Occupational Health Management

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About the Tutorial

A large number of safety and health concerns are now on the rise due to the existence of hazardous waste sites. The health hazards that evolve at these sites pose an alarming level of threat to the employees within an organisation.

In this tutorial, we will discuss the various aspects of the safety related to employees and their working environment in an organisation.

Audience

This tutorial is designed primarily for the Human Resource team and Managers, who want to understand how to provide safety and protection to their employees. It also throws light on how to create a safe and productive work environment for all the employees within an organisation.

Prerequisites

The readers of this tutorial are expected to have a basic understanding of the complexity of Employee Safety at workplace and the strategies for protecting the employees in the organisation.

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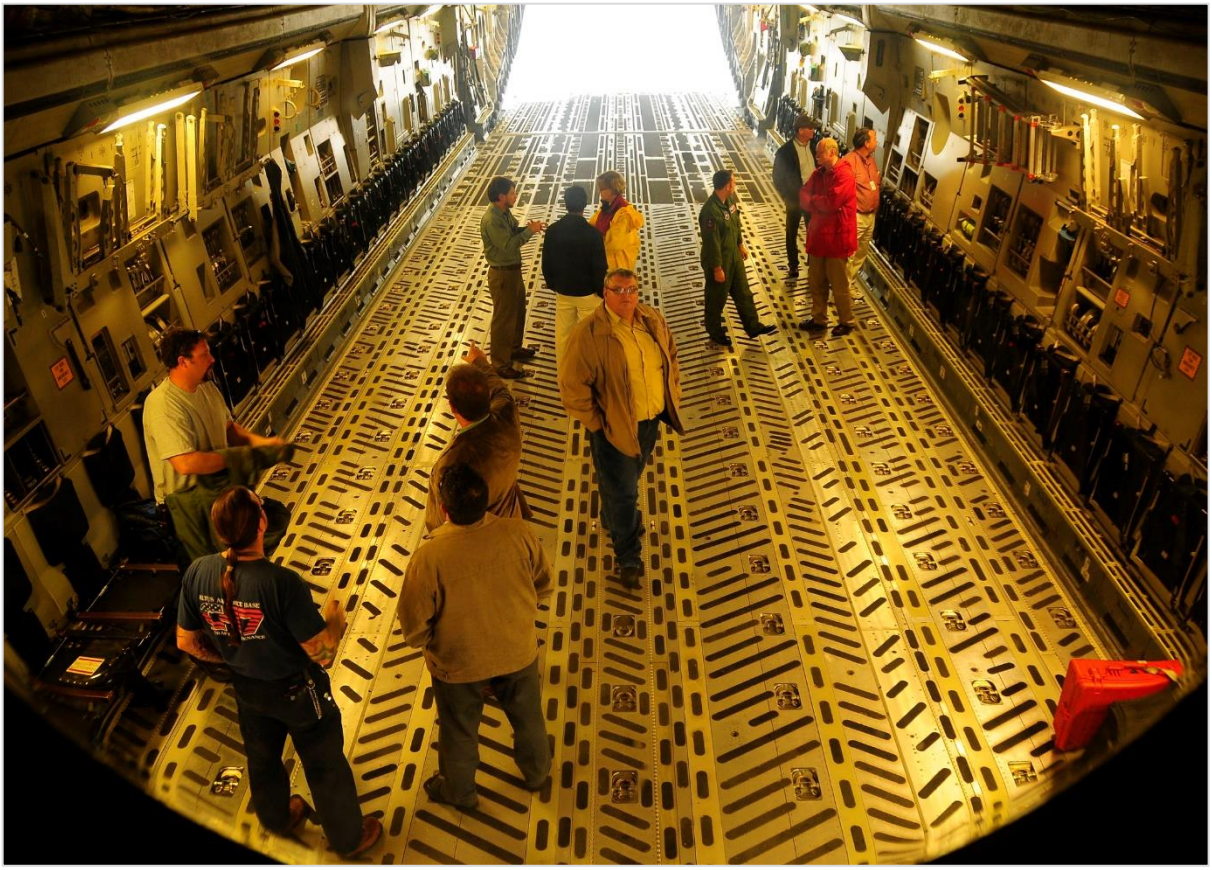
1. Occupational Health Management — Types of Hazards

A large number of safety and health concerns are now on the rise due to the existence of hazardous waste sites. The health hazards that evolve at these sites pose an alarming level of threat to the employees within an organisation. These hazards have a higher chance of manifesting into serious forms of injuries, and in some cases, death.



The level of these threats depend upon the nature of the work being executed within the premises of the site along with the very nature of the site. Some of these hazards may include:

- Exposure to Chemicals
- Threats concerning fire and explosion
- Deficiency of Oxygen
- Ionisation due to Radiation
- Biological Hazards
- Hazards concerning Safety
- Hazards caused due to Electricity

- Stress due to Heat
- Exposure to Cold
- Hazards due to Noise

Various factors differentiate other dangerous substances involved in an occupational workplace from a site possessing a hazardous surrounding. An uncontrolled site condition is definitely one of these major factors.

A few hazardous substances if not handled carefully may pose a threat to the humans working within those sites. On the contrary, inadequate control over the handling of these substances poses threat not just to the workers but also the public.

An array of different substances present in the site is another major factor that contributes to the concern within the hazardous setting. A single location might potentially contain hundreds or even thousands of chemicals at a certain moment of time.

Due to the vast number of substances that might have been present in a worksite, it is impossible to accurately assess all the chemical hazards with a higher frequency. Moreover, it is too difficult to even identify and trace every substance present within the area, specifically during the initial stages of the assessment.

Based on the inadequate information, a Project Team Leader will have no choice but, to **enforce protective measures** over his employees. Eventually, not only the hazards of direct exposure and the disoriented physical environment of the hazardous occupational site offer a threat to the workers, but also the stress of working while being clad in protective attire.

An amalgamation of the aforementioned situations creates a working environment that might pose an array of health hazards which;

- May offer an immediate threat to the health and the life of the employees.
- Maybe tough to identify.
- Maybe different for different locations within the site and the tasks that are undertaken.

- May change with the progression of the activities conducted within the site.

This chapter shows a glimpse of the general categories of hazards that might be held by the site. While pursuing a site, it is important to presume that all the hazards are already existent within the site, even before the site has properly been assessed.

Exposure to Chemicals

A comprehensive protection against all potential threats can be ensured by conducting a site health and safety program. This program may encompass all the various possible hazards along with the various ways to overcome them. It should be subjected to frequent updates for new information, as the condition within the site changes.

In a hazardous occupational site, it is a primary concern to avoid direct contact with toxic chemicals. Generally, a site might contain an excess of chemicals in solid, liquid, and gaseous states of matter. A vulnerable person is most likely to be contaminated by these substances due to breathing, skin absorption, ingestion, or the contact of the chemicals with any wounds on his body.

A contaminating substance can damage at the contact point or might go into the bloodstream of the contaminated person and toxify a remote organ of his body. The remote organ may not be close to the contact point.

Generally, chemical exposures are of the following two types:

- Acute Chemical Exposure
- Chronic Chemical Exposure

Acute chemical exposures generally start to show up symptoms immediately after the occurrence of the exposure, when a person interacts with an alarmingly high concentration of contaminants.

A chemical exposure is said to be chronic when a person is exposed to a low concentration of the contaminant, regularly for a relatively long period. The time required for these contaminants to exhibit symptoms depends on the number of exposures, the duration of each exposure, and the nature of the chemical itself.

For a specific contaminant, the symptoms shown in the case of an acute exposure might be very different from that of a chronic exposure. Whether chronic or acute, the aftermaths of an exposure might vary depending on the contaminant from being temporary and mild to being permanent fatal.

Some chemicals may lead to coughing, burning sensation, nausea, headaches, rashes, or teary eyes. Others might cause serious health issues without showing even the slightest bit of symptoms (mostly in case of chronic exposure).

These exposures have the potential to manifest into dangerously fatal diseases such as cancer, respiratory diseases, and ocular diseases, without showing any symptoms for several years. Moreover, there are certain toxic chemicals that are colourless, odourless, and untraceable by human senses.

These chemicals may affect the psychology, may dull the senses of a person, or might not show any symptoms at all immediately. This is why the senses of a worker cannot be relied upon to detect any potential toxic exposure.

Not only the nature of the chemicals exposed affect the nature of the exposure, but also the entrance point and the duration of the exposure play an important role in determining the degree of concern, the exposure raises. Moreover, it is also influenced by personal factors and habits such as smoking, alcoholism, medication, age, sex and nutrition levels.

Inhalation is the fastest route in the case of contamination in an occupational site. The chemical reagents lurking around such an environment pose an alarming threat to the lungs of the workers. Furthermore, the substances that might not be as harmful to the lungs might be transmitted to the other vulnerable parts of the body by mixing into the bloodstream.

The human sensory organs might not detect some chemicals, as they might be colourless as well as odourless. These chemicals might not show their symptoms immediately, but may exhibit toxic behaviour in the future.

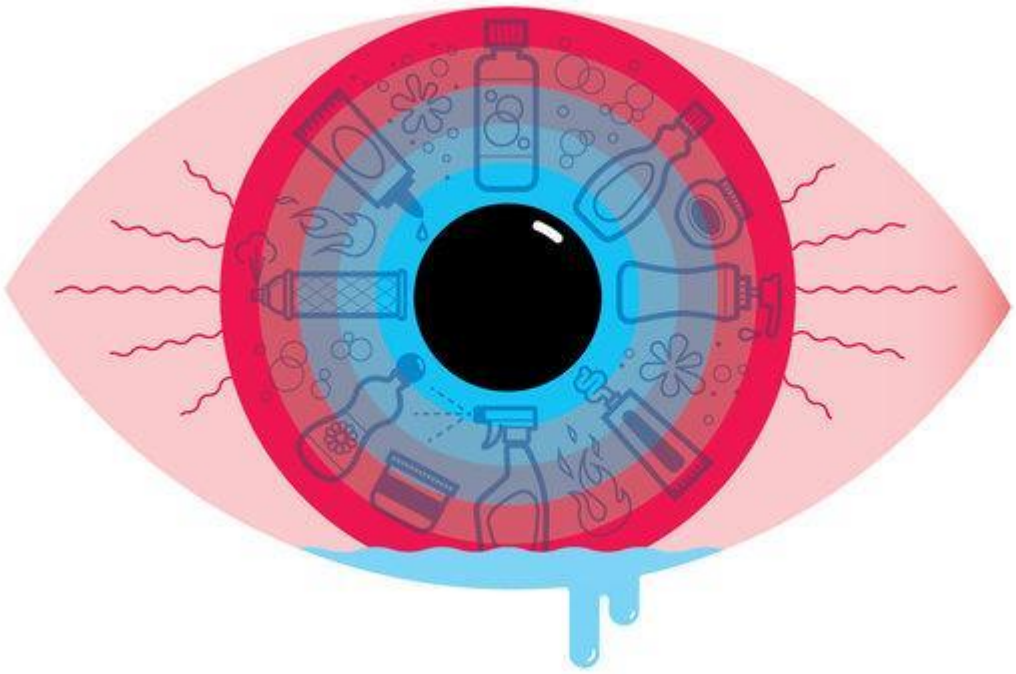
Therefore, it is very important to invoke respiratory protection measures in such environmental settings that might potentially contain certain hazardous contaminants in the atmosphere.

It might sound surreal, but, there is a high chance that contaminants in the atmosphere might find their way into the bloodstream of a person through a minor puncture in his eardrum. So, proper check-ups must be conducted for the workers with punctured eardrums before getting into such environments.

Other potential routes for contaminants for getting into the human body are the eyes and the skin. The human skin might absorb some contaminants; these can get into the bloodstream, eventually making their way into the vulnerable organs. Abrasion, moisture, and cuts on the skin accentuate the risk of contamination.

Other potential routes that help contaminants to get into the human body are the eyes and the skin. Some contaminants might get absorbed by the human skin and get into the bloodstream, eventually making their way into the vulnerable organs. Abrasion, moisture, and cuts on the skin accentuate the risk of contamination.

The eyes are another vulnerable track for the chemicals as it is easy for airborne chemicals to get absorbed by moist surfaces. The chemicals are dissolved by the enzymes present in the eyes and get into the bloodstream from there.



Hence, it is advised to wear protective eye gear, avoid skin contact, avoid contact lenses, and evade any chemical contact. This will significantly diminish the risk of any potential contaminants getting into the eyes.

Ingestion is another primary potential route for contaminants from getting into the bloodstream. Even though it might not seem as significant a route as compared to the other potential routes, however, it is very crucial to have a good comprehension of the cause of this kind of exposures.

Petty personal habits such as smoking, eating, drinking, chewing gum or tobacco, applying cosmetics in the worksite elevate the risk of being contaminated through ingestion. Therefore, it is recommended to maintain proper isolation in canteens from the work site's environment.

The final route for toxic chemicals to contaminate workers is by injection. This refers to the situation where the contaminants get into the bloodstream through punctures caused by wounds. To prevent this, a worker must wear safety shoes, avoid hazardous risks, and take adequate precautions based on his common sense.

Threats of Fire and Explosion in Waste Sites

The various potential causes of fires and explosions in waste sites include:

- Fire, explosion, and heat producing chemical reactions.
- Flammable chemicals that have the potential to ignite and explode.
- Unstable shock and friction responsive compounds.
- Released materials under pressure.

It may be too spontaneous for someone to foresee an explosion or a fire accident. However, such mishaps might occur due to various activities being carried out in the site such as mixing incompatible chemicals, introducing a fire or a spark into an inflammable substance, or mishandling containers of flammable substances.

The outbursts in a hazardous site, not only cause intense heat, smoke inhalation and airborne projectiles but also pose an immense threat to the outer environment. The fire hazards are as dangerous to the public outside, as for the workers working in the premises of the site.

Consider the following precautions to achieve proper protection against such hazards in occupational environments:

- Adequately qualified field monitors must be employed for monitoring fire hazards in a potentially flammable workplace.
- All materials that might potentially induce an ignition must be kept far away from the flammable environment.

- It should be ensured that all the equipment used within the site must be non-sparking and safe
- Implementation of safe practices must also be ensured while handling potentially flammable chemicals.

Deficiency of Oxygen

At sea level, the oxygen content of atmospheric air is about 21 per cent. When this percentage starts to drop below 16 per cent, the effects become distinctively apparent. Consider the following affects faced by a person due to a lack of Oxygen in the environment:

- A significant decline in the ability to judge, coordinate and pay attention
- Increased breathing rate
- Increased heart rate and heart damage
- Nausea
- Vomiting
- Unconsciousness
- Death

An oxygen concentration equal to 19.5 percent or lower, results in physiological changes such as errors in measurements. The primary reason behind oxygen deficiency is the displacement of oxygen due to the presence of other gasses, or the consumption of oxygen by the various chemical reactions in the worksite.

Confined spaces, in particular, are the areas most prone to oxygen deficiency. These places should be thoroughly monitored for the deficiency of oxygen every now and then.

Atmosphere-Supplying Respirators Equipment must be implemented by qualified professionals whenever oxygen concentration falls below 19.5 per cent by volume.

Ionisation due to Radiation

One or more of the following three harmful types of radiations are emitted by radioactive materials:

- Alpha radiation
- Beta radiation
- Gamma radiation

Alpha Radiation

Alpha radiations have a minimal ability to penetrate and can easily be stopped by clothes, but if alpha radiation inflicted materials are ingested, the situation might get fatal. Thus, although alpha radiations pose a very minimal threat to the human body, they must not be taken lightly and must be properly dealt with.

Beta Radiation

Beta radiation is capable of inflicting serious skin damage like rashes and burns and can damage the blood cells that are present just beneath the skin. Like alpha radiation, beta radiations are even more harmful if ingested or inhaled. The implementation of protective clothing, good personal hygiene, and adequate decontamination processes are advised to prevent beta radiation.

Gamma Radiation

Gamma radiations can easily pass through clothes as well as human tissues and are capable of inflicting serious permanent damage to the human body. Even chemical protecting clothing has little to no effect against gamma radiations. However, the implementation of proper respiratory equipment and other protective instruments can reduce gamma radiation damage significantly.

It is recommended to consult a physicist in the case the radiation level is discovered above that of the natural background. In case, the radiation level goes above 2 mrem/hr, all the activities must be shut down immediately and the premise must be evacuated. The premise must be closed until the physicists deem the site to be fine for reactivation.

Biological Hazards

Research facilities and hospitals generate wastes that might contain infectious organisms that are very hazardous for the personnel within a site. As in the case of chemical hazards, these harmful organisms might be traversed through the air, water, or food. Other dangerous biological substances that might be harmful to the employees within an organisation include:

- Insects
- Pathogens
- Poisonous Plants

The use of protective clothing and respiratory protection can immensely help in reducing the chances of contamination. Moreover, an already exposed body part or an equipment can be disinfected by implementing simple remedies like thorough washing and scrubbing.

Safety Hazards

Occupational sites might contain a plethora of hazards concerning safety such as;

- Ditches and holes
- Carelessly placed objects like drums, boards, barricades, or other objects
- Pointed and sharp objects like pieces of glass, nails, and metallic pieces
- Steeply elevated grades
- Slippery floors
- Uneven ground
- Unstable infrastructure such as fragile deteriorating walls, weathering ceilings, etcetera

There are some safety hazards that are caused due to the nature of the job that is undertaken. For instance, an additional hazard to the workers working with heavy equipment is created due to the weight of the equipment itself. Another example is the use of protective attire that might hinder a person's agility, eyesight, hearing, and smell, thus elevating the risk for an accident to occur.

The accidents that involve physical infliction may cause direct injury because of the damaged protective gear, or the risk of an explosion caused due to the mixing of chemicals. The site workers should always be aware of potential safety hazards and should alert their supervisors if they come across any new hazards so that, the hazard can be encountered at the earliest.

Electricity Hazards

An alarming amount of risk of electrocution and shock to the workers is offered within the workplace by electrical transmission equipment such as overhead power lines, buried cables, and downed electrical wires.

Various low voltage equipment having proper earthing along with proper isolation from water and corrosion must be used within a site to reduce the risk of electrical hazards. To take this a step further, the weather around a workplace must be monitored and the work should be suspended if a thunderstorm is predicted around the workplace. Undischarged electrical capacitors might also inflict a heavy shock upon a person. Proper earthing can easily solve this problem.

Stress due to heat

Stress due to heat is a very dangerous hazard, specifically to the workers who donn protective attire. The same gear that protects them from chemical exposure also hinders them from properly dissipating heat and moisture from their body. Therefore, personal protective clothing, contrary to its name, can raise quite a safety concern.

Stress due to heat might occur within a minimal time of around fifteen minutes depending on the environment within the workplace. The danger posed by heat stress can be equivalent to the threat caused by chemical exposure to a worker.

The stress might show up with minor symptoms like rashes, drowsiness, discomfort and cramps, and eventually morph into the impaired ability to function, which in turn, potentially poses a threat to the co-workers. Heat stress can also lead to intense suffocation and even death. To prevent heat stress from building up, the following precautionary measures can be implemented:

- Excessive, unnecessary protective gears should be spared.
- Careful training must be given to the workers wearing safety equipment.
- Their health should be regularly checked up.
- The equipment should be properly monitored.
- There must be adequate breaks and the span of work must be divided into pieces rather than being one constant continuum.
- The fluids used in these gears must be replaced frequently.

Exposure to Cold

In the case of a workplace having a very low temperature, and low wind chill factor, there is a consistent risk that the workers might get hypothermia, frostbite or any physical defect. The following tips might help in guarding against these:

- Appropriate clothing must be worn.
- Warm shelters must be readily available.
- Work periods must be scheduled in tandem with rest periods.
- The physical health condition of the workers must be monitored frequently.

Hazards due to Noise

A humongous amount of noise is created while working around heavy machines. The following are some of the effects of noise:

- Annoyed, distracted, and startled workers.
- The threat to the ears of the workers that might temporarily or permanently result in a loss of hearing.
- A huge deal of interference in communication that might hinder the reach of a potential warning against another danger.

If the employees are monitored to be exposed to a noise of 90 dBA (decibels on the A-weighted scale) for a time span of more than 8 hours, the administration must take charge and implement certain measures such as a hearing conservation program.

2. Occupational Health Management — To Plan and To Organise

The first and foremost essential element within a hazardous occupational workplace is the abundance of planning and organisation. The risk within these workplaces can be significantly diminished by anticipating and implementing precautionary measures within the worksite before the commencement of the work. This chapter deals with three aspects of planning, they are:

- The development of an organisational structure for the whole site's operation.
- Establishment of a comprehensive work plan considering each phase of the operation.
- Establishment and implementation of a site safety and work plan.

Planning should be perceived as a perpetual process. Depending on the conditions of the site, the site safety plan must be changed to suit the need at hand. Thus, the primary intention behind this chapter is to lay down a starting point for the activities involved in planning within an occupational setting.

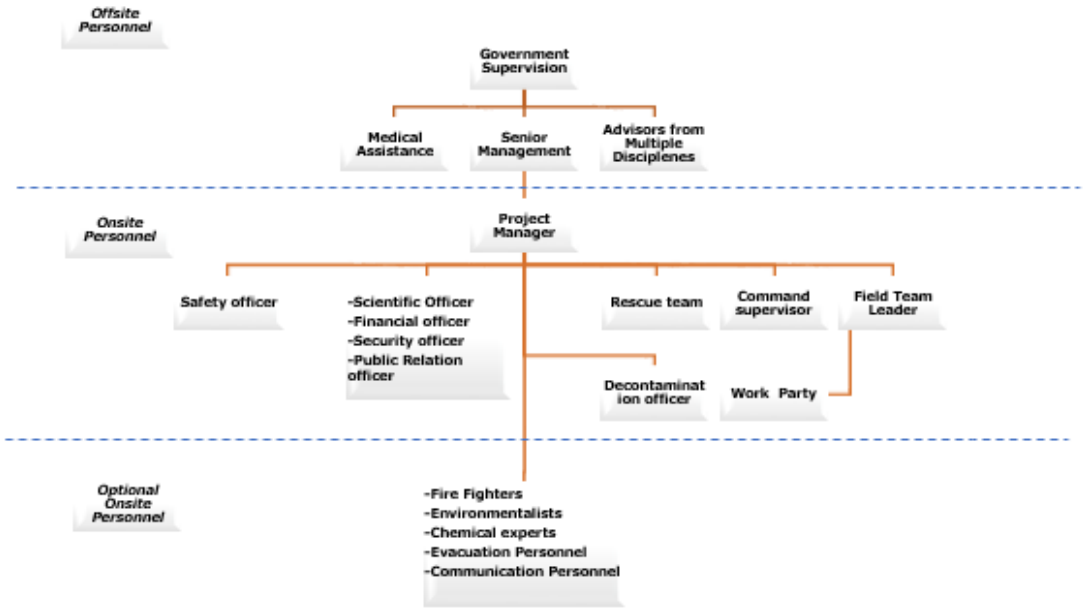
The Structure of Organisation

The structure of the organisation founding the overall objectives of the project must be laid out in the first phase of the planning process. The following conditions must be followed by the structure:

- Appoint a leader and make him the authority that directs all the activities.
- Appoint all the other human resources required to undertake the project in their respective field of expertise.
- Define the lines between responsibility, communication, and authority.

With the progress of the project, some necessary changes must be made to the organisational factors like authorities and individual responsibilities. This is crucial to streamline the performance of individual tasks. In the case of these changes, the changes must be updated across all the documents and must be conveyed to all the parties involved.

The following figure represents an example of a framework an organisation can be based upon. It deals with twenty-four categories of offsite as well as onsite personnel.



In the above illustration, the personnel are categorized on the basis of their responsibilities and roles within the occupational environment. They are also divided into offsite and onsite categories depending on their designation.

We are attempting to comprehend the scope of responsibilities and roles to be covered by this example. In order to design an organisational structure, the above illustration and its categorisation can be used as a skeletal structure or a starting point.

For an organisation of a smaller scale, several of the above functions may be performed by a single person. However, irrespective of the size of an effort, the presence of a site

safety and health officer is a must across all response teams. The safety and health officer will be responsible for the implementation of all the health and safety measures.

The Site Safety Officer should easily be able to communicate with all the other occupational safety professionals, specifically with the industrial hygiene specialist.

Upon the successful establishment of the organisational system, all the individuals responsible for its reinforcement should be identified as they must explain the respective job roles to all the safety professionals in the response team.

The attitude of the project managers across all levels of the organisation is another crucial aspect in the field of workplace safety. An ideal project manager must be committed to all the intricate aspects of the workers' safety and must prioritise the safety of the workers over the successful completion of the project before the deadlines.

The attitude, in the beginning, sets the nuance for the entire span of the project. The Project Manager and the Site Safety Officer need to be supported by the senior management for the successful establishment and implementation of safety programs.

Several factors within the organisation indicate the successful implementation of worker safety programs. Some of these factors are:

- The actions and the involvement of the management in worker safety reflect their strong determination and promise towards worker safety.
- Open communications regarding safety and other job-related matters are openly discussed between the workers, managers and supervisors.

- The cleanliness within the workplace is well maintained and the workplace is well organised, safeguarded against any airborne contamination.
- The organisation has a well-established recruitment process and employee support.
- The management does not shy out on applying variations in its safety program to better suit the task at hand.
- The management organises certain disciplinary plans to ensure that its employees adhere to the proposed safety practices.

The responsibility of the Offsite Personnel

Although, most of the Offsite personnel belong to the senior management level in the hierarchy. It is the decision taken by them that determines the trajectory of various aspects such as worker safety within an organisation. In fact, every facet of the organisation depends on the decision taken by these individuals.

Let us now learn about major roles and responsibilities related to safety:

Senior Management

The senior management includes the decision-makers of an organisation who set-forth the objectives, requirements, and the structure of the organisation. Their responsibilities include:

- Provision of the required facilities, equipment, and financial support.
- Provision of human resource and the time required by them to finish the work at hand.
- Appreciation of the efforts of the onsite management and work in proper sync with them.
- Taking strict disciplinary measures in the case of unsafe work practices.

Advisors from Multiple Disciplines

The advisors are seasoned experts from different fields such as Law, Chemistry, Medicine, Engineering, Industrial Hygiene, Information Technology, Physics and Public Relations. This group of individuals form a crucial part of the upper management as they provide important advice with respect to their field of expertise to lay down the foundation of the safety system within the organisation.

Medical Assistance

This aspect of the management comprises of qualified physicians, nurses, and ambulance personnel. Some of the key responsibilities of the medical assistance include:

- Being aware of the kind of materials within the workplace, the risks they pose, and their remedies.
- Being always ready for providing emergency treatment that includes decontamination, first aid and other immediate measures that might be required to be taken in case of any serious injuries.
- Providing appropriate medical measures for specific kinds of medical emergencies.

Onsite Personnel

The onsite personnel work in the field and look into how the work is carried out in the organisation. For a safety practice to be properly implemented, these employees must be well informed of the safety practices. The employees must adhere to these practices.

Project manager

The project manager controls the daily processes of the workplace from the site itself. Project managers are considered as leaders in the worksite and act as a bridge between the workers and the higher management. Some of their key responsibilities are:

- To come up with a review of a situation with respect to the safety plan and the field team.
- Getting access to the intricate parts of the site and coordinating the safety-related activities with the higher officials.
- Making sure that the work plan is completed on schedule.

- Informing all the members of the field team of their individual responsibilities and safety concerns.
- Coordinating with the Safety and Health Officer to ensure proper implementation of safety practices.
- Making the final report of the overall activities carried out within the site.
- Liaising with the Public Affairs Department.

Safety and Health Officer

A Safety and Health Officer assists the Project Manager with necessary advice on common safety practices and their implementation within the site. In the case of any threat to the health of the workers within the site, the safety officer has the privilege to immediately suspend the work until the threat concerned is gone.

The responsibilities of a Health and Safety Officer are as listed below:

- Selecting the appropriate safety outfit and equipment required to undertake a specific task.
- Ensuring the hygiene and the proper storage of these outfits and equipment.
- Gaining control of every exit at all the access control points.
- Coordinating safety activities with assistance from the Scientific Advisor.
- Monitoring the workers for various exposures, threats, and contamination.
- Checking each worker's suitability to work as recommended by the physician.
- Advising and implementing new safety plans suitable for the work undertaken.
- Monitoring hazards within the site.
- Inspecting for the proper enforcement of the Safety Plan.
- Establishing a buddy system within the work site.
- Being aware of the threats within the worksite and keeping all the necessary contacts in a very close proximity.
- Coordinating emergency medical procedures.
- Notifying the higher officials in the case of a hazard outbreak.

Field Team Leader

For certain organisations, the field team leader is the same as the Project manager. However, in the case of larger organisations, the field team leader is appointed separately. He may also be a member of the working party. However, the designation of a Field Team Leader varies from organisation to organisation.

The field team leader is responsible for:

- Managing all the operations in the field.
- Executing the plan of the work and setting the schedule for the workers.
- Ensuring the implementation of safety practices within his team.

- Enforcing control over the site.
- Documenting the field activities and collecting samples.
- Liaising with public affairs.

Command Post Supervisor

The Command Post Supervisor establishes communication and provides necessary assistance. Some of his key responsibilities are:

- Communicating with the emergency personnel whenever an emergency is raised.
- Assisting the Site Safety officer in rescue operations.
- Maintaining a record of the site activities.
- Maintaining proper communication among the working parties with the help of walkie-talkies, signals and gestures.

Documentation Officer

These officers are responsible for documenting procedures, supplies, and equipment. Some of their key responsibilities include:

- Setting up of decontamination lines along with organizing the decontaminants appropriate to decontaminate specific contaminants.
- Supervising over the decontamination of all the equipment and personnel.
- Collecting samples from the contaminated areas.
- Ensuring the disposal of contaminated clothing.
- Making the medical personnel aware of any threat or contamination that they come across.

Rescue Team

The rescue team is always alert to intervene in the case of a rescue situation. Some of their responsibilities are:

- Staying in an alert stance donned with protective clothing in the site.
- Rescuing any endangered worker.

The Working Party

The working party consists of all the team personnel working in the field. The size of the work party may differ from organisation to organisation. However, it must comprise at least two people. Some of the responsibilities of the members of the working party are:

- Completion of the task within the time limit while adhering to the safety plan.
- Following the Site Safety Plan.
- Informing about any unsafe situations to the Site Safety Officer.

Optional Onsite Personnel

The Optional Onsite Personnel are the individuals who are not regularly present on the site, but they pay a visit to the site as and when needed.

Scientific Advisor

The Scientific Advisor guides the Project Manager with respect to the scientific aspects of the project. He provides advice for monitoring of the field, data analysis, sample collection, and much more.

Other Optional Personnel

It is impossible to account for all the personnel that might be having one job role or another in a site within the bounds of this document. However, some other notable types of personnel are:

- Logistics Officers: They control the transport of materials to and from the worksite.
- Photographers: They capture the conditions within a site for future reference.
- Financial/Contracting Officers: They provide financial and contractual support to the site.
- Public Information Officers control the transmission of information of the conditions within a site to the public through news and press conferences.
- Security officers are responsible for the security of the site from outer interventions.
- Recordkeepers maintain records regarding various proceedings of a site.
- Bomb-explosion Squad demonstrates the proper use of explosives and helps in the disposal of explosive materials.
- Environmentalists help in assessing the environmental factors around the site.
- Evacuation Personnel assist in the successful evacuation of a work site in the case of an emergency.
- Firefighters are invoked in the case of a fire outburst at the work site.
- Health Physicists evaluate the radiation level within the site.
- Industrial Hygienists asses the overall health of the employees and advice proper health practices.
- Toxicologists assess the toxicity of various substances present in the site.

3. Occupational Health Management — Education and Training

A person entering a hazardous occupational site should know and should be able to comprehend the potential risks that the site may have on his health and safety. However, this risk is also a factor of the clean-up frequency of the site.

Employees appointed for the clean-up task must be well-acquainted with the procedures and programs laid out by the Site Safety Plan. They must also be trained enough to evade any contamination within a contaminated environment.

If at any instance, there is a visitor to the site, he must be given proper training on how to identify hazards and on the Standard Operating Procedures of the site. The visitor should be capable enough to conduct the visit safely. The main motives behind providing proper training to the employees are:

- Acquainting the workers with the potential hazards in the site.
- To instil adequate knowledge and skills to work in the site with the optimum level of safety.
- To make workers know about the working and the limitations of safety equipment.
- To make sure that emergency exits are easily accessible to the workers.

The level of the training depends on the personnel's job role and how much risk does he have to face while performing his duties. However, it is strongly recommended that the training program must include classroom sessions as well as hands-on sessions, as these hands-on sessions show a pragmatic view of the equipment and safety practices.

A training program that involves working around hazardous substances must be practically conducted in the site with proper supervision from the trainer.

Each training session must be carried out by using simple language that can be understood by everybody. A written book of instructions on Standard Operating Procedures must be given to all the workers. Aids for teaching is welcome and the classroom sessions must be interactive in nature with an adequate amount of hands-on training.

It should also be mandatory for all the employees to complete the training program involving drills simulating various emergency situations. Refreshing the training after a year is also a commendable practice to stay updated on the latest trends in Safety.

Training Programs

The employees in an organisation must not be allowed to engage in any activities in the site until they undergo proper safety training that is at least specific to their job and makes them aware of the hazards that they might come across.

Training sessions on job specific safety hazards and overall safety hazards in the site must be conducted for the workers such as general labourers, equipment operators, technicians and other necessary personnel. This training must encompass the safety hazards along with the ways to counter these hazards.

These training sessions must contain classroom sessions that might include the following subjects depending on the specific job roles:

- Safe work practices
- Site Safety Plan
- The nature of expected hazards
- Reacting to emergencies
- Regulations on the use of Vehicles
- Safety Practices while using Field Equipment
- Advantages and drawbacks of Protective clothing
- Techniques that help in safe Sampling

Adding to the classroom session, trained and experienced supervisors must provide practical hands-on training to these workers in the actual field. General workers who might potentially be exposed to unique conditions or who might occasionally don the mantle of a supervisor should get additional training in the below-mentioned areas:

- Development of Site Safety Plan
- Surveillance of the site
- Implementation and decontamination of protective clothing and equipment.
- Measurement of explosivity and radioactivity by utilizing the special equipment.
- The safe utilisation of special equipment

Other higher officials who work within the proximity of the site such as Project Manager and other team leaders should undergo the same training as other workers along with special training for enhancing their guidance and decision-making. This special training must include:

- Managing the site clean-up operation
- Management of the work zones in a site
- Ways of communicating with the press and the general public

The employees concerned with health and safety must be well-versed in the training that is being provided to all the other employees in the organisation and should undergo advanced training with respect to safety practices.

Whenever a visitor pays a visit to the site, he must be given an elementary training on safety before entering the premises of the site. This elementary training can be a brief induction on safety. However, these visitors must be refrained from accessing Exclusion Zones.

Training Record

A record with respect to the training must be maintained within the personnel file of each employee for assuring that every person entitled to the task has undergone adequate training and are updated on the latest hazards and their remedies.

4. Occupational Health Management — Conduction of Medical Programs

The workers working in a hazardous environment can encounter a very high level of stress. The tasks that they carry out might expose them to contaminations from different hazards. There is a very high possibility that they might develop stress due to the protective clothing that they wear to protect themselves from fire and other harmful substances.

It is very crucial to implement a Medical Program for the assessment and the monitoring of the worker's health. This monitoring must be carried out before the employment as well as after the employment of the workers for the provision of emergency treatment when required.

A collection of general guidelines for the designing of a medical program for employees' health has been proposed in this chapter. This chapter covers the information and prototype protocols for the following:

- Pre-employment Screening
- Periodic Medical Check-ups
- Treatment on the basis of Emergency
- Maintenance of Records

The suggestions in this chapter are based on the assumption that workers in the site have the necessary protection from various exposures through engineering, administrative controls, and specific Personal Protection Equipment, along with an easy access to decontamination methods. However, the purpose of Medical surveillance is just to assist other safety measures in ensuring optimum safety within the work site.

Development of a Medical Program

Considering the particular needs, location and the risk of exposure of the workers, a medical program must be developed for each site. An Occupational Health Physician in conjunction with the Site Safety Officer must be in charge of the development of the Medical Program.

It is also mandatory for the director of the site's medical program to be board-certified in the fields of medicine along with having a commendable experience in Occupational Health Management Services.

However, a director of such a calibre is difficult to find as there are very few doctors who are trained in Occupational Health Management, particularly in the case of remote work sites. If this happens to be the case, a Local Physician with the assistance of an Occupational Health Consultant might carry out the management and perform relevant examinations.

Moreover, an Occupational Health Nurse can also perform these functions. However, a suitably qualified physician who is responsible for the program must appoint the nurse.

All the tests and medical analysis must be conducted within a laboratory that has a commendable performance in an inter-laboratory testing program. A Medical Program must cover the following components:

- Surveillance
- Treatment
- Record Maintenance
- Review of the Program

The active involvement of workers is a huge factor that determines the effectiveness of a Medical Program. Moreover, the management should be strongly committed towards the safety and the health of the workers.

The commitment of the management must be evident not only through medical procedures, but also by encouraging its employees to maintain their health by exercise, balanced diet and refrainment from tobacco, alcohol, and other harmful drugs. Particularly, the management should do the following:

- Ask the potential employees to submit a medical record detailing their medical history.
- Make sure that the records remain confidential.
- Encourage workers to report any potential exposure, irrespective of the seriousness.
- Encourage the workers to report any complicated physical condition to the physician.

The training of the employees should be focused on the idea that minor disturbances and the apparent minor complaints may turn out to be quite significant. During the development of a medical program, the site conditions along with monitoring the medical needs of each worker must be taken into consideration as well as the potentials exposures within the site.

Moreover, the routine task of each worker must also be considered. For example, a miner will be exposed to a different set of dangers than a regular field worker. In the same way, an employee dealing with an official task would require less medical attention than a worker working in the field at a higher altitude.

Although it is not possible to identify all the potential contaminants within a worksite, the following are some types of contaminants that are commonly witnessed across various workplaces:

- Asbestos
- Aromatic Hydrocarbons
- Dioxins
- Heavy Metals
- Herbicides
- Halogenated aliphatic Hydrocarbons
- Organophosphate and carbamate insecticides
- Polychlorinated biphenyls

While compiling a protocol for testing, it must be kept in mind that the development of the standard medical tests was done within factory settings and other confined environments. Therefore, some of these tests might actually turn out inappropriate for hazardous occupational sites.

The wide variation of risks across different circumstances is yet another factor to consider, not only regarding the type and the intensity of exposure, but also regarding the individual physical factors such as height, weight, sex, diet, stress, allergies, preconceived medication, and off-site exposure.

Effective Medical Program

In this section, we will learn about the various procedures that can be included within a Medical Program to make it effective. Of course, one is free to add or remove certain procedures in the Medical Program, depending on the conditions of the site and the nature of the job, to best suit the safety requirements of a site.

Pre-Employment Screening

The Pre-Employment Screening is conducted for the employees who have been hired and are yet to join the workforce. In the Pre-Employment Screening Phase, the following parameters must be recorded:

- Medical History
- Occupational History
- Physical Examination
- Fitness to work wearing Protective Equipment
- Basic monitoring for Particular Exposures

Periodic Medical Check-ups

Periodic Medical Check-ups are intended to be performed on the employees within the tenure of their employment; this is considered a must for the field workers. A periodic medical check-up must cover the following:

- Updating medical and occupational history every year for conditions such as exposures, designations, etc.
- Higher frequency of testing based on specific exposures.
- Routine Medical examinations with Yearly testing.

Emergency Treatment

The emergency treatment must confine the following aspects:

- Provision of first aid within the site.
- Development of liaison with a local hospital and medical consultants.
- The arrangement of decontamination measures for the victims.
- The arrangement of readily available transport of victims.

Non-Emergency Treatment

Non-Emergency Treatments are as necessary as the Emergency ones. A slew of mechanisms must be developed for non-emergency treatments. These treatments can include treatment for minor diseases, infections, and other conditions that might not require the immediate attention of the physicians.

Record Maintenance

Specific records must be maintained with respect to the medical conditions of specific workers. Consider the following aspects related to record maintenance:

- Maintenance of the records.
- Recording and reporting injuries and other illness faced by the workers within the site.
- Regularly reviewing the Site Safety Plan when additional tests are needed.
- Periodically reviewing the program emphasizing on the present hazards in the site and the hygiene within the site.

Pre-Employment Screening

Pre-employment screening encompasses two major functions:

- Determining whether the individuals are fit for their duties, considering their ability to work while donned in protective attire.
- Providing a baseline data for comparing future medical data.

These functions are elaborated below:

Fitness for Duty

Workers at hazardous sites while wearing protective equipment at the same time perform various strain-inducing tasks. The protective equipment is very likely to produce a high amount of stress due to heat that gathers within. For ensuring the workability of the employees covered in protective gear, the pre-employment screening must emphasize the following in the context of medical history:

- A worker should fill a medical history questionnaire and this questionnaire must be reviewed before any acquaintance with him.
- It must be noted that special attention must be paid to any prior chemical exposure or contamination in the worker's previous job.
- A revaluation of any past illnesses and chronic diseases must be done, specifically regarding diseases such as asthma, eczema, lung diseases and cardiovascular diseases.
- It must be determined whether a worker is susceptible to any allergies.
- Various lifestyle habits and hobbies must be recorded.

A few physical examinations must be conducted. Let us now learn what these examinations are:

- A physical examination comprising of the various organs, specifically emphasizing on pulmonary, musculoskeletal and cardiovascular systems.
- Recording conditions such as obesity and lethargy, that might lead to heart stroke.
- Recording conditions such as facial scars, missing body-parts, poor eyesight, etcetera that might hinder the use of a respirator.

Consider the following actions related to the ability to work while wearing Protective Equipment:

- The individuals who fail to perform based on the medical history and the physical examination must be disqualified.
- The limitations of the workers while wearing protective equipment must be noted down.
- Additional testing for the ability to wear equipment must be conducted when necessary.
- In the case, wearing a respirator is required during the job, the worker's capability to work must be assessed wearing the respirator.

Baseline Data

A baseline data maintained during the pre-establishment stage is necessary for comparing it with the data that is to be recorded in the future. A biological monitoring test, as well as a medical screening test, might be included in a baseline data assessment. Due to the ambiguity of the types of exposures that exist, it is not feasible to prescribe specific tests to all the workers.

Periodic Medical Check-ups

Periodic medical examinations must be conducted from time to time. It is very essential for the determination of biological trends to compare baseline data with the sequential medical reports that are recorded during these medical examinations.

This is primarily conducted to predict any adverse effects that might take place in the future due to the exposure to certain substances. The contents and the frequency of the exams may vary depending on the exposures and the nature of the job.

Generally, various industries conduct these periodic medical examinations annually. However, the frequency of these exams may vary depending on the nature of the contaminants, environment, and the working conditions within the work site.

The periodic medical check-ups may include:

- Medical evaluation with an emphasis on illness, health status, and probable work-related symptoms.
- Physical examination to determine the overall fitness of the workers.
- Additional medical tests depending on the health condition of the workers.

Termination Medical Examination

When the employment of an employee in a hazardous site ends, a final medical examination must be conducted. However, this examination may only be limited to

determine the changes in the medical conditions of an employee, since the last medical examination, if the following three conditions are met:

- The last examination was held at least six months ago.
- There is no occurrence of any exposures since the last examination.
- The worker does not show any symptoms of a contamination since the last examination.

In case, if any of the above conditions are not met, a full medical examination is strongly recommended upon the termination of the employee.

Treatment Based on Emergency

Each site must possess provisions for emergency as well as non-emergency treatment. It is very crucial to plan in advance and anticipate the various hazards that might occur.

During the development of procedures, plans, and the list of equipment, the reach of existing and potential hazards, particularly affecting the site, must be taken into consideration.

These assumptions must not only be made from the worker's perspective; the visitors, officials, and vendors also need to be considered. The site emergency response program must integrate emergency treatment into itself. The following guidelines will help in laying down an effective emergency treatment program:

- A team of site workers should be trained on emergency first aid.
- The employees should be trained on emergency decontamination along with emergency response plan.
- An emergency first aid station should be established within the premises of the work site.
- A physician must be appointed who can be contacted throughout the day.
- A call on demand team of medical specialists from various fields must be set up for consultation during emergency situations.
- Emergency contacts such as ambulance, fire brigade and poison control must be at a hand's reach.
- Imprint maps and directions to various places in the site.
- Develop a radio communication system for an emergency.

In case of non-emergency treatments in hazardous sites, arrangements must be done for the workers who are experiencing adverse effects as an outcome of the exposure to various hazardous substances.

Along with the health assessment programs, the management must ensure that any health condition that they might witness due to the exposure to various substances must be taken care of, and certain precautions must be prescribed to reduce further symptoms.

Offsite medical consultants must also examine and treat non-job related medical conditions that the employees might have been facing, which, eventually would hamper

their work. A copy of the medical record of the workers should be present within the work site.

Maintenance of Records

It is very crucial to keep proper records in a hazardous site as the nature of the work and the risk levied upon the workers may be alarmingly high depending upon the conditions.

Various employees during their work tenures might put up at different locations and various sites. Moreover, the adverse effects of long-term exposures might not show up for many years. Records help medical care providers in determining the previous exposures that the employee might have had. The following tips are recommended while maintaining records:

- The records of previous employees must be kept for at least thirty years.
- The records must be assessable to the workers.
- The records regarding occupational illness and injuries must specifically be maintained.

5. Occupational Health Management — Personal Protective Equipment

Everyone entering a hazardous site must be safe from hazards. The main motive behind the usage of Personal Protective Equipment, commonly known by the acronym PPE, is to offer a barrier for the isolation of individuals from the physical, chemical, and biological hazards that are offered by a hazardous site.

All the organs of the body can be protected by carefully selecting appropriate Personal Protective Equipment. This chapter introduces various types of PPE and describes their usages in different situations. However, the term PPE, in general, refers to Personal Protective Equipment as well as Personal Protective Clothing collectively.

All occupational sites must adhere to an established PPE program. The following should be the primary objectives of the PPE program:

- Protection of the wearer from safety and health hazards
- Prevention of incorrect PPE methods and malfunctions

The following should be included in the comprehensive PPE program:

- Identification of hazards
- Surveillance of the environment
- Medical monitoring
- Selection of the PPE
- The utilisation of the PPE
- Maintenance of the PPE
- Decontamination of the PPE
- Policy statements
- Procedures
- Guidelines

The copies of the written PPE program must be made available for each and every employee working in the organisation. Moreover, each worksite should also possess a reference copy of the PPE program. The technical data on the following must also be made available to the employees:

- Maintenance manuals
- Equipment Manual
- Regulations for usage
- Other Essential information

Review and Evaluation of the PPE Program

The PPE Program must be subjected to a review at least once in a year. The following factors must be considered in the review:

- A survey covering each site for ensuring the proper enforcement of the regulations regarding the PPE.
- A record of the time for which the workers wear various PPE in terms of person-hours.
- Experiences of illnesses and accidents.
- Exposure levels.
- Equipment selection adequacy.
- Operational guidelines' adequacy.
- The proper implementation of cleaning, decontamination, inspection, maintenance, and storage programs.
- The effectiveness of training programs.
- Coordination with Health and Safety programs.
- The completion rate of objectives.
- Program records adequacy.
- Recommendations for the improvement and modification of the program.
- Cost of the program.

The outcomes of the evaluation of the program must be made available to the employees as well as the top management for the adaption and the implementation of the program.

Respiratory Equipment Selection

Inhalation is one of the major routes for contaminants to enter the body, respiratory protection is very important in hazardous environments. Respiratory protective devices are also known as respirators and are made up of a facepiece that is attached to an air source or an air purifier.

The respirators having an air source are called atmosphere-supplying respirators and come in the following two types:

- **Self-Contained Breathing Apparatus (SCBA):** The air supply source is carried by the user.
- **Supplied Air Respirator (SAR):** The air supply is located at a remote location and the air is transmitted by a hose.

On the other hand, air purifying respirators have an air purifying element that purifies the surrounding air. These respirators are further distinguished according to the type of airflow used to supply air to the facepiece.

In our subsequent section, we will discuss the different types of respirators distinguished according to the type of airflow.

Positive pressure respirators

A positive pressure respirator continues to maintain a constant positive pressure in the facepiece while inhaling as well as exhaling. The following are the two main types of positive pressure respirators:

Pressure demand respirators

Where the mask's positive pressure is maintained (except when the breathing rate is too high) by an exhalation valve and a regulator. In the case of any leakage, the regulator sends a continuous stream of air preventing any contaminants from getting in through the leak.

Continuous-flow respirators

Where a stream of air is continuously fed to the facepiece. In the case of SAR variants of these respirators, the intrusion of ambient air is checked by the continuous flow of air while rapidly using air supply on the other hand.

Negative pressure respirators

A negative pressure is created due to inhalation, which draws air into the facepiece in negative pressure respirators. The most dangerous flaw in negative pressure respirators is that, if any leaks or cracks occur in any part of the respirator, the user inhales contaminated air.

Respirators can further be differentiated depending on the type of facepiece being used in conjunction with the air source. Generally, facepieces come in two different configurations:

- **Full-facepiece masks** encompass the entirety of the face starting from the hairline to the chin. Good eye-protection is provided by them.
- **Half-facepiece masks** only cover the area under the nose and above the chin. No eye-protection is provided in these facepieces.

Self-Contained Breathing Apparatus (SCBA)

SCBAs generally have a facepiece attached to a regulator to an air source by a hose. The wearer of this respirator carries the air source. In atmospheres that are immediately dangerous to life and health (IDLH), only positive pressure SCBAs are recommended.

Most of the contaminants can be checked by SCBAs. However, the limited supply of air in the case of SCBAs limit them from continuous prolonged usage, depending upon the rate of consumption of the user and the amount of air carried by him. The heft and the bulk of these respirators hinder the movement of the wearer in confined spaces and may even cause heat stress.

Supplied Air Respirators

Supplied air respirators provide purified air and never pure oxygen. These respirators supply air from a stationary source. Both positive and negative pressure variants of these respirators are available. The highest level of protection in SARs is provided by positive

demand SARs having escape provisions and they are the only SARs recommended in hazardous sites.

In the case of an IDHL atmosphere, a SAR is never recommended unless an escape SCBA is equipped with the SAR. The following two types of air sources are used by SARs:

- Compressed air source
- Air compressors that directly delivers purified air to the respirator

Although SARs can be used for a significantly longer period as compared to SCBAs, the hose connected to a stationary source of air hinders the wearers from going further distances.

Combination respirators

A combination respirator provides the best advantages of an SCBA and a SAR. A regulator is used in the case of these regulators to switch between the SCBA and the SAR modes of its operation. This switching can be either achieved manually or automatically.

A self-contained air supply in these respirator enables its wearer to enter into and exit out of an area, while the connected airline enables its wearer to work for a prolonged period of time at a single stretch.

Air purifying respirators

An air purifying element along with a facepiece constitutes an air purifying respirator. The air purifying element might either be a removable component of the facepiece itself or maybe a separate device connected to the facepiece via a corrugated hose. Different air purifying respirators purify the ambient air by different approaches such as:

- Absorption
- Adsorption
- Filtration
- Chemical reaction

However, these respirators find their place in the areas having lower concentrations of contaminants and these respirators are absolutely not recommended for IDHL atmospheric conditions.

Protective Clothing and Accessory Selection

Any item that provides skin/body protection is considered personal protective clothing. Some of these may include:

- Encapsulating suits
- Non-encapsulating suits
- Gloves
- Aprons
- Leggings
- Sleeve protectors

- Proximity garments
- Firefighters' protective clothing
- Blast suits
- Radiation protective suits
- Cooling garments

Protective clothing serve a purpose. Not all types of protective clothing can help against chemical exposures. In conjunction with the protective clothing, there are certain tools and accessories that must be carried by certain personnel. Some of these accessories are:

- Flashlights
- Lanterns
- Knives
- Locator beacons
- Dosimeters
- Safety harness
- Two- way radios

The personal protective clothing items have been briefly described below:

Encapsulating suit

An encapsulating suit encapsulates the whole body of the wearer. Gloves and boots may or may not be attached to these suits. These suits protect against chemical exposures, dust, splashes and vapours.

However, due to the lack of proper airline, an immense amount of heat stress may develop with the one who is wearing it. It is highly recommended to use this suit with a cooling suit when used with a closed circuit SCBA.

Non-encapsulating suit

A non-encapsulating suit is usually an assembly of separate pieces of protective clothing such as jackets, hoods, and pants. Just like an encapsulating suit, this suit protects against particles, splashes and other contaminants. However, it cannot protect against vapours and gasses. Moreover, it does not offer any head or neck protection.

It may also contribute to the build-up of heat. It is strongly recommended to tape-seal junctions near the wrists and the ankles while wearing this suit.

Aprons, leggings, and sleeve protectors

These items are commonly worn along with non-encapsulating suits. These clothing items offer an additional level of protection from splashes, dust particles, and chemicals.

Firefighters' protective clothing

A firefighter's protective clothing comprises of fireproof gloves, helmets, bunker coats/ running coats, bunker pants/running pants, and running boots. This suit protects the firefighters against fires, heat, minor explosions, hot water, and certain particles.

However, this attire does not help much in preventing risks from gases and chemicals. Moreover, it is too difficult to decontaminate this suit.

Proximity garment

Proximity garments, also known as approach garments, are a set of protective clothing. The set comprises boot covers, as well as gloves and hoods made of aluminised nylon. These garments provide an extra layer of protection over other full body suits discussed above.

These garments protect against heat, but not against chemical exposure. However, these garments can be custom made to protect against certain chemicals. It is highly recommended to use auxiliary cooling and SCBA with these garments.

Blast suit

A blast suit consists of blast vests, bomb blankets, and bomb carriers. The suit provides a certain level of protection against minor blasts and detonations. Bomb blankets can also be used to redirect a blast. However, hearing protection is something that is not offered by a blast suit.

Radiation protective suit

A radiation protective suit is a combination of various types of antiradiation clothing items that provide protection against alpha and beta radiations but fail to protect against gamma radiation.

Cooling garment

A cooling garment dissipates the excess heat from the body of the personnel wearing other full body suits. Cooling garments significantly reduce the risk of a heat stress emergency. Consider the following approaches while implementing cooling garments:

- Cool and dry air is circulated throughout the suit by a pump that uses refrigeration coils, vortex coolers, or heat exchangers for the transmission of air.
- Packets of ice are inserted into a jacket.
- A pump throughout the body of the wearer circulates water from a reservoir.

Safety Helmet

A safety helmet is often made from hard plastic, rubber, or a combination of both. It protects the head of its wearer against accidents, projectiles, blasts, blows, and many other head injuries. In addition, the inner lining of the helmet protects the wearer from cold.

Hood

A hood protects its wearer against splashes of chemicals, particles, and rain. It is often worn along with a helmet.

Face shield

A face shield protects the face from the top to the chin. Proper sizes of face shields must be provided for the best fit and the best level of safety. However, they are not capable of protecting the face against projectiles.

Safety glasses and goggles

These eye-gears protect the eyes against chemical splashes and dust particles that might potentially get into the eye. However, they cannot stop larger projectiles. They also help in protecting the eyes against lasers and bright lights.

Sweatbands

Sweatbands absorb the sweat dripping from the head and stop the sweat from entering into the eyes.

Earplugs

Earplugs must be worn in sites having a very high level of noise. This equipment prevents the noise from entering into the ears.

Gloves and sleeves

Gloves and sleeves offer a great deal of protection to the hands and the arms of the wearer while handling chemicals and other hazardous substances.

Safety boots

Safety boots usually provide a great deal of protection from chemicals and other such contaminants. Furthermore, they are reinforced with steel for additional protection from physical inflexions.

Knives

Knives come in handy in a multitude of scenarios. From cutting a rope to cutting a fatally suffocating suit, a knife has it all covered.

Flashlights and lanterns

These hand-held light sources are essential for approaching dark environments, confined spaces, and buildings. Moreover, they can also be used as an SOS signal during an emergency.

Dosimeter

A dosimeter is used to measure the ionising radiation of a certain surrounding. It is highly recommended to couple a dosimeter with a full body suit.

Locator beacon

A locator beacon helps the emergency personnel in locating any injured or contaminated personnel needing help. These beacons use radio waves, sound, or light to transmit the signal.

Two-way radio

A two-way radio can be used to communicate with remotely located personnel. These radios use radio waves to transmit voice signals.

Safety harness

A safety harness is a mandatory equipment that must be worn by the personnel who work at greater heights. It significantly diminishes the risk of an emergency due to a fall.

6. Occupational Health Management — Decontamination

Decontamination is the process of clearing or neutralising various contaminants that a person or an equipment might have collected in a hazardous occupational site. The process of decontamination assures a protection from contaminants that may permeate and contaminate an individual.

Furthermore, decontamination helps in quarantining the clean areas within a site by putting a check on the transfer of contaminants through contaminant carrying personnel. It also prevents the mixing of incompatible chemicals while stopping the transfer of uncontrolled contaminants within the site.

A brief overview of the various types of contaminants that may potentially be encountered by the workers within an occupational site is introduced in this chapter. This chapter also deals with the factors influencing the communication of the contaminants and the remedies to the contamination due to these contaminants.

Adding to this, this chapter also gives out a set of general guidelines for the development of a decontamination program within a site. It also helps in deciding the health and safety aspects of the decontamination procedure.

However, decontamination for personnel or equipment contaminated by radiation is beyond the scope of this chapter. It is strongly recommended to consult a health physicist in case of contamination due to radiation occurs.

Plan for Decontamination

As part of the Site Safety Plan, a documentation plan must be developed for decontamination. This plan should be set up prior to the entrance of any personnel or equipment into the areas where there is a potential danger of exposure to certain contaminants. The decontamination plan must consider the following:

- Calculate the number of decontamination stations.
- Acknowledge the necessary equipment for decontamination.
- Identify the various decontamination methods.
- Layout plans for the prevention of clean areas from getting contaminated.
- Plan procedures and steps for isolation while disposing of contaminated equipment.
- Establishment plans for eliminating worker contact from the Personal Protective Equipment while decontaminating them.

In case the type of the Personal Protective Clothing/Equipment is changed, there is a change in the site conditions, or if the nature of the job within the site is changed, a revision of the plan must be conducted.

Preventing Contamination

The establishment of Standard Operating Procedures is the first step towards decontamination. These procedures minimize the contact with the contaminants, thus, minimizing the risk of contamination. Let us now consider the different activities that can help prevent contamination:

- Give proper emphasis on minimizing contact with hazardous substances or chemicals.
- Implement remote handling, container opening, and sampling.
- Put sampling and monitoring equipment in bags leaving small openings near the sensors.
- Whenever possible, wear disposable outer clothing and utilize the disposable equipment.
- Use removable coating for covering tools and equipment, thus, decontamination would just be one strip away.

- Cover the contaminant source.

Adding to the above, Standard Operating Procedures must be established for maximising workers' protection. For example, defined dressing procedures before entering into the hazardous site will diminish the risk of contaminants bypassing the protective clothing and thus, will significantly decrease their escape from the decontamination process.

Generally, fasteners such as buttons and zippers must be closed, along with gloves and boots being tucked, under the sleeves and the legs of the outer garments. Hoods, on the other hand, must be worn outside the collar. A secondary pair of robust outer gloves is also a must-have. Above all, proper taping of the junctures must be done to achieve the perfect prevention from contaminants.

Before using each time, the Personal Protective Equipment must be examined for any punctures and defects that might render the wearer exposed to certain contaminants. Likewise, any cut or injury on the surface of the skin also inclines the risk of contamination for the worker. Therefore, workers having wounds spread across a larger surface area on their skin must refrain from entering potentially contaminated sites.

A basic training covering all the standard operating procedures must be given to every person for avoiding contact and maximizing the safety of the workers. These procedures must be enforced throughout the entirety of the site operation.

Types of Contamination

Contaminants may either be found on the surface of the personal protective equipment or may permeate into the personal protective equipment. It is easy to remove surface contaminants; however, it is tough to remove and even detect the contaminants that permeate within the personal protective equipment.

If the process of decontamination does not remove the contaminants that have permeated into the personal protective equipment, they might continue with permeating further into the material and might inflict an unsuspected exposure. The following five factors affect the extent of permeation.

Contact time

The time for which a contaminant is in contact is directly proportional to the risk and the extent of the permeation. This is why it is very important to remove contaminants by implementing a decontamination process.

The concentration of the Contaminant

Molecules are transmitted from the areas having higher concentrations of molecules towards the areas having lower concentrations of molecules. As the concentration of the contaminant increases, its potential of getting into the clothing also increases.

Temperature

The risk of an exposure to a contaminant is directly proportional to the temperature.

Size of the molecules of the contaminant

Permeation is inversely proportional to the size of the contaminant molecules.

The physical state of the contaminants

Gases, vapors, and liquids having low viscosity, are more effective contaminants than high viscosity fluids and solids.

Decontamination Methods

Decontamination must be performed on all the clothing, equipment, samples, and personnel leaving the potentially contaminated area in the site. These areas are often referred to as Exclusion Zones. The following three approaches are usually considered for decontamination:

- Removing contaminants physically.
- Sterilizing contaminants by using chemical detoxification.
- Removing contaminants by a combination of both.

Removing contaminants physically

In most of the cases, the total mass of contaminants can be removed by implementing the following physical measures:

- Rinsing
- Dislodging/displacement
- Evaporation
- Wiping

The physical methods that deal with a high amount of pressure and/or temperature must be used with a lot of caution and should only be used where they are really necessary. The following categories of contaminants can be removed by physical means:

Loose Contaminants

Dust particles and vapours that stick to the equipment and the workers, or that are trapped in minute openings like stitches, can be removed by immersing them in water and other rinsing liquids. Antistatic solutions can be coated on the clothing to enhance the removal of electrostatic contaminants.

Adhesive Contaminants

Some contaminants stick to the clothing due to their adhesive property. A great variety of adhesive qualities can be seen across a series of contaminants. The adhesive property of these contaminants also changes depending on environmental factors such as temperature, atmospheric pressure and air density.

Some examples of these contaminants are cement, glues, resins, and muds. These contaminants have a higher adhesive property than that of elemental mercury and thus, are very tough to remove by physical means. However, these contaminants can be removed by methods such as solidification, freezing, absorption, adsorption and melting.

Volatile liquids

The process of evaporation and rinsing with water can remove the contaminants that take the form of volatile liquids. Steam jets can immensely escalate the process of evaporation of volatile liquids. However, there is a very high risk for the workers to inhale the contaminant-filled vapours. Therefore, proper caution must be taken to ensure proper isolation of the vapours.

Removing Contaminants Chemically

Washing and cleaning with cleaning solutions is the next step that should be followed after the physical removal of contaminants. The following methods can be utilized to do this:

Dissolving Contaminants

Surface contaminants can be chemically removed by dissolving these contaminants in a solvent. Chemical compatibility of the solvents with the contaminants is essential for the removal of these contaminants. To be specific, this is particularly important in the case of decontaminating Personal Protective Clothing that is made up of organic materials and can be damaged by organic solvents.

Adding to this, a very high degree of caution must be taken in the selection, usage and the disposal of highly flammable and potentially toxic organic solvents. The following kinds of organic solvents are the most widely used:

- Ethers
- Alcohols
- Ketones
- Straight-chain Alkenes
- Petroleum products
- Aromatics

Halogenated Solvents

Generally, halogenated solvents are toxic in nature and are not compatible with Personal Protective Clothing. These solvents must only be used in extreme cases, where it is impossible for other cleaning agents to remove the contaminants.

Surfactants

Physical cleaning methods are aided by surfactants by the reduction of adhesive forces between the contaminants and the surface to be decontaminated. The most commonly used surfactants are household detergents. Detergent, when mixed up with certain proportions of organic solvents, results in a better dispersal and dilution of contaminants.

Solidification

The physical removal of liquids or gel-based contaminants can be greatly enhanced by solidifying them. The following mechanisms of solidification are usually followed across industries:

- Using absorbents such as powdered lime and grounded clay to remove moisture.
- Using chemical reagents and polymerisation catalysts to chemically react with the contaminants.
- Using ice water to freeze the contaminants.

Rinsing

The contaminants can be removed through rinsing by solubilisation, physical attraction, and dilution. Rinsing multiple times with cleaning solutions removes a lot of contaminants as compared to a single rinse. Rinsing continuously will remove even larger amounts of contaminants than multiple rinsing.

Sterilisation

A more practical approach for the inactivation of infectious agents is to chemically disinfect them. However, it is generally impractical to implement standard sterilisation techniques for bigger equipment and protective clothing. This is why sterilisation is usually recommended for disinfecting infectious agents specifically.

Designing a Decontamination Facility

In a hazardous occupational site, the Contamination Reduction Zone (CRZ) must contain the decontamination facility. The Contamination Reduction Zone is usually the area between the Support zone and the Exclusion Zone. Several factors within a site contribute to the determination of the level of decontamination required. These factors include:

- The toxicological, physical, and chemical property of the contaminants.
- The site's pathogenicity.
- The number of contaminants along with their location and containment.
- The potential of contaminants for permeating, degrading, and penetrating the substances used for creating the personal protective clothing and equipment.
- The reach of incompatible wastes.
- The locomotion of the personnel and the equipment across various zones in the occupational site.
- The decontamination methods available for workers.
- The effect of the decontaminating substances on the safety and the health of the workers.
- Emergencies.

An organised process must be laid out by decontamination procedures for reducing contamination across various levels. A series of procedures in a particular sequence must be included in the decontamination process.

For example, heavily contaminated items such as boots and gloves must be the first to be decontaminated. A separate station must be dedicated to each procedure to reduce cross contamination. Decontamination line is the term given to the sequence of stations. Furthermore, physical barriers must be present in between these stations for preventing cross-contamination.

The entry and exit points of different zones must be legibly marked and there must be separate entry and exit points for the Contamination Reduction Zones and the Exclusion Zones. Separate dressing and redressing stations must be provided at the entrance and the exit points of the Contamination Reduction Zones.

Methods of Disposal

It is very crucial to decontaminate and dispose the equipment and materials used for decontamination. The collection and placement of brushes, buckets, clothing, and other tools must be done within containers that are properly labelled. Moreover, the washed water and the solutions used in the decontamination process must be collected and isolated from the environment. Plastic bags should be used to contain the clothing and the equipment that are not completely decontaminated.

7. Occupational Health Management — Emergency in a Site

Emergencies are recurring possibilities within a hazardous waste site due to the nature of the job being performed. These emergencies are quick and unexpected and are needed to be attended immediately. The emergency may range from a situation as insignificant as a worker experiencing heat stress, to a situation as intense as a huge explosion in the site.

Any hazard can call for an emergency within a site. Biological agents, chemicals, radiation, and other physical hazards can seed emergencies such as explosions, spills, and toxic atmospheres.

The following are a list of the most probable causes that call for emergency situations:

Worker-Related

- Chemical exposure
- Minor accidents
- Medical problems
- Electrical shock
- Physical injury

Substance-Related

- Leaks
- Fire
- Explosions
- Toxic vapours
- Collapsing containers
- Radiation

The emergencies within a site are evaluated by their potential for generating complex emergencies. One hazard might give rise to another; for example, a fire might break out due to an inflammable chemical spill. Moreover, there is a high chance for the rescue personnel rescuing other victims, to themselves become inflicted by the hazard. These scenarios suggest that advance planning and preparation is essential to tackle an emergency situation within a site.

The important factors to be considered during planning the responses to emergencies has been covered in this chapter. Definitions of the nature of the emergencies along with their types and an outlined contingency plan have been discussed in this chapter.

Planning

In case of an emergency, the actions that are to be taken are decisive in nature. The choices that are made rapidly, may have long-term consequences. Life-threatening

situations may be seeded due to even minute delays in time. There must be a ready availability of personnel to respond spontaneously and rescue the victims.

Planning is an essential aspect for handling emergency situations and thus, a contingency plan must be developed. The contingency plan comprises of written documents that set forth procedures and policies as a response to site emergencies. The following must be incorporated into the contingency plan:

- Personnel
  - Training
  - Line of Authority
  - Roles
  - Communication
- Site
  - Security and control
  - Refuge
  - Mapping
  - Decontamination Stations
  - Evacuation Routes
- First aid/ Medical Assistance
- Equipment
- Reporting
- Documentation
- Emergency Procedures

The following characteristics should be followed by a Contingency plan:

- It should be developed as a separate section of the Site Safety Plan.
- It must comply with and integrate with the disaster, fire, and the pollution response of the geography the site is present in.
- The personnel concerned with the emergency plan must rehearse it regularly during mocks and drills.
- It must be reviewed from time to time in case of changes in the environment or the nature of the job in the site.

The Involvement of Personnel in the Emergency Plan

This phase of the emergency plan comprises not only of the personnel present either onsite or offsite, but also the others like representatives from other agencies, contractors, and visitors.

There is a variety of ways to deploy emergency personnel. The emergency response department can include specialised individuals, small and large teams, or several interacting teams, depending on the requirements of the site.

Onsite Personnel

All the individuals and the teams participating in the emergency response must be identified by the contingency plan and their roles must also be defined by the emergency plan. All the personnel, irrespective of their way of involvement in the emergency response, must be aware of their own responsibilities in case of an emergency. They must also be aware of the authorities and their extent.

Leader

In case of an emergency situation, a single individual must be able to assume control over the decision-making process on the site. This leader must:

- Be selected while creating the emergency response plan. This person may be a project manager, a site safety officer, a field team leader or any other person assuming a leadership role.
- Be supported by a special supporting leader.
- Have enough authority to resolve disputes regarding health and safety concerns.
- Be able to get and buy supplies when necessary.
- Must be supported by the management.

Project Manager

- Gives the direction to the emergency response operation.
- Serves as a contact between government officials.

Site Safety Officer

- Suggests the suspension of an operation that poses a risk to the health and the safety of the workers.
- Invokes evacuation routes, emergency procedures, and calls important contacts such as ambulance, fire-brigade, hospitals, poison control, and police.
- Informs the local public safety officials about the danger.
- Provides first aid on the site.

Command Post Supervisor

- In the case of a rescue operation, notifies support personnel via calls.
- If necessary, helps the Site Safety Officer in the rescue operation.

Rescue Team

- Stays ready, partially dressed in safety equipment to rescue any worker from an emergency.

- Informs about the emergency to the emergency response personnel.

Decontamination Station Officers

- Perform decontamination in emergency situations.

Medical Team

- Treats and transports the affected personnel to local hospitals or clinics.

Communication Personnel

- Links with various service providers for mutual aid.
- Informs the public about the situation in the site.

Environmental Scientists

- Anticipate the outcomes of the cause of the emergency.
- Assess the side effects of the emergency on water present in the environment.
- Determine the risk of toxic gasses.
- Estimate the level of exposure on the people and the ecosystem.

Chemical Experts

- Provide immediate advice in the case of a chemical emergency.

Firefighters

- Attend fires that might have broken out in the site.

Teams

Even if certain individuals may perform certain tasks in the site in case of an emergency, a greater efficiency is achieved by invoking teams rather than individuals. There may be various teams comprising onsite personnel working on decontamination, rescue, entrance and exit, etcetera.

Offsite Personnel

Individual experts such as toxicologists, meteorologists, and other representatives comprise he offsite personnel. These offsite personnel may belong to the organisation owning the site or may be consultants from other organisations or the government. The personnel play a crucial role being part of the advance planning. They must:

- Arrange individual experts for guidance.
- Arrange appropriate agencies for support.
- Alert authorities about the potential emergencies.
- Evaluate the response times and the resources.
- Know the backup facilities.

- Train professionals on hazards and how to tackle them.
- Identify a person to contact in each department in the case of an emergency.

Training

Some level of emergency training must be given to all the personnel working in or around the site as a spontaneous response is necessary in the case of an emergency. A training program should have the following characteristics:

- Directly relatable to the anticipated solutions specific to the site.
- Brief and to the point.
- Pragmatic and realistic.
- Provision for skills to be practised regularly.
- Feature frequent drills.
- Ensure proper maintenance of training records.

All the people entering the site must be aware of the potential hazards and the actions that might instigate a hazardous emergency. They must also know how to deal with an emergency. Any visitors entering the site must be given some elementary training on safety and emergency conditions. This training can include:

- Recognition of Hazards
- Standard Operating Procedures
- Emergency Signalling
- Refuges and Evacuation routes

The on-site personnel who have emergency roles to be performed in emergency situation should thoroughly understand the emergency response. Adequate training must be given to these individuals on the following aspects:

- Signals and the methods of communication
- The chain of command in an emergency
- The process of calling for help
- Evacuation in the case of an emergency while still wearing protective equipment
- Clearing closed places of injured personnel
- The proper usage of off-site support

Certifications in the field of first aid and CPR must be obtained by these persons along with adequate practice in treatment techniques focussing specifically on:

- Identification and treatment of chemical and physical injuries
- Identification and treatment of heat and cold stress

Usually, offsite emergency personnel like ambulance caretakers and firefighters are the first to respond to an emergency and are also as prone to hazards as the onsite personnel.

This personnel must have a good understanding of dealing with emergency situations and how to handle them tactfully.

A lack of knowledge might add to the emergency and might result in manifesting the seemingly minor emergency into a serious one. On the other hand, inadequate information on the onsite chain of command could create confusion and might contribute to delays. The management of the site must provide the offsite emergency personnel with adequate information on the following:

- Hazards specific to the site
- Proper response techniques
- Procedures to be followed in the case of an emergency
- Process of decontamination

The Recognition of Emergency and its Prevention

On a daily basis, every single personnel must be alert constantly for identifying the indicators of a hazardous situation and for identifying the symptoms in themselves and others for warning them of hazardous conditions and contamination. If dangerous situations are recognised spontaneously, an emergency can be averted.

- Meetings should be held before daily work assignments on the following topics:
- Objectives to be completed
- Time Constraints
- Potential Hazards
- Emergency Procedures

A debriefing session should be held after the completion of the daily work for reviewing the accomplished work and the issues faced.

Mapping of the Site

It is necessary to accumulate a detailed overview of the site for advance planning. A sitemap is the most valuable tool to serve this purpose. The sitemap contains a graphical representation of the site along with the documentation of various potential hazards in various places on the site.

An ideal sitemap must show the potential areas for the development of emergencies. The following should be specifically highlighted in the sitemap:

- Hazardous areas
- The terrain of the site
- The routes for evacuation
- Accessibility of the site
- The location of the work crew
- Changes in activities and procedures

- Population outside the site and the potential risk posed to the environment

Planning and training is another area where the map can come in handy. Alternative response strategies and potential emergency scenarios can be pointed out with the help of the sitemap. In case of an emergency, the affected areas must be pinpointed on the sitemap. Furthermore, weather conditions and forecasts can also be added to the sitemap.

Moreover, the design of the emergency plan can also be laid out with the help of the sitemap. The map can be used to identify the following:

- Affected Zones
- Evacuation Routes
- Emergency first aid
- Decontamination
- Command Post Stations

Safe Distances

It is impossible to recommend a one-size-fits-all value for a safe distance, as there is a wide variety of hazardous substances and releases on various site. For instance, a small leak in chlorine may require a safe distance of 140 feet, while a large leak might need an evacuation distance of at least one mile, depending on the environmental factors.

The intensity of the emergency itself determines the safe distance depending on a lot of site-specific factors. However, proper planning on the basis of an assumed estimation can help in emergency situations. The factors influencing safe distances are:

- Toxicity of the substance
- The substance’s physical state
- The volume of the substance released
- The frequency if the release
- The way of the release
- The substance’s vapour pressure
- The substance’s vapour density relative to the outer air
- The speed and the direction of the wind
- The stability of the atmosphere
- The altitude of the release
- The temperature of the atmospheric air
- The topography of the locality

Public Evacuation

If an incident threatens the health and safety of the surrounding population, it is important for the public to be informed of the catastrophe and they also might need to be evacuated

to a safe place. The site management along with the local governing agencies must lay out and plan the actions to be taken in the case of these situations in advance.

Refuges

Onsite Safety Stations or refuges can be constructed for local emergencies that do not need an evacuation of the site. These refuges must only be used when necessary. The refuge must be located in a relatively safe area near the periphery of the Exclusion Zone. Food consumption, liquid consumption, and changes in the air must be prohibited from these refuges. The following are some of the typical elements located in a refuge area:

- Shaded resting area
- Water to decontaminate workers and equipment
- Wind indicator
- Communication system
- Monitoring devices
- Fire Extinguishers
- Bolt Cutters
- Hand tools