



Post-Emergency, Multi-Hazard Health Risk Assessment in Chemical Disasters PEC

Deliverable D. E. 3

Guidelines For Mitigation Of Population Exposure



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1 INTRODUCTION

1.1 Background

Chemicals are essential to sustain as well as development of man's life. (PAN American Health Organization , 1984). However, apart from their intended purposes, many chemicals also have unintended adverse consequences for human health and the environment. Thus, the production, use and disposal of chemical substances are accompanied by “negative effects” expressed as human and environmental risks.

These risks legitimate and sometimes require government action to ensure human and environmental protection. For risk management purposes, basic information is needed about hazards and exposures to potentially harmful substances. The acquisition of sufficient knowledge concerning negative effects is necessary to assess and manage risks. Adequate means are also required to force producers and manufacturers to reduce risks in a cost-effective way by adopting or developing better safety measures that improve the production process or substitute less- or non-hazardous substances by safer alternatives.

Due to the existence of externalities of chemical production, use, and disposal, informational tools alone, without complementary remediating measures, are not expected to achieve an internalization of these adverse effects by the firms. Often, additional needed regulatory measures are not likely to be created or enforced, and informational tools can at most only partially mitigate the problems connected with chemicals hazards and risks.

On the other hand, literature review has shown that the exposure to toxic chemicals represents an important public health problem worldwide (WHO, 2000). According to a WHO estimate (WHO, 2000), unintentional poisonings led to 300,000 deaths in the year 2000 and over 70,000 deaths occurred in children up to 14 years old. Large number of people are injured or die each year as a result of exposure to both man-made chemicals and naturally occurring toxins (OECD, 2009). The International Federation of the Red Cross has estimated that between 1998 and 2007, there were nearly 3,200 technological disasters with approximately 100,000 people killed and nearly 2 million people affected (IFRC, 2009). The lack of knowledge, wrong or risky activities such as: miss-perception, miss understanding, purposely being ignorant or miss handling, etc., of toxic chemicals after the chemical disaster, often aggregates to the high health risk of the community (OECD, 2009).

To mitigate the toxic release risk, the overall encompassing policies with guidelines and recommendations are required. It is observed that mitigation activities were completely focused on the technical or operational activities like: using alternative less hazardous chemical in production, neglecting the ‘the public’ (Koch, 2006). But over the last decade a clear recognition was observed that, for practical, political and moral reasons, the argument for involving ‘the public’ within the realm of major hazard regulation is a strong one. Not only do those at risk ‘beyond the boundary fence’ need to know how best to protect themselves in the event of an accident, they also have a right to know that they are at risk, and a potentially powerful voice in a society increasingly conscious of risk and its spatial and social distribution.

Seveso Directive has also acknowledged “include the public” section in various ways (Walker,



1999). The provisions it contains build on experience with the original Seveso Directive, as well as reflecting the broader evolution of relationships between government, industry and public in the handling of risk problems. In part, the Seveso view of ‘the public’ revolves around ‘need to know’ communication about emergency action—but ‘right to know’ access to information and rights of participation in decision-making and planning.

The well drafted¹ policies², law³, rules, guidelines⁴, and recommendations, are the best tool to curb the emission of the toxic chemicals into environment and thus reduces health risk (WHO, 2017).

This report focuses on providing practical recommendations to reduce/mitigate population exposure after an industrial disaster releasing toxic substances. Given their general nature the recommendations proposed are applicable to a wide variety of chemicals including the forty-eight toxic substances and mixtures covered by the Seveso III Directive⁵.

The mitigation guidelines curbs the exposure through: reducing the pollution at source, periodic and constant monitoring the release of toxic substances into environment, educating and informing the nearby communities about the possible health risks (short and long term), increasing the spreading of awareness about how to response to disasters, basic do’s and don’ts in chemical disaster situations, etc. Such strict policies make responsible authorities liable to reduce health risk by under taking various required mitigation actions including, not to cross the approved level of the thresholds, wellbeing of the nearby community, etc.

In the final section of the report specific recommendations to reduce/mitigate exposure to the four chemicals addressed in the PEC project (benzene, acrylonitrile, cadmium and arsenic) are provided.

The proper knowledge of exposure and mitigation will enable us to provide apt guidelines and recommendations. Hence, this report further provides the information on: a) recommendations to authority including public (government) and industry about how to prevent the exposure, b) mitigative actions including ‘what to-do’ in disaster situations, preventive measures to take, and c) basic first aid, response, decontamination information specifically regarding to the toxic chemical agents.

1.2 Exposure

Exposure science is intended to advance the knowledge of the mechanisms and dynamics of events that result in adverse health outcomes, either to understand their cause(s) or to prevent them (Barr, 2006). Exposure science describes the environment, the behavior of agents in the environment, the characteristics and activities of human receptors and the processes that lead to contact and uptake of agents by humans. Exposure science uses this information to describe conditions in the real world that will lead to human health risks. It provides the scientific knowledge, methods, data and tools

¹ Such policies where specifically points out not only the aims, goals, but also suggests the actions through which the aim can be achieved and it is updated, evaluated periodically.

² a course or principle of action adopted or proposed by an organization or individual.

³ the system of rules which a particular country or community recognizes as regulating the actions of its members and which it may enforce by the imposition of penalties.

⁴ a general rule, principle, or piece of advice.

⁵ <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0018>



for developing current, prospective and retrospective exposure assessments that link exposure to health outcomes and evaluate various options to manage exposures effectively (NRC, 2012). Toxic chemical agents can get into human body through the four routes: inhalation⁶, skin (or eye) absorption⁷, ingestion⁸, and injection⁹ (Levitt, 2015).

1.3 Mitigation

Risk mitigation is defined as taking steps to reduce adverse effects containing a continuous cycle of prevention, preparation, response and lesson learned stages (Figure 1).



Figure 1 Continuous improvement cycle

Coordination and cooperation among the different stakeholders: government, political organization, INGOs, experts, academic, technical experts, economic, industries, corporate and community, is the prerequisite for mitigating health risk posed by toxic chemicals. Mitigating the health risk, can be achieved by taking right actions on right time. These mitigative actions are of: technical – this involves all actions to be taken at factory level where all technical arrangements are required, and social - where social side involves actions such as, education community, spreading awareness about safe chemicals thus promoting and practicing the safe culture, etc. As the aim, this report will only focus on the guidelines related to social type to mitigation exposure.

These guidelines were conceived for the study area of Priolo in Sicily, in the Province of Syracuse, Sicily (Italy). However, due to their general character these recommendations can be seamlessly transferred to other situations where a chemical accident causing the releases into the environment of toxic chemicals may occur.

⁶ chemicals in the form of vapors, gases, mists, or particulates, inhalation is the major route of entry.

⁷ Many chemicals can also cross the skin barrier and be absorbed into the blood system.

⁸ Chemicals that inadvertently get into the mouth and are swallowed do not generally harm the gastrointestinal tract itself unless they are irritating or corrosive

⁹ Substances may enter the body if the skin is penetrated or punctured by contaminated objects.



2 RECOMMENDATIONS FOR COMMUNITY AND AUTHORITIES

Community training and awareness is the key to mitigate the effects on human health posed by the toxic release. It is obvious that, communities which are educated and well trained¹⁰ in preventive actions, always led to the low human lives loss (Alderic 2009). If the community is more aware and takes responsibility of their own tasks, then, not only, the health risk but also deaths can be reduced. For example, in Bhopal gas accident, plant workers were well trained in the response actions knowing what exactly to do in the case of toxic gas release, so ensuing in less fatality as compared to community people. This example shows how training and educating the community is very important for mitigating the exposure and reducing or avoiding the possible health effects. Mitigating exposure involves: a) emergency preparedness including understanding the nature and forms of risk, b) emergency response by effectively responding to chemical disaster, and c) prevention; includes avoiding the future risk. It is important to remember that the mitigation strategies, which is explained below in detail, are applicable for a wide chemical space including the forty-eight chemicals and mixtures covered by the Seveso III Directive.

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The role of community in mitigation is of two ways: primary poison and secondary poison. Primary poisons prevention activities intervene before the event, that means the event has still not occurred aiming to prevent it from occurring, either by controlling the victim's access to the agent, controlling the action of an agent upon the victim, or controlling or changing hostile environmental factors. Primary prevention strategies may be active or passive. Active strategies are more focusing at changing the populations behavior, risk perceptions, etc., whereas passive strategies involve the identification of interventions - for both the structural and non-structural components - for risk mitigation of buildings and plants. For the aim of this report, only active strategies will be discussed in detailed further while passive actions are addressed by Deliverable D.E.2. Active Strategies seek to change attitudes, lifestyles and behaviors of individuals and groups, for example, by educating communities and individuals about poison awareness and safety practices, or campaigning for initiatives such as safer packaging, labelling and storage of chemical products may reduce the risk of the chemical hazards.

Secondary poisons prevention is the action taken after an exposure has occurred, to prevent the poisoning from progressing to a more serious, irreversible or chronic stage and to restore the victim to his/her former state of health. It includes the initial steps to minimize the effects of the toxic agent, the diagnosis, decontamination and first aid treatment, and specific antidote therapy. This may include educating both the community and professionals about how to recognize and manage poisonings and how to give first aid after a toxic exposure by, for example, washing the skin and eyes immediately after contamination by a pesticide.

2.1 General recommendations for Emergency Preparedness

As described above, emergency preparedness and sound emergency response, forms the core of mitigation activities. Effectively carved guidelines and recommendations will ensure the enforcement of such mitigation activities. It is needless to say that effective emergency preparedness can reduce the human lives loss and lessen the environmental damage. General

¹⁰ The community which understand its role and is always aspiring the chemical safety hence, actively, responsibly takes part in every level of exposure reduction tasks.



principles focusing on the emergency preparedness carved for authorities are given below.

- The roles and responsibilities of individuals and organizations expected to be involved in every stage of mitigation. Emergency response activities should be clearly defined in emergency plans.
- On- and off-site emergency plans should be reviewed regularly and kept up-to-date. All aspects of on-site and off-site emergency plans at all levels should be tested under simulated conditions, in conjunction with regular exercises based on the plans.
- As part of the emergency planning process, there should be an assessment of the types of emergency medical resources (including personnel, equipment, facilities, supplies and funds) needed to respond to different types of emergencies and the range of possible casualties.
- The availability of up-to-date antidotes, as well as other emergency pharmaceutical supplies necessary for the treatment of the number of persons.
- Hospitals and other treatment facilities, which may be called up on during response to an accident involving hazardous substances, should develop systems for receiving and handling large numbers of patients at one time.
- In case of scarcity of resources, consideration should be given to pooling of resources among neighboring communities and neighboring countries.
- As part of the planning process, information and communications needs should be examined. The parties who need information, and the types of information they require, should be identified. The emergency plan should provide for appropriate communication and coordination among all members of the response team.
- All information provided for emergency preparedness and response activities should be clear, concise, and geared to the audience to which it is addressed.
- Public authorities should ensure that designated information sources are available for use in regard to health/medical aspects of emergency planning and response.
- Networking among information centers/sources should be promoted and practiced.
- The emergency response personnel should acquaint themselves with the substances produced, used, transported or otherwise handled in significant quantities in their community.
- Industry should make available all resource inventory¹¹ of hazardous substances for emergency preparedness and response.
- Public health and education authorities should ensure that health/medical personnel involved in emergency response activities are well trained and educated.
- First responders (police, fire and ambulance personnel) should be trained and educated in effectively managing release of hazardous substances into environment.
- Management should ensure that everyone employed at a hazardous installation receives appropriate training and education on how to handle hazardous substances, on procedures to follow in order to avoid accidents occurring, and on actions to take, should an accident occurs.

¹¹ It includes information regarding health-related information concerning the hazardous substance(s) storages, handles, processes, manufactures and/or distributes, or which are otherwise used in the workplace.



- The effectiveness of training and education programmes should be regularly assessed. As part of this process, simulation exercises should be carried out to test the competency of those likely to be involved in accident response.

2.2 General Principles for emergency response

It is impossible to avert all the risk and stopping disasters to occurs. However, what can and should be done is to reduce the after effects of any disasters. Hence, despite of preparedness, it is extremely important to get prepared to face the disasters. Thus developing effective emergency response guidelines becomes mandatory for industry authorities. The following guidelines has laid down assuming that disaster has occurred (i.e. ‘during’ phase of disaster). In case of disasters, the following types of information should be collated, disseminated and updated regularly:

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- the nature of the incident
- the hazardous substances involved and their physical/chemical properties
- the potential severity of the incident
- the incident’s potential off-site effects
- risk possibilities at the accident site
- personal protection needs of emergency responders
- first aid possibilities and limitations
- the quantity and type of the hazardous substance(s) involved
- treatment facilities available for emergency response
 - i. means (ambulances, helicopters, etc.) of transporting victims from the site to treatment facilities
 - ii. medical information related to symptomology, delayed effects, specific treatments required, and decontamination resources that are available or that can be obtained rapidly (for example, pharmaceutical supplies, decontamination and hospital facilities, additional medical staff, biological monitoring services, laboratory facilities, and information sources)
 - iii. the registration and triage system being used
- identification of the hazardous substance(s) involved or, if this information is unavailable, of the category of substance(s) involved, together with information on the associated health end-points and symptoms and the best treatment approach
- the expected number and type of patients, the nature of their injuries, and the severity of exposure.

2.3 General Safety Principles for communities/people

The safety principles targeted towards the communities are given below. These principles emphasis on the role of community in the mitigation activities. It is expected that communities should put these principles to practice in order to reduce the health risks posed by chemical accidents. Some of these principles are given below followed by the recommendations.



- **Be aware of the risks in your community and know what to do in the event of an accident.** Members of communities should make sure that they understand the risks they face and what to do in the event of an accident to mitigate possible adverse effects on health, the environment and property. This involves reading and maintaining any information they receive, sharing this information with others in their household, and seeking additional information as appropriate.
- **Participate in decision-making relating to hazardous installations.** The laws in many communities provide opportunities for members of the public to participate in decision-making related to hazardous installations, for example by commenting on proposed regulations or zoning decisions, or providing input for procedures concerning licensing or siting of specific installations.
- **Co-operate with local authorities, and industry, in emergency planning and response.** Representatives of the community should take advantage of opportunities to provide input into the emergency planning process, both with respect to on-site and off-site plans. In addition, members of the public should co-operate with any tests or exercises of emergency plans, following directions and providing feedback, as appropriate.

2.4 Recommendations for the population

This section of the chapter gives the detailed information about what exactly to do before, during and after the disaster situations followed by the evacuation and decontamination, if required.

2.4.1 Recommendations for community in pre-disaster situation

- Know the sound of the chemical alarm siren, the instructions to be followed and the action to be taken.
- Know and follow the post disaster safety instructions to avoid further exposure.
- Prepare and have at hand an emergency kit for the family in case evacuation becomes necessary and also reserves of water and food to last throughout the period, which could last several days, during which you have to remain confined at home.
- Plan and organize your confinement in hermetically sealed premises. This, especially for those living in the vicinity of the chemical plant.
- Actively participate in the decision making with authorities.
- Learn and educate yourself about the disaster management plan, contingencies plan.
- Know about the various chemical signs and act accordingly
- Inform authority in any suspicious chemical leak as early possible.
- Partake in every training and awareness program conducted by local public authority or plant authority.
- Every family should keep a family emergency kit ready (see Figure 2).



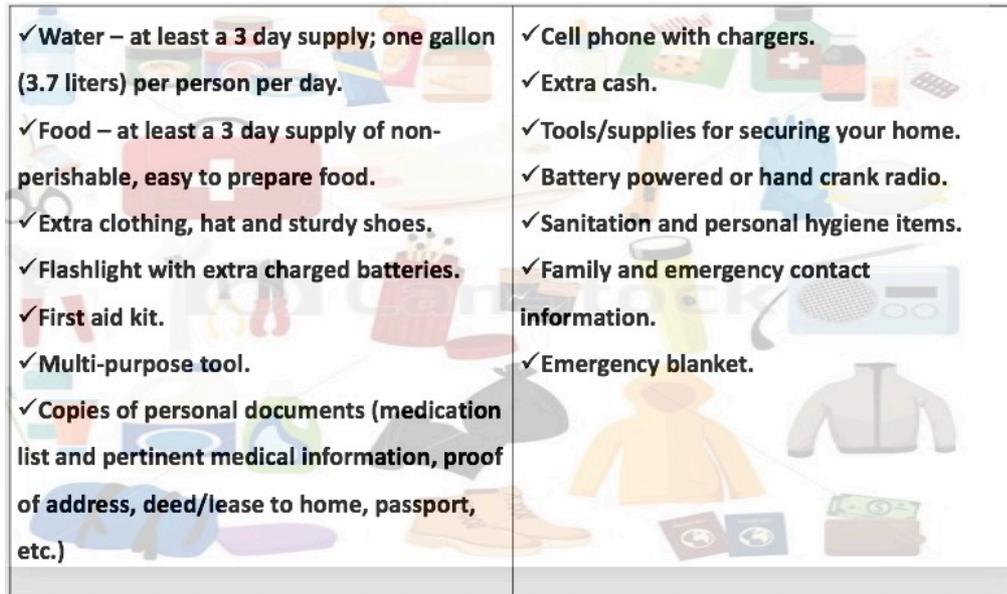


Figure 2 Family Emergency Kit

2.4.2 Recommendations for populations during the disaster

- Keep calm and do not panic.
- Listen to the radio, television and social media and follow official instructions. Inform your neighbors, especially the elderly and disadvantaged persons and assist them.
- Stay inside, if at home, or shelter in a building and close all doors and windows.
- Seal all exterior openings and turn off the ventilation, air conditioning and heating.
- Protect your mouth and nose, if in the open, with a wet cloth or a protective mask.
- Shelter in the nearest building and remain inside until otherwise instructed by the authorities.
- Do not use telephone unless absolutely necessary as this overloads the telephonic communication system.
- Follow the orders of the civil protection, fire service, police or other intervening services.
- Eat only food stored inside a building, such as tinned food and preserves.
- Drink water only from bottles or cartons.
- Follow the instructions on the use of tap water.
- If you are in a car, turn off the ventilation and close the windows. Listen to the radio and shelter in the nearest building. Follow the instructions of the authorities. If in public transport, follow the crew's instructions.

2.4.3 Recommendations for community people after the disaster occurs

- After the accidental release stay inside home.
- Cover the nose and mouth with clean cloth or even shirt, t-shirt, which is readily available.
- Listen to the announcement made by the local authorities or chemical plant authority.
- Follow the instructions given by authority immediately.



- Know do's and don'ts beforehand.
- Know your shelter place.
- Know your evacuation route very well.
- Make sure shelter place will be easily accessible to all.
- Don't come out of the building unless asked to do so.
- Follow all instructions given by authority in terms of food, water and any other materials.
- Act as mentioned in offsite chemical disaster management plan beforehand.
- Should have family communication plan ready.
- Active cooperation is necessary.

2.4.4 Recommendations for in-place sheltering/evacuation

Many times, the industrial hazards need the evacuation in which the community's participation is very important. There are also guidelines about how to do evacuations properly and effectively. In such cases, the following actions need to be taken into consideration. An accidental release of hazardous chemical sometimes necessitates evacuation of people from certain areas to prevent injury or death. These areas can include those directly affected by toxic fumes and gases or fire and those areas that may be potentially affected during the course of the incident (e.g., through wind shift, a change in site conditions). Evacuation is a complex undertaking.

Decisions about whether or not to evacuate as well as about evacuation distances are incident-specific and must be made at the time of an actual release. When considering the safety of the population at risk, the authority in command must decide about ordering:

- in-place sheltering: remaining indoors and sheltering
- evacuation with the removal of the population from the at risk area

2.4.5 In-place sheltering guidelines (from community's perspectives)

- Close all doors to the outside and close and lock all windows. (windows seal better when locked). Seal gaps under door-ways and windows with wet towels and those around doorways and windows with duct tape or similar thick tape.
- Turn off all heating systems and air conditioners.
- Seal any gaps around window type air conditioners, bathroom exhaust fan grilles, range vents, dryer vents, etc. with tape and plastic sheeting, wax paper, or aluminum wrap.
- Turn off and cover all exhaust fans in kitchens, bathrooms, and other spaces.
- Block fireplaces or close fireplace dampers.
- Close as many internal doors as possible in homes or other buildings.
- If an outdoor explosion is possible, close drapes, curtains, and shades over windows.
- Stay away from windows to prevent potential injury from flying glass.
- If you suspect that the gas or vapor has entered the structure you are in, hold a wet cloth over your nose and mouth.
- Building superintendents should set all ventilation systems to 100 percent recirculation so that no outside air is drawn into the structure. Where this is not possible, ventilation systems should be turned off.



2.4.6 Evacuation with removal of population from the risk area guidelines (from community's perspectives)

- Follow instructions, guidance of authority promptly.
- Stay calm and don't panic.
- Help elderly, children towards the evacuation route or shelter.

2.5 Recommendations for Authorities and Chemical Industries

Besides educating community, reducing the release of toxic chemicals from the source is of utmost important. These type of recommendations are required to do for one time only such as, substituting highly hazardous chemical to less hazardous chemical. It automatically helps to reduce the exposure for plant workers and also for general populations. The detailed guidelines for public authority and industry authorities are given below.

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2.5.1 Recommendations for Chemical Industries

Any industry generally consists of: the management – the team and expertise who designs the plants and production etc. and the laborers who carried out the planned activities. The recommendations for management and workers are given below. Effective and precise implementation of these principles can lead to avoidance of chemical disasters.

2.5.2 Recommendations for Management

- **Know the hazards and risks at installations.** The hazard identification and risk assessment(s) needed for a complete understanding of the risks to employees, the public, the environment and property in the event of an accident and should be undertaken from the earliest stages of design and construction, throughout operation and maintenance, and should address all possibilities of occurring natural and man-made disasters.
- **Promote a “safety culture”** that is known and accepted throughout the enterprise. The safety culture, reflected in an enterprise's Safety Policy, consists of both an attitude that safety is a priority (e.g., accidents are preventable) and an appropriate infrastructure (e.g., policies and procedures).
- **Establish safety management systems and monitor/review their implementation.** Safety management systems for hazardous installations include using appropriate technology and processes, as well as establishing an effective organizational structure (e.g., operational procedures and practices, etc.)
- **Utilize “inherently safer technology” principles in designing and operating hazardous installations.** This should help reduce the likelihood of accidents and minimize the consequences of accidents that occur. For example, replacing hazardous substances with less hazardous ones; reducing operating pressures and/or temperatures; improving inventory control; and using simpler processes.



- **Prepare for any accidents that might occur.** It is important to recognize that it is not possible to totally eliminate the risk of an accident. Therefore, it is critical to have preparedness planning at place in order to minimize the effects on health, the environment including off-site planning
- **Assist others to carry out their respective roles and responsibilities.** The management should co-operate with all employees and their representatives, public authorities, local communities and other members of the public.
- **Seek continuous improvement.** Although it is not possible to eliminate all risks of accidents at hazardous installations, the goal should be to find improvements in technology, management systems, and staff skills in order to move closer toward the ultimate objective of zero accidents.

2.5.3 Recommendations for Workers

- **Act in accordance with the enterprise's safety culture, safety procedures, and training.** Labor should comply with all the procedures and practices relating to accident prevention, preparedness and response, in accordance with the training and instructions given by their employer.
- All employees (including contractors and sub-contractors) should report to their supervisor any situation that they believe could present a significant risk.
- **Make every effort to be informed, and to provide information and feedback to management.** In this regard, labor and their representatives should work together with management in the development and implementation of safety management systems, including procedures for ensuring adequate education and training/retraining of employees.
- **Be proactive in helping to inform and educate your community.** Fully informed and involved employees at a hazardous installation can act as important safety ambassadors within their community.

2.5.4 Recommendations for providing information to the community people

As emphasized above, providing correct, useful, easy information on correct time to people, is the key to minimize the public health risk posed by the toxic chemical release threat. Hence, 'what type of information public must know' (or Citizen's rights to know the risk and safety procedure) becomes utmost important. It is obvious that, the information given to the public should be: easy, relevant, concise, in local language, possibly with pictures, etc. This information can be given in various ways including internet (website), cultural program, public meetings etc. If any information is changed then the updated information has to communicated to public as early as possible. Below are some of the recommendations for authorities (public and chemical industry) suggested by the



COMAH regulations (HSE, 2015).

- a. the name of the operator and the address of the establishment;
- b. an explanation in simple terms of the activity or activities undertaken at the establishment;
- c. the hazard classification of the relevant dangerous substances involved at the establishment which could give rise to a major accident, with an indication of their principal dangerous characteristics in simple terms;
- d. general information about how the public will be warned, if necessary, and adequate information about the appropriate behaviour in the event of a major accident or an indication of where that information can be accessed electronically;
- e. the date of the last site visit carried out further to a programme for routine inspections under regulation 25(5), and where more detailed information about the inspection and the related inspection plan can be obtained upon request;
- f. details of where further relevant information can be obtained;
- g. irrespective of the request to provide information from people, the authority should provide the all relevant information.
- h. the information should be given on the reasonable period and time and not on the last moment.
- i. general information relating to the nature of the major accident hazards, including their potential consequences on human health and the environment, summary details of the main types of major accident scenarios and the control measures to address them;
- j. confirmation that the operator is required to make adequate arrangements within the establishment, in particular liaison with the emergency services, to deal with major accidents and to minimize their consequences;
- k. appropriate information from the external emergency plan in relation to dealing with any consequences outside the establishment from a major accident which must include advice about co-operating with any instructions or requests from the emergency services at the time of an accident;

2.5.5 Recommendations for Public Authorities

Seek to develop, enforce and continuously improve policies, regulations, and practices. It is important for public authorities to establish policies, regulations and practices, and have mechanisms in place to ensure their enforcement and regularly review and update, as appropriate, policies, regulations, and practices.

Provide leadership to motivate all stakeholders to fulfill their roles and responsibilities. In this regard, the authorities should establish and enforce appropriate regulatory regimes, promote voluntary initiatives, and establish mechanisms to facilitate education and information exchange.

Monitor the industry to help ensure that risks are properly addressed. Public authorities should establish mechanisms for monitoring hazardous installations to help ensure that all relevant laws and regulations are being followed, and that the elements of a safety management system are in



place and are functioning properly, taking into account the nature of the risks at the installations.

Help ensure that there is effective communication and co-operation among stakeholders.

Public authorities have an important role: a) in ensuring that appropriate information is provided to, and received by, all relevant stakeholders, b) in facilitating education of the public concerning chemical risks and what to do in the event of an accident.

Promote inter-agency co-ordination. Chemical accident prevention, preparedness and response is, by nature, an inter-disciplinary activity involving authorities in different sectors and at different levels.

Know the risks within your sphere of responsibility, and plan appropriately. Public authorities are responsible for off-site emergency planning, taking into account the relevant on-site plans. In addition, public authorities should ensure that the resources necessary for response (e.g., expertise, information, equipment, medical facilities, finances) are available.

Mitigate the effects of accidents through appropriate response measures. Public authorities (often at the local level) have primary responsibility for ensuring response to accidents that have off-site consequences, to help reduce deaths and injuries, and to protect the environment and property.

Establish appropriate and coherent land-use planning policies and arrangements. Land-use planning¹² can help to ensure that installations are appropriately located, with respect to protection of health, environment and property, in the event of an accident. It can also help to prevent the inappropriate placing of new developments near hazardous installations.

2.5.6 Recommendations for Public authorities during the disasters

When an accident involving chemical substances that could endanger life or the environment occurs in a chemical works or installation, those in charge of it should immediately take the following planned measures:

- Deal with the causes of the accident and implement the safety measures which will minimize its consequences.
- Immediately inform the relevant local authorities of the accident.
- The local or regional authorities of the area in which the installation is located are responsible for informing the public, sounding the alarm if need be, and deciding upon the instructions to be followed by the population. The local or regional governing body ensures the coordinated use of the civil and military means required to deal with the disaster.

2.5.7 Guidelines for Chemical Industry regarding incident command during the disasters

This section reports the detailed guidelines for industry authority about what and how to do if disaster occurs. Properly following these guidelines will surely reduce not only the deaths but also the after effects of disaster.

¹² establishing and implementing both general zoning as well as specific siting of hazardous installations and other developments



1. Establish Incident Command System.
2. Approach hazard site with caution. Position personnel, vehicles, and command post at a safe distance upwind and uphill of the site, if possible.
3. Ensure safety of responders.
 - a. Identify all hazards (danger of fire, explosion, toxic fumes, electrical hazards, structural collapse, etc.).
 - b. Obtain information concerning the chemicals from placards, labels, shipping documents, and other immediately available sources.
 - c. Keep upwind of smoke, fumes, etc.
 - d. Follow usual protocols for respiratory protection, use of protective clothing, etc.
 - e. Monitor changing conditions that could create hazardous situations.
4. Locate victims and facilitate extrication, emergency care, and transportation of the injured, following EMS¹³ guidelines. Do not delay rescue or transport of a seriously injured, contaminated patient.
5. Communications: Notify hospital of possible contamination/exposure of victim immediately.
6. Establish a control zone by;
 - a. Rerouting traffic.
 - b. Marking controlled area by use of ropes or tapes.
 - c. Limiting entry to rescue personnel only.
 - d. Ordering evacuation or sheltering as needed.
7. Prevent/fight fires as if toxic chemicals are involved.
8. Ensure contamination control.
 - a. Do not allow eating, drinking, smoking, or other activities within contaminated areas that might lead to intake of chemical.
 - b. Avoid direct contact with materials where possible. Utilize protective clothing and anything available for remote handling (shovels, branches, ropes, etc.).
 - c. Limit the time spending near chemicals. Rotate staff as necessary.
 - d. Evacuate personnel from the immediate downwind area. Detain personnel who were in the accident area until they can be decontaminated.
 - e. Wrap, label, and isolate all clothing, tools, etc., used in the controlled area and retain them until they can be decontaminated.
 - f. Determine if measures are needed to contain all accident debris in the control zone until clean-up is achieved. Prevent unnecessary handling of incident debris.

¹³ EMS –Emergency Medical Services guidelines regarding toxic release.



9. Documentation

- a. Record the names and addresses of all persons involved (including those who insist on leaving the area), rescuers, those removed for medical attention, and ambulance personnel.
- b. Make detailed records of the incident.

3 GUIDELINES FOR BENZENE, ACRYLONITRILE, ARSENIC AND CADMIUM

This chapter gives the guidelines for community and plant workers, related to four chemicals specifically addressed in the PEC project, namely: Benzene, Acrylonitrile, Arsenic and Cadmium.. These guidelines involve the response, first aid, decontamination, risk mitigation and education.

3.1 Response

If get in the exposure, immediately follow the following actions.

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Removing your clothing

- Quickly take off clothing.
- Any clothing that has to be pulled over the head should be cut off the body instead of pulled over the head.
- If you are helping other people remove their clothing, try to avoid touching any contaminated areas, and remove the clothing as quickly as possible.

Washing yourself

- As quickly as possible, wash your skin with large amounts of soap and water. Washing with soap and bottled water will help protect people from any chemicals on their bodies.
- If your eyes are burning or your vision is blurred, rinse your eyes with plain water for 10 to 15 minutes. If you wear contact lenses, remove them after washing your hands and put them with the contaminated clothing.
- Do not put the contacts back in your eyes (even if they are not disposable contacts).
- If you wear eyeglasses, wash them with soap and bottled water. You can put your eyeglasses back on after you wash them.

Disposing of your clothes

- After you have washed yourself, place your clothing inside a plastic bag. Avoid touching contaminated areas of the clothing. If you can't avoid touching contaminated areas, or you aren't sure where the contaminated areas are, wear rubber gloves or put the clothing in the bag using tongs, tool handles, sticks, or similar objects. Anything that touches the contaminated clothing should also be placed in the bag.
- Seal the bag, and then seal that bag inside another plastic bag. Disposing of your clothing in this way will help protect you and other people from any chemicals that might be on your clothes.
- When the local or state health department or emergency personnel arrive, tell them what you did with your clothes. The health department or emergency personnel will arrange for



further disposal. Do not handle the plastic bags yourself.

3.2 First Aid guidelines

First aid includes the following immediate procedures but not on the exposure sight but on the safe zone.

Eye Contact

- Immediately flush with large amounts of water for at least 15 minutes, lifting upper and lower lids. Remove contact lenses, if worn, while rinsing

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Skin Contact

- Quickly remove contaminated clothing. Immediately wash contaminated skin with large amounts of soap and water.

Inhalation

- Remove the person from exposure source (as far as possible).
- Begin rescue breathing (using universal precautions). If breathing has stopped then start CPR¹⁴.
- Transfer victim promptly to a medical facility.

3.3 Guidelines at Work Place

The OSHA Personal Protective Equipment Standard requires employers to determine the appropriate personal protective equipment for each hazard and to train employees on how and when to use protective equipment.

3.3.1 Personal Protective Equipment

Gloves and Clothing

Avoid skin contact with toxic substances . Wear personal protective equipment made from material which cannot be permeated or degraded by this substance. Safety equipment suppliers and manufacturers can provide recommendations on the most protective glove and clothing material for your operation.

Eye Protection

1. Wear indirect-vent, impact and splash resistant goggles when working with liquids.

¹⁴ CPR – Cardiopulmonary resuscitations. This is done when the person is not breathing by pressing hard till 1 to 1 ½ inch deep at sternum place for 15 times and giving 2 rescue breaths while closing the nose openings till the doctors arrived or till the automated external defibrillator (AED) arrives at the place.

2. Wear non-vented, impact resistant goggles when working with fumes, gases, or vapors.
3. Wear a face shield along with goggles when working with corrosive, highly irritating or toxic substances.
4. Do not wear contact lenses when working with toxic substances.

3.4 Family risk mitigation recommendations

This section explains ‘how’ families can reduce the exposure for the four chemicals below separately.

3.4.1 Benzene

- First, if benzene was released into the air, get fresh air by leaving the area where the benzene was released. Moving to an area with fresh air is a good way to reduce the possibility of having more serious health effect from exposure to benzene in the air.
 - If the benzene release was outside, move away from the area where the benzene was released.
 - If the benzene release was indoors, get out of the building.
- If near to source which is releasing benzene, emergency coordinators may tell to either evacuate the area or to “shelter in place” inside a building to avoid being exposed to the chemical, then follow the steps explained in the second chapter (see 2.3.4).
- If you think you may have been exposed to benzene, you should remove your clothing, rapidly wash your entire body with soap and water, and get medical care as quickly as possible.
- If you think your water supply may have benzene in it, drink bottled water until you are sure your water supply is safe.
- If someone has swallowed benzene, do not try to make them vomit or give them fluids to drink. Also, if you are sure the person has swallowed benzene, do not attempt CPR. Performing CPR on someone who has swallowed benzene may cause them to vomit. The vomit could be sucked into their lungs and damage their lungs.
- Seek medical attention right away.

3.4.2 Acrylonitrile

- Move away from source causing the release of acrylonitrile as early as possible.
- Wear appropriate personal protective clothing to prevent skin contact.
- Compressed gases may create low temperatures when they expand rapidly. Leaks and uses that allow rapid expansion may cause a frostbite hazard. Wear appropriate personal protective clothing to prevent the skin from becoming frozen.
- Wear appropriate eye protection to prevent eye contact.
- Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite
- do not drink tap water.
- drink the bottled water.
- in case of eye or skin contact, wash with plenty of water;
- report to company health centre for assessment of symptoms; and if necessary, transport



exposed person to nearest hospital for medical attention.

- If 'in-shelter' or evacuation is advised by emergency responders then follow actions prescribed in section 2.3.4.

3.4.3 Cadmium

Cadmium contamination can occur mainly from ingestion of contaminated food (e.g., crustaceans, organ meats, leafy vegetables, rice) or water (either from old Zn/Cd sealed water pipes or industrial pollution) and can produce long-term health effects. In order to reduce exposure to cadmium the following precautions need to be done.

- If you reside near the release source, then evacuating from the affected area is good option as water, food is contaminated.
- Check and obey local fishing advisories before consuming fish or shellfish from local waterways.
- Check and obey local advisories before consuming vegetables from local waterways.
- Avoid eating fish and vegetables from not recommended or hazardous waste sites.
- Cover your mouth with wet cloths (such as shirts etc.)
- Cover your eyes by glasses or any protection without limiting the vision.
- Limit contact with soil (for example, through use of a dense groundcover or thick lawn) to reduce exposure to arsenic
- Seek medical attention for eliminating the chances of pulmonary oedema even no symptoms have shown.
- Prevent toddlers/ children from playing outside so as to reduce the inadvertent ingestion of soil.
- Discourage your children from putting their hands in their mouths or engaging in other hand-to-mouth activities in case of soil contamination.
- Increase the intake of calcium salts, zinc and adequate supply of protein in diet as it helps to discharge cadmium from the body.
- Do not swipe the dust in the house, if possible use vacuum cleaner, as the cadmium particles will be absorbed after the cadmium release.
- Ventilation should be used in house and the aspired air should be vented outside to avoid producing dust.

3.4.4 Arsenic

Arsenic present in solid state naturally in soil thus contaminating crops and groundwater table. The exposure of arsenic is caused by two ways: the dust particles of arsenic enters into air and dissolving arsenic into the water. To mitigate the exposure to arsenic, people should follow the following actions.

- Drink only bottled water. If possible, identify and ensure nearby tube-wells or ground water which was used for drinking water that have water with a low arsenic content with Government's help.



- Use a water filter in each household which is easy to use, maintained and dispose.
- Use other chemicals to be used daily to remove arsenic from household drinking-water. Like, the small packet of chemicals that can be mixed in water and left to stand overnight is very cheap and is simple to transport.
- Use surface water sources that have been treated by filtration and chlorination as an alternative source of water for cooking.
- Install arsenic removal tools/equipment/systems which is based on absorption of arsenic and ensure the appropriate disposal of the removed arsenic.
- Use dust masks, gloves, and protective clothing at home in case of dust pollution.
- Remain inside the house in case of dust pollution.
- Limit contact with soil (for example, through use of a dense groundcover or thick lawn) to reduce exposure to arsenic.
- By paying careful attention to dust and soil control in the home (air filters, frequent cleaning), you can reduce family exposure to contaminated soil.
- Prevent toddlers/ children from playing outside so as to reduce the inadvertent ingestion of soil.
- Discourage your children from putting their hands in their mouths or engaging in other hand-to-mouth activities in case of soil contamination.
- Always store household chemicals in their original labelled containers; never store household chemicals in containers that children would find attractive to eat or drink from, such as old soda bottles.
- Keep your Poison Control Centre's number by the phone.



4 CONCLUSION

Effective, enforced and implementable guidelines are effective tools to reduce the health risk posed to the population by releases of toxic substances after chemical accidents.

In this context, the main aim of this report was to provide recommendations and guidelines to the local authorities, general population and chemical industry on how to mitigate population exposure to toxic chemicals in the aftermath of a chemical accident involving the release of considerable amount of a wide variety of toxic chemicals covered by the Seveso III Directive. The final section of the report focuses on the recommendations for the specific four chemicals addressed in the PEC project, namely Benzene, Arsenic, Acrylonitrile and Cadmium.

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The guidelines laid down in this report are mainly focusing on mitigating exposure through increasing the capabilities of not only the communities but also the local authorities, chemical industry and local NGOs to face chemical disasters by enhancing the understanding and the nature of existing risks, and equipping them by the techniques through which they can protect their and their family's lives effectively and sustain minimum loss.

The guidelines are focused on two main aspects: prevent the risk i.e. avoiding or minimizing the chemical disaster to occur and mitigate the exposure to toxic chemicals released from the chemical accident once it occurred.

Guidelines to avoid or reduce the risk of chemical disasters involve: a) guidelines and recommendations for emergency preparedness – to prepared fully beforehand of disasters to reduce the after-effects, b) emergency response – to respond disasters sustaining minimum human and environmental losses, c) role of people, government and industries in pre, during and after disaster phases– in this light the proposed guidelines provide clear suggestions to people, government and chemical industries about their roles and functions in responding a chemical disaster.

Emergency preparedness guidelines provide the recommendations of doing certain things before disaster occurs such as all resources should be checked and kept ready, all on site and off site plans needs to be updated and checked through conducting the regular and periodic mock drills¹⁵. Whereas emergency response guidelines give the information about the readiness of the procedures to be followed and of the actors involved.

Guidelines about the role of people gives the information about how people should behave in pre, during and past disaster situation to minimize the effects of the disasters. The recommendations related to the role of industries provide information about how the release of toxic substances can be reduced by using simple but effective methods, such as shifting from using high hazardous chemical to less hazardous chemical. Eventually, the guidelines related to the role of authorities give the information regarding how to keep control of emission of toxic substances into environment from the industries by regular monitor and ensuring the safety of the people and plant workers.

¹⁵ Mock Drills – are the exercises conducted by pretending that the disaster has occurred. This practical filed based exercise tests: a) how government, local ngo, industries etc. are prepared to face any chemical disasters, b) how community people are ready to cope with it, c) how different stakeholders, police, fire, local government coordinated and communicated with each others, etc. It gives the critical gaps observed during the exercise which later can be added into on site or off site plan.



The specific guidelines related to the four chemicals addressed on the PEC project explains the do's and don'ts after occurring the chemical disaster covering response, first aid and exposure mitigation for people/family issues. The guidelines regarding the response and first aid are similar for four chemicals but differs in exposure mitigation activities.

For volatile and high volatile compounds (including benzene and acrylonitrile) release will be mainly into the atmosphere. Toxic clouds can travel fast giving very limited time for people and even for local authorities to react and so endangering people to high exposure levels in a short term time frame. In this case guideline for exposure mitigation in the aftermath of the accident include recommendations to remain inside structure (house, office, etc.), close the doors, windows, air conditioning systems, cover the bottom of the doors and windows by wet clothes and moving to a safer place as soon as possible. Beside what mentioned above in such cases, people should: wear protective eye glasses, do not drink tap water unless otherwise told to do so, wash your clothes immediately and disposed them safely into the separate bag, untouched with other humans

Due to the different phys/chem and toxicokinetic properties people can be exposed to Arsenic and Cadmium through different exposure routes beside inhalation such as ingestion of contaminated food and drinking water as well as through dermal exposure to contaminated dust. Thus, recommendations for Arsenic and Cadmium exposure mitigation should include to follow advice to eat or not to eat fish or some types of fish and vegetables, to drink only bottled water to not to swipe the dust, as it will cause the dust particle to float into the air and thus get absorbed in human body (use instead vacuum cleaner), to discourage toddlers and children from putting their hands in their mouths or engaging in other hand-to-mouth activities.



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