MONOGRAPH

EFFECTIVE MANAGEMENT OF OPERATIONAL EXPERIENCE TOWARDS ENHANCED INDUSTRIAL SAFETY

EFFECTIVE MANAGEMENT OF MEDICAL EMERGENCIES AT WORKPLACE

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INDUSTRIAL SAFETY
&
OCCUPATIONAL HEALTH

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Effective Management of Operational Experience towards Enhanced Industrial Safety

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CONTENT

1.0 INTRODUCTION

There is a famous saying – Practice makes man perfect. It intends that learn from your mistakes and avoid them in subsequent attempt which ultimately will lead you to your intended goal. In normal life, human being always try to learn from his own experiences or knowledge he has gained from his ancestors' experience. This principle is equally applicable to our occupational life also. At work, we do receive warnings about any abnormality in advance and if we are able to identify the same with its root cause we have to rectify it. Otherwise it will impact our task. The organizations who understand this, are able to control such activities constructively and those who don't, suffer the consequences of their negligence.

While many industries know how important operational risks are, they still continue to struggle with the best way to identify and manage them. Hence industries of all types and size should have best practices for identifying and managing key operational risks, if they intend to excel in today's dynamic environment. Operational risk management fills this need by providing both the new and experienced operational risk professionals with all of the tools and best practices needed to implement a successful operational risk framework. It contains informative post-mortems on some of the notorious operational risk events of our time and explores the future of operational risk in current regulatory environment.

It has been observed that nearly all industrial accidents were preceded by some warnings and if efforts had been made to understand these warnings and take appropriate countermeasures, it would have been possible to prevent most of them. Hence it is prudent to learn from these warnings/ errors during operation to improve safety of the plant through appropriate changes in the safety culture/ safety management system.

Operational Experience Feedback System

Main requirements of an effective operational experience feedback system include:

a. Reporting of deviations/ events within the plant
b. Reporting and exchange of information among plants and organizations including designers, manufacturers, constructors etc.
c. Storage, retrieval and documentation system for events
d. Screening of events
e. Investigation and in-depth analysis of safety significant events
f. Implementation of actions recommended in assessment and their evaluation
g. Dissemination and exchange of information with other organizations
h. Monitoring of operational experience feedback system
i. Training specific to feedback system

Based on the above requirements, this monograph covers topics related to operational experience feedback system. Chapter 2 deals with the methods used for safety audit and inspection which are important tools being employed by organizations to identify and correct

weakness in their safety culture. Chapter 3 describes aspects related to reporting of safety related deviations (SRDs, while Chapter 4 describes reporting of low level events. In Chapter 5, techniques used for event investigation/ root cause analysis are briefly described with case studies. Chapter 6 details the link between accident investigation and operational experience while Chapter 7 elaborates management of operational experience feedback for improvements in safety management system.

Objective

The objective of this monograph is to highlight importance of periodic feedback of operational experiences for continual improvement in industrial safety and provide practical examples & case studies for better understanding of the reader.

References:

1. Feedback of Operational Safety Experience from Nuclear Power Plants (Proceedings of an International Symposium on Feedback of Operational Safety Experience from Nuclear Power Plants jointly organized by IAEA and NEA of OCED, held in Paris May 16-20, 1988
2. AERB Safety Guide on “Operational Safety Experience Feedback on Nuclear Power Plants” (AERB/NPP/SG/O-13, September 2006)
3. IAEA Tecdoc-596 on “Reviewing operational experience feedback” April 1991

2.0 METHODOLOGY FOR SAFETY AUDIT AND INSPECTION

Safety audits and inspections are one of the important tools to identify the lacunae in safety management system. Findings of the audits/ inspections point out the deficiencies which can be regarded as feedback on the safety management system. Based on this feedback plant management needs to take appropriate corrective actions and evaluate these actions for their effectiveness in eliminating the deficiency. Plant should maintain records of all these activities. Audit findings and corresponding corrective actions should be disseminated to all individuals working in the organization through discussions/ trainings to avoid their recurrence.

A) Safety Audit

A **safety audit** is a structured process whereby information is collected relating to the efficiency, effectiveness and reliability of a company's health and safety management system.

Such safety audits are regarded as one of the responsibilities of the occupier of the company, e.g. Rule 10 (4) and (5) Manufacture, Storage and Import of Hazardous Chemicals (Amendment) Rules, 1994, states that occupier of the industry shall carry out an independent safety audit of the industrial activities and forward a copy of the auditor's report along with his comments to the concerned authority within 30 days after the completion of such Audit.

Generally, safety audits are carried out annually by either one or more representatives of the company itself or independent experts who are not associated with the company. Safety audit includes walk-through of the facility, interaction with management or employees, and reviewing company documentation.

Safety audit is intended to identify the risks and their levels within the workplace, to identify strengths and weaknesses in safety management system, to assess whether the organisation's safety procedures are complying with legal requirements and to evaluate the documentation and practices w.r.t. standard practice and legal requirements.

Safety audits are beneficial because they:

A. Promote constant review of systems to ensure that they do not become weakened by habit

B. Facilitate planned improvements to programs, policies, and procedures

C. Help to identify training needs for workmen.

D. Help to demonstrate management's dedication to health and safety of the employee

Methodology for safety audit

The following steps are adopted for conducting a successful Safety Audit.

Step 1: Preparation for a safety audit

A. Identification of the scope of Safety Audit

Before starting the audit it is important to determine audit team and area or system to be audited. Physical boundary, processes involved, organisation structure and audit criteria/standard are to be predetermined before the audit. For this purpose, it would be essential to study all relevant documents such as operating procedures, equipment maintenance/ inspection manuals etc.

B. Formation of audit team

Safety audit is carried out through multidisciplinary audits team (consisting of 2 to 4 persons) with necessary experience and background to undertake in-depth audit in a particular discipline viz. process, maintenance, electrical, occupational safety etc. One of the team members is nominated as the leader of the audit team. A diverse team can give broader audit perspective.

Some organisations hire external consultants specialised in safety auditing while others utilise the services of an internal auditing team comprised of experienced individuals from different areas of the company. It needs to be ensured that that every audit team member knows audit procedure very well.

C. Preparation of safety Audit checklists

Checklists is a very useful tool for systematically carrying out the Safety Audit. A detailed model checklist covering important areas and the audit criteria requirements is prepared before each audit.

Step 2: Conduct the safety audit

During the audit, written plans, procedures and other documents should be reviewed, which can help auditors to establish a baseline to compare the written process with actual action. Part of this review includes looking for strengths and weaknesses in the procedures - both in what is laid down and what is actually followed at the shop floor.

Interaction with the operating personnel in workplace provides additional insight to the audit, as they operate the process regularly and they can explain not only how things operate, but also what works well and what could be done differently.

Some audit teams use checklists during audits while others simply take notes on their observations. Since audits are specific to the organisation and are designed to meet the objectives that the organisation has established, it is up to the organisation to determine which methods work best for capturing the information. The following steps are normally followed during the course of conducting the audit.

A. Opening meeting with the management

Safety audit begins with an opening meeting with the management, where the Audit Team Leader explains the audit methodology and reporting process.

B. Audit activities

- Physical 'Walk Through' for basic assessment including task observation
- Document review
- Sample selection & interviewing

C. Audit coverage

General safety aspects such as management system adopted for health & safety, chemical safety, machine safety, emergency preparedness, accident/ incident reporting and analysis are covered in the safety audits along with other aspects related to process safety, maintenance safety, fire safety etc.

D. Closing meeting with management

Before finalising the report, the audit team makes a feedback to the operating/management personnel of the area/installation regarding findings of the audit and recommends corrective actions accordingly, for compliance.

Step 3: Submission of report

After the audit, team members summarize their findings in a report. A good audit report is objective and concise, includes both positive and negative findings. In addition to the findings, a report includes a list of recommended actions and areas for improvement, based on the audit findings.

Step 4: Prioritise the corrective action

Based on the safety audit reports the plant management needs to prioritize corrective actions. The plant management may consult the audit team to set priorities based on the level of hazard each finding presents. Deficiencies with higher risks should be given most priority over items with lower risks.

Step 5: Dissemination of audit findings

Safety audit findings in terms of report should be made available to employees to make them aware about the risks involved and necessary steps to avoid them. Plant management should encourage its employees to report any observation similar to the audit finding and should initiate corrective actions.

Safety audits examine whether programs and strategies are meeting a company's goals while *Safety inspections* look for hazards, risks, and other tactics that might prevent a company from operating safely.

B) Safety Inspection

It is a formalized and documented process of identifying hazards in the workplace. It generally compares the findings/observations against legal requirements and acceptable standards to ensure that a given work environment falls within acceptable safety limits.

A safety inspection is generally carried out by safety professionals or persons having adequate knowledge on work related safety to identify potential hazards and violation / deviations from the legal requirements / standard practices.

Safety inspections are carried out by following the standards checklists that help the inspectors to thoroughly assess each area for potential hazard and identify the instances that may cause safety issues.

Work Place Inspection

The work inspection team involves health and safety professionals, managers, supervisors, and members of health and safety management committees. The inspection process mainly focuses on four key areas:

- People - Workers, their behaviour and working methods
- Plant - Machinery, equipment and vehicles
- Premises - The workplace itself and the working environment
- Procedures - Standard operating procedures, maintenance procedures, safety work permit system etc.

The frequency of inspection depends upon the nature of work being done, the materials, substances and equipment involved in the work process and the procedures being followed. Depending on these factors, inspections may be carried out daily, weekly, monthly, bi-annually or annually.

Inspections reveal potential workplace hazards. Once these hazards are identified, they can be properly addressed. Therefore, it is very important that inspections be part of a company's safety/loss prevention program.

Workplace hazards can cause damage to worker, environment and property of the company. Accidents are a disruption to daily operations, and this in turn reduces operational efficiency. Thus unsafe acts and unsafe conditions that are observed should be addressed as soon as possible.

Safety Inspections help to:

- ♦ Maintain a safe work environment
- ♦ Control unsafe acts and conditions
- ♦ Ensure operational efficiency
- ♦ The inspection process seeks to identify potential causes of incidents or accidents, which is the first step in their prevention.

Safety inspections can be carried out by a team comprised of authorized personnel having experience in respective fields which are to be inspected.

Examples of area wise work inspection checklists are as follows:

A) Emergency Equipment (say First Aid Box)

1. Is the first aid kit placed at appropriate place and properly protected?
2. Is it containing the items as per the list kept in the box?
3. Is it having the instructions book?
4. Are all components replaced as needed (some first aid kit items have expiration dates)?
5. As appropriate, have employees received first aid/CPR training?

B) Fire Safety

1. Whether fighting equipment are provided in adequate numbers?
2. Are the firefighting equipment being regularly inspected, serviced, and ready for use in the event of an emergency?
3. Whether employees been trained in use of the firefighting equipment?
4. Whether fire exit points are marked and clearly visible?
5. Whether Emergency Contact numbers are displayed at prominent locations?
6. Whether standing Fire Order has been prepared for the organization and available at important locations?
7. Whether any instruction exists forbidding the use of elevators in case of fire in the building?
8. Whether fire exit point are marked with self-luminescent stickers or provided with lamps connected to UPS?

C) Containers of hazardous materials/Chemicals

1. Whether the container of hazardous materials s have any leak? (Be sure to check around joint flanges, gaskets, plugs and valves, if the containers are so equipped.)
2. Whether any “No Smoking” display provided in the nearby of the containers.
3. Whether the containers must be properly labeled? (Replace the damaged /faded labels)
4. Whether the Hazardous material containers have spill containment (referred to as secondary containment)? (It is generally acceptable to keep one or more hazardous material containers in a secondary containment area.)
5. Whether the secondary containment is capable of holding 1.5 times the volume of the largest container within the secondary containment area?

D) Electrical Safety

1. Whether the electrical cord of portable tools are frayed?
2. Whether patched cords in use?

3. Whether ground/earth connection not provided / removed?
4. Whether cords with damaged connections are in use?
5. Whether outlets not covered?
6. Whether power supply panels left open?

E) Building Safety

1. Are exit pathways clear?
2. Are the rails sturdy?
3. Are treads, risers, etc., in good condition?
4. Is area properly lighted for emergency use?
5. Whether Emergency Light point(s) provided especially at the EXIT points?
6. Whether any tripping hazard exists on the floor(s)?
7. Whether illumination level is adequate (both interior and exterior)?
8. Whether there is any leakage / seepage from the ceiling that can create environment for growth of mold?
9. Whether the leakage / seepage point is in close proximity to electric fittings / lighting?

A sample checklist has been provided at the end of this chapter for information.

It is always advisable to prepare checklists for different work areas/ locations covering all the likely hazards and should reflect actual work conditions. After completion of the inspection, finding are summarized in a report along with corrective actions based on the review by inspectors.

Corrective Action:

Both unsafe conditions and unsafe acts should be corrected as soon as possible. Corrective action should be appropriate to the situation. It should be timely and effective. In this method also actions can be prioritize based on the hazard potentials of the deficiencies.

Unsafe conditions must be addressed within a reasonable time period. A follow-up inspection may be necessary to ensure that unsafe condition has been rectified.

When possible, employees should be involved in the inspection process. By virtue of their experience/ task knowledge, they are often able to develop safer, more efficient processes.

Safety inspection also contribute in periodic feedback on the operational experience related to various occupational safety aspects such as process training of employees, safety procedures and their implementation etc.

SAMPLE SAFETY INSPECTION CHECKLIST

NAME OF AGENCY/OFFICE: _____

Area(s) Inspected: _____ **Inspected by:** _____ **Date:** _____

ITEM	YES	NO	CORRECTIVE ACTION – DATE
1. Is there litter or spilled liquid on the floor?			
2. Are floor surfaces chipped: does carpeting show worn spots or holes?			
3. Are warning signs posted near cleaning areas, repair work or redecorating efforts?			
4. Are aisles free of boxes, wastebaskets, chairs, and other obstacles that impede traffic?			
5. Are restrooms kept clean and floors dry?			
6. Do cords present a tripping hazard?			
7. Do cords look frayed?			
8. Are cords draped over hot pipes and/or appliances?			
9. Are flimsy extension cords in use?			
10. Are all appliances connected with three-pronged plugs?			
11. Are electrical outlet boxes or bonnets exposed so that they present a hazard?			
12. Are cover plates for electrical switches or receptacles cracked or broken?			
13. Do employees stand on chairs, desks, boxes, drawers, or other improvised ladders?			
14. Do employees lean way back in chairs with their feet off the floor?			
15. Do employees put tops on cups of coffee or other liquids while carrying them through the office?			
16. Do employees run in the office?			
17. Are stairwells well lit?			
18. Are stairway handrails, treads and/or risers in good condition?			
19. Are stairs free of litter, spills or clutter?			
20. Are desk or file drawers left open?			
21. Are files, lockers, cabinets, and bookcases bolted securely?			
22. Is more than one file drawer open at once?			
23. Are files top-heavy with empty drawers at the bottom and full drawers on top?			
24. Are transparent glass doors marked so they can be seen?			
25. Must employees step up or down to go through a doorway? If so, is a warning sign posted?			

3.0 REPORTING SYSTEMS FOR SAFETY RELATED DEVIATIONS (SRDS)

A hazard is any actual or potential condition that can cause injury, illness, or damage to property and/or the environment. Reporting of safety related deviation is one of the methods to identify a hazard and rectify it appropriately. This reporting can be achieved through safety audit and safety inspection but reporting of SRDs by employees plays an important part too.

Particular attention is to be paid to Safety Related Deficiencies that are or are most likely to develop into unsafe or unhealthy conditions because of factors such as chemical reaction, corrosion, vibration, heat, stress or impact as individual or combination of factors etc.

To identify SRDs work place elements like the people (employees), work environment (which includes noise, vibration, illumination, temperature, and ventilation), equipment, materials and process need to be carefully assessed. Here the process means how the worker interacts with the other elements in a series of tasks or operations.

Typical Safety Related Deficiencies include

- Hazards due to unsafe workplace conditions e.g. inadequate machine guards.
- Hazards due to unsafe practices e.g. negligence of operators towards safe practices and use of shortcuts
- Chemical hazards caused from solid, liquid, vapour, gas, dust, fume or mist.
- Ergonomic hazards caused by physiological and psychological demands on the worker, such as repetitive and forceful movements, awkward postures arising from improper work methods, and improperly designed workstations, tools, and equipment.
- Inherent physical hazards caused by noise, vibration, energy, weather, heat, cold, electricity, radiation and pressure etc.

Safety Related Deficiencies (SRDs) reporting system

There are many techniques used in industry, all developed through a systematic safety approach, to reduce hazards. It is obvious that all risks cannot be eliminated. Furthermore, it is just as easy to over-analyse a problem as it is to neglect some meaningful analysis.

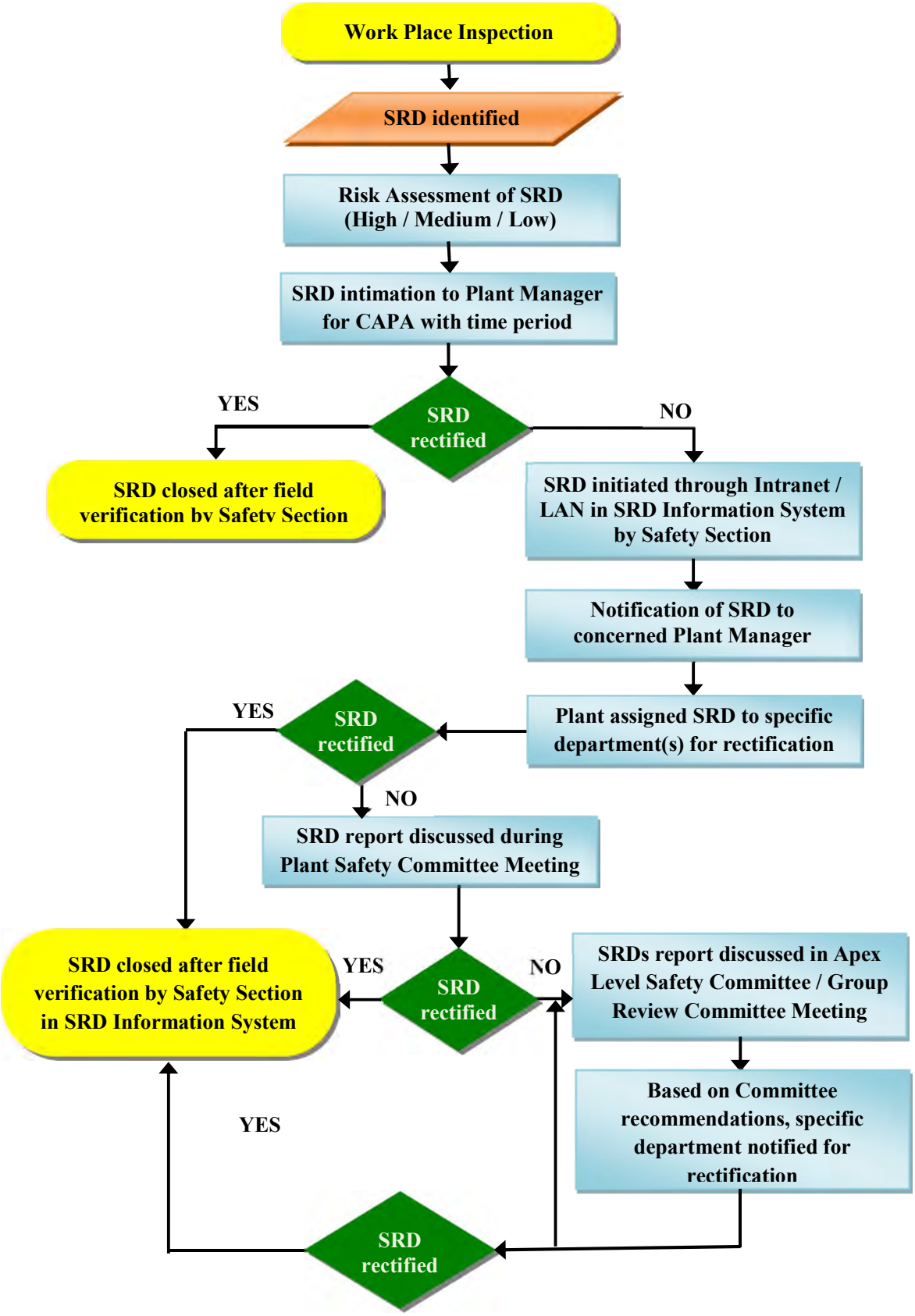
The Hazard/ deficiency reporting and tracking process is used to ensure that all hazards associated with plant operations are discovered, addressed, and the risks minimized to the fullest extent practical. The process is established to eliminate hazards, reduce them to an acceptable level of risk, or present them to management for further analysis.

Methodology of Safety Related Deficiencies (SRDs) reporting system:

1. **Hazard Identification:** A majority of the hazards are identified by shop-floor employees as they go about their daily work routine and through periodic workplace inspections using plant checklists. Plant safety inspection checklist may cover areas like machine guarding, firefighting systems, emergency escape routes, compliance to statutory requirements etc.

2. **Risk Assessment Matrix:** The purpose of this matrix is to correlate hazard severity to probability.
3. **Safety Related Deficiencies Tracking:** A computer based system may be employed for communicating SRDs. The system may be called as "Safety Related Deficiencies Information System". In this system, identified officials like safety officers may be authorized to log SRDs with risk criteria.
4. **Management Review:** The reported SRD's are communicated to the concerned officials through above system. Based on the SRD prompt action is initiated and on completion of the same, a closure report for the deficiency may be generated for record purpose. An authorized person/ section can maintain records related to SRDs. Pending SRDs should bbe reviewed in different organization levels/committees for implementation of corrective and preventive actions to avoid untoward incidents. Outline of the typical Safety Deficiencies Report Process is depicted in the following figure 3.1.

Fig. 3.1 Outline of the typical safety deficiencies reporting system



4.0 REPORTING AND INVESTIGATION OF LOW LEVEL EVENTS SUCH AS NEAR MISS ACCIDENTS, FIRST AID INJURIES ETC.

Accidents do not happen, they are caused. Causes should be removed to eliminate accidents. It is a misnomer that accidents just happen. Any accident is preceded by many low level events that could have acted as warnings for future. This fact has been highlighted by review of industry operating experience. Employers that encourage the reporting of near misses gain an opportunity to prevent future incidents.

A Low Level Event such as Near Miss Accident or First Aid Injury can be defined as an unplanned and undesirable occurrence due to unsafe act or unsafe condition or both, that may or may not lead to an incident/ accident but has the potential to result in an incident/ accident in future. Low level events have potential to cause personal injury, damage to property, loss of productivity and environmental damage. Event reporting is required to prevent their recurrence.

As per H. W. Heinrich's 300-29-1 model (1931), for every accident that causes a major injury in a workplace, there are 29 accidents that cause minor injuries and 300 accidents that cause no injuries.

As per Frank E. Bird model (1961), for every major injury, there are 10 minor injuries, 30 accidents causing property damage and 600 accidents with no injury or damage.

As per Conoco Phillips model (2003), for every fatality, there are approximately 300,000 At-risk behaviors.

Thus it can be concluded that a large enough number of unsafe acts eventually result in a fatality.

Low Level Events (LLEs) provide a much larger base for more effective control of accidental loss. There is a need to shift from reactive to proactive approach. By eliminating the causes of near misses, the potential for more serious accidents is drastically reduced and this is the basis of any proactive safety management system. High potential incidents should be analyzed thoroughly.

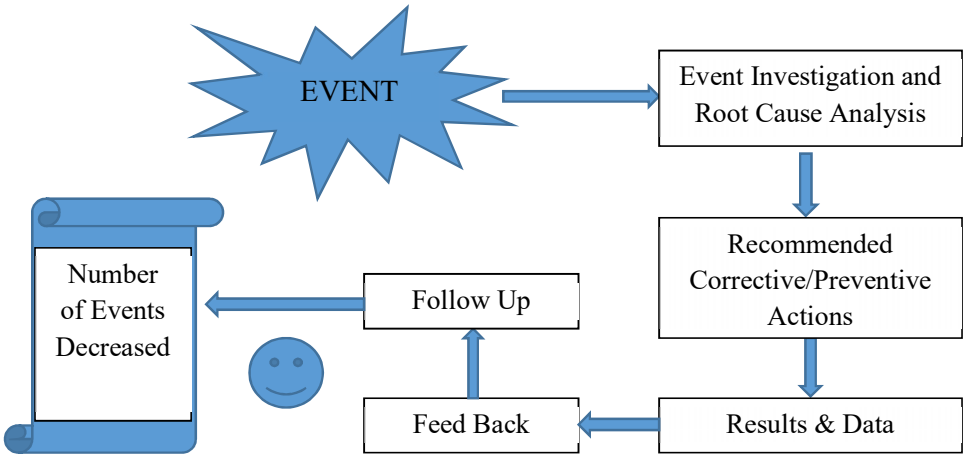
Low Level Events must be reported to promote their investigation to find out how and why it happened. Corrective actions should be taken to minimize or eliminate the chances of recurrence of the same event. By event reporting system, management and workers will become aware of possible hazards that need to be removed for improving the work environment. The purpose of event reporting is not to fix the blame. It is conducted to obtain information.

There are many reasons as to why employees are reluctant to report accidents. Sometimes it is the fear of getting blame, fear of retribution and being labeled unfairly. Sometimes they face pressure not to report from their seniors. But many times they fail to understand the significance of the accident. Employees should be sensitized to report event at all times even if it is a minor one.

Event reporting establishes the facts as ‘Who or what was involved? What went wrong? Where it happened? When it happened? What hazards were present? What controls failed? What could have happened? Consequential events can be summarized to identify root causes, describe other weaknesses, identify corrective/preventive actions, allocate responsibility and timescale. When an accident or incident occurs, initial response is from supervisor/ site in charge who takes actions as per safety plan. This involves first aid, informing management, preparing report with witness and forwarding to safety section. Safety section investigates the incident/accident by interviews, photographs etc. Accident Analysis helps in finding causes and preventive measures are recommended.

5.0 EVENT INVESTIGATION

This chapter provides guidance on how to effectively conduct a comprehensive event investigation using Root Cause analysis (RCA), and develop appropriate corrective measures with the purpose of preventing or reducing the probability of similar events occurring in the future. A typical event investigation model is simplified below:



Pre-requisites

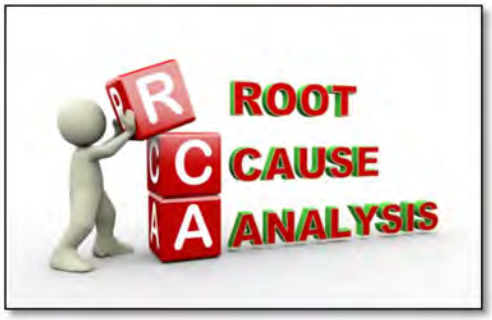
a. The organisation should have the approved written procedure for event investigation, defined roles and responsibilities of the participating personnel and time limit for an analysis/investigation.

b. A committee should be constituted and made responsible for initiating and performing investigation of the event.

c. The review committee consists of management personal should review and approve the results of the event investigation and authorises subsequent actions.

d. The root cause investigators should be proficient in the use of internationally recognised Root Cause Analysis methods and tools.

Root Cause Analysis



Root Cause Analysis (RCA) is a problem solving method aimed at identifying the root causes of problems or events. Root Cause Analysis is based on the principle that problems can best be solved by correcting their root causes as opposed to other methods that focus on addressing the contributory causes/ symptoms of problems. Through corrective actions, the underlying causes are addressed so that recurrence of the problem can be minimized. It is ideal to think that a single corrective action will completely prevent recurrence of the problem. This is why root cause analysis is often considered to be an iterative process.

Root Cause Analysis is used as a tool for continuous improvement. If a Root Cause Analysis is used for the first time, it is a reactive way of identifying and solving problems. This means that an analysis is performed after a problem or incident has occurred. By gaining experience with root cause analysis, its use changes from reactive to proactive, so that problems can be anticipated in time. Root Cause Analysis is not a strictly defined methodology. There are many different tools, processes and philosophies that have been developed based on Root Cause Analysis.

The main applications of RCAs are:

1. To identify the root cause of an Accident/Event Analysis.
2. To identify the root cause of the quality and manufacturing issues.
3. To identify the root cause of the Process based issues/problems.
4. To identify the root cause of the equipment/machineries.
5. To identify the root cause of the system.

Despite the fact that there seem to be no clear definition of the differences in the objectives among the various applications, there are some common principles that can be considered to be universal. It is also possible to define a general process for performing Root Cause Analysis.

Steps to carry out the RCA

a) **Identify the event to be investigated and gather preliminary information**: Events and issues can come from many sources (e.g. incident report, risk assessment, Job Hazard Analysis). The facility should have a process for selecting events that will undergo an RCA.

b) **Describe what happened:** Collect and organize the facts surrounding the event to understand what happened.

c) **The situations, circumstances or conditions that increased the likelihood of the event are identified**: Gather the information on the incident/event and interview the witnesses and assess.

d) **Identify the root causes:** A thorough analysis of contributing factors leads to identification of the underlying process and system issues (root causes) of the event. The RCA tool/technique to be chosen according to the nature of the event.

e) **Approve the Investigation Report:** The investigation report and the root causes shall be approved by the management.

f) **Design and implement corrective/preventive action to eliminate the root causes:** The management will direct the concerned to change processes and systems to reduce the likelihood of another similar event.

g) **Review of changes:** After implementation, review the changes or preventive actions periodically.

Root Cause Analysis Tools/Techniques

There are several techniques available for identifying the root cause of an event. In this chapter the following tools and techniques widely used by DAE units to identify the root cause of an event are described:

1. Interviewing
2. Task analysis
3. Pareto Analysis
4. Cause and effect analysis
5. Fault tree analysis
6. Event tree analysis
7. 5 Whys
8. Failure Mode and Effects Analysis
9. Psychological and Physiological Evaluation

According to the nature of an event/incident, the tools shall be selected to identify the root cause.

1. Interviewing

Interviewing is face-to-face communication between event investigator and witnesses to obtain facts pertinent to an issue or an event. In order to obtain pertinent information from the interviewees it is necessary to consider the respondents sensibilities. For this reason the interviewer requires special training.

The important aspects of the interviewing tool are:

- The interviewee shall be treated well and they shall feel comfortable
- Interviewing is an important tool for data gathering and is used for all investigations
- Focused on fact-finding not fault finding
- Need a no-blame culture
- Requires a degree of skill on the part of interviewer
- To be done as soon as possible: facts become less clear, memory is lost and opinions established as time passes
- Some direct witness may not always be available, you may have to select others
- Collaboration between interviewees should be avoided prior to the interview

- Not all interviewees would necessarily be directly involved in the event (e.g. work planning, supervision, etc.)
- There should not be a close relationship (professional or personal) between interviewer and interviewees.

Methodology

1. The event investigator/ interview team shall have the maximum information about the event.
2. The even investigator shall prepare a questions well in advance.
3. The optimum time for holding the interview is between 2 and 72 hours after the event.
4. Make sure that the right people are selected for interview.
5. The interview should take place in a quiet, relaxed setting and where no interruptions occur.
6. Need not to ask tricky and straight question. Questions shall be broad and leading to specific information.
7. Never interrogate the interviewee. They shall be treated amicable.
8. The interviewee should be encouraged to provide any additional information that may assist the interviewer in the inquiry.
9. No assumptions shall be made. Ask for clarifications.
10. Contradictory information provided by the interviewee must be considered as perceptions which may be important in the investigation.

On completion, the interviewer should ensure the interviewee feels the interview was objective. The interviewer should reconfirm what will happen with the information aimed from the interview and how this will be used in the RCA process.

Record the Result

The questions and the statements of the witnesses shall be recorded and correlate with the event and the root cause of an event may be arrived after a brainstorming by the team.

Application

This will facilitate to collect the first hand information about the event and helps to analyse in detail by using other means of techniques.

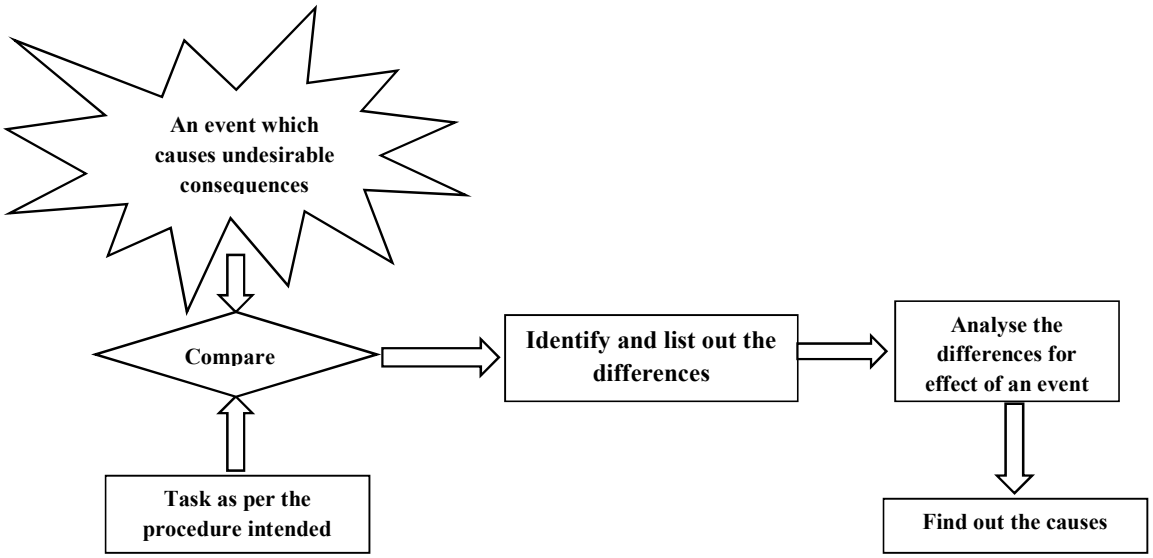
2. <u>Task analysis</u>

Task analysis (TA) aims at providing a better understanding of what is exactly involved in carrying out an activity when performed correctly. TA involves collecting data about the operational procedures for performing a particular task, as well as collecting information about some additional aspects of the tasks such as the job conditions, the required skills and knowledge, safety and environmental factors, references, equipment, etc.

Methodology

a. The first part of task analysis, how the task should have been performed can be a studied by reviewing procedure and other documents. Task analysis using paper and pencil provides investigators with a good insight of the task, helps to identify questions to use later for interviewing. It is useful for analyst not familiar with the task.

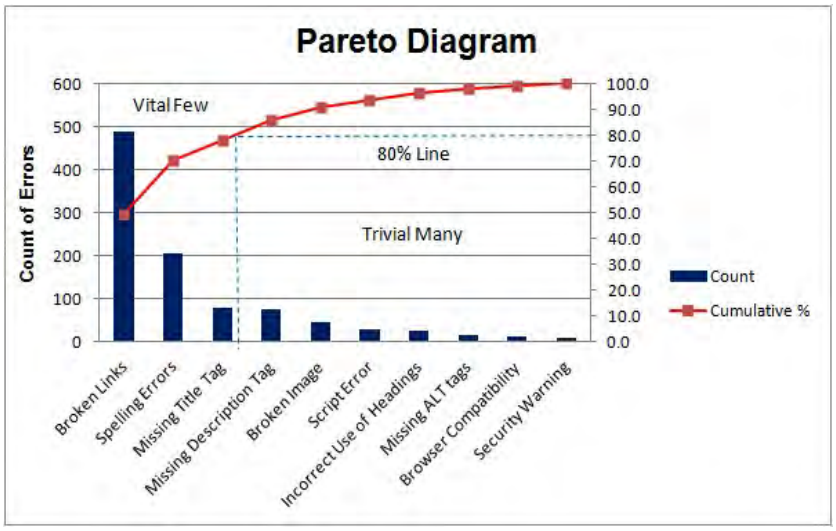
b. The second part of task analysis, how the task was actually performed is almost always used as an investigation tool of human performance issues involved in events. It is absolutely critical to view the event from the standpoint of the individuals involved in the event. To accomplish this goal one must be able to stand in the shoes of the individuals involved. It is almost impossible to recognize many of the human factors and environmental issues without walking through the event and these issues typically play a significant role in events in nuclear power plants.



Task Analysis Steps

3. Pareto analysis

The Pareto Analysis, also known as the Pareto principle or 80/20 rule, assumes that the large majority of problems (80%) are determined by a few important causes (20%). It is a creative and practical way of looking at the causes of problems. It stimulates ideas about thinking and organizing. This method of analysis helps identify



the main causes (20%) that lead to 80% of the problems that need are to be solved. As soon as the main causes have been identified, the diagnostic techniques such as the Ishikawa diagram or fishbone analysis can be used to identify and address the deeper causes of the problems.

Methodology

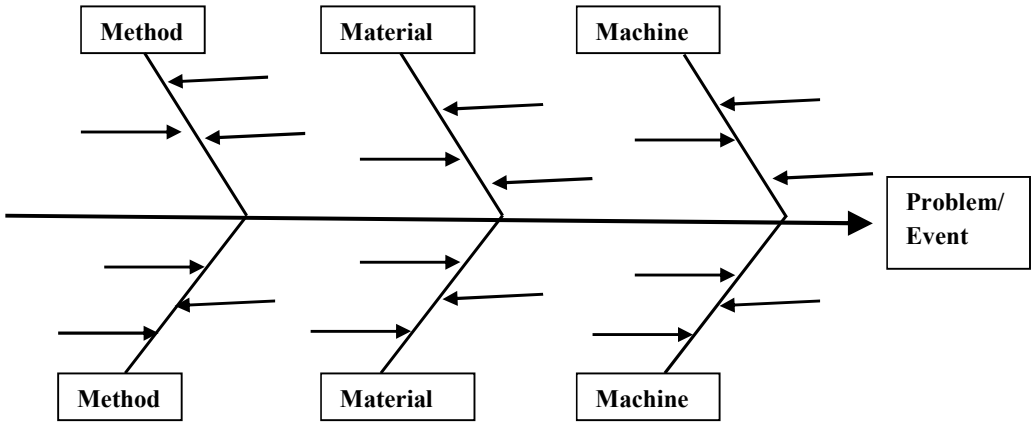
In order to apply the Pareto analysis in practice some basic steps have been defined which can be followed to arrive at a thorough analysis. Here are eight steps to identifying the principal causes you should focus on, using Pareto Analysis:

1. Create a vertical bar chart with causes on the x-axis and count (number of occurrences) on the y-axis.
2. Arrange the bar chart in descending order of cause importance that is, the cause with the highest count first.
3. Calculate the cumulative count for each cause in descending order.
4. Calculate the cumulative count percentage for each cause in descending order. Percentage calculation: {Individual Cause Count} / {Total Causes Count}*100
5. Create a second y-axis with percentages descending in increments of 10% from 0 to 100%.
6. Plot the cumulative count percentage of each cause on the x-axis.
7. Join the points to form a curve.
8. Draw a line at 80% on the y-axis running parallel to the x-axis. Then drop the line at the point of intersection with the curve on the x-axis. This point on the x-axis separates the important causes on the left (vital few) from the less important causes on the right (trivial many).

4. <u>Cause and Effect Analysis (Fishbone Diagram)</u>

The purpose of this tool is to identify root causes by examining the relationship between cause and effect. It is performed by asking successively what effects have occurred and why, and proceeding from the last failure/deficiency backwards to find the cause.

Using the cause and effect tool is simply starting with the most significant event and determining the cause(s) of it. The cause(s) for this event's cause(s) are then determined, and this chain of events and causes is continued until no other causes can be determined.



These causes are then verified by determining if the root cause criteria have been met. On the basis of information gathered, the Cause and Effect Diagram (CED), also known as the Fishbone Diagram, can be created. It is a tool to graphically identify and organize many possible causes of a problem (effect) based on pre-defined classification of possible causes. The Fishbone diagram is an initial step in the screening process.

Methodology

- While creating the CED, the main issue should be written in a box that is typically in the centre of the right edge of the page.
- A line called the 'spine' or 'backbone' extends to the left starting from the edge of the main box.
- Branches angle off of the spine, each representing a cause or effect of the main issue.
- Each of these branches may contain additional branches.
- After identifying potential root cause(s), further testing will be necessary to confirm the true root cause(s).
- This methodology can be used on any type of problem, and can be tailored by the user to fit the circumstances.

The attributes of the cause and effect analysis are:

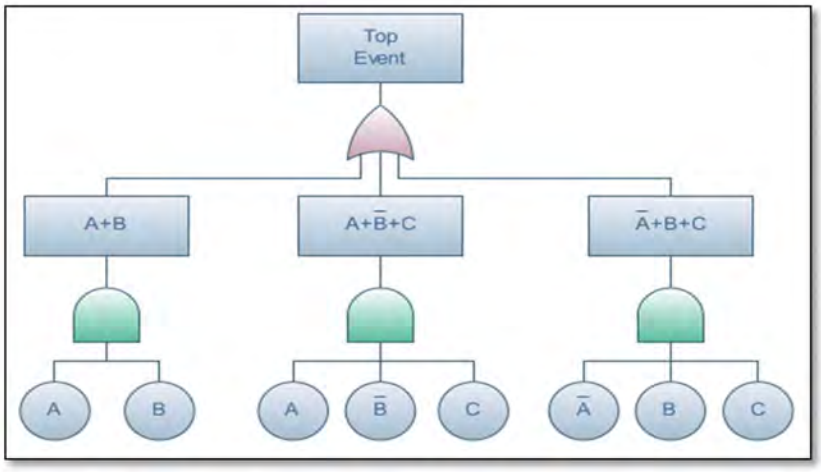
- Successively ask and answer the why question;
- Where to stop: Stop to the farthest cause that can be corrected within the operating organization;
- Arrives to the underlying cause of an event in a very direct manner;
- Similar to a fault tree analysis but showing only the actual failed branches.

Application

A cause and effects analysis is often used in addressing events initiated by both human performance and equipment failures. For most events initiated by human performance issues, it is usually easier to use this tool later in the event investigation. Because of its logic and relationship aspects, a cause and effect analysis does not lend itself to use as one of the primary investigation tools for human performance issues. Human performance issues often have multiple influences on the event and often cannot be clearly specified until late in the investigation.

5. Fault Tree Analysis

The fault tree analysis (FTA) is one of the most widely used methods in system reliability, maintainability and safety analysis. It is a deductive procedure used to determine the various combinations of hardware and software failures and human errors that could cause undesired events (referred to as top events) at the system level.



The deductive analysis begins with a general conclusion, then attempts to determine the specific causes of the conclusion by constructing a logic diagram called a fault tree. This is also known as taking a top-down approach.

The main purpose of the fault tree analysis is to help identify potential causes of system failures before the failures actually occur. It can also be used to evaluate the probability of the top event using analytical or statistical methods. These calculations involve system quantitative reliability and maintainability information, such as failure probability, failure rate and repair rate. After completing an FTA, you can focus your efforts on improving system safety and reliability.

Methodology

Define the undesired event to study.

1. Once the undesired event is selected, all causes with probabilities of affecting the undesired event are studied and analyzed.
2. After selecting the undesired event and having analyzed the system so that we know all the causing effects (and if possible their probabilities) we can now construct the fault tree. Fault tree is based on AND and OR gates which define the major characteristics of the fault tree.
3. After the fault tree has been assembled for a specific undesired event, it is evaluated and analyzed for any possible improvement or in other words study the risk management and find ways for system improvement. A wide range of qualitative and quantitative analysis methods can be applied. This step is as an introduction for the final step which will be to control the hazards identified. In short, in this step we identify all possible hazards affecting the system in a direct or indirect way.
4. After identifying the hazards all possible methods are pursued to decrease the probability of occurrence.

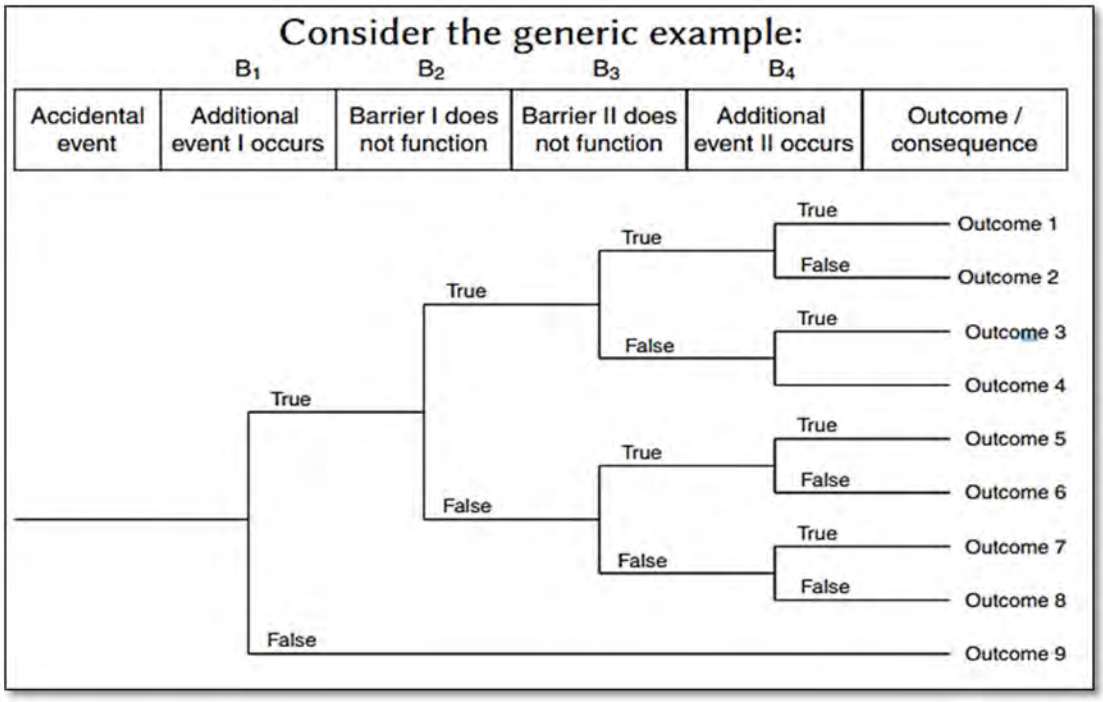
Application

FTA is recommended for evaluating events involving equipment failures but it could be used for analysis of human performance-related events also. If used early, it can help identify areas to initially focus on during the investigation. The fault tree can then be annotated to track the progress of the investigation as possible failure paths are eliminated from consideration. The tree may also be used near the end of an investigation to ensure all possible scenarios have been covered. Fault trees could be really useful for troubleshooting reoccurring problems,

such as quality defects, because such problems tend to have a common set of causes and sub causes.

6. Event Tree Analysis

Event Trees are one of the most widely used methods in system risk analysis. It is an inductive failure analysis performed to determine the consequences of single failure for the overall system risk or reliability. Event Tree Analysis uses similar logic and mathematics as Fault Tree Analysis, but the approach is different - FTA uses deductive approach (from system failure to its reasons) and ETA uses the inductive approach (from basic failure to its consequences). An event tree itself is a visual representation of single failure sequences, its



influence on other events and on the whole system:

The purpose of this tool is to identify potential outcomes from an initial event. An event tree analysis (ETA) is an inductive procedure that shows all possible outcomes resulting from the initiating event and additional occurrences or factors. It takes into account whether installed safety barriers are functioning or not. Design and procedural weaknesses can be identified, and probabilities of the various outcomes from an accidental event can be determined. Event tree models can be developed as standalone, and also in combination of event tree - fault tree models for more complex event progression scenarios.

Methodology

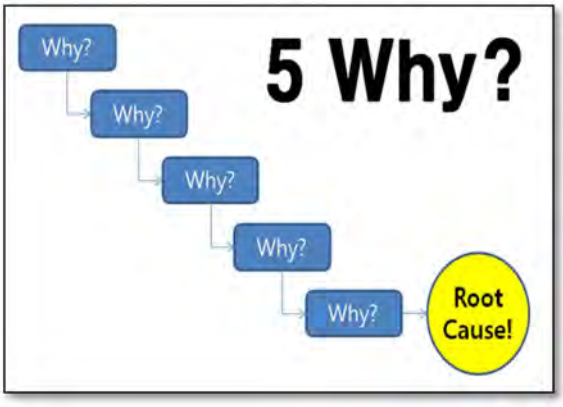
- Identify (and define) a relevant initial event that may give rise to unwanted consequences. It is always recommended to start with the first significant deviation (system or equipment failure, human error or process upset) that may lead to development of undesirable occurrence. For each occurrence the following are identified: a) the potential progression(s); b) system dependencies; c) conditional system responses.

- Identify the barriers that are designed to deal with the event. The barriers that are relevant for a specific event should be listed in the sequence they will be activated. Examples of barriers include automatic detection systems (e.g. fire detection), automatic safety systems (e.g. fire extinguishing), alarms warning personnel/operators, procedures and operator actions, mitigating barriers. Additional occurrences and/or factors should be listed together with the barriers, as far as possible in the sequence when they may take place.
- Construct the event tree constructing starts by an initiating event (not the final event), depicting by separate branches of a tree what happens if the line of defence is successful (S) or fails (F). Branching stops when a significant consequence or concern is identified.
- Describe the (potential) resulting sequences.
- Determine the frequency of the event and the (conditional) probabilities of the branches in the event tree.
- Calculate the probabilities/frequencies for the identified consequences (outcomes).
- Compile and present the results from the analysis.

Application

Event tree analysis is a tool used to help in assessing safety significance of the event both in Root Cause Analysis and in probabilistic safety analysis. Event tree analysis is useful in quantitatively determining the probability of the different consequences when the probability of each line of defence is known. It allows analysis of dependencies between various factors and 'domino effects' that are difficult to model using fault trees, and allows for determining the effectiveness of possible corrective actions to prevent recurrence by quantitative analysis of possible future failures if proposed corrective actions were to be implemented.

7. The 5 Why's Analysis



The '5 Whys' is a questions-asking technique used to explore the cause/ effect relationships underlying a particular problem. Ultimately, the goal of applying the 5 Whys is to determine a root cause of an issue or problem.

This procedure involves asking 'Why?' five times in succession. A true root cause can follow a series of 'therefore' statements backwards up through the 5 why analysis. The investigator should ask 'why?' until he goes outside of the scope of the investigation or until fixing the cause is beyond the control or desire of the organization. Although many root cause processes attempt to dictate the number of 'why's' that should be asked, 'why' needs to be asked until fixing the issue becomes prohibitive from a business or realistic perspective. The questioning 'Why?' could be continued further to a sixth, seventh, or even greater level. The investigator should be encouraged to avoid assumptions and logic traps and instead to

trace the chain of causality in direct increments from the effect through any layers of abstraction to a root cause that still has some connection to the original problem.

Methodology

First Why: 1st Why must be a short, concise sentence that plainly explains the reason. Do not try to justify it, there will be time to do that later on in the following why's if it is pertinent to the thought process. It is Okay to write it down even if it seems too obvious for you. (It may not seem that obvious to other persons that will read the document).

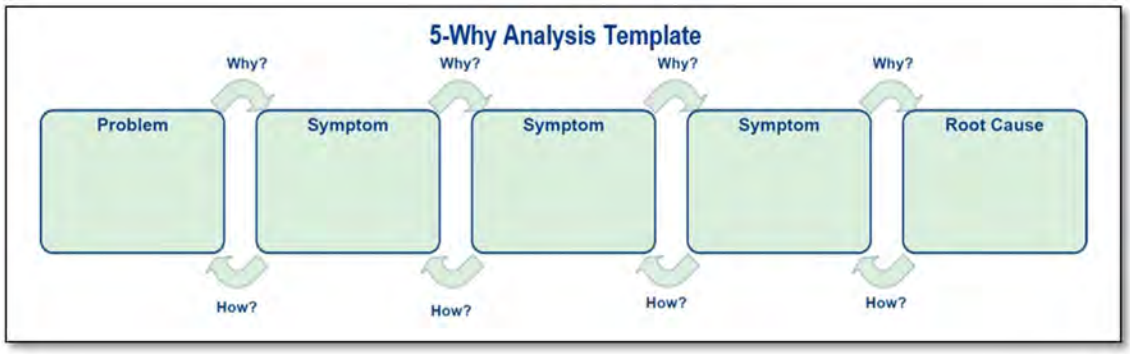
Second Why: A more concise explanation to support the first statement. Get into the technical arena, the explanation can branch out to several different root causes here. It is OK to follow each of them continuing with their own set of remaining 3 why's and so forth

Third Why: This 3rd why is critical for a successful transition between the obvious and the not so obvious. The first two why's have prepared you to focus on the area where the problem could have been originated; the last three why's will take you to a deeper comprehension of the problem. Visualize the process where the product went through (process mapping) and narrow down the most likely sources for the problem to occur.

Fourth Why: Clear your mind from preconceived explanations and start the fourth why with a candid approach. You may have two or more different avenues to explore now, explore them all. Even if one or several of them turn out not to be the root cause of the problem, they may lead to continuous improvements. This is a good time to include a Cause and Effect analysis and look at the 5 M's.

Fifth Why: When you finally get to the fifth why, it is likely that you have found a systemic cause. Most of the problems in the process can be traced to them. If you have reached the fifth why and you are still dealing with process related cause(s), you may still need one or two more why's to deep dive into the systemic cause.

Application



This technique can be used for all types of events to identify organizational weaknesses, simple technique, used to challenge the causes find with other techniques. If an investigator knows how to ask good, successive 'why' questions, and is able to ask them to the right people, he or she will find at least one root cause for a given problem. This approach takes little time to perform – as few as five minutes can be used to perform a 5Why analysis. If it is performed repeatedly with the same group of people in a sound manner, its use can lead to a new way of thinking amongst those people that have been exposed to the tool's use.

8. Failure Mode Effect Analysis

Failure Mode and Effects Analysis (FMEA) is a step-by-step procedure for identifying all possible failures and their effects. It is most commonly used for technical applications, but can also be applied for processes and product design.

FMEA defines the term "failure mode" to identify defects or errors, potential or actual, in a product design or process, with emphasis on those affecting the system. A "failure effect" is the result of a failure mode on the product or system function as perceived by the user. Failure effects can be described in terms of what the end user may see or experience. The study of consequences of identified failures is called effects analysis.

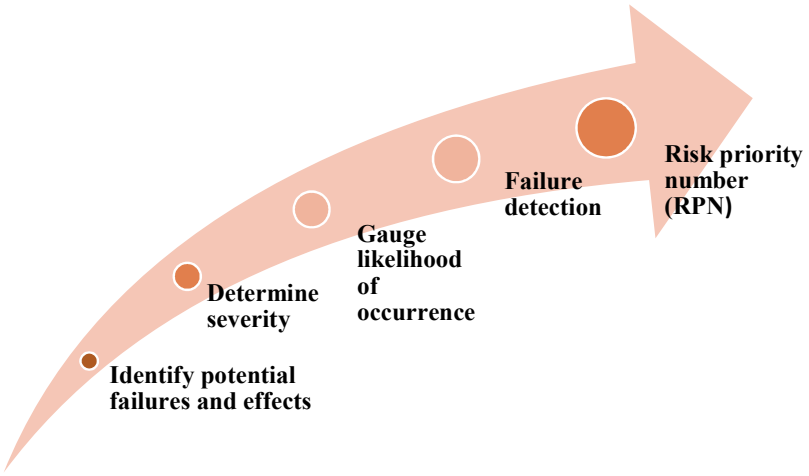
It involves reviewing schematics, engineering drawings, operational manuals, etc, to identify basic faults at the lowest level and consequently determine their effects at a higher level. This approach is also considered as an inductive analysis tool that methodically details, on an element-by-element basis, all possible failure modes and identifies their resulting effects on surrounding elements and or the overall system.

FMEA prioritizes failures according to severity, frequency and detectability. Severity describes the seriousness of failure consequences. Frequency describes how often failures can occur. Detectability refers to degree of difficulty in detecting failures.

Methodology

1. **Identify potential failures and effects:** The first FMEA step is to analyse functional requirements and their effects to identify all failure modes. List all failure modes per function in technical terms, considering the ultimate effect(s) of each failure mode and noting the failure effect(s).
2. **Determine Severity (S):** For each failure mode, identification of all the consequences on the system, related systems, process, related processes or regulations. These are the potential effects of failure. The team should ask what happens when this failure occurs. Determine the seriousness of each effect. This is represented with a severity rating, or S. Severity is usually rated on a scale from 1 to 10, where 1 is insignificant and 10 is catastrophic. If a failure mode has more than one effect, only the highest severity rating for that failure mode should be written on the FMEA table.
3. **Gauge Likelihood of occurrence (O):** For each cause, determination of the likelihood of occurrence. This rating estimates the probability of failure occurring for that reason during the lifetime of the scope. Occurrence is usually rated on a scale from 1 to 10, where 1 is extremely unlikely and 10 is inevitable. On the FMEA table, all the likelihood of occurrence should be listed.
4. **Failure Detection (D):** For each cause can be estimated how well the controls can detect either the cause or its failure mode after they have happened but before a problem occurs. Detection is usually rated on a scale from 1 to 10, where 1 means the control is absolutely certain to detect the problem and 10 means the control is certain not to detect the problem (or no control exists). On the FMEA table, all the detection rating should be listed.

5. **Calculation of the Risk Priority Number (RPN):** For each failure mode, the risk priority number shall be calculated by multiplying the severity, likelihood of occurrence and detection rating (RPN= S × O × D). These numbers provide guidance for ranking potential failures in the order they should be addressed.
6. **Identification of the recommended actions:** These actions may be design or process changes to lower severity or occurrence. They may be additional controls to improve detection. The responsible for the actions and target completion dates have to be indicated in the form. Once actions are completed, results and the date should be indicated on the FMEA form, together with new S, O or D ratings and new RPNs. The same may be repeated till we get the optimum solution.



Failure Mode Effect Analysis

Application

FMEA is used during design of a process to prevent subsequent failures. Later it is used for control, before and during ongoing operation of the process.

- When a process, product or service is being designed or redesigned, after quality function deployment;
- When an existing process, product or service is being applied in a new way;
- Before developing control plans for a new or modified process;
- When improvement goals are planned for an existing process, product or service;
- When analysing failures of an existing process, product or service;
- Periodically throughout the life of the process, product or service;
- To help to find a causal element within other RCA tools.

9. Psychological and Physiological Evaluation

Heinrich's theory suggested that 88% of all accidents were caused by a human decision to carry out an unsafe act. In order to mitigate the unsafe acts initiated by the human can be analysed and the psychological /physiological causes can be evaluated to eradicate the unsafe acts. Job relevant individual traits' are features of human beings that define potentials and abilities for professional activity and training. These features are formed on the bases of genetic, social, and psychological factors. Requirements to the job relevant individual traits get stronger when work complexity and conditions increase.

'Psycho-physiological evaluation' is an investigation of job relevant individual and psychophysiological traits. It is focused on the evaluation and forecast of the professional reliability of worker. Professional reliability is considered to be the relationship between these job relevant individual traits and the job requirements.

Methodology:

The psychological-physiological evaluation is also used in RCA to find root causes associated to psychological and physiological traits. Psychological and physiological investigation includes these following steps:

- Psychological evaluation with use of special psychological diagnostic tools;
- Psycho-physiological evaluation with use of computer and other tools;
- Psychological (employee oriented) interview;
- Additional data gathering on individual traits from professional behaviours;
- Preparation of conclusions based on obtained data analysis.

The psychological physiological evaluation areas are:

- To assess motivation and attitudes;
- To assess Job relevant individual traits;
- To assess Psycho-physiological traits (cognitive processes: perception, attention, memory, thinking, central nerve system characteristics);
- To assess Fitness for duty (mental overstrain, emotional overdrive, mental overwork, mental passivity, illness).

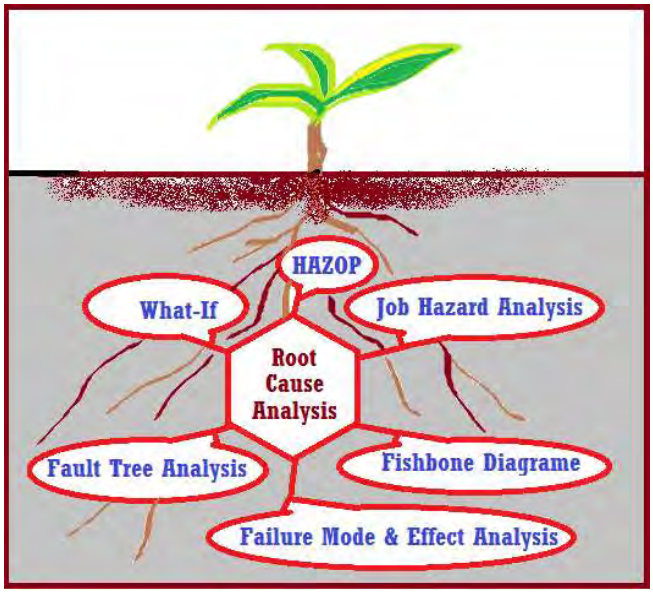
Application: the tool could be used in Root Cause Analysis for step of direct and root cause of erroneous actions of employee and allows to detect them on level of psychology and physiology and thus allows to proactively remove a human factor failure mode.

6.0 LINKING OF ACCIDENT INVESTIGATION AND ROOT CAUSE ANALYSIS TO OPERATION EXPERIENCE FEEDBACK

Process of Accident Investigation:

Accident investigation is a process of systematic collection and analysis of information after an accident or event has occurred. Accident investigation is conducted to identify contributory causes and root causes of the accident in an organised way. As an end result, every investigation will conclude with the recommendations. Objective of the recommendations are to take corrective actions to prevent occurrence of similar events in the future.

Accident investigation involves analysis of the failure which caused the accident. It consists of data collection, data analysis, identifying causes and recommending preventive measures. An effective investigation requires a structured approach for information gathering and analysis. The quality of collected data will give perfection to the analysis. Perfect analysis will give true picture of the accident scenario and real causes. There are many tools available for analysing accident data. Root Cause Analysis (RCA) is one of the methods for the accident analysis.



Accident investigation also reveals effectiveness of Safety Management System (SMS) in an industry. It helps to identify flaws and inadequacies in safety measures and safety culture. The real benefit of accident investigation and correction of causes of accidents will lead to less injuries, industrial well off, cost reduction, improved image of the organization and enhanced employee morale.

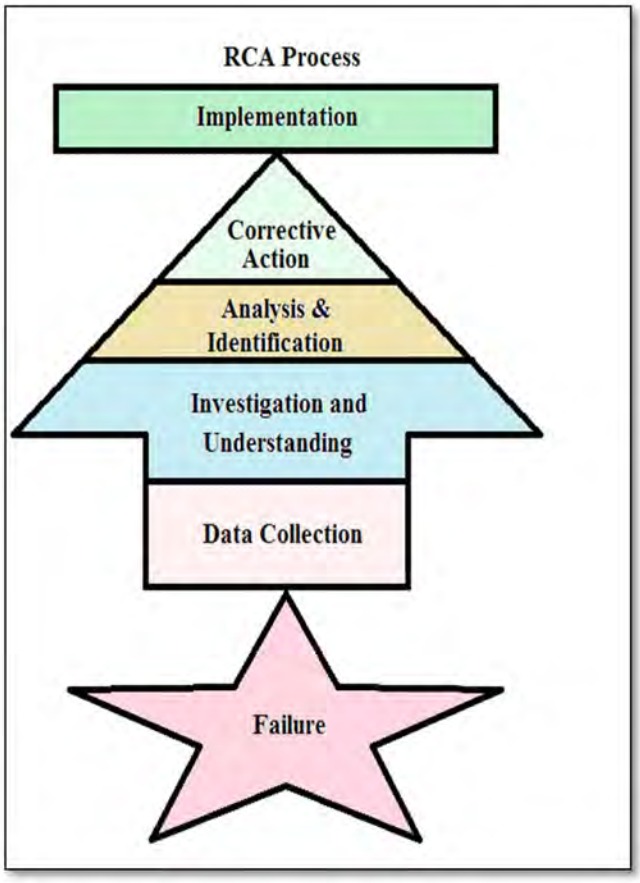
Critical investigation of an accident or incident by identifying the root of each cause is known as Root Cause Analysis (RCA). It is an effective tool for problem solving by identifying the root causes of accidents or incidents. The philosophy of Root Cause Analysis states that, instead of correcting symptoms or immediate causes, the problems shall be analysed by correcting root causes. By giving focus on addressing the root causes, the issues shall be resolved more effectively. RCA analysis will permit to address the underlying causes effectively. But the other regular methodologies will address immediate causes only. They will not be so effective, as the real (root) cause may still exist at the work

location, unattended and remain dormant until at some other occasion another accident occurs. If root causes are not addressed, accidents will repeat, leading to other associated problems including increased absenteeism of employees. So to prevent re-occurrence, identifying and rectifying all possible root causes is essential. There are many methodologies in practice to carry out RCA. But the philosophy used is almost similar. A typical basic structure is shown below:

The basic process of RCA consists of different steps. It may vary from case to case. But in general, the steps given below are followed for the RCA:

The RCA process consists of seven steps.

1. **Define the problem**: Define the problem or the factual description of the incident. Both qualitative and quantitative information like nature, size, locations and timing shall be used to describe the incident.
2. **Data Collection**: Data and evidence shall be collected and classify them along a time line of incidents until the eventual problem or incident is found. Each special deviation in the form of behaviour, condition, action and passivity must be recorded in the time line.
3. **Why Analysis**: Ask *'WHYs'* repeatedly several times to identify the effects and record the causes associated with each '*WHY'*. In general 5 WHYs in sequence are enough to reach up to root cause. This is also called "*5 WHY Theory of Root cause Analysis*"



4. **Classification of Causes**: Classify the causes within the causal factors that relate to a crucial moment in the sequence including the underlying causes. If there are multiple causes, which is often the case, document these, preferably in order of sequence for a future selection. Identify all other harmful factors also. Some of the causes could be contributory causes.

5. **Identify Corrective Actions**: Chalk out the corrective actions and improvement measures which prevent the recurrence with a sufficient degree of certainty. Explore whether corrective actions or improvement measures can be simulated in advance so that the possible effects become noticeable. The same is applicable with respect to the other underlying causes. The solutions shall be derived which comply with the intended goals

and objectives and must not cause any new and unforeseen problems.

6. **Recommendations and Solutions**: The recommendations are the solutions for each problems identified during analysis. Implement the solutions (corrective measures) that have been made by unanimity with all agencies. Monitor the effectiveness of the solutions (corrective measures) closely and adjust if necessary.
7. **Report Preparation**: A detailed report shall be prepared in which all causes and root cause identified are mentioned clearly. The problem solving methodology used shall be clearly mentioned. The report shall clearly give the details of recommendations and actions to be taken. The agencies for follow up shall also be mentioned.

Benefits of Accident Investigations:

There are many benefits for the accident and post event investigations. The direct benefit is the correct identification of root causes and recommendation of corrective measures to prevent reoccurrences. The implementation, monitoring and evaluation of corrective actions will lead industrial well-off.

Beyond this, the following are some other benefits:

- Employers demonstrate their commitment to safety to their workers and public
- The members of investigation team will get trained in investigation techniques
- Reveal the importance of reporting accidents/incidents;
- Accidents/incidents are promptly reported; accidents/incidents are immediately investigated;
- Improved awareness of workers on accident prevention;
- Accident/incident trending

Accident Investigations and Operating Experiences:

Knowing the issues and causes in advance will help to identify the weak links and problems in a system. This can help to keep away accidents as much as possible. It will help to take measures in advance. The lessons learnt from previous experience is called Operating Experience (OE). Many post-event investigations reveals that, prior knowledge from other industry Operating Experiences had been available, which had it been used effectively, could have prevented recurrence of

an accident. The importance of applying OE was made clear in 1979 when the Kemeny Report of the investigation of the Three Mile Island Nuclear Station accident included the following recommendations:

"There should be a program for the systematic assessment of experience in operating reactors, with special emphasis on discovering patterns in abnormal occurrences. An overall quality assurance measurement and reporting system based on this systematic assessment shall be developed to provide:

1) *A measure of the overall improvement or decline in safety, and*
2) *A base for specific programs aimed at curing deficiencies and improving safety.*
3) *Licensees must receive clear instructions on reporting requirements and clear communications summarising the lessons of experience at other reactors."* **[01]**

As RCA is an integral part of accident investigation, lessons learnt from accident investigations are the control measures for identified causes of accidents. Use of Root Cause Analysis is considered as an effective tool for constant improvement. As it help to develop a proactive approach in problem solving. When RCA is being carried out first for a particular case, it will be a reactive way of identifying and resolving the issues and problems. The process will help to identify the causes and corrective measures for each cause. The flaws and errors occurred in the system will be critically identified. The reality of the system and weakness in Safety Management System will be revealed beyond doubt. By this user will get new learning lessons. This is called experience. Likely, by doing different RCAs, the user will get more experiences and slowly the process will shift from reactive to proactive in nature.

When the users have a collection of OEs, roughly similar operating cases can be perceived from it. By critically examining those case studies, user can have a judgement on their own systems. This shall be used to take proactive approach in accident prevention. When we have a number of RCA reports, more issues which are common in nature will be identified. As the cases investigated increase, the generic issues will come out. There is a strong link for every case studies towards accident prevention. That is why, all level of management is having a strong commitment towards sharing of OE.

References:

[01] OELG- UK: Operating Experience and Learning / A Guide to Good Practice - April 2015

7.0 MANAGEMENT OF OPERATIONAL EXPERIENCE FEEDBACK FOR IMPROVEMENTS IN SAFETY MANAGEMENT SYSTEM

"Operating Experience Feed Back" is a data bank which contains a set of lessons learnt from the investigations carried out. The first requirement for an effective OE Management is the availability of information. At international level, many agencies like WANO, COG, and IAEA are available from where the investigation reports related to nuclear industries can be obtained. The declared mission of WANO is to maximize the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark and improve performance through mutual support, exchange of information, and emulation of best practices. With safety as the goal, WANO helps operators to communicate effectively and share information openly. World wide experience shows that, many accidents could have been prevented, had the lessons been learned from previous incidents.

In addition to the international sharing of OE, national level information are also shared amongst the organization. Sources of national level information are (a) newsletters developed and circulated by different professional bodies, (b) in house reports on accident investigation and (c) professional meets organized by various organization in country. These information are critically reviewed at corporate and utility levels. Lessons learnt from these are disseminated amongst the employees through training program and safety committee meetings. Some of the applicable OE information are utilized for improving effectiveness of Safety Management System by Engineering and Administrative controls.

Using OE effectively includes analyzing both organizational and industry experience to identify fundamental weaknesses and then determining appropriate organization-specific actions. This will minimize the likelihood or reduce the consequences of similar events. This will lead to development of learning organization.

Importance of OE in Safety Management System:

Safety Management System (SMS) is a comprehensive management system designed to manage safety elements in the workplace, which includes policy, objectives, plans, procedures, organization, responsibilities and other measures. One of the important components of SMS is accident prevention. So, the rectification of similar fault in a system will help to prevent the recurrence of similar problem.

As the capacity addition program is in progress, new generation of Nuclear Professionals are joining in nuclear Industry. When new workers join the industry, the OE and learning lessons will give them more insight to the problems they may face. OE also give value addition for simulator training for nuclear operators.

Another important use of OE is for trending accidents and incidents. Similar kind of failure in a number of industries of similar type will give the requirement which need immediate attention. The systematic use of OE in an industry is a good evidence for identifying management commitment for safety.

What is Management's Role in OE?

The management should set clear expectations for an OE process. These include establishing the capability to:

- Promote a 'no blame' / 'just' culture in order to encourage a healthy OE program
- Review and screen internal and industry OE information for applicability to the organization in a timely manner
- Establish criteria to help determine which industry OE applies to the organization
- Make industry OE widely available and easily accessible to the organization's personnel in a manner that encourages its routine use
- Distribute applicable industry OE to the appropriate personnel for review, analysis, and internalization
- Investigate and identify the causes of the organization's events as well as identified trends
- Trend the organization's own events to identify recurring issues
- Develop, track, and implement actions to correct weaknesses identified by reviews of the organization's and industry OE
- Periodically assess how effectively OE information is used and what is the effectiveness of the overall OE program
- Share OE with the wider industry in a timely manner
- Routinely benchmark industry program for best practices through participation in industry working group meetings, seminars, and other similar activities
- Determine attitudes and behaviors related to personal safety, environmental protection and also identify any latent organizational weaknesses

Line managers are responsible for helping personnel learn from industry experience through actions such as communicating important information, analyzing the information, conducting event investigations, and ensuring the effective implementation of Specific, Measureable, Achievable, Realistic and Time-bound (SMART) corrective actions.

Line managers should provide resources and encouragement so that their personnel routinely and proactively use OE information. A common characteristic of organizations that use OE effectively is the strong line management involvement.

Line Management support of OE programmes include:

- Establishing responsibilities
- Establishing a learning environment

- Fostering a sense of ownership
- Willingness to honestly appraise the organization for strengths and weaknesses
- Setting goals
- Communicating and reinforcing expectations
- Monitoring the implementation and use of the information
- Measuring the effectiveness of the OE programme

A primary responsibility of management is to develop a culture in which OE information is considered a vital component for top performance in all areas of the organization's activities. Ideally, diverse methods are put in place for the organizations' personnel to apply OE. When the principles for OE is adopted positively in a nuclear organization, a strong Nuclear Safety Culture will get cultivated within the organization. More specifically, it is important that OE is highly valued and that an attitude of "it can happen here" is encouraged.

The internalization of OE is a way of conducting business that recognizes the value of understanding previous experience and seeks to apply it at every reasonable opportunity. Organizations that have successfully internalized OE lessons take the time to understand and communicate them to their personnel, search for them before acting, and learn from them to avoid making the same mistakes made by others. One key to successfully internalizing OE information is management's commitment to establish strong engagement with the workforce.

OE & Organization Safety Culture:

Establishment of OE management is a crucial requirement for learning lessons from past events. For this, it is clear that OE has to be an integral part of the organization's culture. Use of this tool shall be encouraged by managers throughout the organization. The organization's personnel in all level should regard OE as helpful and important to them. The willingness to use this information at every opportunity. Methods of using OE should be structured to provide applicable information to the right personnel in time to make a difference.

There shall have supervisory control to cross check the adoption of OE lessons in regular work. Also, if any recommendation from OE is found not directly applicable or further additions are required, this shall be communicated to the higher management. When the line managers analyze the causes of significant organizational events, OE must be routinely reviewed to determine if and why previous lessons were not effectively learned or applied.

8.0 Case Studies

In this section, three case studies are briefly described to highlight the importance of prompt and appropriate feedback taken from operational experience and implement suitable corrective measures to improve safety management system.

Case Study 1: Effective utilization of operational experience by an automobile company

In an automobile company a safety audit was carried out to identify the root causes behind frequent complaints of illness reported by the operators working on a newly developed assembly line and health hazard related to paint shop of the factory.

In the audit, it was found that newly developed assembly line requires manual operation against automated operation as proposed by the designers. Citing the economic viability, automated operation design was rejected by the plant management and manual operation was implemented. Due to the manual operation, the operators reported severe back pains and were advised to take rest for two weeks. Auditors recommended to shift to automated operation from faulty manual operation. Company management complied the recommendation and could see reduction in complaints of illness by operators.

Similarly at paint shop the auditors noted deficiencies related to use of appropriate PPEs by operators, adequate closure of the working area in the paint shop and proper ventilation of the work area. The Plant management implemented all the recommendations of the safety audit. All the deficiencies were rectified with suitable administrative and engineering measures due to which health hazard in the paint shop area could be reduced.

One of the managers in this plant suggested to implement the recommendations of the safety audit in similar plant of the automobile company located in other country. Based on the feedback and learnings from the above safety audit, the company management implemented the recommendations of the safety audit in its plant in other country also and thereby standards of occupational health of the operators and industrial safety of that plant were improved.

This case study underlines effectiveness of appropriate and timely feedback taken by the company management from the operational experience.

Case Study 2: Failure of Steam Line in a Power Plant

This incident happened in a power plant. A shut down of the boiler was planned to carry out maintenance of its internal components. To effect this, steam input to the turbine generator (TG) was being lowered in steps. During this activity, a loud sound was heard by the control room operator. On checking, it was observed that three bellows provided in low pressure turbine steam inlet line had ruptured and a large piece of pipe had broken along with its support and fallen on the turbine floor. The system was immediately brought to safe level.

Since shutdown activity was in progress no person was present at the turbine floor at the time of incident and hence no one got injured.

The incident was thoroughly investigated. During the investigation of the incident, following observations were noted:

a. While stopping the steam input to turbine, one of the valves on HP steam line did not close fully. This partial closure of HP steam stop valve and sequential closure of all its downstream isolation valves (as per the logic) lead to over pressurization of the section between HP steam isolation valve and LP steam inlet line and resulted into failure of bellows and pipe line.

b. During the incident pressure between HP steam valve and LP steam inlet line had reached its maximum; however the relief valve did not activate as its set pressure was even higher.

c. It was noted that similar event of rupture of LP steam inlet line bellow had occurred earlier during TG rolling where LP steam isolation valves were manually closed by without closing the HP steam valve.

d. During investigation of that incident review committee had recommended to lower the set pressure of relief valve than the maximum working pressure of the LP steam line. Based on the recommendation of the review committee, the plant decided to procure new relief valves as set pressure of existing valves could not be lowered. However this recommendation was not implemented by the plant management citing the reason that suitable relief valves were not available in the market. The recommendation remained pending for years and lead to another similar but bigger accident (described above).

e. Other contributory causes of this incidents were reported as jamming of HP steam valve guide assembly due to damage of its spindle, and set pressure of the relief valve provided on the LP steam inlet line was well above the maximum working pressure of the bellows. It was also noted that in service inspection procedure for bellows & steam lines was not prepared and followed.

From above case study, it can be noted that due to the lack of procedure to take feedback from operational experience of past incident and lack of intent shown by the plant management to implement suitable corrective measures an incident with potential of serious consequences has happened.

Case Study 3: Challenger space shuttle accident (1986)

On January 28, 1986, the NASA shuttle orbiter mission STS-51-L and the tenth flight of Space Shuttle Challenger (OV-99) broke apart after 73 seconds into its flight, killing all seven crew members.

A presidential commission was constituted to investigate this disaster. The commission found that disintegration of the vehicle began after an O-ring seal in its right solid rocket booster (SRB) failed at lift-off. The O-ring was not designed to fly under unusually cold atmospheric conditions. Its failure caused a breach in the Solid Rocket Booster (SRB) sealed joint,

allowing pressurized burning gas from within the solid rocket motor to reach the outside and impinge upon the adjacent SRB aft field joint attachment hardware and external fuel tank. This led to the separation of the right-hand SRB's aft field joint attachment and the structural failure of the external tank. Aerodynamic forces broke up the orbiter. Flames then broke out of the booster and damaged the external fuel tank, causing the spacecraft to disintegrate.

The commission concluded that the cause of the Challenger accident was the failure of pressure seal in the aft field of the right Solid Rocket Motor and it was due to a faulty design unacceptably sensitive to a number of factors such as effect of temperature, physical dimensions, characters of materials etc.

The commission also concluded that those who made the decision of launch of the spacecraft, were unaware of the history of problems concerning the O-rings and the joint. They were also unaware of the initial written recommendation of the contractor advising against the launch at temperatures below 53°F and the continuing opposition of the engineers at Morton Thiokol (the company that designed solid rocket boosters) after the management reversed its position.

From this incident it can be concluded that the ignorance towards operational experience feedback & learning and failure to comply written recommendation resulted into serious consequences.

Apart from the above factors, the investigating team had also cited various communication and management errors that affected the critical launch decision on January 28, 1986, including a lack of problem-reporting requirements; inadequate trend analysis; misrepresentation of criticality; lack of adequate resources devoted to safety; lack of safety personnel involvement in important discussions and decisions; and inadequate authority, responsibility, and inter-dependence of the safety organization.

References:

1. Fundamental Principles of Occupational Health and Safety – Benjamin O Alli, Second Edition, International Labour Office, Geneva
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Effective management of medical emergencies at workplace

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CONTENTS

1.0 INTRODUCTION

It is of paramount importance that the management of the industries takes care of the working conditions so that it should not adversely affect the health of the workers. Workplaces need a plan for emergencies that can have a wider impact. Special procedures are needed for emergencies such as serious injuries, poisoning, electrocution, fire, explosion, cyclones, flood, release of radioactivity and chemical spills.

Nobody expects an emergency or accident- especially one that affects them, their employees, and their organization. But the simple truth is that emergencies and disasters can strike anyone, anytime, and anywhere. The best way to protect workers and the organization is to expect the unexpected and develop a well-thought-out emergency action plan when immediate action is necessary.

Any industrial organization involves working with various materials, machinery, chemicals and other hazardous environment. If proper care is not taken during the work it may results in injuries/serious medical condition to the employee(s). This monograph lists out various types of emergencies arising in the course of work, causes, symptoms and management.

A medical emergency is a sudden unforeseen encounter in a clinical practice. It requires prompt action.

1.1 Workplace Emergency

A workplace emergency is an unforeseen situation that may cause physical or environmental damage. Emergencies may be natural or manmade and include the following:

- Trauma viz. Fall from height, Crush Injuries, Fractures, Amputations
- Toxic gas releases,
- Chemical spills,
- Cardiac emergencies
- Other Medical emergencies
- Psychiatric Emergencies
- Floods,
- Hurricanes,
- Tornadoes,
- Fires,
- Radiological accidents,
- Explosions etc.

1.2 Preparedness of Self, Employees, and Organization

The best way is to prepare to respond to an emergency before it happens. Few people can think clearly and logically in a crisis, so it is important to do so in advance, when you have time to be thorough.

All organizations have to train their workers to handle emergencies. Each of us should know that what we would do if the worst happened. What if person has a fall from height or a person suddenly becomes unconscious. Once we have identified potential emergencies, consider how they would affect us and our workers and how one should respond.

1.3 Medical Assistance during an Emergency

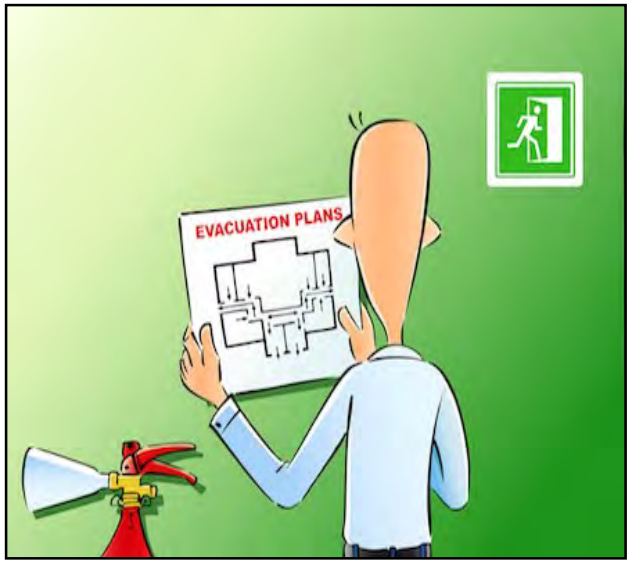
Appropriate first-aid should be given to the victim at the site of accident. If medical facilities / First Aid Centers are available at worksite, arrangements can be made to handle emergency cases. Treatment of a serious injury should start within 3 to 4 minutes of the accident. Medical personnel must be accessible to provide advice and consultation in resolving health problems that occur at the workplace.

Safe and timely shifting of the serious patient in ambulance, after administering the first aid treatment, remains the corner stone in overall outcome of the injury.

1.4 Emergency Action Plan (EAP)

An emergency action plan covers designated actions employers and employees must take to ensure employee safety from any emergencies. All employees are required to have awareness about the emergency action plan of the organization. It is a good way to protect themselves, their colleagues and their organization during an emergency. Putting together a comprehensive emergency action plan that deals with all types of issues specific to the worksite is not difficult.

1.5 Contents of an Emergency Action Plan



While developing any emergency action plan, it is a good idea to look at a wide variety of potential emergencies that could occur at the workplace. It should be tailored to the worksite and include information about all potential sources of emergencies. Developing an emergency action plan means one should do a hazard assessment to determine what, if any, physical or chemical hazards in the workplace could cause a medical emergency.

At a minimum, it should include the following:

- A preferred method for reporting fires and

other emergencies;

- An evacuation policy and procedure;
- Emergency escape procedures and route assignments, such as floor plans, workplace maps, and safe or refuge areas;
- Names, titles, departments, and telephone numbers of individuals both within and outside the site (On Site and Off Site) to contact for additional information or explanation of duties and responsibilities under the emergency plan;
- Procedures for employees who remain to perform or shut down critical plant operations, operate fire extinguishers, or perform other essential services that cannot be shut down for every emergency alarm before evacuating

2.0 STATUTORY REQUIREMENT

Atomic Energy Factories rules 1996 provide many safety provisions for dangerous operations which are more serious and cause occupational diseases and poisoning. Rules for dust and fume , ventilation and temperature, disposal of waste and effluents, lighting, drinking water, latrines & urinals, spittoons, cleanliness, washing facilities, machine guarding, first-aid, canteen , dining hall, crèche, notice of accident poisoning & diseases are also for the health protection. Atomic Energy Regulatory Board (AERB), which has the mandate for enforcing the Factories Act in the units of the Department of Atomic Energy and is very particular so far as the occupational health of the workers is concerned.

Atomic Energy Regulatory Board (AERB) is very particular so far as the occupational health of the workers is concerned and in order to streamline the procedures in 1993 a committee was formed known as Occupational Health Advisory Committee (OHAC) which was reconstituted in 1999 as Advisory Committee on Occupational Health (ACOH). Subsequently, this committee was reconstituted in 2018 as Occupational Health and Safety Committee (OHSC). This committee evaluates the facilities available in the units for occupational health, compiles the health records of the units, and compares the health records of the units and requests for additional data which are required for the purpose of analyzing health parameters. It reviews the medical records, especially for pre-existing medical ailment or any chronic disease that may endanger the worker / colleague while discharging the duties and also suggests various corrective measures.

All the units have to conduct the following medical examination for their workers;

1. Pre-Employment Medical Examination (PEME)
2. Periodic Medical Examination (PME)
3. Specific Medical Examinations for Crane Operators, Drivers and Fork-lift Operators, Work at Height, Firemen, Central Industrial Security Force (CISF), Security, Canteen workers as per statute.

During the comprehensive medical examinations, special emphasis is given to detect and record following symptoms /ailments / diseases.

- Seizure disorders
- Colour vision defect and Depth perception
- Chronic cardiac disease History of any cardiac surgery
- Diabetes Mellitus
- Locomotor disability
- Psychiatric Disorder

Special care / duty change, if required has to be undertaken by the respective organizations for these workers.

3.0 TYPES OF EMERGENCIES

Nuclear facilities comprise of several type of plants which involve mega construction and commissioning, operation and maintenance, material handling and processing and different R&D activities. Though due care is taken while carrying out the activities still possibility of injuries cannot be ruled out. AERB has a well-defined injury reporting system which is applicable to all the organizations under DAE including NPPs.

Medical Emergency: any occurrence or incident that causes serious bodily harm or injury to the worker which requires immediate medical attention is a medical emergency. Medical emergencies of importance in any industry are described below.

3.1 Trauma – Crush Injuries, Fractures, Amputations, Fall from Height

Trauma care begins at the site of accident and the first task is to shift the victim to a safe place away from the accident site. The victim should be moved carefully as any haphazard movement can cause life threatening injuries. The brain relates to the rest of the body through the spinal cord which lies within the backbone. Injury to the spinal cord is the most dreaded complication of improper movement of an injured patient as it can cause permanent disability or even death.

The victim must be placed on a clean, flat and firm surface as it facilitates resuscitation.

- **Call for Help**

The nearest hospital/Doctor should be informed first. An attempt should be made by first aider to evoke a verbal response from the victim. If the patient speaks coherently it indicates that he is mentally alert, and his vital functions are being maintained. When a patient is found unconscious the common practice amongst the general population is to sprinkle some water on the patient's face and pour some water in the throat. This practice should be avoided as the water could aspirated into the lungs and cause serious complications. The next task is to maintain the 3 vital functions of the body. Airway, Breathing and Circulation (ABC). To maintain these functions, First aider ought to know

a) Assessment of airway patency

b) Maintaining airway patency by chin lift and jaw thrust man oeuvres

c) Assessment of breathing

d) Maintaining breathing with mouth to mouth respiration

e) Assessment of circulation

f) Maintaining cardiac function in a patient with cardiac arrest by external cardiac massage.

- **Airway and Breathing**

Preventing obstruction of the airway, preventing aspiration of foreign material into the airways and maintaining respiration are the 3 critical aspects of providing first aid to a trauma victim. Once the victim is found to have altered levels of consciousness, open the mouth and clear it of all the foreign material. Then with one hand on the forehead and other under the chin, till the head partially back. This prevents obstruction of the airway and allows the victim to breathe freely, if the respiratory function is intact. Then place your ear close to the victim face and listen breathing, watch for chest movements and feel for any exhaled air. If you are certain that the victim is breathing keep the airway patent and turn your attention to the next step, and if the victim is not breathing artificial respiration should be performed.

Pinch the nostrils close with the thumb and index finger of the hand on the victims head, take a deep gulp of air, seal the victim's mouth with your mouth and blow air into the victim's airway. Watch the victim's chest move as you provide artificial respiration. The normal respiratory rate of an adult is around 12-14 minute and artificial respiration should be given at this rate.

- **Circulation**

While providing first aid to a trauma victim, the rescuer must make an attempt to maintain circulation with external cardiac massage. The carotid artery in the neck is the best place to look for the pulse of a trauma victim. To feel the carotid pulse, locate Adam's apple and slide tips of the fingers into the groove beside it.

If there is no pulse, the heart has stopped and external cardiac massage must begin immediately. With the victim stretched flat on his back kneel beside him and position his head to keep the chin up to keep the airway open. Feel the chest to locate the lower tip of the victim's breast bone. Place two fingers of the left hand on the top and place the heel of the right hand next to the fingers (i.e. the heel of the hand should be about 1½" from the tip of the breast bone i.e. sternum). Then place the left hand atop the right hand and position your body so that your shoulders are directly above your hands with arms straight and elbows locked. Lean the weight of your body towards the patient so as to compress the sternum 1.5 to 2 inches for 0.5 seconds and suddenly release.

Don't lift hands completely of the sternum a smooth and firm thrust, push down using enough force to press the lower one-third of the breastbone. Perform 15 external cardiac compressions a rate of 80-100 per minute then open the air way and deliver two breathes. If 2 rescuers are available one will do compression and other person will do mouth to mouth breathing and he will call for help in between.

The ratio should be 15:2. If single rescuer is available the ratio should be 5:1. Continue chest compressions, perform 4 cycles of 15 compressions and 2 ventilations, check for return of carotid pulse. If absent resume CPR. If present and blood pressure is recordable continue ventilation alone at the rate of 12 per minute. Do not interrupt CPR for more than 7 seconds, CPR must be carried out for at least 30 minutes before it is considered unsuccessful.

- **Cardio-Pulmonary Resuscitation (CPR)**

Cardio-pulmonary resuscitation (CPR) is a life saving procedure for those trauma victims whose heart had stopped and respiration has ceased, and comprises of artificial respiration and external cardiac massage.

The average human heart, beating at 72 beats per minute, will beat approximately 2.5 billion times during an average 66 year lifespan, and pumps approximately 4.7-5.7 litres of blood per minute. It weighs approximately 250 to 300 grams (9 to 11 oz) in females and 300 to 350 grams (11 to 12 oz) in males.

There has been a change in the recommended sequence for the lone rescuer to initiate chest compressions before giving rescue breaths (C-A-B rather than A-B-C). The lone rescuer should begin CPR with 30 compressions rather than ventilation to reduce delay to first compression.

- **Bleeding**

When you find a victim bleeding profusely, place a clean cloth over the wound and apply pressure over the wound. This is most often adequate to control even severe bleeding and all it needs is a bit of courage from those present at the accident site. The practice of applying tight tourniquets around a bleeding limb should be avoided as it may compromise the chance of a good repair of the wound. It is likely that one will encounter a victim with a part (finger, hand, foot, arm or leg) severed due to injury. An amputated part can be re-implanted if the patient reaches a proper hospital within 6 hours of injury and the amputated part is transported properly. The severed part must be placed in a clean polythene bag with normal saline which is in turn placed in a bag filled with ice.

- **Fractures**

A fracture is the partial or complete breakage of a bone.

Simple (Closed) Fracture– The broken ends of the bone do not cut open the skin and show on the outside.

Compound Fracture – When the fractured bone is in contract with outside air as a result of an injury (so that dirt, dust and germs etc. into the protruding bone and the wound)

Compound fracture - In addition to the fracture, an important internal organ like the brain or major blood vessels, the spinal cord, lung, liver spleen etc., may also be injured. Furthermore, a complicated fracture may be simple or compound.

Signs and symptoms

General symptoms and signs of a fracture: -

1. Pain at or near the seat of fracture

2. Tenderness or discomfort on general pressure over the fractured area

3. Swelling about the seat of fracture. This swelling frequently renders it difficult to perceive other signs of fracture and care must be taken not to underestimate the seriousness of the condition.

4. Deformity of the limb

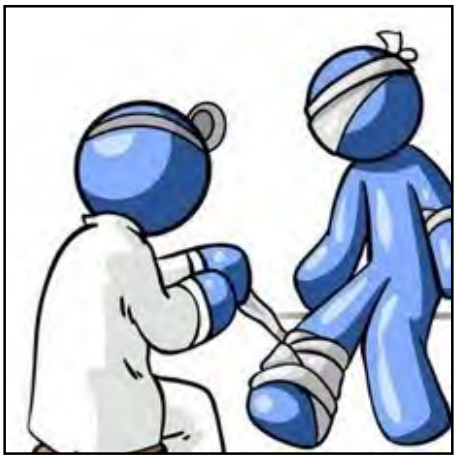
5. The irregularity of the bone

6. Crepitus (grating)

When one end of the broken bone moves against the other, a crackling sound is heard, which is known as crepitus.

Treatment of fractures

1. Treat the fracture on the spot. Don't move the patient till the injured part has been immobilized unless life is in immediate danger from some other cause. If, however, circumstances are such that final immobilization cannot be completed on the spot, carry out a temporary fix to enable the patient to be moved for a short distance to more suitable and safe surroundings. Hemorrhage and severe wounds must be dealt with before continuing with the treatment of fractures, with due regard to requirements of both types of injuries.



2. Steady and support the injured parts at once, so that movement is impossible. This prevents further injury and the increase in the bleeding which always takes place at the site of the fracture. It also prevents broken bone ends from piercing or damaging the skin, blood vessels, nerves or muscles.

3. Immobilize the fracture using bandages or the use of splints. Using the patient's body as a means of support, application of bandages would be adequate. Additional support of splints may be required when there is a possibility of long distance or difficult transport, before medical aid is possible. Splints are required when lower and upper limbs are fractured.

The use of bandages: -

- Never apply a bandage over the site of a fracture. They must be applied sufficiently firmly to prevent harmful movements, but not so tightly as to prevent the circulation of blood.
- In the case of a fractured limb, further swelling may occur, causing the bandage to become too tight. Should this occur, loosen them at once to allow normal circulation to return. Padding must always be placed between the ankles and knees if these are tied together.

Fractures of the upper limbs: -

These may occur

1. Close to the shoulder
2. Near the middle of the shaft
3. Close to or involving the elbow joint.

Fracture of the forearm: -

Shortening is unlikely to be observed unless both bones are broken.

Fracture of the lower end of the radius: -

This "Colles' Fracture" is extremely common and frequently occurs due to a fall on an outstretched hand. It may be mistaken for a sprain of the wrist, and on the other hand, there may be a considerable deformity.

Fracture of the hands and fingers: -

Fracture of the bones of the hand may be accompanied by severe bleeding into the palm.

Treatment of all fractures of the upper limb: -

- Do not remove the patient's jacket, if any.
- Bend the elbow and lay the injured limb against their chest with the fingers just touching the opposite shoulder.
- Apply adequate padding between the limb and the chest.
- Fix the hand in position with a collar and cuff sling, taking care that there is no constriction at the wrist
- Secure the limb firmly to the chest by two broad bandages.
- The first with its upper border level with the top of the shoulder.
- The second with its lower border level with the tip of the elbow.

- Tie off both bandages on the opposite side of the body.
- Feel the pulse on the injured side to ensure there is no interference with the circulation of the limb.

For a cut, be sure to apply clean dressing after administering first aid.

Major cuts, or wounds can be classified as follows: -

- Incised wounds caused by a sharp instrument like a razor.
- Lacerated wounds, which have torn and irregular edges, caused by machinery, animal claws, etc.
- Contused wounds, accompanied by bruising of the tissues, caused by a direct blow or by crushing.
- Puncture wounds, which have comparatively small openings, but may be very deep, caused by a stab from any sharp-pointed instrument, like a needle, knife or bayonet.

In case of wounds, follow the steps below: -

1. Place patient in a suitable position, elevating the bleeding part, unless it is a fractured limb.
2. Do not disturb any blood clots formed.
3. Removing as little clothing as possible, expose the wound.
4. Remove any foreign bodies which are visible and can be easily picked out or wiped off with a clean dressing.
5. Apply and maintain both direct and indirect pressure.
6. Apply a clean dressing and bandage.
7. Immobilize the injured part. When the wound is near a joint, immobilize it using splints if needed.

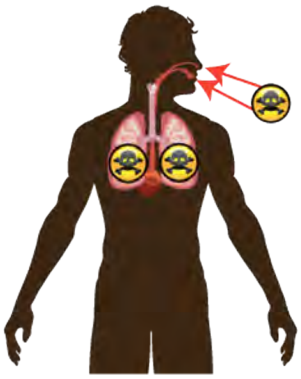
Remember, that if there is a foreign body in the wound which cannot be removed easily, cover it with a dressing, and build up enough pads around the wound without applying pressure to the foreign body.

If there is no foreign body in the wound, but the cut is deep, ensure that you use enough padding into the wound's depths, and ensure pads project well above the level of the skin to ensure adequate pressure on the torn ends of the blood vessels.

3.2 Toxic Inhalations

Many types of gases—such as chlorine, phosgene, sulphur dioxide, hydrogen sulphide, nitrogen dioxide, and ammonia—may suddenly be released during industrial accidents and may severely

irritate the lungs. Other inhaled agents may be directly toxic (e.g., cyanide, carbon monoxide) or cause harm simply by displacing oxygen and causing asphyxia (e.g. methane, carbon dioxide).



The effect of inhaling irritant gases depends on the extent and duration of exposure and on the specific agent.

Chlorine, phosgene, sulphur dioxide, hydrogen chloride, hydrogen sulphide, nitrogen dioxide, ozone, and ammonia are among the most important irritant gases. Hydrogen sulphide and cyanide are potent cellular toxins, blocking the cytochrome system and inhibiting cellular respiration. A common exposure involves mixing household ammonia with cleansers containing bleach; the irritant gas chloramine is released.

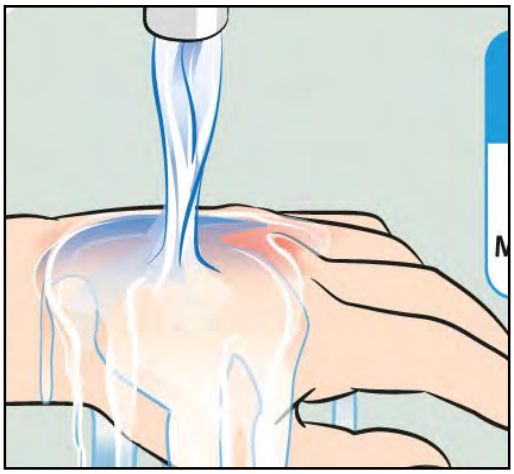
Symptoms depend on which gas or chemical is inhaled and how deeply and for how long it was inhaled.

- Symptoms may include irritation of the eyes or nose, cough, blood in the sputum, and shortness of breath.
- Chest x-rays, computed tomography, and breathing tests are used to determine how much lung damage has occurred.
- Gases such as chlorine and ammonia easily dissolve and immediately irritate the mouth, nose, and throat. The more peripheral parts of the lungs are affected only when the gas is inhaled deeply.
- Some gases—for instance, nitrogen dioxide—do not dissolve easily. Therefore, they do not produce early warning signs of exposure, such as irritation of the nose and eyes, and they are more likely to be inhaled deeply into the lungs. Such gases can cause inflammation of the small airways (bronchiolitis) or lead to fluid accumulation in the lungs (pulmonary oedema).
- Inhalation of some gases and chemicals may also trigger an allergic response that leads to inflammation and, in some cases, scarring in and around the tiny air sacs (alveoli) and bronchioles of the lung. This condition is called hypersensitivity pneumonitis.
- Radioactive gases, which may be released in a nuclear reactor accident, may cause lung and other cancers many years after the exposure.
- Other inhaled gases may cause a general body poisoning (including breathing difficulty) because they are poisonous to the body's cells (such as cyanide) or because they displace oxygen in the blood and therefore limit the amount of oxygen reaching the tissues (such as methane or carbon dioxide).

- Inhalation of some chemicals, such as arsenic, beryllium compounds and hydrocarbons, can cause cancer. Cancer may develop in the lungs or elsewhere in the body, depending on the substance inhaled.
- People should not enter an environment where poisonous gases may be present to rescue an exposed person unless they have protective gear that supplies them with fresh air or oxygen from a tank.

3.3 Burns and Scalds

Fig: Causes of burns and scalds



Burns are injuries that result from dry heat like fire, flame, a piece of hot metal, or the sun, contact with wire carrying high tension electric current or by lightning or friction. Scalds are caused by moist heat due to boiling water, stream, oil hot tar etc.

Exposure to extreme cold conditions like high altitude and in labs dealing with cryogenic chemicals can cause tissue damage (Frost bite)

Chemical burns are caused by strong acids (example sulphuric acid, nitric acid) or by strong alkalis (Caustic soda, caustic potash, quick lime or strong ammonia).

Similarly burns can also be caused by exposure to ionizing radiation and non-ionizing radiation like UV, visible light infra-red and laser.

- **Degrees of burns**

The degree of burns indicates the degree of damage to the tissues. There are three degrees of burns:

First degree: When the skin is reddened

Second degree: When there are blisters on the skin, and

Third degree: When there is destruction of deeper tissues and of charring.

The danger from burns depends on the area of the burns rather than the degree. Superficial burns over a large area of the body are more dangerous than the complete charring of a part of a limb. It must be noted that in the same person, different parts of the body may show different degrees of burns.

- **Rule of Nine areas of burns**

  Rule of Nine is used to estimate the body surface area (BSA) affected by burns. This is a quick way to estimate the extent of burns in adults. The system divides the body into multiples of nine. The sum total of these parts equals the total body surface area. The figure of Rule of Nine is shown below.

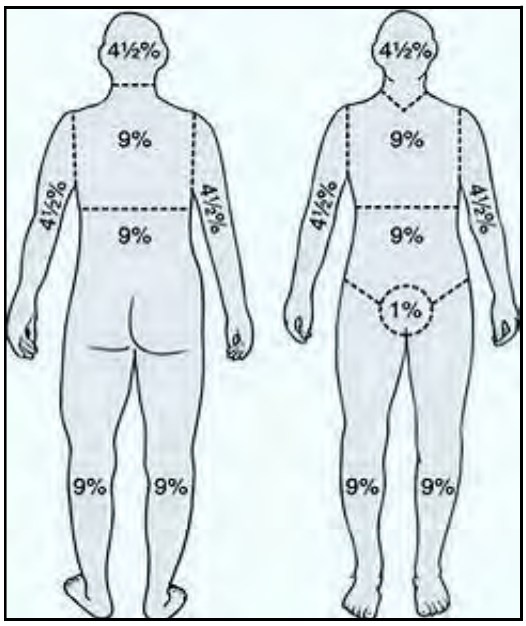


Fig.: Rule of Nine

Rule of Nine – Estimates the severity of burns

Burns considered critical if:

- Over 25% of BSA has 2nd degree burns.
- Over 10% of BSA has 3rd degree burns
- 3rd degree burns on face, hands or feet.

Any burn of over 30% irrespective of deep degree should be hospitalized as priority.

The first two degrees are seen in scalds also.

When the chemicals fall on skin or cloth worn by the person, any of the three degrees of burns may be produced. When swallowed, the chemicals if strong will damage the tissues with which they come into contact while swallowing viz., lips tongue, throat, food passages and stomach. There may be damage to the skin around the mouth.

- **Dangers due to fire**

Helping a person whose clothes have caught fire.

The first aider should know how to deal with a person whose clothes have caught fire.

1. Put out flames by whatever means available such as clean water, cotton cloth, blanket etc. Most of the burns can be quenched by readily available clean water. Water also cools burnt area causing less damage to occur.
2. Do not allow the person to run about. This only fan the fire and makes the flame spread.
3. Hold a rug blanket, coat or table cover in front of you while approaching a man whose clothing has caught fire.

4. Lay him down quickly on the ground and wrap tightly with any thick piece of cloth, rug or coat. Smother the flame by gently rolling the casualty or by gentle pats over the covering.
5. If the clothes in front of the body have caught fire lay him on his back and vice versa, till suitable material is brought to smother the flame.

- **Rescuing persons from fire**

1. In rescuing persons from a room which has caught fire, speed and clear thinking is required.
2. Remember, clean air is at ground level. So, crawl along the floor to pull out a person who is lying unconscious or is disabled.
3. Have a wet handkerchief round your face when you rescue.
4. If there is Carbon Monoxide in the room, these precautions do not protect the rescuer from carbon monoxide poisoning. When there is fire in a closed room, there is always some amount of carbon monoxide; therefore, quick action is all important.
5. When there is fire in a room in which the doors and windows are closed, do not open the windows and doors to let in air. The rush of air will increase the fire and it will burn more intensely.

- **Effect of burns**

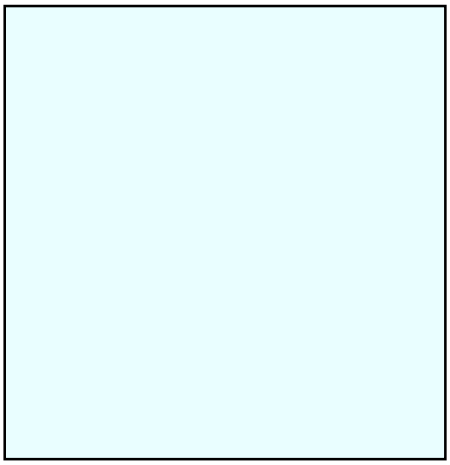
Immediate Effect

- Intense pain
- Shock

Late Effect

- There may be infection in the damaged area.
- After healing, it will leave scars causing disfigurement and or restriction of movements (contractures).

Burns of the eye



Acid burns

1. First aid for acid burns of the eye should be given as quickly as possible by thoroughly washing the face, eyelids and the eye for at least 15 minutes.
2. If the casualty is lying down, turn his head to the side, hold the eyelids open and pour water from the inner corner of the eye outward. Make sure that the

chemical does not wash into the other eye. Cover the eye with a dry clean protective dressing (do not use cotton) ad bandage.

3. Caution the victim against rubbing his eye.
4. Get medical help immediately preferably an eye specialist.

Alkali burns

Alkali burns of the eye can be caused by alkali solution, drain cleaner or other cleaning solution. An eye that first appears to have only a slight surface injury. May develop deep inflammation and tissue destruction, and person/employee may lose the sight.

1. Flood the eye thoroughly with water for 15 minutes.
2. If the casualty is lying down, turn his head to the side. Hold the lids open and pour water from the inner corner outward. Remove any loose particles of dry chemicals floating on the eye by lifting them off gently with a sterile gauze or a clean handkerchief.
3. Do not irrigate with soda solution.
4. Immobilize the eye by covering with a dry pad or protective clothing. Seek immediate medical aid.

Burns in the mouth and throat

They occur from drinking very hot liquids, inhaling hot air (fire in the room) or drinking corrosive chemicals. They cause severe and dangerous choking by producing very quickly swelling of the mouth, tongue or the air passages.

The casualty may show –

- Damaged skin around the mouth
- Difficulty in breathing may have symptoms of shock, may be unconscious. Immediately evacuate to the nearest Dispensary/hospital.

Electrical burns

These are caused by high current and voltage at the point of entry and going through the body and at the point of exit.

High voltage industrial (power) current can jump 16-18 meters (17-20 yards) and kill the rescuer. Therefore, do not approach the casualty till the switch has been turned off. These currents not only cause local damage but effect the respiratory and cardiac centres. They produce therefore, superficial or deep burns including charring, but also cause stoppage of breathing and heartbeat.

Treatment

- Remove the casualty from the electric source.
- Cover the burn.
- Treat the shock.
- If breathing or heartbeat has stopped, resuscitate.
- Put in recovery position.
- Evacuate speedily to the hospital.

Sunrays

Direct exposure can have ill effect on Skin and Eyes.

a. Skin: The injury skin known as 'Sunburn' is due to ultraviolet rays. The burn is produced by over exposure to sunrays when the body is covered with sweat, sea water or the wind is blowing strongly. However, high up in the mountains, burns can be produced even on a dull overcast day with strong winds.

The skin becomes red, itchy and painful. It may go into blister formation with marked swelling and becomes very painful.

Treatment

Remove the casualty to a shaded cool place and bathe the skin with cold water, cover the burn area and evacuate to the hospital – giving frequent sips of cold water.

b. Eyes: Reflect light from the sun produces thermal and photochemical burns in the front and back of the eye depending upon the duration of exposure. Reflected light from snow (snow blindness), welder's flash and looking at the solar eclipse also produces the same. The eye becomes red, painful, waters profusely, cannot be opened and sight is affected.

Prevention

Wear dark glasses, protect eyes by protective helmets and goggles while doing welding.

Treatment

Bathe eyes with cold water. Lightly dress the eyes with sterile non fluffy pad send to the eye specialist.

Prevention of burns

Most of the conditions under which burns occur can be prevented.

1. While working near heat sources, see that your clothes are not hanging free, or flapping about.

a. Never go near fire when wearing material made out of nylon or similar fibres as these clothes catch fire easily and quickly. It is a good practice to use a cotton overall while working.

b. Never put kettles or other vessels with hot liquids near the edge of a stove, sink or table or the short pointing towards you.

2. Never sleep with a kerosene lamp near the bed.
3. Do not hang clothes near/on open fire.

3.4 Cardiac Emergencies

A Heart attack occurs when the heart cannot get enough oxygen because of a blockage in one of the arteries that feed it. Heart attacks are caused by lack of blood supply to the heart itself. It comes on suddenly - sometimes after physical effort, but generally not so.

Fig.: Heart Attack

Signs and symptoms

Pain and discomfort in the chest area. Shortness of breath. There may be an earlier history. Face is pale. He feels pain in the left chest or the pit of the stomach. Pain may extend to side of arm or up in the throat. Vomiting and sweating profusely are always present.

Symptoms of heart attack

Classic symptoms of a heart attack are pain, pressure, tightness, or heaviness in the chest, or pain radiating from the chest to the arm(s), shoulder(s), back, jaw, and/or neck. A person may also experience:

- Shortness of breath
- Dizziness
- Nausea or vomiting
- Unresponsiveness
- Cool, pale, sweaty skin

Call

Call emergency Number and get an Automated External Defibrillator (AED) immediately.

Care

1. Have the person rest quietly.
2. Have the person ***chew*** either 1 regular-strength or 2 low-dose acetylsalicylic acid (ASA) or Dispersible aspirin tablets.

Other pain killing medications such as acetaminophen, ibuprofen, Paracetamol do not have the same effect as ASA in reducing damage due to heart attacks. Do not substitute ASA with acetaminophen or ibuprofen.

Nitroglycerin (Tab Sorbitrate 5mg or 10mg S/L) is a medication used to relieve chest pain and can be used under medical advice.

3.5 Radiological Emergency

Radiation emergency may be caused if a person gets exposed to a high level of ionizing radiation (>1Gy acute whole body dose causing Acute Radiation Syndrome (ARS) or >6Gy localized dose causing Cutaneous Radiation Injury (CRI)).

ARS may be classified according to the system most affected as:

Hematopoietic syndrome (1-8 Gy): The injury to bone marrow results in reduction of platelets (thrombocytopenia) and white blood cells (granulocytopenia) with resultant bleeding and infections.

Gastro intestinal syndrome (8-30 Gy): The injury to intestinal mucosal stem cells gives rise to death due to severe diarrhea leading to severe dehydration, electrolyte disturbances, infection and death in 2 weeks.

Neuro-Vascular syndrome (> 30 Gy): The low blood pressure and swelling of the brain and injury to various other vital organs like lungs, kidneys and liver results. Death may occur in 2 days.

3.6 Other Medical Emergencies

Apart from the above-mentioned medical emergencies, there are certain emergencies that can cause imminent danger life of the person if not treated in time. These emergencies may not be always associated with the unsafe conditions or unsafe act but can arise due to the pre-existing medical condition. Many times, environmental condition also plays an important role in aggravating a simple medical condition into a medical emergency. Such emergencies are described below.

- **Shock**

Shock is a condition of collapse which should be treated on top priority second only to attending to obstructed breathing stoppage of heart, or severe bleeding. It may lead to death if not treated in time.

Nervous shock is due to strong emotional upset e.g., fear pain, or bad news, and not necessarily due to a serious injury. (Does

not need treatment, as such)

True shock is seen in the following accidents:

1. Severe bleeding
    a. Shock is produced with loss of blood
    b. It may develop at once or be delayed
    c. Bleeding may be seen outside when coming out of cut artery or the tear of a varicose vein; or it may be inside: for example, bleeding into the chest or abdominal cavity.
2. Severe burns: when extensive when more than half the skin surface is affected.
3. Heart attacks: when the blood supply to the heart is obstructed.
4. Abdominal Emergencies; like burst appendix, perforated stomach, intestinal obstruction etc.
5. Crush injuries: as in collapsed buildings, explosion etc.,
6. Loss of body fluid due to excess of vomiting, diarrhoea, dysentery etc.
7. Bacterial infection discharge of poisons (toxins, into the blood caused by bacteria.

Signs of symptoms of shock

1. Casualty feels faint or giddy
2. Complaints of blurring of vision
3. Face the lips look pale
4. Pulse may become slow at first but later always bears faster but gets feeble
5. Vomits (in many cases)
6. Becomes unconscious in later stages of shock

- **Electrical Injuries**

Causes of Electrical injuries

If any part of the body comes in contact with a live wire which is exposed and not covered by insulator or with a cable or rail in which current is leaking, a person gets an electric shock. In houses, the blowing out of switches or fuses or faulty electrical connections can cause such injury. The injury may be quite mild or so severe as to cause immediate death. Electrical shock is produced only when an electric current pass through the human body which is in contact with earth. It passes even more quickly if the part is wet.

In wet conditions even lower voltage may be dangerous. A very strong current passing to earth through lower limbs may be less dangerous than a weaker current passing through the chest especially so when it enters through the hands and arms.

The effect of electric shock

1. There may be fatal paralysis of heart.
2. There may be sudden stoppage of breathing due to paralysis of muscles used in breathing
3. Heart may continue to beat, while breathing has stopped. In this condition the face appears blue.
4. There may be burns, either superficial or deep. They depend on the strength of the electric current causing the injuries.

Precautions

1. When the current is of low voltage the first aider should stand on an insulated material which is dry. (Insulating materials are rubber – soled shoes, wooden planks or piles of newspaper). Rubber gloves, if available, should be worn. If not, dry coat, cap or other clothing may be used. Old dry newspaper also gives protection.
2. When the current is of a very high voltage, as in the case of over-head (high tension) lines, there is greater danger. The casualty may not be in a actual contact with the wire as the current can pass through the gap (causing an arc). The first aider in such circumstances should keep as far away as possible from electric wires. (The casualty is to be dragged out to a non-conducting material. A walking stick, dry bamboo pole, wooden plant or a dry rope is to be used).
3. If the casualty is not breathing normally or heart has stopped beating give artificial respiration and external cardiac massage for a long time.
4. Treat for shock.
5. Treat for burns, if any.
6. Transfer to a hospital or seek the help of a medical practitioner, who is nearest.
7. Even when the casualty has recovered fairly well after first aid is given he/she must be examined by a medical specialist because electric injuries are liable to relapse.

- **Unconsciousness**

Any interference with the normal functioning of the brain and the nerves bring about partial or total loss of consciousness. An unconscious state indicates not only that there might be some

disease or injury of the brain but also serious injuries and diseases elsewhere in the body.

Unconsciousness due to injuries are of two kinds.

a. Partial when it is called stupor and

b. Complete when it is known as coma.

Tests for degree of unconscious states

a. When spoken to the casualty - may not respond. While in stupor he can be roused with difficulty, in coma there is no response at all.

b. In stupor one cannot open the eyelids as the casualty will resist this attempt. But in coma lids can be opened without any resistance.

c. Pupil test.

   Pupil is the round opening in the centre of the Iris. In stupor caused by diseases or injuries the pupil contracts when light is made to fall on it . But in coma there is no response to light. In fact, it is often widely dilated in deep coma.

Causes of unconsciousness

a. Brain injuries

b. Apoplexy (Stroke)

c. Hypoglycaemia (low sugar) / Diabetes (high sugar)

d. Epilepsy

e. Psychiatric Disorders

f. Fainting

g. Heat stroke or exhaustion

h. Snake bite

i. Dog bite

a) Brain Injury

Direct injury to the brain can cause one or two conditions viz. concussion and compression.

Concussion is more a shakeup of the brain as a whole rather than an actual injury to the brain substance. It is caused by a blow on the head, fall from a height on the feet or on the buttocks, or even a blow on the point of the jaw.

Signs and symptoms

- Loss of sensibility: This can be mild stupor or coma. Mild cases are attended with a blackout of short duration or it may just be confusion. Stupor and coma are a result of serious shake ups. It may lead on to compression. Therefore, there is a need for careful watching. In fact, no head injury case should be treated casually.
- At the time of recovery there is generally nausea and vomiting, loss of memory for events before and after injury are not rare.

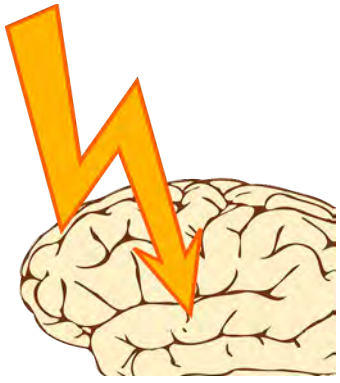
Concussion

Concussion is a more serious conditions, when an active pressure is produced on some part of the brain, like a blood clot or a fractured bone of the skull. A concussion may lead to compression. The casualty may not return to consciousness even after a day or more.

Signs and symptoms

- At first there may be stupor, which may be followed by coma.
- Breathing will be noisy.
- Slow pulse and flushing of face are expected.
- Temperature may be raised. In the absence of a thermometer, the head being hot to the touch is enough to know this.
- The pupils may either be dilated or unequal in size
- Paralysis of one side or a part of the body if seen is a sure sign of brain injury.
- There may be convulsions in rare cases.

b) Apoplexy (Stroke)



A stroke occurs when the blood flow to part of the brain is interrupted. A person of any age can have a stroke. Apoplexy occurs in middle age and after, and in patients with high blood pressure. A diseased blood vessel in some part of the brain ruptures and the blood floods the brain tissue causing unconsciousness. This medical condition is also known as stroke

Signs, symptoms and management

The signs are in way like those of compression. The treatment is on the general lines given above.

What to Look For

- A sudden, severe headache

- Dizziness or confusion
- Unresponsiveness or temporary loss of responsiveness
- Sudden loss of bladder or bowel control

Management of Stroke

FAST

When trying to determine if a person is having a stroke, remember the acronym FAST:

F ACE—facial numbness or weakness, especially on one side

A RM—arm numbness or weakness, especially on one side

S PEECH—abnormal speech, difficulty speaking or understanding others, or a loss of speech

T IME—time is important; call

Call

Call for help or dial emergency number and get an AED.

Care

1. Have the person rest in a comfortable position.
2. Note when the signs and symptoms first started (or the last time the person was known to be well).

c) Hypoglycaemia (low sugar) / hyperglycaemia (high sugar)

Any fluctuation in the blood sugar levels (either extreme low <50mg/dL with symptoms or abnormally high >450mg/dL will cause hypoglycaemia or hyperglycaemia

Signs and symptoms

Hypoglycaemia (low sugar)

- Skin moist with sweating
- Shallow and quiet
- No smell of the sort
- Fainting – rarely unconsciousness

Diabetes (high sugar)/ hyperglycaemia

Diabetic Coma

- Skin dry
- Breathing deep and sighing

- May smell of acetone (mostly apple smell)
- Unconsciousness deep or stupor only

d) Epilepsy

Epilepsy is a disease of the young usually in the beginning the attacks of convulsions are rare, but they become and more and more frequent later. The casualty hurts himself when he falls down.

1. In minor epilepsy the casualty becomes pale, his eyes become fixed and staring and he becomes unconscious for few seconds. He resumes his work soon, as though nothing has happened. Watch the casualty for development of a major attack, if any. Treat as for fainting.
2. Major epilepsy is a serious mater. The attack always follows headache, restlessness or a feeling of dullness. The casualty is aware that immediately he is going to get an attack of epileptic fits.

The fit itself has the following four phases

- Sudden loss of consciousness, which makes him fall to the ground. He may cry or scream
- The body becomes rigid for a few seconds. The face is flushed.
- The fits begin in full force, the casualty may injure himself by stinking against hard or sharp objects. There is frothing at the mouth and he may bite his tongue. He may pass urine and motion as these get out of control.
- The attack lasts for a few minutes, the convulsion stops. The casualty is dazed and confused. He may act in a strange manner without known what he is doing. After some times he becomes normal.

Unresponsive States due to psychiatric disorder

Rarely does a first aider need to attend to these cases. Emotional or mental stress brings on the attacks.

Signs and symptoms

1. Loss of control of emotions rigidity of the body and seeming unconsciousness.
2. Pseudo Convulsions. Patient may shout or cry, tear hair, keep the eyes lightly closed when ‘unconscious’. Patient’s behaviour is attention seeking.
3. There may be deliberate falls with no injury caused to any part of the body. If left alone the patient may not exhibit any of the above symptoms.
4. The situation is difficult to diagnose. First aider should find out the background of the casualty by enquiries to decide whether it is a psychiatric disorder.

e) Psychiatric Disorders

- Psychiatric Disorders can usually be classified as: Organic and Functional.

  In the Organic Category are disturbances related to Substance induced or withdrawal state, Cardiovascular, Neurological, Metabolic or Neoplastic causes. While the Functional causes include Acute Psychotic Episode, Suicidal behaviour, Severe Panic Disorder, Violence or threats of Violence.

- The hallmark of diagnosing an Organic State includes the disturbances in cognition viz. consciousness, attention, language deficits with the presence of other bodily findings related to the system or organ which is the primary cause.

f) Fainting

Fainting is very common. It is always due to reduced blood supply to the brain. Fear of an operation etc. Fright, sad news or pain can cause fainting. A sudden fall in blood pressure also can produce it. It may also develop slowly in weak persons or people staying for long period in hot or stuffy places as in parades or stuffy rooms.

Signs and symptoms

- Unconsciousness occurs either suddenly or the casualty may have giddiness for a second, the body crumbles into a heap and soon becomes unconscious.
- Face is pale (due to reduced blood supply to head or brain)
- Pulse is weak and slow
- Breathing becomes less deep than normal.
- Skin is cold and sticky.

g) Heat stroke or exhaustion

The effects of excessive heat are

- Heat exhaustion
- Heat stroke

Both these conditions are caused by too high a temperature in the atmosphere but the signs and symptoms as also the treatment are quite different. Therefore, they must be learnt and treated differently. Humid surroundings also add to the immediate occurrence of the conditions. Lack of body fluids and salt also, in an important factor.

Signs and symptoms: Heat Exhaustion

1. Headache, dizziness, slower onset, nausea, vomiting occasionally abdominal cramps, collapse.
2. Unconsciousness follows
3. Face pale with cold sticky sweat
4. Pulse : weak
5. Temperature normal or slightly high

Heat stroke

1. A dangerous condition coming on suddenly. But it may follow untreated exhaustion.
2. Unconsciousness rapid, but may come up after headache
3. Vomiting, face flushed, skin hot and dry.
4. Pulse: full and bounding
5. Temperature: Rises rapidly up to 104 F or even higher.
6. Death will occur soon if temperature is not lowered soon.

h) Snake bite

There are more than 2500 different kinds of snakes. Only about 200 of them are venomous. All snake bites are not fatal. Only a very small quantity of the venom might have been injected. Most people die not because of the venom, but from fear.

Aim of first aid

To reassure the person

a. To stop spreading of the venom
b. To obtain medical aid

There are three families of medically important venomous snakes. All have fangs at the front of their mouths whereby they inject venom from the parotid glands.

The Elapidae (cobras, kraits, tiger snakes and coral snakes) are found in all parts of the world. They have short fangs and are land snakes, the venom of which produce neurotoxic features. Local tissue necrosis may occur, a feature characteristic of venom of Asian cobras and the African spitting cobra.

The viperidae, which have long erectile fangs, are divided into vipernae (True vipers) such as the Russell's viper, Carpet viper and European adder. These occurs in all parts of the world except America and Asian Pacific area. The second subgroup is the Crotalidae (Pit vipers) such as Rattle snakes, Fer-de-lance and Malayan pit viper which have a small heat – sensitive pit between eye and nostrils. The venom of the Viperidae is vasculo – toxic.

The hydrophidae (Sea snakes), which are abundantly found in the Asian Pacific Coastal waters, and have short fangs, characteristic features are flattened tails. The venom of these snakes is myotoxic. At least 50% of the people bitten by snakes suffer few or no toxic effects as little or no venom has been injected. By contrast, if the dose of venom is high mortality without effective treatment is 10% in Elapidae poisoning within 5-20 hours of the bites. 10% for Sea snakes within 15 hours and 1-15% in viperidae within 2 days. In the early stages the snake bite is very unpredictable and all patients must be carefully monitored for at least 12 hours.

i) Dog bite

Dog bites are sometimes are very serious. They may cause infection. If the animal is suffering from rabies it will be transmitted to the person. The condition is known as Hydrophobia. The dog should not be killed, it must be chained ad kept under observation for ten days. If the dog is healthy after this period, there is no danger of rabies.

Aims of first aid

a. To prevent rabies or other infections.

b. To get medical aid

4.0 ROLE OF FIRST AID TREATMENT IN MEDICAL EMERGENCY

Prevention is better than cure but when prevention is not possible and injury does take place, cure is the only prevention of further injury and this cure is primarily to be provided by the first aid. The role of a first aider is to provide immediate, lifesaving, medical care before the arrival of further medical help. This could include performing procedures such as:

- Placing an unconscious casualty into the recovery position
- Performing Cardiopulmonary resuscitation (CPR)
- Using an automated external defibrillator (AED)
- Stopping bleeding using pressure and elevation
- Keeping a fractured limb still

A first aider's overall aim should be to **preserve life.** Other aims of first aid include prevent the worsening of the patient's condition and to promote recovery. The first aider should observe carefully, think clearly and act quickly. He should be calm, cool and confident. He should ask someone to call a doctor and inform the hospital immediately giving some details of the cases involved.

While waiting for the doctor he should give first aid methodically. First aid is based on scientific medicine and surgery. It is skilled assistance. But the first aider is not a doctor. After the doctor takes charge, the first aider's responsibility ends. He can then stand by to help the doctor.

5.0 PRE-HOSPITAL MANAGEMENT

5.1 At the Site of Incident

- Inhalation – Shifting of the patient to a safe place away from the danger. Washing of the affected area with copious amount of water in case of splash of any chemical.
- Trauma – Stabilize the patient depending upon the type & extent of injury. Eg tight bandage to arrest the bleeding, covering of the exposed injured body part with clean cloth, Properly securing & packing the amputated part, Immobilization of fractured bones, log rolling of the patients before shifting them in ambulance in cases of fall from height, Cardio pulmonary resuscitation (CPR)
- Medical Emergencies – CPR in case of Cardiac arrest, Glucose power in case hypoglycemia, loosening of the tight clothing in case of heat stroke, shifting the patient to a aerated place in case of seizures.

5.2 During Transportation of Victim to the First Aid Centre

If the patient is transported in ambulance then a qualified nursing staff has to accompany the victim from the place of accident to first aid center. En-route patient's vitals to be monitored and according to the condition of the patient, he has to be stabilized.

5.3 At the First Aid Centre

Oxygen inhalation, IV fluids, arresting of the bleeding, stabilizing of the affected bone by splints, maintenance of respiration, CPR, Defibrillation if required. All efforts to be made to stabilize the patient hemodynamically before shifting into hospital.

5.4 During Transportation of Victim from the First Aid Centre to Hospital

- Airway, Breathing, Circulation (ABC) of the patient shifted is to be monitored and maintained by the nursing staff/ doctors accompanying the patient.

Normally following steps should be carried out for trauma victims by the first aider or worker attending the casualty

- applying compression bandage
- Applying splints to immobilize the broken bones to prevent further injuries
- Securing the amputated part and properly packing and transportation it in a sterile polycover (polythene bag) which is to be kept in another polycover with ice.
- Care of spine (back) by putting the patient on hard surface. Preferably the shifting of the patient on spine board. Care of neck (cervical) to be given highest importance by either neck stabilizer or by putting hard cervical collar.

5.5 Management of Exposure by Toxic inhalation

- Remove the victim to a safer place

- Resuscitation if required (CPR)
- Oxygen therapy

Oxygen is the mainstay of treatment for people who are exposed to gases. If lung damage is severe, a person may need mechanical ventilation. But any person who has breathing problems after inhaling a gas is usually monitored in a hospital overnight to ensure that serious complications do not occur. Drugs that open the airways (bronchodilators), intravenous fluids, and antibiotics may be helpful. Corticosteroids such as prednisone are often given to reduce inflammation in the lungs.

Immediate attention that is required in serious burns are:

1. Keep the casualty quiet and reassure him.
2. Wrap him up in clean cloth.
3. Do not remove adhering particles of charred clothing
4. Cover burnt area with sterile or clean dressing and bandage. In case of burns covering a large part of the body, it is sufficient to cover the area with a clean sheet or towel.
5. Keep him warm but do not overheat him.
6. If the hands are involved, keep them above the level of the victim's heart.
7. Keep burnt feet or legs elevated.
8. If victims face is burnt, sit up or prop him up and keep him under continuous observation for breathing difficulty. If respiratory problems develop an open airway must be maintained.
9. Do not immense the extensive burnt area or apply ice-water over it because cold may intensify the shock reaction. However, a cold pack may be applied to the face or to the hands or feet.
10. Shift the casualty to the dispensary or to the nearest hospital, if he is fit to be moved.
11. If you cannot take him to a hospital, wait for the doctor to arrive.
12. Do not open blisters.
13. Keep him wrapped up in clean cloth.
14. Treat for shock.
15. Remove quickly from the body anything of a constricting nature like rings, bangles, belt and boots. If this is not done early, it would be difficult to remove them later as the limb begins to swell.
16. If medical help or trained ambulance personnel cannot reach the scene for an hour or more and the victim is conscious and not vomiting, give him a weak solution of salt and

soda or electoral powder at shop floor and enroute – one teaspoonful of salt or freshly prepared electrolyte solution. Allow the casualty to sip slowly. Give about 4 ounces to adult over a period of 15 minutes. Discontinue fluid, if vomiting occurs. Do not apply ointment or any form of grease or other home remedy.

5.6 Management of Minor burns and scalds

In the case of minor burns:

1. Clean the area gently with clean water.
2. Submerge the burnt area in cold water.
3. Apply a solution of salt and water (one teaspoonful to a pint of water) in out of the way places.
4. Cover with dry dressing.
5. Do not apply cotton and wool directly on the burnt area.
6. Do not apply any greasy substance.
7. Give warm drinks for example sweetened tea or coffee.

5.7 Management of chemical burns

1. Wash off the chemical with a large quantity of water by using a shower or hose if available as quickly as possible for at least 15 minutes. This flooding with water will wash away most of the irritant.
2. Cut out contaminated clothing
3. Do not touch the burnt area with bare fingers.

5.8 Cardiac Emergencies Management

Do not disturb the casualty unduly. Send for doctor immediately. The casualty needs to be taken to a hospital/doctor at once and by quickest means. Do not let him walk or sit up. Lift him and carry if possible, in lying or back rest possible position. Support him if in the sitting position so that the strain on the heart is less, loosen tight clothing so that he breathes freely.

Treating him/her within the first 90 minutes of a heart attack dramatically increases the chances of survival. Before the person reaches a hospital, an aspirin/clopitab/atorvastatin (Poly pill) tablet can lower the risk of clot formation.

Seat the patient in a comfortable position. If breathing isn't normal or the patient is unresponsive, hands-on CPR (Cardiopulmonary resuscitation) may be applied, to double the chances of survival.

5.9 Other Medical Emergencies

5.9.1 Shock Management

1. Reassure the casualty (when conscious).
2. Put him comfortably on his back except in cases or injury of the head, of the chest or of the abdomen , lower the head, of the chest or of the abdomen, lower the head slightly and turn it to a side. In cases of vomiting place in the three-quarter back – up position.
3. Loosen tight clothing do not remove clothing
4. Wrap in light bed sheet or thin rug.
5. Never use hot water bottles or very warm rugs. Do not rub any part of the body with anything.
6. In cases of injuries to chest or abdomen, nothing should be given by mouth as he may later need an operation or blood transfusion.
7. Observe all the above quickly as even minutes delayed may mean death. If there is no chest or abdominal injury, and the patient is conscious, give sips of water, hot tea or coffee or coconut milk (never given any alcoholic drinks)
8. Most important: Remove to hospitals as top priority.

5.9.2 Electrical Injuries Management

Intelligent and prompt action is required. If the first aider is not cautious, he may also receive severe electric shock or even die along with the casualty.

If the casualty is still in contact with the conductor switch off the current. If the switch is not be found, remove the plug, or cut off the current by breaking the wire. (Before cutting off the current, ensure that you stand on a dry piece of wooden board. Do not use scissors or knife).

5.9.3 Unconsciousness (General) Management

1. See that there is a free supply of fresh air and that the air passages are free. Take the casualty away from harmful gases, if any if inside a room, open doors and windows. Remove false teeth if any. Above all keep back crowds, they only obstruct.
2. Loosen clothing at neck, chest and waist.
3. If the weather is cold, wrap blankets around the body.
4. If breathing has stopped or about to stop turn the casualty into the required posture and start artificial respiration.
5. Breathing may be noisy or quiet. If not noisy, let the casualty lie on his back. Raise the shoulders slightly by a pad and turn the head to one side. Watch for some time. If breathing becomes difficult, or gets obstructed, change the posture to ease breathing. If

breathing is noisy (i.e. the lungs are filled with secretions and the air passing through makes a bubbling noise) turn casualty to three – quarter – prone position and support in this position with pads (in a stretcher case, raise the fool of stretchers so that lung secretion drain easily).

6. Apply specific treatment for the cause of unconsciousness.
7. Watch continuously for any changes in the conditions; do not leave the casualty until he is passed on to medical hands.
8. No form of drinks should be given in this condition.
9. It is best to remove the casualty to a healthier place on a stretcher.
10. On return to consciousness, wet the lips with water. If there is thoracic or abdominal injury sips of water also can be given.

5.9.4 Usual unconscious states – Concussion Management

General rules laid down above are to be followed. But it should be kept in mind that brain injury is serious condition and requires urgent medical care.

5.9.5 Diabetic coma and over-dose of insulin Management

For coma follow general rules: but send for the doctor once.

Insulin overdose: Feed with glucose water or sweets or biscuits or sugar, if he can take/ consume.

5.9.6 Epilepsy Management

a. Just keep the casualty under control, do not use force to stop the convulsions. Remove objects that may cause injuries.
b. Prevent biting of tongue by inserting a spoon wrapped in a handkerchief near the back teeth, when the jaws are relaxed.
c. Wipe froth from the mouth.
d. Follow the general rules for treating unconsciousness.
e. Watch for recurrence, if any. Leave the casualty after making sure he is aware of his surrounding s. Advise him to see a doctor.

5.9.7 Unresponsive States due to psychiatric disorder

a) Ignore the attack.
b) Be firm in dealing but be kind
c) After recovery i.e. control of his activities is gained, give him some work to do.
d) Follow the general rules laid down. The casualty should not be allowed to get back to work, unless advised by the doctor.

5.9.8 Psychiatric Disorders Management

- One must always keep calm and avoid a confrontational attitude.
- DO NOT shout at the patient and try and make him/her feel comfortable and reassured.
- ALWAYS ask for and look out for additional help.
- Try and remove potentially dangerous items viz. scissors, knives, metallic objects like torches, ropes, etc. in order to minimise the danger to self and the patient.
- Call for a Mental health professional or a Staff Liaison Personnel or Social Worker, etc.
- Benzodiazepines, like Injectable Lorazepam or Antipsychotics like Haloperidol or oral Olanzapine are useful in calming the patient.
- It is always advisable to keep a close watch on the patient in the emergency situation.
- Diagnose and treat the Organic cause if present before labelling the patient as Functional.

5.9.9 Fainting - Immediate Management

a. The moment the person feels faint get his head down quickly. If sitting get the head between the knees and hold it there for a minute or two. It may be necessary to lay him down, with the head at a slightly lower level than his feet.

b. If the casualty has become unconscious, lay him down as described above.

c. See that there is plenty of fresh air ask the onlookers to disperse.

d. Loosen clothing at waist, chest and neck.

e. After recovery only slowly raise the head, then make him get up and sit down.

f. Give sips of fruit juice or tea or coffee or even water.

5.9.10 Heat Exhaustion/ Heat Stroke Management

1. Heat Exhaustion

   a. If the casualty is unconscious, remove him to a cool place, give him plenty of salt water (1/4 teaspoon of salt in a glass of water) keep him comfortably warm. Watch him carefully and be prepared to treat if he develops heat stroke.

2. Heat Stroke

   We have to bring down his body temperature quickly. Keep the casualty in the coolest possible place.

   Remove clothing and sprinkle cool water (if possible ice water) on the body or wrap him in a thin wet sheet and fan him. The temperature begins to fall, but is should not get

lower than 102 º F. After this stage is reached wrap him in dry sheet and keep fanning on recovery, treat as for heat exhaustion.

5.9.11 Snake Bite

General First Aid Measures - Apply firm pressure bandage above the bite area and immobilization of the part substantially delays spread of the venom. Patients are very often very apprehensive and should be reassured and sedated if necessary.

a. Lay the patient down, give him complete rest, clean and reassure him: never make him walk.

b. If the bite is on the arm or leg, apply a constrictive bandage on the heart side of the bite tight enough to obstruct and stop the flow of the venom to all parts of the body. Don't tie it too firmly.

c. If water is not available, and you have no cracks on your lips, tongue and inside of the cheeks, you can suck the wound and spit out the poisonous material repeatedly.

d. Wash the wound with soap and water. Flush the wound with a lot of water.

e. Cover the wound with a sterilized dressing.

f. Get medical aid or send the person on a stretcher to the dispensary/hospital as quickly as possible. If the snake has been killed, carry it to the dispensary for identification. If breathing fails, commence artificial respiration.

Clinical features - Local pain and fang marks are very variable and of no helping in diagnosis.

Elapidae - There is seldom any local swelling. Vomiting, hypotension and a polymer leucocytosis suggests a systemic envenomation. More specific signs of muscle, weakness, such as ptosis, glossopharyngeal palsy and cough indicates severe poisoning and may be delayed for 10 hours after the bite. There is a danger of respiratory paralysis, ECG changes are seen and rises in cardiac enzymes occur.

Viperidae - Local swelling starts almost immediately. This is also a feature of poisoning in bites by Asian cobras and African spitting cobras, but may not develop up to 2 hours. Early sense of systemic poisoning, which may develop within 15 minutes of the bite include vomiting, hypotension and signs of abnormal bleeding from or into any site. Later signs include increase in local swelling which may become massive over 48-72 hours with associated bruising. Blister formation around the sight of the bite is common and spreading blisters suggest a large dose of venom and may precede necrosis. Local tissue necrosis with an offensive putrid smell is typical of cobra bites. Shock may occur and haemorrhage into a vital organ which is often fatal may occur up to a week after the bite, if anti venom has not been given.

Hydrophidae - the early features are similar to Elapidae. More specific signs are generalized myalgia with the appearance of myoglobinuria 3-5 hours later. Paresis of the limbs may follow with respiratory paralysis within a few hours of the bite, although it may be delayed for upto 60 hours. Hyperkalaemia may result in cardiac arrest and acute renal failure may occur.

Treatment -

1) The site of the bite should be cleansed and then left strictly alone, otherwise the risk of infection is increased. If skin necrosis occurs, sloughs should be excised with skin grafts applied as appropriate.
2) General measures, including intravenous fluids, should be given to support vital functions.
3) Sedatives are required if the patient is apprehensive.
4) Appropriate anti tetanus prophylaxis should be given taking account of the patient's immune state.
5) Anti-venom should be given only if there is clear evidence of systemic poisoning.

Some local effects, however, especially necrosis, may be avoided or minimized if antivenom is given within 4 hours of the bite. All antivenoms may cause severe allergic reactions which may be fatal. Appropriate precautions, therefore, are mandatory. The potency of the antivenom should be checked by first making sure that it is clear and has no opacity. Depending on the severity of poisoning 20-100 ml antivenom is diluted in 2-3 volumes of isotonic saline. This is then given by slow intravenous infusion (15 drops per minute). Inj. Adrenaline (1:1000 solution) must be immediately available. If a reaction occur the drip is stopped temporarily, and 0.5 ml Adrenaline injected intramuscularly. Provided the adrenaline is given at the first sign of Anaphylaxis, it is rapidly effective, and the drip can be restarted with care.

There is marked variation in the requirements of different patients for antivenom. Therefore, it is important to give sufficient antivenom to counter act the toxic effects of the poisoning and children require the same doses of antivenom as adults. This is especially important in neurotoxic poisoning.

5.9.12 Dog Bite -Management

All dog bites must be treated as potentially bite by a rabid dog.

1. Wipe the saliva away from wound.
2. Wash the hand thoroughly with plenty of soap and water
3. Cover the wound with a dry, sterile dressing. Do not put carbolic acid, nitric acid etc.

Get medical aid or send the patient to the dispensary/hospital for proper treatment of the wound and the casualty.

6.0 Management of medical Emergencies in Hospital

Effective and timely medical intervention plays an important role in the outcome of the injury/ disease. There are standard protocols to handle various medical emergencies. The people involved in giving the first aid / definitive treatment should follow the guidelines described below:

6.1 Trauma – Crush Injuries, Fractures, Amputations, Fall from Height

Following actions to be take when patient is shifted to hospitals

- Controlling of bleeding by securing the bleeder and properly ligating/ suturing of the wound.
- Fracture management by either POP application or open reduction & internal fixation.
- Managing the vital parameters of the patient and salvaging of the amputated part by doing micro surgery.
- Investigations to rule out any head injury or spine injury or damage to any visceral organs and treatment thereon.

6.2 Toxic Inhalations

Management of Exposure by Toxic inhalation

- Continue oxygen inhalation
- Antidote/ steroids depending on the nature of toxic inhalant
- Stabilising vital parameters
- Ventillatory support if required
- Supportive and conservative treatment

6.3 Chemical Burns

Management of serious burns and scalds

- Shifting the patient to clean isolation room
- Sterile dressing of the affected part
- IV fluids
- Antibiotics for prevention of infection
- Treatment of complications
- Supportive and conservative
- Skin grafting / plastic surgery to cover large burn area

6.4 Cardiac Emergencies Management

After receiving in hospital the patient to be shifted to ICCU. All effort are to be made first to stabilise the patient and then to ascertain the diagnosis. Treatment should be as per the diagnosis. However common medical management cardiac emergency is listed below

- Oxygen inhalation
- Cardiac emergency medicine in case of suspected heart attack
- Defibrillation if required
- Thrombolysis
- Ventilatory support if required

All other type medical emergency should be treated either at the site hospital or at the referral hospital depending up to the nature and type of medical emergencies.

6.5 Radiological Emergency Management

Management of radiation exposure depends upon the dose received. The treatment corresponding to different doses is described below:

Hematopoietic syndrome (1-8 Gy): Needs blood component therapy and treatment of opportunistic infections. Hematopoietic Growth Factors or Cytokines are administered to increase the rate of hematopoietic recovery by stimulating bone marrow stem cells and may obviate the need for a bone marrow transplantation. Doses higher than 9 Gy may however require a Bone Marrow Transplant (BMT) or Peripheral Blood Stem Cell Transplant (PBSCT). With good medical and nursing care, the person may recover.

Gastro intestinal syndrome (8-30 Gy): Treatment of severe dehydration, electrolyte disturbances, infection.

Neuro-Vascular syndrome (> 30 Gy): The low blood pressure and swelling of the brain and injury to various other vital organs like lungs, kidneys and liver results and only palliative care remains possible.

6.6 Management of CRI

Sterile protective dressings, use of antibiotics and pain killers are required. Full thickness burn will necessitate skin grafting if area is more than 2 to 3 sq. cm. Large areas of necrosis and gangrene require excision of tissue and, at times, even amputation. External contamination has to be treated as a priority in order to prevent the spread of contamination as well as to prevent it from being internalized.

Elimination of 90% of contamination is achieved by removal of clothing alone. Over-aggressive and over- zealous treatment should be avoided in order to prevent injury to the natural barriers of the skin resulting in enhanced absorption.

Decontamination should be carried out at the site of the accident preferably in separate place earmarked for this purpose. It should be easily accessible to the exterior of the building to ensure minimum spread of contamination when the patient arrives. The floor of the room should be easily washable or should be covered with polythene sheets. The room should have water supply, low-level sink for collection of contaminated water, and a place for monitoring instruments.

Generally, trained Health Physics staff does the monitoring and treatment. The doctor is required in case of persistent contamination with associated injury or contamination of sensitive parts of the body; e.g. eyes, nose, mouth etc.

Internal contamination, though not life threatening, also needs to be treated with decontaminating agents early, as late decontamination may not offer the same benefits. Decontamination has to be carried out using specific antidotes.

6.7 Specific Treatment

	Radionuclide	Common mode of contamination	Target organ	Specific Treatment
1.	Iodine (I131)	Inhalation Ingestion Subcutaneous absorption	Thyroid	Potassium iodide
2.	Strontium (Sr90)	Ingestion Wound	Bones	Aluminium phosphate gel Calcium alginate Aluminium hydroxide gel
3.	Caesium (Cs137)	Inhalation Ingestion	Muscles	Prussian blue
4.	Tritium (H3)	Inhalation Ingestion Skin absorption	Whole-body	Increased fluids Diuretics (drugs that increase urine output)
5.	Phosphorus (P32)	Ingestion	Bones	Stable phosphorus in the form of Glycero-phosphates
6.	Uranium (U235)	Inhalation Ingestion Wound	Kidneys	Sodium bicarbonate infusion
7.	Plutonium (Pu239)	Inhalation Wound	Liver Bones	Ca-DTPA aerosol Intra-venous Ca-DTPA

6.8 Other Medical emergencies

Hospital Management of Other Emergencies is beyond the scope of this document. The Physician/Surgeon will decide on further medical management of the patient.

6.9 Conclusion

It is expected that this monograph helps employees/all concerned to understand the emergencies arising during the work, its causes, symptoms and treatment procedures and

follow the same without losing the valuable time to save the invaluable human life. Though all the medical emergencies required a definitive treatment but mainstay remains timely intervention at the place of accident, during transportation from accident spot to first aid centre / hospital and at the first aid centre.

Annexure

Typical Checklists for Inspection of Ambulance Vehicle & First Aid Centre

A. Checklist for Inspection of Ambulance Vehicle

Sr. No.	Ambulance vehicle articles	Required quantity	Availability (Yes/No)	Observations/ Remarks
1	Oxygen Cylinders – Containing Human Oxygen – Complete with spanner key, Humidifier, Flow Meter, Pressure Regulator, tubing (Intra Nasal Catheters) with Arrangement for Fixing in the Vehicle and anti-rotation grip for easy & quick operation of valve	1		
2	Foot operated suction Apparatus - with clean protected tubes, free from contamination for immediate use	1		
3	a) Canvas folding stretchers - in neat, clean and good working condition	2		
	b) Wheeled stretchers - in neat, clean and good working condition	1		
4	Portable Emergency Light with charger	1		
5	Flash light (Good Torch)	1		
7	Insulated gauntlet	1 pair		
8	Bag-valve mask (hand operated artificial unit) - AMBU BAG	1		
9	Mouth gags (Plastic)	2		
10	Tracheotomy Adaptors	As specified by certifying surgeon		
11	IV fluids with administration unit	2		
12	BP Apparatus with cuff	1		
13	Cuff	1		
14	Stethoscope	1		
15	Immobilization units			
	a) Long & short padded boards			
	b) Wire ladder splints			
	c) Triangular bandage	2		
	d) Long spine board (Ply board of 6' x 2.5' x 5mm thick) for patients with injury in spinal cord) with neck support	1		
	e) Short spine board			
16	Dressings			
	a) Gauze pads of different size	5		
	b) Universal dressings (25 cm x 90 cm)			

	c) Roll of Aluminium foils			
	d) Soft roller bandages (15 cm x 5 cm)	5		
	e) Adhesive tapes in 7.5 cm rolls	1		
	f) Safety pins (Big size)	4		
	g) Bandage sheets			
	h) Burn sheets			
17	Poisoning: -			
	a) Syrup of Ipecac			
	b) Activated charcoal (Prepackaged in doses)			
	c) Snake bite kits			
	d) Drinking water Container for drinking water 5 litre	1		
18	Emergency medicines (As per the list available in ambulance)	As specified by certifying surgeon		
19	Fixed cupboard of adequate size with sliding doors - to keep emergency drugs, instruments & disposables	1		
20	Flexible / collapsible hooks / rings fixed to the ceiling or other suitable arrangement to hold intravenous fluid bottle	2		
21	Double walled thermo flask for drinking water	1		
22	Wash basin with tap connected to a water container of a least five litre & a drainage pipes for water outlet	1		
23	Folding type wheelchair	1		
24	First aid box of standard specification and contents as specified by certifying surgeon	1 set		
25	Pillow with case, bedsheet, blanket, towel	2 set		
26	Emesis bag	4		
27	Bed pan	1		
28	Portable urinal pots for male and female	1 each		
29	Tumbler glasses	2		
30	Ambulance vehicle **(Engineering part)**			
	a) Stepney in good condition	1		
	b) Wheel jack & spanners	1 set		
	c) Headlights, back lights, brake lights, internal lights, indicators rear view and side mirrors in good condition	As per the standard fittings		
	d) Horn & Siren	As standard fittings		

	e) Valid PUC certificate	As applicable		
	f) Documents on vehicle registration, insurance and driving license of the ambulance driver	As applicable		
31	Availability of manpower			
	a) Full time driver (cum mechanic to remove)	1 in each shift		
	b) Helper trained in first aid	1 in each shift		

B. Checklist for Inspection of First – Aid Centre /Ambulance Room

Sr. No.	Articles at First-Aid Centre	Required quantity	Availability Yes /No	Observations/ Remarks
1	Glazed sink with hot water facility	1		
2	Table with smooth top at least 180 cm x 105 cm	1		
3	Means for sterilizing instruments	1 set		
4	Couch	1		
5	Plastic bucket (10 litre capacity each as below) :			
	a) Yellow (for human anatomical waste)	1		
	b) Red-for solid waste items contaminated with blood & body fluids, cotton, dressings, lines etc. tubing, catheters, IV sets etc.	1		
	c) Blue translucent (for needles, syringes, scalpels, blades, glass etc.)	1		
	d) Black (for discarded medicines)	1		
6	Disposable plastic bags-in yellow, red, blue & black (made of virgin, recyclable plastic having 5 kg. capacity)	20 pieces in each colour		
7	Rubber hot water bags	2		
8	Kettle and sprit stove or other suitable means of boiling water	1		
9	Plain wooden splints			
	a) 900 mm x 100 mm x 6 mm	6		
	b) 350 mm x 75 mm x 6 mm	6		
	c) 250 mm x 50 mm x 12 mm	4		
10	Woollen blankets	4		
11	Hand Towels	4		
12	Artery forceps	3 pairs		
13	Spiritus ammoniac aromatics	120 ml		
14	Smelling salt plain	60 gm		

15	Sponges medium size (sponge holding forceps)	2		
16	Kidney trays	4		
17	Antiseptic soaps	4		
18	Glass tumblers	2		
19	Wine glasses	2		
20	Clinical Thermometers	2		
21	Tea spoons	2		
22	Graduated 120 ml measuring glasses	2		
23	Minim measuring glasses	2		
24	1000 cc wash bottle for washing eyes	1		
25	Bottle of (1 ltr) carbolic lotion 1 in 20 (Any antiseptic liquid for floor cleaning and antiseptic cream / lotion)	1		
26	Anti-tetanus toxoid	Adequate quantity		
27	Injections-morphia, pethidrine, atropine, adrenaline, coramin, novocain	6 each		
28	Coramine liquid	60 ml		
29	Tablets of antihistaminic & antispasmodic	25		
30	Syringes with needles 2 cc, 5cc, 10cc, 50cc 20cc	Adequate quantity		
31	Surgical scissors	3		
32	Needle holders big & small	2 each		
33	Suturing needles & materials	As specified by certifying surgeon		
34	Dissecting forceps	3		
35	Dressing forceps	3		
36	Scalpels	3		
37	Stethoscope	2		
38	Rubber / Pressure bandage	2		
39	Oxygen cylinders-Containing human oxygen - in full size complete with stand / trolley key, humidifiers, flow regulator, pressure gauges & pressure regulator	3		
40	Electric hand torch (Torch)	1		
41	Screen	1		
42	Chairs	3		
43	Metallic stretchers with trolley	**1**		
44	Folding canvas stretchers in clean and good working condition	2		
45	Records			

	a) Daily inventory register of first aid centre items	1		
	b) Injury register for departmental employers	1		
	c) Injury register for contractors' employees	1		
	e) List of important telephone numbers	1 copy		
46	Standard wheel chair	1		
47	Conventional folding wheel chair	1		
48	Emergency lights with chargers in good working condition	1		
49	Suction apparatus (pumps)			
	a) Electrically operated '	1		
	b) Foot operated (with tubes, clean & free from contamination for immediate use)	1		
50	Pulse oxymeter	1		
51	Defibrillator with ECG **(AED)**	1		
52	Procedure on bio-medical waste management	1 copy		
53	Hygiene & sanitation, good housekeeping, cleanliness in room & toilets			
54	Ventilation			
	a) First aid room	3-6 changes		
	b) Toilets	6-12 changes		
	c) Illumination level	300 lux		
55	Availability of manpower			
	a) Medical officer / certifying surgeon as in charge of first aid center	1		
	b) Qualified nurse (or dresser cum compounder - not required)	1 in each shift		
	c) Nursing attendant / assistant / ward boy	1 in each shift		
56	Glucometer with test strips	Adequate quantity		

After detailed discussions of the above checklist, Advisory Committee on Occupational Health in its 41st meeting decided that Atomic Energy (Factories) Rules, 1996 shall be followed as a bare minimum requirement. However, following may be noted.

Reference	Item	Decision
Rule 67 (i), (j) & (k)	Wooden Splints	The word wooden may be removed as splints are available with different materials.
Rule 67 (ff)	Injections: morphia	Certifying surgeon can keep alternative injection for this.
Rule 67 (gg)	Coramine liquid (60 ml)	Considering the item is not available in market, Non availability of this will not be considered as violation of Atomic Energy (Factories) Rules, 1996.

Rule 88 (sch-II)	Syrup of Ipecac	Certifying Surgeon can keep alternative syrup for this.

The list of equipment given in Appendix - C of Rule 88 Schedule (II) of Atomic Energy (Factories) Rules, 1996 for Ambulance Van was discussed during the 41st meeting of ACOH. It was felt that all items cannot be accommodated in the Ambulance Van. It was decided that availability of these items should be ensured in the First Aid Centre or Ambulance Room. The necessary items to be kept in van will be decided by the Certifying Surgeon depending on the potential hazards of the facility. However, the authorized list shall be displayed inside the van.

References

1. First Aid to the injured, Authorised manual of the St. John Ambulance Association.
2. First Aid & CPR, Canadian Red Cross Society, digital Book.
3. Atomic Energy (Factories) Rules, 1996
4. Internet - https://www.mayoclinic.org/first-aid/first-aid-cpr/basics/art-20056600
