

F. No. MPS-51013/1/2020-MPS (e- 346166)  
भारत सरकार/ Government of India  
कोयला मंत्रालय/ Ministry of Coal  
(MPS Section)

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Room No. 622A, Shastri Bhawan,  
New Delhi, dated: 10th May, 2022

**ORDER**

**Subject: Implementation of Root Cause Analysis (RCA) based accident investigation by the investigators (internal/external) to ensure reduction in accidents in coal mines- reg.**

The undersigned is directed to convey the decision of Government for implementing Root Cause Analysis (RCA) techniques in accident investigation by the investigators, internal/external to ensure reduction in accidents in coal and lignite mines. In this regard, with a view to ensure culture of Root Cause Analysis (RCA) in accident or incident investigation, guidelines on “**How to conduct accident investigation**” and “**Format for Accident reporting and ATR of Accident Enquiry**” based on Root Cause Analysis has been enclosed as **Annexure-I** and **Annexure-II** for information and compliance.

2. Following the introduction of said Root Cause Analysis (RCA) techniques, all coal companies (including lignite) shall ensure investigation to be done through certified enquiry officers from a date not later than 6 months from notification of these guidelines.

3. For certification of enquiry officers in this regard, format of training (preferably for one week), syllabus for the training has been prescribed in **Annexure-III**.

4. It is also conveyed that all such UGC approved Mining University/ college/ institution awarding Bachelor's degree in Mining Engineering having facility for such training and having faculty trained in Root cause analysis techniques have been authorised to issue such certificates. In addition, professional institutions like IICM and equivalent who are capable of hiring RCA trained faculties for training, are also be authorized to issue such certificates.

This issues with the approval of competent authority.

Encl.: As above.

Signed by Hitlar Singh

Date: 10-05-2022 11:26:24

Reason: Approved  
(Hitlar Singh)

Under Secretary to the Govt. of India  
e-mail id: hitlar.singh85@nic.in

To,

1. Chairman, CIL, Kolkata.
2. CMD, NLCIL, Neyveli.
3. CMD, SCCL, Kothagudem.
4. CMDs of BCCL/ECL/CCL/SECL/WCL/MCL/NCL and CMPDI
5. The Director General, Directorate General of Mines Safety, Dhabhad (Jharkhabnd)
6. Director, (Tech.), CIL/ Director (P), CIL, Kolkata
7. All UGC approved Mining Universities/ College/ Institutions.
8. MDs Private and Public Sector coal companies (As per list)
9. NIC – for placing on website of MoC.

**Distribution list:**

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  21. Shri K.K. Maheshwari, Managing Director, Ultra tech Cement Ltd, 'B' Wing, Ahura Centre, 2nd Floor, Mahakali Caves Road, Adheri (East), Mumbai - 400009 syed.khadry@adityabirla.com

## **How to conduct accident investigation**

The whole accident investigation process is divided into three stages. The stages are:

1. Inspection of site of accident and collection of primary data
2. Collection of detailed information, data or evidences related to the events and causes of the accident for using them in accident analysis to find out the causal path and contributory factors.
3. Analysis of the collected information using Root Cause Analysis (RCA) techniques for establishing logical path of occurrence of the accident and the causal factors of the accident for making appropriate recommendation to prevent reoccurrence of similar accident/incident.

There are several steps under each stages of the investigation, right from reporting of accident to development of corrective actions. The flow chart is also developed in three stages incorporating the steps involved in each stage. Each stage of the investigation process is explained in the following sections.

### **Stage 1. Inspection of site of accident and collection of primary data**

In the first stage of accident investigation, different steps involved before and during the site inspection are outlined as follows:

1. Collecting initial information about the accident
2. Collecting details about mine under investigation
3. Collecting details about the accident
4. Collecting details about the place of accident Capturing details of the site of accident
5. Assessing risk before site inspection
6. Implementing controls measures before entering site
7. Incorporating documents of risk assessment of accident site in the accident investigation report.
8. Taking photographs of accident site
9. Making sketches of site of accident
10. Collecting on spot relevant information/data from the associated people  
Collecting/seizing/preserving of documents/evidence/material etc.
11. Collecting information about workplace environmental condition
12. Collecting additional data / information / document / evidence / material etc. after first round of collection of information/data.
13. Assessing risk before releasing the site of accident
14. Implementing control measures before releasing site
15. Collecting details about victim (s) & witness (s): providing scope for collecting information about the victim (s) and witness (s) (both primary and secondary witness(s)).

## **Stage 2: Planning for Detailed Data Collection**

Stage 2 of the investigation mainly deals with collection of relevant information/data to be used for analysis at stage 3 to find out the root causes. This requires detailed planning of data collection before actually collecting them. This planning will help the investigators to collect useful and relevant information/data, evidences, and not to miss vital information. This planning of data collection is done by developing an incident tree followed by Accident Causation Tree based on the “5-whys” technique. In the following section, it is explained how the investigation methodology provides the scope of planning for data collection and capturing data/information and evidences during the process of investigation:

- 1) Planning for detailed data collection by developing an incident tree followed by Accident Causation Tree using “5-why” technique with the primary data.
- 2) Identification of list of information/data to be collected related to involvement of People, Environment, Equipment, Procedure, Organisation and (PEEPO) factors in causation of the accident following the developed incident tree and Accident Causation Tree.
- 3) Collecting information from the associated people regarding involvement of PEEPO in causation of the accident by conducting personal interview, or from records, documents, diaries etc.
- 4) Collection of information from additional people who were directly or indirectly involved in the accident but their statement etc. not collected earlier.
- 5) Collection of information about Task Environment and Work Environment like work pressure, less than adequate task planning etc. and workplace environmental conditions like weather conditions, status of housekeeping, illumination etc. at the time of accident incorporating details of the environmental parameters as observed/measured.
- 6) Collecting information related to involvement of plant/equipment/instruments/ accessories or materials or tools etc. including adequacy of safety features or safety provisions, operability, maintenance etc. in causation of the accident.
- 7) Collecting information about the effect of procedures related to the activities or hazards leading to the accident like availability/absence of procedure and adequacy or effectiveness of the procedures related to the activities or hazards in causation of the accident.
- 8) Collecting information about the effect of organisational factors related to the accident (as provided in Step 4) in causation of the accident.
- 9) Collecting information about any other issues related to accident

## **Stage 3: Data Analysis, Determination of the Root Causes along with all Possible Causes, Implementing Corrective Actions**

In stage 3 of accident investigation, analysis of the accident is conducted to find out “how” and “why” did it happen? This is the most important step of accident investigation. Detailed methodology to be adopted and tools to be used at different steps of accident analysis have been described in section 2.

It is important to conduct the accident analysis systematically, step by step, to ensure that the causation path of the accident is established as correctly as possible and each node of the

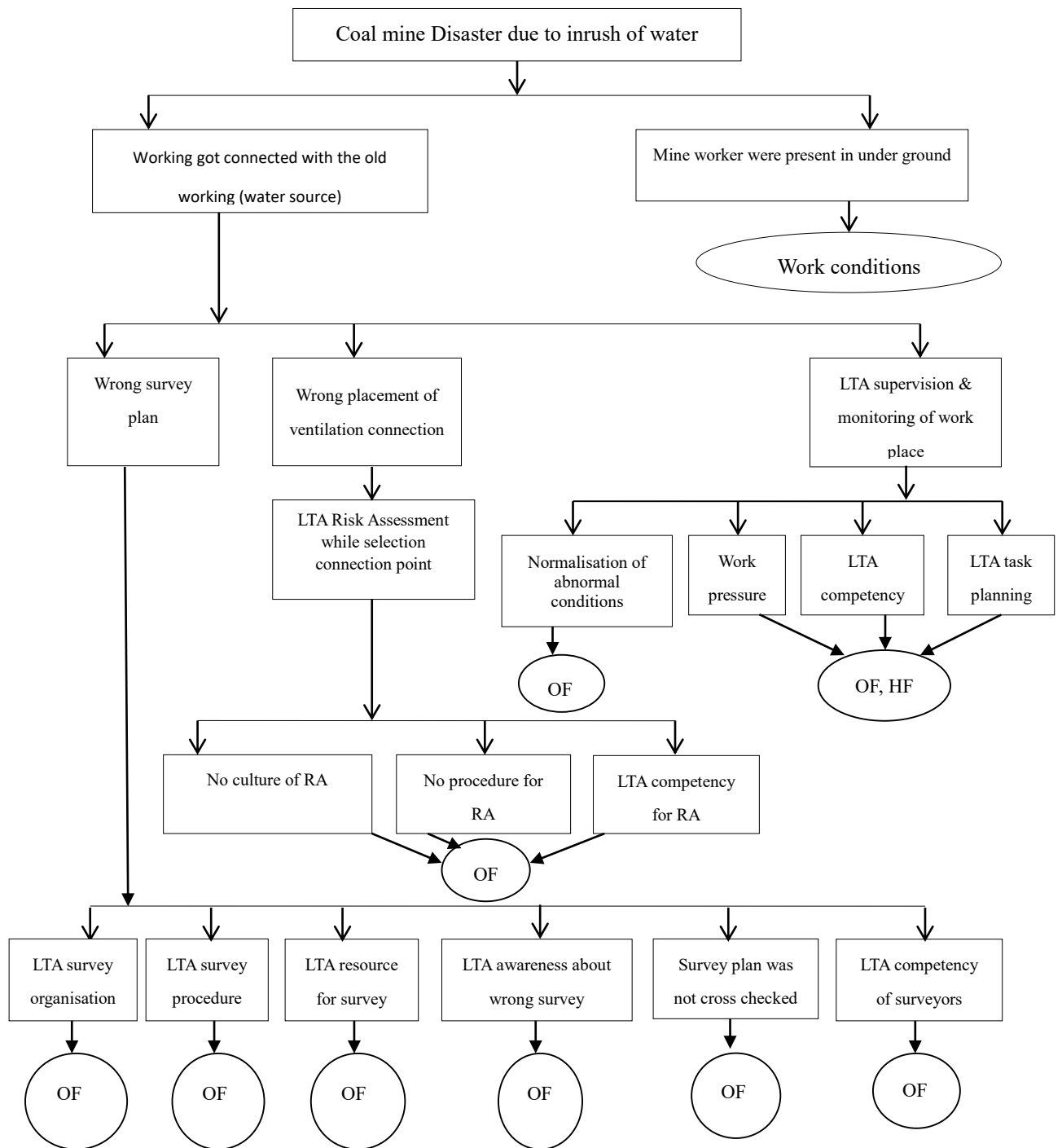
causation path is validated with available data/evidences/information. For systematic and logical analysis of all collected information, a structured and systematic approach is proposed in this accident investigation methodology to establish “how” the accident took place and “what” the contributory factors that led to the accident.

The following section provides how to proceed through this stage of accident investigation and different steps of accident analysis are outlined with a flow diagram to guide the investigators progressing systematically to the end point of identification of corrective actions and developing action plan:

- 1) Developing an incident tree based on the collected information/data/evidence etc as per the time line.
- 2) Validating each event of the incident tree against the collected data/evidences
- 3) Identifying missing information/data for validation of Incident Tree
- 4) Collecting the specific information/data/material etc. as identified in previous step
- 5) Validating each node of the incident tree
- 6) Correcting and updating the developed incident tree
- 7) Developing the event sequence hypothesis from the valid incident tree
- 8) Identifying the contradictory fact/statement about the valid event sequence hypotheses
- 9) Collecting details about the contradictory facts of the accident hypothesis
- 10) Developing an Accident Causation Tree based on the collected information/data/evidence etc. (Figure 1)
- 11) Validating each node of the Accident Causation Tree with the collected information/data
- 12) Identifying the missing data/information/material etc. for validation of Accident Causation Tree
- 13) Collecting specific information/data/material etc. which were missing.
- 14) Validating the Accident Causation Tree with the collected data /information / evidences.
- 15) Developing hypothesis of all possible causal path of the accident from the valid chains of Accident Causation Tree
- 16) Identifying the contradictory fact/statement about the valid causal path and its sequences
- 17) Collecting details about the contradictory facts about the causal path of accident
- 18) Generating an Event and Causal Factors Sequence Diagram (ECFSD) (Figure 2 & 3)
- 19) Classifying the causal factors in different category like Organisational Factors (OF), Task Environment (TE), Work Environment (WE), Human Factors (HF) and Failed Defences (FD).
- 20) Generating a Logical Sequence of Contributory Factors Diagram (LSCFD): Providing a scope for establishing the relationship between different sets of causal factors of the accident showing the logical sequences of contributory factors leading to the top event. (Figure 5)
- 21) Developing the corrective actions against each of the identified root causes, possible and potential causes of the accident following the valid causal paths and event sequence hypotheses of the accident considering the hierarchy of controls and the essential parameters of effective recommendations like Specific, Measurable, Accountable, Reasonable, Timely, Effective, Reviewed.
- 22) Developing the corrective actions against identified causes along the alternative causal paths, having the potentiality to cause similar accident.
- 23) Reviewing and examining the effectiveness of developed recommendations

24) Generating draft report of the

27) Developing key lessons of the accident investigation which will be applicable to the whole industry as key lessons for overall safety improvement.



LTA –Less than adequate      OF – Organizational Factor

RA – Risk Assessment    HF – Human Factor

**Figure 1: Example of Accident Causation Tree**

## Events & Causal Factors Sequence Diagram (ECFSD)

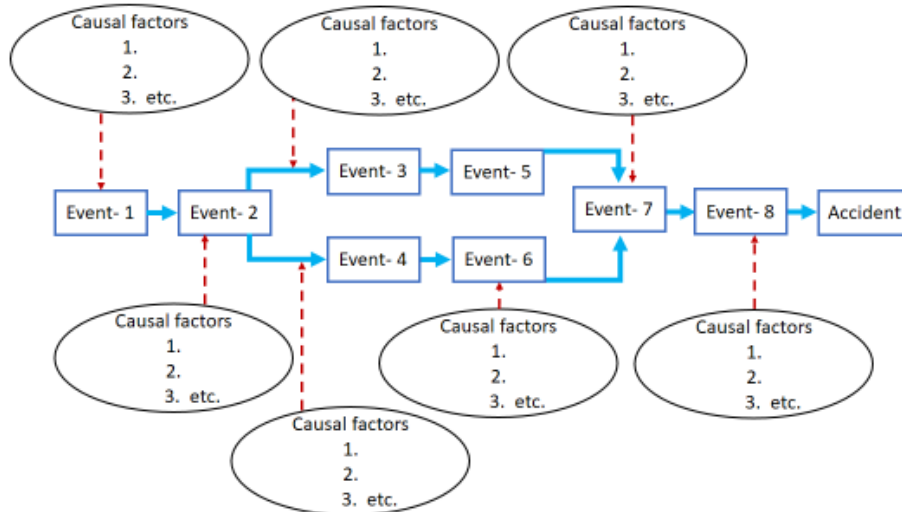


Figure 2: Schematic of Event & Causal Factors Sequence Diagram (ECFSD)

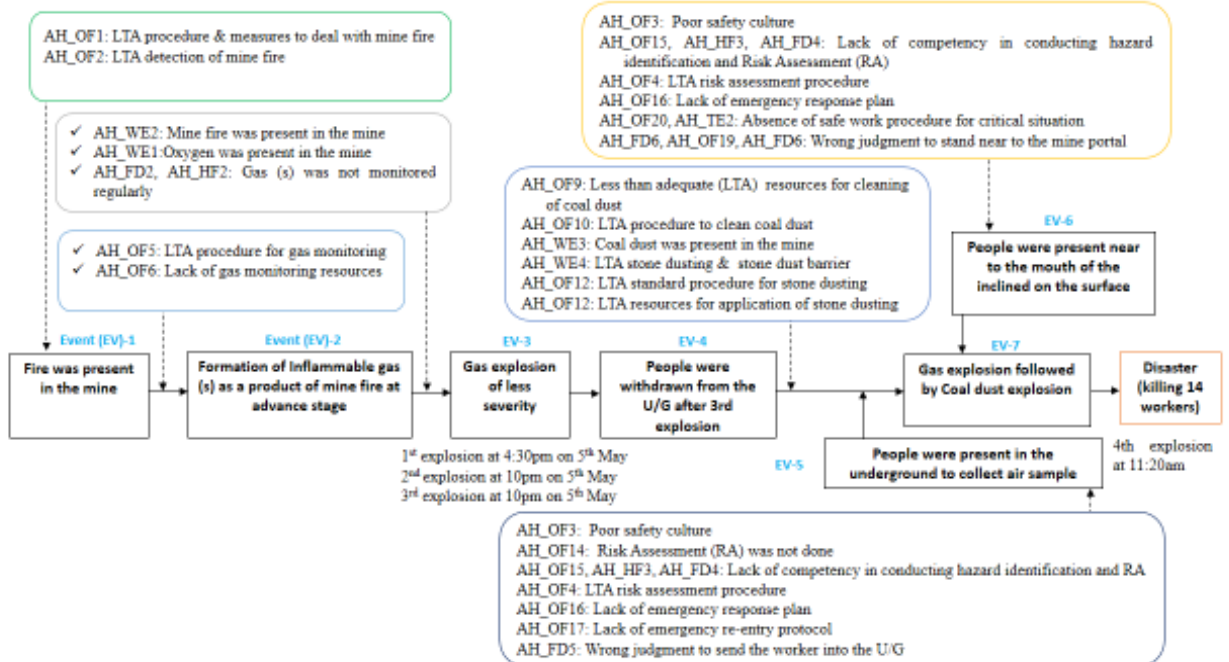
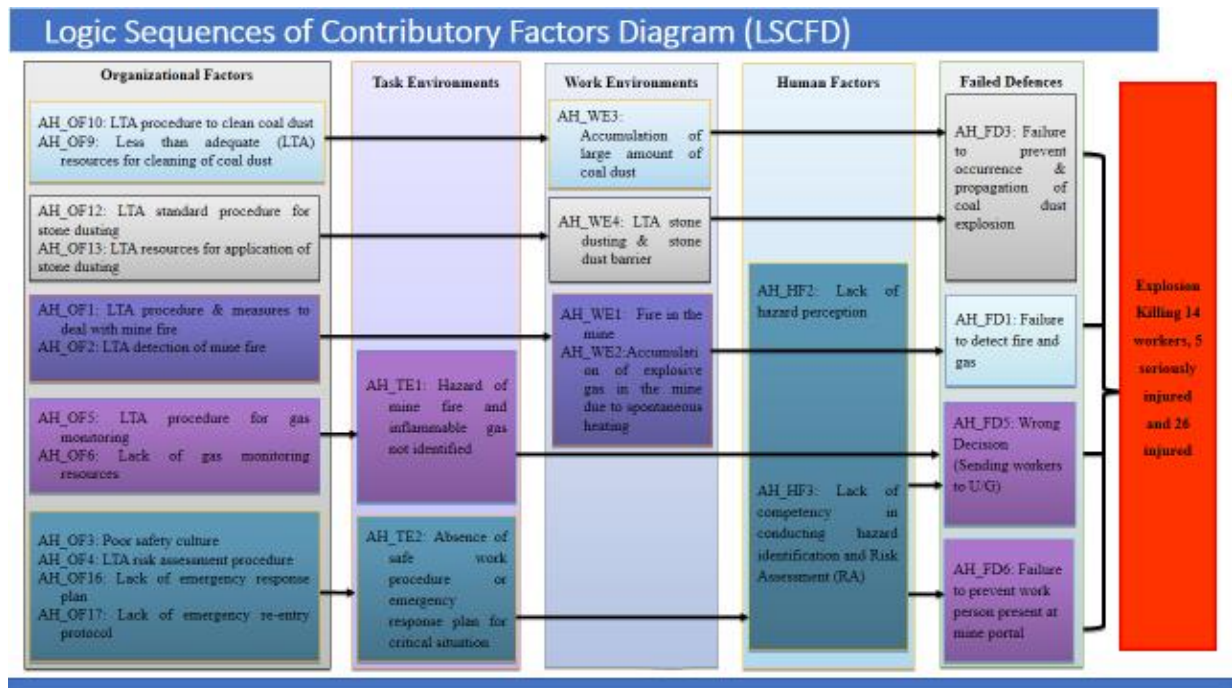


Figure 3: Example of Event & Causal Factors Sequence Diagram (ECFSD)



## A root cause failure analysis of coal dust explosion disaster – Gaps and lessons learnt



**Figure 4: Example of Logical Sequence of Contributory Factors Diagram (LSCFD)**

### 6.0 Recommendations for Corrective Actions

The investigation should identify recommendations for corrective actions to prevent recurrence. This can best be achieved by addressing all absent or failed defences and organisational factors identified by the ICAM analysis. Not all contributing factors can be completely eliminated, and some may be eliminated only at a prohibitive cost. The investigation team should work with line management in the development of corrective actions. The corrective actions recommended by the investigation team should be:

Each recommendation is a written statement of the action management should take to correct a contributing factor. The team reviews each contributing factor and:

- formulates recommendations which, if implemented, will reduce the likelihood of that factor contributing to future incidents;
- recommends improvement to the system defences to limit the consequences of the contributing factor, so that residual risk is recognised by management as acceptable;
- makes interim recommendations for immediate corrective actions after an incident or near-miss as a short-term measure to mitigate current risks prior to the establishment of long-term corrective actions. It is essential any corrective action be fully evaluated by Management to ensure change/s do not weaken other defences or expose other risks.
- Recommendations should be based upon the Hierarchy of Controls.

## 6.1 Hierarchy of Controls

Elimination	Complete elimination of hazard
Substitution	Replacing material or process with less hazardous one
Engineering	Redesign of equipment or work process
Separation	Isolating hazard by guarding or enclosure
Administration	Training, Procedures etc
PPE	Appropriate and properly fitted PPE when other controls are not effective

**Format for Accident reporting and ATR of Accident Enquiry based on Root Cause Analysis**

Company:

Name of Mine:

Owner:

Date of Accident:

Location of the accident: UG/Opencast/Surface

Brief description of the accident:

Findings of the Enquiry Authority (DGMS, ISO etc):

**Identified Causes in brief:**

<b>Identified root causes of the accident related to</b>							
<b>Direct Cause / Failed defence</b> (failure to act / failure to operate / failure to detect / failure to perform/ failure to activate / failure of barrier / isolation/ failure of protection)	<b>Procedure</b> (Procedure or Practices / Process / SoPs/ Risk assessment/ Safe work instructions / Emergency response system/First response/ TARPs/ )	<b>People</b> (People / Human behaviour/ Competency / Training / Experience / Fitness for work / Fatigue)	<b>Equipment</b> Equipment / Accessories/ Tools / Materials / Safety features/	<b>Work Environment</b> (Heat, Humidity, Dust, light, gas, water accumulation, working at height, confined space / layout	<b>Task environment</b> (Multiple activity, complexity, communication, functional delegation, supervision, time constraint/ multiple authority/ hierarchical dominance	<b>Organizational factors</b> (lack of policy /communication/ participation / consultation/ resources/ organization/ Supervision / Leadership/ Conflict of goals etc	<b>Remarks</b>
1.	<b>1.</b>	1.	1.	1.	1.	1.	
2.	<b>2.</b>	2.	2.	2.	2.	2.	
3.	<b>3.</b>	3.	3.	3.	3.	3.	





## SYLLABUS OF TRAINING PROGRAM ON ACCIDENT INVESTIGATION BASED ON ROOT CAUSE ANALYSIS

Sl. No.	Contents	
1.	INTRODUCTION	Definition: ACCIDENT / INCIDENT / NEAR MISS/ HIGH POTENTIAL INCIDENTS
		Objectives of accident investigation
		Why Investigate?
2.	STEPS OF INVESTIGATION	<b>IMMEDIATE ACTIONS</b> <ul style="list-style-type: none"> <li>• Securing the site</li> <li>• Notification</li> </ul>
		<b>INVESTIGATIONS PLANNING</b> <ul style="list-style-type: none"> <li>• Determining level of investigation</li> <li>• Roles and Responsibilities</li> </ul>
3.	INVESTIGATION PROCESS FLOW CHART	<b>INVESTIGATIONS PLANNING</b>
		<b>DATA COLLECTION</b>
		<b>DATA ORGANISING</b>
		<b>DATA ANALYSIS</b>
		<b>RECOMMEND AND REPORT</b>
4.	INVESTIGATION PROCESS	Site Inspection
		Planning meeting
		Team Safety
5.	INVESTIGATIONS PLANNING	Determining level of investigation
		Investigation Team
		Roles and Responsibilities
6.	INVESTIGATION PROCESS	Gathering information from the incident scene <ul style="list-style-type: none"> <li>• Photography</li> <li>• Preserving evidence</li> <li>• Interviews</li> </ul>
7.	INTERVIEWS	General Principles of Interviewing
		Conducting Interviews
		Witness Statement
		Important points to be considered while interviewing
8.	COLLECTION OF RELEVANT DATA	<ul style="list-style-type: none"> <li>• People related</li> <li>• Environment related</li> <li>• Equipment related</li> <li>• Procedures related</li> <li>• Organization related</li> </ul>

9.	SCOPE OF DATA GATHERING	<ul style="list-style-type: none"> <li>• Additional Data Sources</li> <li>• Investigator's 'Go Kit'</li> </ul>
10.	DATA ORGANISATION	Building sequence of events and time line
		Event and Condition Charts
		Incident Tree
11.	DATA ANALYSIS	Root Cause Analysis
		The Five Whys
12.	INCIDENT CAUSE AND ANALYSIS METHOD	<ul style="list-style-type: none"> <li>• Elements of Organisational Accident</li> <li>• Reason's Swiss Cheese Model of accident analysis</li> <li>• Development of causation hypotheses from Incident Tree, Event and Condition Charts and event &amp; causal factors sequence</li> <li>• Validation of hypotheses with valid evidences</li> <li>• Remove contradictions</li> <li>• Review accepted hypotheses</li> </ul>
13.	IDENTIFICATION OF CONTRIBUTORY FACTORS	Identify the Absent or Failed Defences
		Identify the Individual/Team Actions <ul style="list-style-type: none"> <li>• Human error types</li> <li>• Human Factors</li> </ul>
		Identify the Task/Environmental Conditions <ul style="list-style-type: none"> <li>• <i>Workplace Factors</i></li> <li>• <i>Error Factors</i></li> <li>• <i>Common Factors</i></li> <li>• Violation Factors</li> <li>•</li> </ul>
		Identify the Organisational Factors
14.	RULES OF ACCIDENT CAUSATION	
15.	DATA ANALYSIS TECHNIQUES IN ACCIDENT INVESTIGATION	<ul style="list-style-type: none"> <li>• <i>Change Analysis</i></li> <li>• <i>Job Safety Analysis</i></li> <li>• <i>Energy Barrier Analysis</i></li> </ul>
		Change Analysis <ul style="list-style-type: none"> <li>• Identify the Individual/Team Actions</li> <li>• Identify the Task/Environmental Conditions</li> <li>• Identify the Organisational Factors</li> </ul>
16.	IDENTIFICATION OF ROOT CAUSES ROOT CAUSES	Understanding the Causes of the Incident <ul style="list-style-type: none"> <li>• Basic causes</li> <li>• contributing factors and</li> <li>• Root causes</li> </ul>

17.	RECOMMENDATIONS	Characteristics of Recommendations
		Corrective Action Development
		Hierarchy of Controls
		Tracking Recommendations
		Impact and Potential Benefit Assessment
18.	CONCLUDING THE INVESTIGATION	
19.	TEMPLATE OF ACCIDENT / INCIDENT INVESTIGATION REPORT	<ol style="list-style-type: none"> <li>1. Introduction</li> <li>2. Incident Description</li> <li>3. Events timeline</li> <li>4. Accident causation pathway</li> <li>5. Key Findings <ul style="list-style-type: none"> <li>• Basic cause (i.e. “Why did the incident occur?”).</li> <li>• Contributing factors <ul style="list-style-type: none"> <li>○ Absent or failed defences</li> <li>○ Individual or team actions</li> <li>○ Task or environmental condition</li> <li>○ Organisational factors.</li> </ul> </li> </ul> </li> <li>6. Conclusion and Observations</li> <li>7. Recommendations</li> <li>8. Significant Learnings <ol style="list-style-type: none"> <li>a. Accident Analysis</li> <li>b. Corrective Action Plan <ul style="list-style-type: none"> <li>• Recommendation</li> <li>• Responsible Department</li> <li>• Responsible Person</li> <li>• Completion <ul style="list-style-type: none"> <li>• Date</li> <li>• Sign off</li> </ul> </li> </ul> </li> </ol> </li> <li>9. Report Sign-off</li> </ol>
20.	CASE STUDIES	