampling and analysis strategy to set up an tailor-made sampling and analysis plan
	Important aspects for the sampling plan are: location, substances to measure and sampling time.
	Location: is based on the spread of hazardous substances in the area (weather conditions)
	Substances: depending on what is expected, in general: try to measure as many substances as possible
	Sampling time: depending on what information should be collected
Smouldering phase	See acute phase
	Additional samples can be taken for more specific analysis
	Option to take deposition samples
Post-incident/monitoring	Deposition samples of dust/soil/grass/crops can be taken

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Annex 6: SOP - Recovery from a chemical incident

SHARP JA WP9 - SOPs

Recovery from a Chemical Incident

Tom Gaulton

Background Information

Recovery is defined as the process of rebuilding, restoring and rehabilitating the community following an emergency. There are no exact boundaries between the emergency response to an incident and the recovery and remediation phase, as the latter usually lasts as long as the effects of the incident can be expected to persist and continues until the area is returned to normal living. It is vital therefore that decisions and actions taken during the acute or emergency response phase considers an early return to normal living and facilitate recovery, remediation and rehabilitating the community following an emergency to return to normal.

Remediation, recovery or decontamination of the environment is the process of removing, neutralising or limiting exposure to a hazardous substance from: structures, articles and equipment; the environment and people following exposure to that substance. Understanding the issues associated with recovery of inhabited areas (urban or rural areas and different surface types), food production systems and water environments (public or private drinking water supply, recreational waters) has underpinned a series of Recovery Handbooks developed by Public Health England (now UK Health Security Agency, UKHSA) for Chemical, Biological and Radiation (CBR) Incidents.

Recovery Handbooks

The Recovery Handbooks have evaluated the evidence base for recovery options that should be considered following a CBR incident or accident, reviewing and examining historical and recent CBR incidents that have required remediation in order to gain a better understanding of:

- What procedures and protocols (recovery options) are used for decontamination, remediation and recovery
- Problems or constraints associated with the implemented recovery options

Including:

  - public health/ health protection (including psychological effects)
  - technical (i.e. specialist equipment)
  - waste
  - social (i.e. disruption)
  - cost

The Chemical, Radiation and Biological recovery handbooks are aimed at national and local authorities, central government departments and agencies, environmental and health protection experts, emergency services, industry and others who may be involved in developing a recovery strategy following a CBR incident. The handbooks focus on environmental decontamination and provide guidance and checklists on how to manage the recovery associated aspects of CBR incidents.

The Recovery Handbooks are all similar (to aid user operability) and contain scientific and technical information on different procedures and protocols (recovery options) for decontamination, remediation and recovery. The Handbooks are based on an extensive evaluation of the evidence base for all recommended recovery options and an analysis of the factors influencing recovery. The Handbooks also contain a compendia of comprehensive recovery option sheets; guidance on planning in advance of an incident; decision-aiding frameworks for each environment, decision trees; look-up tables and several worked examples. Sources of CBR release considered in the Recovery Handbooks include industrial accidents and can be applied to deliberate release. The Handbooks can be used as preparatory tools, under non-crisis conditions to engage stakeholders and to develop local and regional plans. It is recommended that the Recovery Handbooks are used as part of the decision-making process in developing a recovery strategy following an incident. In addition, the Handbooks may be useful for training purposes and during emergency exercises.

Steps to consider when developing a recovery strategy (using the Recovery Handbooks) include;

Table 1: Steps for developing a recovery strategy

1	Obtain information relevant to the incident, identify environment/area contaminated and properties of the contaminant
2	Identify potentially applicable recovery options for the contaminated environment/areas/ surface type. Some options can be eliminated at this stage based on common sense (i.e. snow and ice removal is a recovery option that wouldn't necessarily be applicable during summertime)
3	Consider applicability of options for the contaminant in the affected environment/ surface type. Some recovery options may be eliminated at this stage if they are applicable for persistent contaminants (years) and the agent involved in the incident has a short persistence (days).
4	Consider key considerations and constraints. Some recovery options may be eliminated during this step if the constraints outweigh the benefits of implementing the option.
5	Consider effectiveness of options. Some recovery options may be eliminated during this step if there is limited efficacy for the agent involved.
6	Consider detailed information on remaining options, including information on waste produced. Some recovery options may be eliminated at this step as the generation of waste is an important factor to consider. The potential volume of waste produced by implementing a recovery option needs to be carefully considered as disposal and treatment of the contaminated waste would also incur costs. Volumes of waste produced by implementing a recovery option would need to be considered carefully as disposal and treatment of contaminated waste will also incur costs.
7	Consider all information in the recovery options datasheet and determine if the recovery option is still applicable (on a site and incident specific basis)
8	Select and combine options to develop recovery strategy
Steps 4-6 are combined in the decision-aiding framework for the Chemical and Biological recovery handbooks.	

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Steps 4-6 are combined in the decision-aiding framework for the Chemical and Biological recovery handbooks.

Interactive support tools for Recovery

To complement the Recovery Handbooks, interactive support tools (for chemical and radiation incidents) have been developed to help with the decision-making process for developing a recovery strategy. Guidance and templates for recording and reporting decisions on recovery are also available. These resources are intended to assist the recovery working group in their evaluation of recovery options (remediation techniques) that are likely to be the most appropriate, applicable and effective on a site- and incident-specific basis:

- chemical recovery navigation tool
- chemical recovery record form
- radiation recovery navigation tool (Inhabited areas; Food; Drinking water)
- radiation recovery record form
- e-learning module: principles of recovery and remediation
- guidance on recovery after a chemical, biological or radiation (CBRN) incident, including HazMat

References

1. The UK Recovery Handbook for Chemical Incidents (https://www.gov.uk/government/publications/uk-recovery-handbook-for-chemical-incidents-and-associated-publications)
2. The UK Recovery Handbook for Radiation Incidents

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(https://www.gov.uk/government/publications/uk-recovery-handbook-for-radiation-incidents-and-associated-publications)

3. The UK Recovery Handbook for Biological incidents (https://www.gov.uk/government/publications/uk-recovery-handbook-for-biological-incidents)

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