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INVESTIGATION TECHNIQUES

UNDERSTANDING AND APPLYING
THE ICAM ROOT CAUSE INVESTIGATION METHODOLOGY

TRAINING

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ICAM INVESTIGATION TECHNIQUES

Learning outcomes:

Part 1: Introduction to incident investigation

1. Explain why it is important to report and investigate health and safety related incidents (the need for effective incident investigation).
2. Outline the need for a systems approach to incident investigation.
3. Outline an effective investigation process.

Part 2: Planning for effective investigations

4. Outline the requirements for planning for effective investigations, including immediate actions following an event, deciding the level of investigation and assembling the investigation team.

Part 3: Gathering and organising investigation information

5. Outline and apply effective methods for information gathering including scene inspections, learning teams, witness interview techniques, and sources of documented evidence.
6. Outline and apply effective methods for organising information and sequencing of events, including the PEEPO chart, timelines, event and condition charts.

Part 4: Analysing investigation information

7. Explain the concept of multiple contributory factors.
8. Outline and apply causation analysis using the ICAM chart.
9. Outline key human factors considerations relevant to causation analysis.

Part 5: Investigation reports and corrective actions

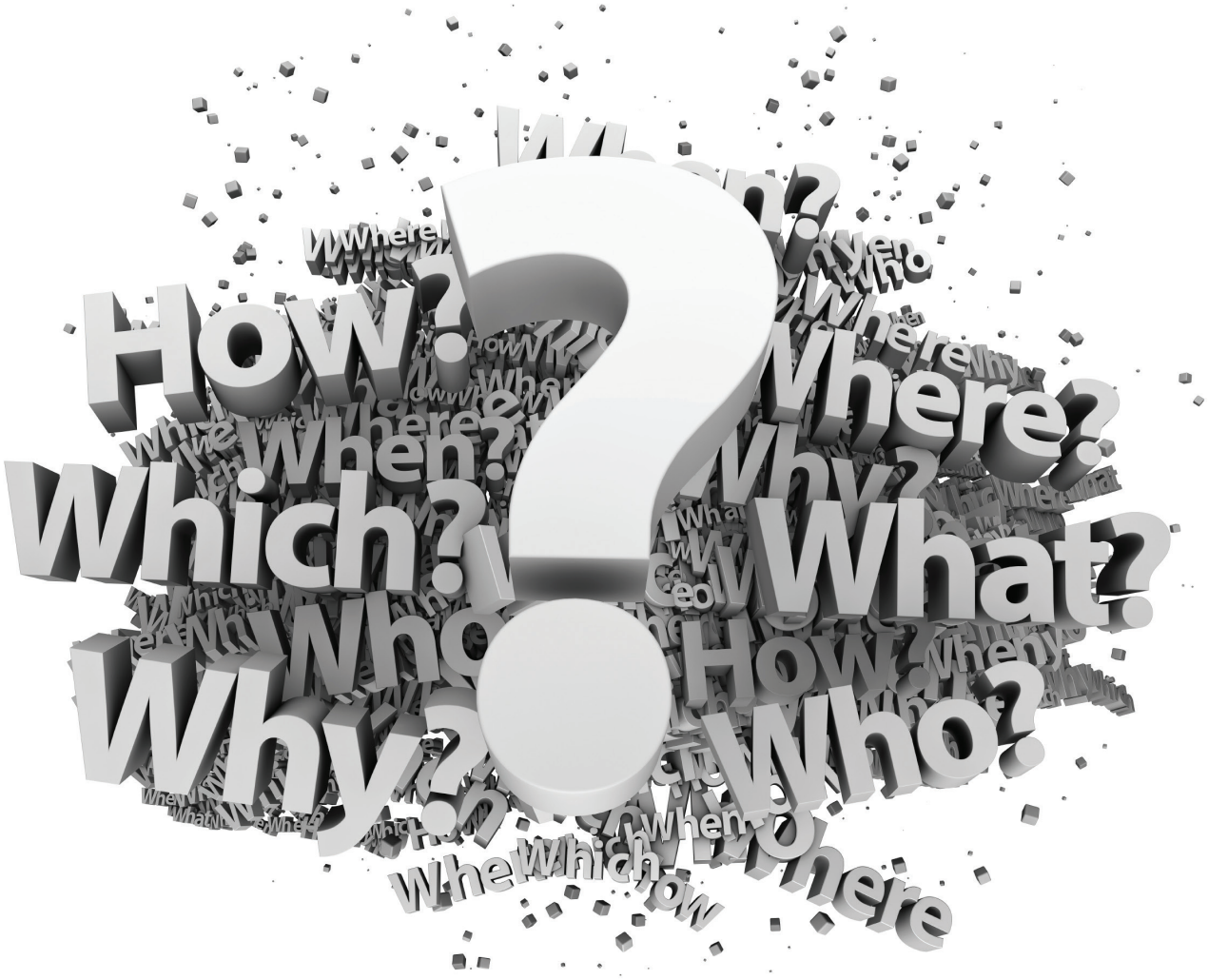
10. Outline the elements of an effective investigation report.
11. Outline and apply the process of deriving effective corrective actions from the ICAM chart.

ACKNOWLEDGEMENT

IMPAC gratefully acknowledges the role of BHP in developing the original ICAM concept and its willingness to make it widely available in the interests of safety.

INTRODUCTION

TO INCIDENT INVESTIGATION



INTRODUCTION
REASONS FOR INVESTIGATION AND LEARNING

WHY INVESTIGATE?

An 'incident' is traditionally defined as an unplanned and unwanted event that caused, or could have caused losses of some kind. To investigate means to inquire or look into something in order to learn what is not currently known. The word is typically associated with negative situations, but it is also important to look into normal, successful activity, to find out why all went well.

We live in a world where unfortunately bad things do often happen. **The focus of this course is primarily the effective investigation of serious negative incidents which have actually, or could potentially have caused death, serious injury or illness, significant damage, or other major loss.** This training course will guide you through the process of incident investigation and provide you with a set of data gathering and analysis tools. The aim is to enable you to make effective and justified recommendations to enable your organisation to improve its ability to manage risk.

> "Underneath every simple, obvious story about 'human error,' there is a deeper, more complex story about the organization. - Sidney Dekker, The Field Guide to Understanding Human Error"

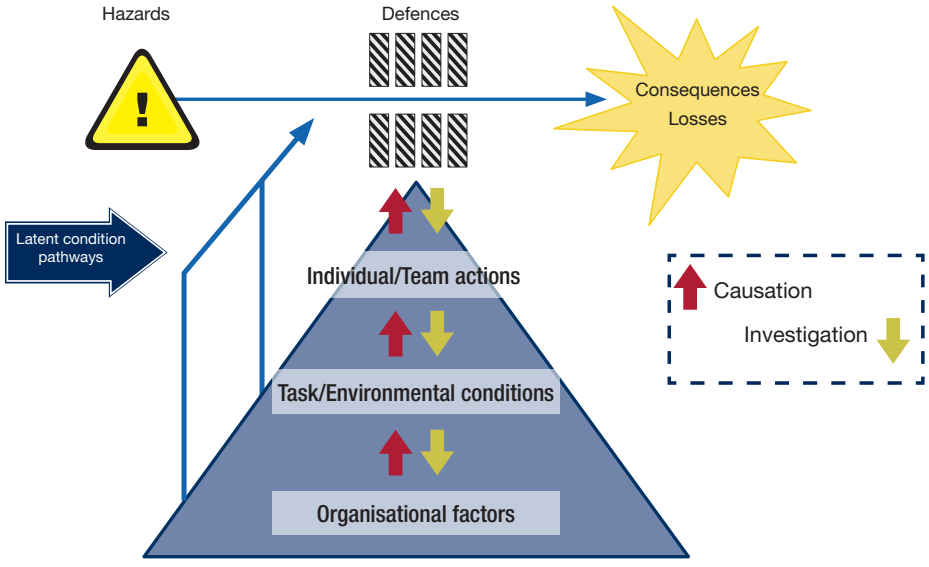
THE SYSTEMS APPROACH

Focusing on the individual actions of a particular operator as the cause of the incident is usually the most intuitive place to look for causes and remedies, and as we shall see, human failure plays a major part in the vast majority of incidents. Human errors and violations however are part of the human condition, in the same way breathing, sleeping and eating are. Effective investigations must instead use models based on research and sound reasoning to look beyond human failings and examine the aspects of the task, the work environment and the surrounding organisation. Events and conditions both at the time of the incident and before must be examined for causal relationships, until the fundamental root causes can be identified.

An effective investigation team will guard against the temptation to apportion blame when carrying out an investigation. Instead, it must take an objective view of the evidence that is gathered to determine both local and systemic causes, so that similar repeat incidents are prevented, and overall safety and resilience is enhanced.

> We cannot change the human condition; we can change the conditions under which humans work. - James Reason, The Human Contribution

CONTRIBUTING FACTORS - SYSTEMS MODEL



Based on work by James Reason

INTRODUCTION
REASONS FOR INVESTIGATION AND LEARNING

THE MAIN PURPOSES OF INVESTIGATING INCIDENTS

Apart from trying to understand what happened and why, effective investigations can serve many purposes.

PREVENT RECURRENCES

Organisations have a moral and a legal duty of care to protect their workers; to do nothing to prevent a reoccurrence of harm or danger is certainly a breach of these duties.

IMPROVING RISK CONTROL MEASURES

Effective investigations have the potential to identify not only ways of improving local defences and resources, but also the underlying organisational factors.

AVOIDING FUTURE EXPENSE

Investigations into minor incidents and near misses can identify the root causes of potentially serious and costly incidents. By addressing these causes, significant financial and reputational costs can be avoided.

INTRODUCTION
REASONS FOR INVESTIGATION AND LEARNING

AVOIDING LEGAL LIABILITY

Serious incidents may result in external investigation and prosecution. The chances of this happening may be reduced if an organisation shows it is taking swift and decisive investigatory action. Incidents are also an indicator of an insufficiently controlled hazard. Organisations are wise to fully investigate to check whether they are operating within the relevant legal requirements.

GATHERING DATA

Detailed investigations can produce a wealth of interesting and useful information about the incident and the surrounding context and causes. The general lessons learned can often be applied to other situations.

IDENTIFYING TRENDS

Investigations into supposedly isolated incidents can identify underlying trends and patterns of incidents and their causes, for example unsafe acts and conditions. By addressing the trends, many potential incidents can be avoided.

INVESTIGATION APPROACH

Various models, or approaches to investigation are used by organisations. The size and complexity of organisations does have some effect on the approach taken, as does the existence of a formal health and safety management system. Some common approaches to investigation are mentioned here:

AD-HOC

There is no structure or step-by-step procedure to the investigation, and no documentation is used, apart from perhaps a basic incident report form. This can be typical of smaller organisations with underdeveloped management systems. The manager will be responsible for all aspects of health and safety, as well as all other management duties. Investigations, if they are done, are informal, unplanned, and often ineffective. The focus can be on finding someone to blame.

IMMEDIATE CAUSES ONLY

There is minimal structure to the investigation, with some notes taken and a plan to interview the people involved. The focus of these investigations tends not to move past the immediate causes.

DETAILED INVESTIGATION

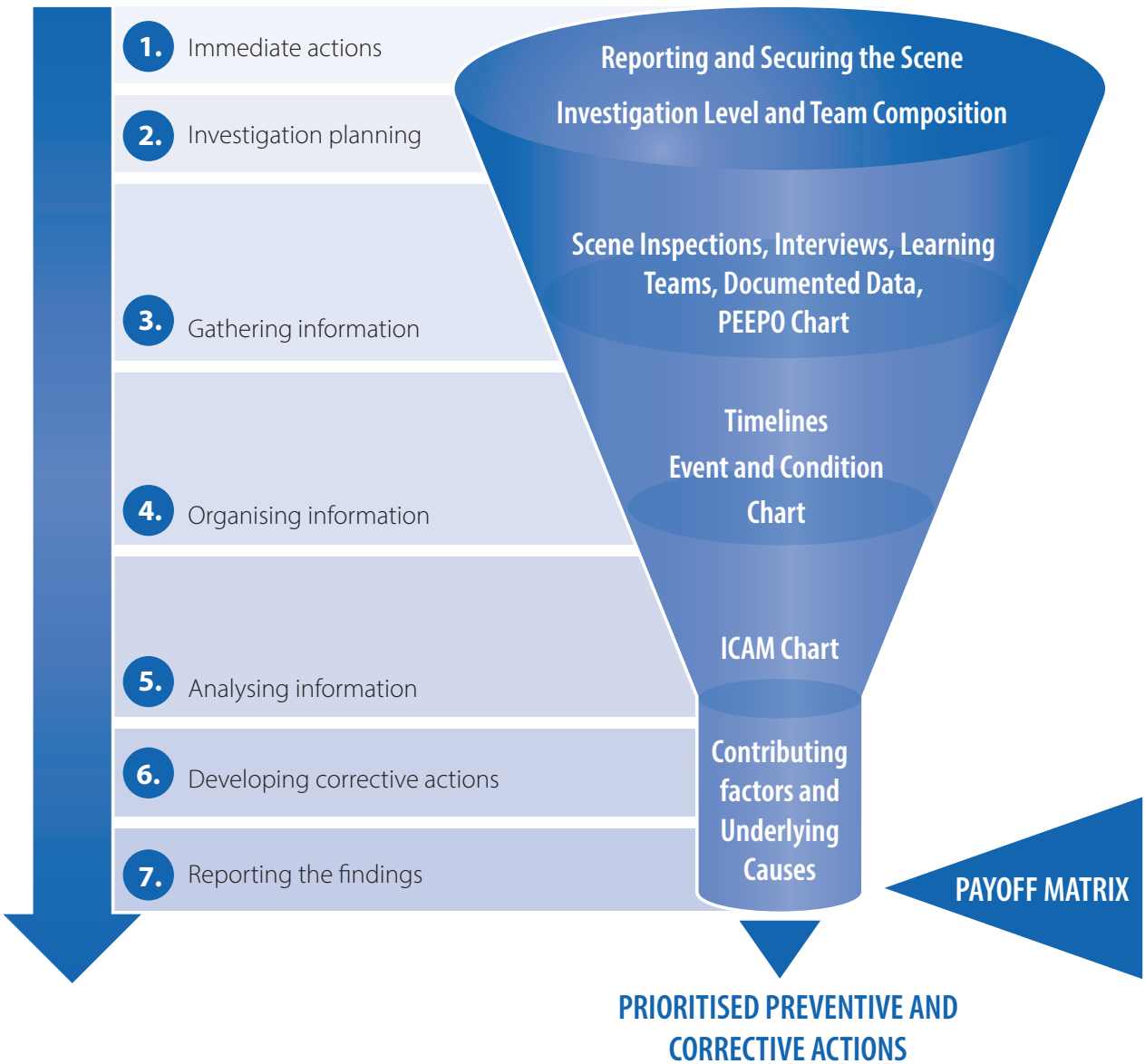
These investigations involve a formal investigation team and use of analytical tools and models. It is this level of investigation that this course will deal with. Learning lessons from what has gone wrong and taking steps to prevent the incident or accident happening again is part of an effective risk management system. Detailed investigation including formal causal analysis will assist your organisation to:

- Understand how and why things went wrong; what really happens in the workplace and how work is actually done
- Identify the root causes of incidents and trends over time
- Introduce corrective and preventive measures which address both local hazard defences and underlying organisational issues.

INTRODUCTION
REASONS FOR INVESTIGATION AND LEARNING

DETAILED INVESTIGATION PROCESS

All effective investigations must follow a process which allows raw data post incident to be consistently and dispassionately converted into completed corrective actions. The funnel diagram shows that initial data collection is very broad, and a series of tools are then used to filter out contributing factors, organising them and analysing to gain the greatest possible learning and improvement opportunities.



REPORTING, INVESTIGATING AND LEARNING

There are some powerful disincentives to taking part in a reporting and investigation scheme, especially one which attempts to gather that deeper level of data about near misses, dangerous conditions, errors and violations. The most powerful of these disincentives include:

- Lack of trust and fear of reprisals
- Scepticism over whether the data will actually be used for anything worthwhile
- The extra work involved in writing reports and conducting investigations.

Examination of successful programmes[1] reveals several key factors that are important in ensuring both quantity and quality of incident reporting:

- Clarity over disciplinary proceedings and indemnity in all but a few very specific cases (this point is expanded on later in the course under the heading of 'just culture')
- Confidentiality or de-identification of report data
- A clear separation of the group collecting and analysing reports and line management, especially those with the authority to initiate disciplinary proceedings (the same holds true for effective investigations)
- Rapid, useful and accessible feedback
- A quick and easy reporting mechanism (paper forms and electronic systems).

A culture where reporting and investigation is valued is arguably a pre-requisite for effective ICAM investigation. Trust, transparency and co-operation between investigators and the workforce will result in more accurate and meaningful ICAM investigations, and will certainly make the job of the investigator easier.

1 Reason, J (1997)

PLANNING
FOR EFFECTIVE INVESTIGATIONS

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

A PRE-PLANNED RESPONSE

Once an adverse event such as an incident or near miss has occurred the consequences of that event can be reduced by a timely and pre-planned response. Such a response can also improve initial data collection for reporting and investigation purposes. We have identified nine key response stages. Whilst this shows a logical stepped approach in reality the first three to four steps will probably happen simultaneously as the incident develops.

Immediate response—ensure safe to intervene

Provide first aid

Notify emergency services

Evacuate the area if necessary and initiate emergency response and mitigation measures

Notify next of kin and support victim

Notify authorities (WorkSafe, Police etc)

Notify legal advisor/insurer

Secure the incident scene

Report and record the incident details

Commence investigation

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IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

IMMEDIATE RESPONSE—ENSURE IT'S SAFE TO INTERVENE

It has been known that when adverse incidents occur, individuals who are close by rush to the assistance of those involved without thinking of the possible risks to themselves. This is often true for situations where work in confined spaces is being carried out. In such cases, those rushing to help have also been affected and the casualty list has increased because the temptation to offer assistance to injured persons feels greater than assessing the risks to ourselves.

> "We must only intervene when it is safe to do so."

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

PROVIDE FIRST-AID

The aim of first-aid is to:

- Preserve life and minimise the consequences of serious injury
- Prevent deterioration by reassuring the casualty and lessening the effects of medical shock; and
- Promote recovery, including the treatment of minor injuries that do not require medical attention.

Every employer should appoint, as a minimum, a person to take charge of the situation if a serious injury or major illness occurs. An appointed person will send for an ambulance and should have some knowledge of basic first-aid, such as artificial respiration and the control of bleeding.

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

NOTIFY EMERGENCY SERVICES

This is usually done at the same time that intervention and first aid is being provided. Someone should take charge of the incident immediately and ensure that while the initial response is being invoked somebody notifies emergency services.

EVACUATE AREA (IF REQUIRED), INITIATE EMERGENCY RESPONSE PLAN AND MITIGATION MEASURES

This may be necessary where there has been a loss of containment such as hazardous substance spill, gas leaks or fire, for example. It may not be necessary in all cases. Serious incidents tend to attract crowds of onlookers either through curiosity or the willingness to help. It is important that the person taking charge of the incident manages this so that access to the incident scene can be gained by the emergency services and that people are kept away who have no positive role to perform in the management of the incident.

Where the scale of loss can be reduced by safely taking action such as closing valves, diverting spills to a sump or fighting a small fire then such action should be initiated. Assembling personnel and equipment to assist the emergency services will also speed up rescue and recovery.

NOTIFY NEXT OF KIN AND SUPPORT VICTIM

In cases involving fatal incidents at work this will usually be done by the Police. However, all other types of incident someone, usually a senior (if not the most senior) manager on site, should be allocated the responsibility.

NOTIFY AUTHORITIES

It will be a requirement to notify the authorities when a serious incident has occurred. WorkSafe NZ/Civil Aviation Authority/Maritime New Zealand and the Police as well as others will need to be informed. Ensure you understand which authority needs to be notified and that someone is given the responsibility to make the notification within the required time frames.

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

NOTIFY LEGAL ADVISER/INSURER

For potentially serious incidents it is wise to seek legal advice early on in relation to issues of liability and disclosure and to assist in managing your relationship with the regulatory authorities. You may be able to claim legal privilege - that is the right to maintain confidentiality of certain information and communications. Consulting a legal advisor does not preclude open discussion or disclosure of any failures identified by the investigation, however it does mean that this is done knowingly rather than inadvertently.

Also your policy may require you to notify your insurance company at the earliest opportunity as they may wish to conduct their own investigation.

SECURE THE INCIDENT SCENE

Whether this is done because of enforcing authority requirements or for your own investigation it is important to ensure that the incident scene remains undisturbed unless there are valid, and legal, reasons not to do so. You may wish to consider a cordon around the incident scene to keep the area clear of 'sightseers' and others who may inadvertently tamper or interfere with valuable evidence.

It is best to begin investigations as soon as possible after the incident. The scene is less likely to have been disturbed and events will still be fresh in people's minds. Conditions are more likely to be similar to the conditions leading up to the incident. The longer the delay, the less reliable the information gathered will be.

Assuming all immediate emergency and first-aid needs have been met, the first priority is to preserve the scene as far as possible. In some cases, the scene of an incident may also become a crime scene and control of the site may pass to the Police or a government inspector. If the scene has to be cleaned up and reinstated, then it is vital for an initial inspection to take place, before any potential clues are lost.

Before attending the scene, consider who might be helpful as part of the inspection:

- Relevant specialists e.g. Fire officer, chemical engineer
- Local manager or supervisor
- Union and/or Safety representative.

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

REPORTING AND RECORDING

The reporting and recording of all loss (and potential loss) events is very important for the overall management of health and safety, and specifically for the purposes of investigation. Reportable events can include personal injuries, ill-health, dangerous occurrences such as fires, explosions, spills, releases, plant, equipment and vehicle failure and similar.

A deeper level of reporting could include 'near-misses', failures of control measures, errors and violations, unworkable procedures, and other situations where safety was difficult to achieve but there was no actual injury or damage.

AT AN IMMEDIATE, LOCAL LEVEL

Effective reporting and recording:

- Ensures that medical attention, support and counselling can be offered as soon as possible to the injured or affected persons
- Enables any potentially unsafe conditions or damaged equipment to be isolated and remedied
- Encourages a transparent, collaborative and supportive culture.

AT AN ORGANISATIONAL LEVEL

Effective reporting and recording:

- Enables interventions to be made to prevent similar future incidents
- Increases understanding of hazards and risk; in particular risk posed by 'organisational incidents' - those rare but catastrophic events
- Meets the monitoring requirements of formal health and safety management systems
- Allows performance against targets to be monitored and reviewed
- Meets any relevant regulatory requirements
- Allows for meaningful statistical analyses which can influence policy and strategy
- Influences the prioritisation of resources
- Allows for benchmarking and comparisons between industry sectors and occupation types
- Enables enforcement action to be taken where appropriate.

IMMEDIATE ACTIONS
IMMEDIATE ACTIONS FOLLOWING THE EVENT

The report form captures the basic information which becomes the starting point for investigation and decision-making about the level of investigation required. Forms can be paper-based or electronic and should include the following as a minimum:

COMPANY DETAILS Name, address etc.	PERSON REPORTING Name, contact details etc.	
ABOUT THE INCIDENT		
PERSONS INVOLVED Details of injured / affected persons, including status (employee, contractor, visitor), gender, age, role, shift/work hours	DATE TIME	Specific location information Business unit/area
EVENT SUMMARY		
A summary of the event, including surrounding context, task and environmental conditions if known, including photographs, diagrams, maps etc. Immediate actions taken following the event		
CONSEQUENCES		
Actual and potential consequences: Injury, ill-health, exposure to hazardous agent, property damage, business disruption, impact on reputation, enforcement action, other consequences		
NATURE OF INJURY		
Nature and severity of injury, bodily location, classification, agency (what caused the harm)		
WITNESSES Details of witnesses including initial witness statements if possible		
NAME	CONTACT	
STATEMENT		
REPORTING TO WORKSAFE NZ UNDER LAW		
SIGN OFF AND DATE REPORTED		

DECIDING THE LEVEL OF INVESTIGATION

A risk assessment should be conducted to determine the level of the investigation. This essentially will guide the composition of the incident investigation team and the escalation procedures for reporting. This will ensure that an appropriate response is given to the scale of the incident being investigated. When carrying out the risk assessment you must take into account:

- The actual consequences of the incident
- The potential consequences of the incident
- Other impacts such as cost and legal implications

PLANNING
DECIDING THE LEVEL OF INVESTIGATION

The outcome of the risk assessment will determine whether your investigation level will be:

- Low Level
- Medium Level
- High Level

Here is a very simple example of an assessment process to determine the level of the investigation. Organisations may develop their own to suit their own processes and systems but this format is produced here for illustrative purposes.

Likelihood of harm/loss	Severity of harm/loss			
	Slight	Serious	Major	Fatal
Unlikely				
Possible				
Likely				
Certain				

The level of the investigation should be proportionate not only to the actual outcomes, but also the likely potential outcomes.

Investigating normal work

ICAM can also be used for planned investigations or 'learning reviews' of normal work, where nothing has gone wrong. The idea is to look into why nothing went wrong, to identify the positive contributing factors, and to then make recommendations on how to encourage these positive factors to be a feature of normal work in future.

PLANNING
DECIDING THE LEVEL OF INVESTIGATION

LOW LEVEL

A low level investigation will involve a short investigation (an hour or so) by the relevant supervisor or line manager into the circumstances to try to prevent a recurrence and to learn any general lessons.

MEDIUM LEVEL

A medium level investigation will involve a more detailed investigation, taking a few days, led by the relevant supervisor or line manager, often supported by the health and safety advisor and employee representatives.

HIGH LEVEL

A high level investigation will involve a team-based investigation, over several weeks, involving supervisors or line managers, health and safety advisors, relevant domain experts (engineers, electricians etc) employee representatives and possibly external consultants. It will be led by an experienced investigator under the supervision of senior management or directors, and may run in parallel with an investigation by the regulator.

> The level of investigation relates to the resources made available to the investigation in terms of time, personnel, access to plant and premises, and the competency of the lead investigator. Beliefs about incident causation and the use of robust methodology remains consistent.

It is important to investigate incidents and near-misses at the right level because this helps to ensure:

- Appropriate resourcing
- Senior management involvement
- Access to subject matter experts
- Authority of the report and its recommendations.

ASSEMBLING AN INVESTIGATION TEAM

Staff at all levels should be involved in investigations at various points and in various capacities. This is important to ensure that the investigation outcome is accepted by the organisation as an accurate reflection of what happened. Recommendations for actions are also more likely to be successful if a number of people have been involved in identifying and designing them.

The main objectives of the investigation team are to:

- Establish the facts
- Identify contributory causes
- Recommend corrective action to reduce the risk and prevent recurrence
- Report the findings.

INVESTIGATION LEAD

Depending on the organisation and the seriousness of the incident under investigation, the lead officer for the investigation could be:

- A director
- A senior manager
- Subject Matter Experts
- An operational manager
- An internal health and safety practitioner; or
- An external consultant.

It is important that the lead officer has the right level of authority within the organisation to ensure that there are no barriers to the investigation e.g. access to the scene, equipment and people for interviewing. It is also critical to allow for the investigation lead's 'day job' to be covered by someone suitably competent. This will allow the investigation lead to focus all of their attention on the task at hand.

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PLANNING
ASSEMBLING THE INVESTIGATION TEAM

MANAGERS AND SUPERVISORS

Managers and supervisors should be involved as they will likely be required to implement any remedial measures. It is also the case that the root causes of incidents and accidents often relate to management failures. Encouraging managers and supervisors to take ownership of an investigation will increase the likelihood of a positive change in attitudes toward health and safety. However, care should be taken not to involve managers and supervisors in investigating issues in areas where they have direct control as this may affect their judgment.

EMPLOYEE SAFETY REPRESENTATIVES

It is important to involve representatives of the workforce, as they have the most to lose when things go wrong, and the most to gain from effective investigation outcomes. They can also be crucial in securing general support of the workforce in the methods and outcomes of the investigation.

HEALTH AND SAFETY PRACTITIONERS

Persons with competence in health and safety management are indispensable for more detailed and high-profile investigations. They will bring knowledge and expertise in investigation methods and ensure a systematic and objective approach is taken. They should also lend credibility and objectivity to the outcomes of an investigation.

WHO ELSE?

You should also keep an open mind with regard to anyone that may positively contribute to your investigation team.

The complexity of the nature of the incident and the workplace will impact on the size and composition of the investigation team.

PLANNING THE INVESTIGATION

Once the initial response has been invoked the investigation lead should call a meeting to establish the ground rules and modus operandi of the investigation. The purpose of this meeting is to ensure that a comprehensive and thorough investigation is carried out.

INITIAL PLANNING

This initial planning meeting needs to consider such issues as:

INVESTIGATION RESOURCES

- Office or meeting room capable of being locked or secured
- Access to resources such as computers, phones etc
- Administration assistance if required
- Equipment or other items required to carry out the investigation (a suggested list is given at the end of this section).

ACCESS REQUIREMENTS

- Personnel, witnesses
- Documentation such as maintenance records, time sheets, training records etc
- Premises and equipment.

PLANNING
ASSEMBLING THE INVESTIGATION TEAM

TEAM SAFETY

The investigation lead is responsible for the safety of the team members and should work closely with the person who has operational responsibility for safety at the incident scene. Team members must exercise the greatest care whilst the investigation is underway and ensure that all procedures are followed, all signs observed and all safety protective equipment is worn or used.

> Any reconstruction of the incident must in no way place personnel in harm's way and no equipment should be operated such as valves or switches etc. Unless a proper analysis has been carried out to determine the effects.

REPORTING PROTOCOLS

The investigation lead is also responsible for ensuring that all requirements and protocols for reporting are met. This includes any internal forms, procedures, and lines of communication with management. There may also be external notification requirements - i.e. to WorkSafe NZ in the event of an incident causing serious harm.

SCOPE OF THE INVESTIGATION

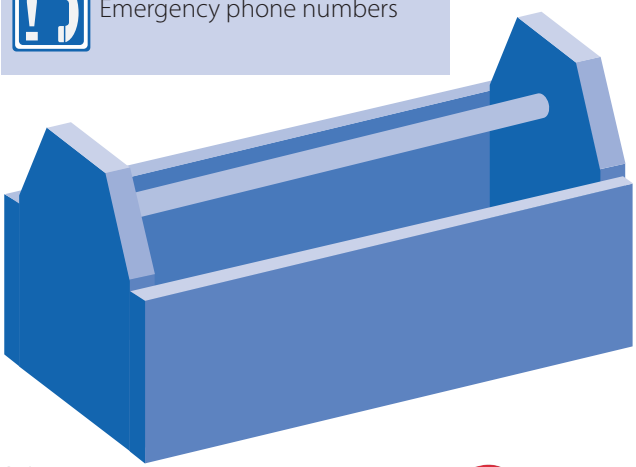
Out of this initial planning meeting the investigation lead needs to state the scope and the terms of reference for the investigation including items such as:

- The purpose of the investigation
- The team composition
- Any outside sources of expertise required
- Any limitations or areas outside the scope of the investigation
- Time scales with key targets.

INVESTIGATORS TOOL KIT

The type of equipment you need depends very much on the type of incident itself but some suggestions are given below as basic items for an investigators tool kit:

- Air contaminant testing equipment (if needed)
- Mobile phone and power back-up
- Clip board, notebook, pen & pencil, dictaphone recorder
- Torch and batteries
- Tape measure
- Zip lock plastic bags and labels
- Emergency phone numbers



- Protective clothing (as required)
- Camera
- First-aid kit
- Chalk and/or fluorescent spray paint
- Breathing apparatus (if needed)
- Disposable gloves
- Caution tape

- Anything else?

GATHERING INFORMATION

COLLECTING AND ORGANISING INFORMATION

SITE INSPECTION

The investigation lead should take immediate action to ensure control of the incident scene and to preserve the scene. Things to look out for at the scene are:

Positions of injured workers and other personnel	Access and egress
Materials being used at the time of the incident	Housekeeping
Position of all equipment in relation to other equipment	Condition of the facility and equipment
Position of valves, switches, controls etc	Weather at the time
Condition of the floor surface	Presence of any unauthorised personnel
Any safety equipment in use	Evidence of loss of containment
Damage to equipment and any evidence of safety equipment failures	Witness marks (paint marks, scratches, smears, discolouration, burn marks etc.)
Position of any guards	Presence or absence of warning signs or barriers
Lighting and noise levels at the site	

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

Discovering what happened can involve quite a bit of detective work. Be precise and establish the facts as best you can. There may be a lack of information and many uncertainties, but you must keep an open mind and consider everything that might have contributed to the adverse event. Hard work now will pay off later in the investigation.

Many important things may emerge at this stage of the process, but not all of them will be directly related to the adverse event. Some of the information gathered may appear to have no direct bearing on the event under investigation. However, this information may provide you with a greater insight into the hazards and risks in your workplace. This in turn may enable you to make your workplace safer in ways you may not have previously considered.

ORGANISING THE INFORMATION

Facts and queries which may be confirmed as facts will quickly begin to build up. It is helpful to be able to organise this information in such a way so that all possible contributing factors have been identified. ICAM uses the 'PEEPO' chart, a way of ensuring that you gather facts which relate to a wide range of potential contributory factors. Even though you might begin to form some ideas about what contributed to causing the incident, you must be disciplined and stick to gathering facts and confirming queries. There are five categories of contributing factors:

P People

E Equipment

E Environment

P Procedures

O Organisation

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

PEOPLE

Here we need to try and identify as many people as possible who might be able to provide information on how and why the incident occurred. Remember not to restrict this to those directly involved in the incident itself. There could be others who may corroborate certain facts such as those present during a tool box talk etc.

Factors that need to be considered here are:-

- The names and contact details of those directly involved, any primary witnesses, and also secondary witnesses
- Employment status—casual, self-employed, contractor etc
- The behaviour of those involved—why did they do what they did?
- Any medical conditions that may have affected their actions
- Any sensory impairments such as vision or hearing
- Training, experience, and certifications held
- Number of hours worked on the day and during the previous days
- Past incidents
- Social relationships with other team members
- Information about language and culture.

It is important to note which parts of the body have been injured and the nature of the injury i.e. bruising, crushing, a burn, a cut, a broken bone etc. Be as precise as you are able. If the site of the injury is the right upper arm, midway between the elbow and the shoulder joint, say so. Precise descriptions will enable you to spot trends and take prompt remedial action. For example it could be that what appears to be a safe piece of equipment, due to the standard of its guarding, is actually causing a number of inadvertent cut injuries due to the sharp edges on the guards themselves.

Facts such as whether the injured person was given first-aid or taken to hospital (by ambulance, a colleague etc) should also be recorded here.

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

Training should provide workers with the necessary knowledge, skills and hands-on work experience to carry out their work efficiently and safely. The fact that someone has been doing the same job for a long time does not necessarily mean that they have the necessary skills or experience to do it safely. This is particularly the case when the normal routine is changed and the lack of understanding becomes apparent. There is no substitute for adequate health and safety training. Some problems that may arise are as follows:

A lack of instruction and training may mean that people struggle to complete a task.

Misunderstandings, which arise more easily when employees lack understanding of the usual routines and procedures in the organisation.

A lack of respect for the risks involved, due to ignorance of the potential consequences.

Poor handling of dangerous materials or tools, due to employees not being properly informed about how things should be done correctly.

Problems due to the immaturity, inexperience and lack of awareness of existing or potential risks among younger people. You must assess the risks to younger people before they start work.

People should also be matched to their work in terms of health, strength, mental ability and physical stature.

EQUIPMENT

Make a note of all items of equipment that may have played some part in the incident, or are at the scene of the incident. Equipment also includes fixed assets such as machinery, conveyors, racking, tanks and the like. You will need to gather information about each of these items of equipment, so making a list is a good place to start.

Identifying information such as serial or registration numbers can usually be found on a nameplate attached to the equipment. If there is a register of equipment there may be an asset number. Note all the details available, the manufacturer, model type, model number, machine number and year of manufacture and any modifications made to the equipment. Note the position of the machinery controls immediately after the adverse event. This information may help you to spot trends and identify risk control measures.

You should consider approaching the supplier if the same machine has been implicated in a number of adverse events. Shop floor process and layout changes are a regular occurrence. Unless you precisely identify plant and equipment, you will not detect, for example, that a machine or particular piece of equipment has been moved around and played a role in several incidents, in different locations.

For each piece of equipment (where relevant) you need to determine:

✓	Who owns the equipment and is responsible for its maintenance
✓	Inspections
✓	Maintenance schedules
✓	Statutory checks
✓	User/operator checks
✓	Defect logs
✓	Testing
✓	Operating instructions
✓	Design and construction standards

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

Some examples of useful questions to ask when gathering data about equipment include:

How does the equipment usually perform in terms of breakdowns and maintenance requirements?

Is it appropriate for its intended use?

Does everyone who uses it know how to use it properly?

Does it get inspected/checked/tested on a regular basis, and why?

Has it ever been modified, and why?

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

You should observe the location of the adverse event as soon as possible and judge whether the general condition or state of repair of the premises, plant or equipment was adequate. Those working in the area, together with witnesses, and any injured parties, should also be questioned. Working in the area, they will have a good idea of what is acceptable and whether conditions had deteriorated over time. Consider the role the following factors may play:

- A badly maintained machine or tool may mean an employee is exposed to excessive vibration or noise and has to use increased force, or tamper with the machine to get the work done
- Equipment that is cumbersome or difficult to use will sometimes be ignored or used incorrectly
- A noisy environment may prevent employees hearing instructions correctly as well as being a possible cause of noise-induced hearing loss
- Uneven floors may make movement around the workplace, especially vehicle movements, hazardous
- Badly maintained lighting may make carrying out the task more difficult
- Poorly stored materials on the floor in and around the work area will increase the risk of tripping
- Ice, dirt and other contaminants on stairs or walkways make it easier to slip and fall
- Tools not in immediate use should be stored appropriately and not left lying around the work area.

Plant and equipment includes all the machinery, plant and tools used to organise and carry out the work. All of these items should be designed to suit the people using them. This is referred to as ergonomic design, where the focus is on the individual as well as the work task the item is specifically designed to carry out. If the equipment meets the needs of the individual user, it is more likely to be used as it is intended i.e. safely. Consider user instructions here. A machine that requires its operator to follow a complicated user manual is a source of risk in itself. Consider also language and literacy issues.

ENVIRONMENT

You will need to collect information on any environmental conditions that may have contributed to the incident.

Factors that need to be taken into account are:

- Weather and precipitation
- Noise
- Lighting, visibility and sun strike
- Temperature and humidity
- Ventilation and air quality, presence of contaminants
- Ground and work surface conditions and stability
- Housekeeping
- Work space, layout and design
- Vibration
- Accelerative/decelerative forces
- Wind and air turbulence
- Air pressure
- Radiation - ionising and non-ionising
- Electricity - natural and generated.

The environment where the incident happened will hold a wealth of important data for the investigaton lead to gather. The first issue to investigate is the presence of various hazards in the work environment. Record data not only on hazards which caused injury or damage, but all potential sources of harm in the vicinity of the incident.

However, the work environment can also have a significant impact on people's ability to work safely - that is, to concentrate, to notice hazards, and to perceive warnings and danger. For example, it may be impossible to see or hear warning signals. It can also influence attitudes and the likelihood that procedures and rules will be adhered to or broken. For example a short-cut to the canteen across a busy loading bay.

PROCEDURES

How the work was being performed and how it was scheduled could be a significant factor and play a major part in contributing to the incident.

The work that was being done just before the adverse event happened can often cast light on the conditions and circumstances that caused something to go wrong. Provide a good description, including all the relevant details, e.g. the surroundings, the equipment/materials being used, the number of employees engaged in the various activities, the way they were positioned and any details about the way they were behaving etc.

Adverse events often happen when something is different. When faced with a new situation, employees may find it difficult to adapt, particularly if the sources of danger are unknown to them, or if they have not been adequately prepared to deal with the new situation. If working conditions or processes were significantly different to normal, why was this?

Describe what was new or different in the situation. Was there a safe working method in place for this situation? Were workers aware of it and was it being followed? If not, why not? Learning how people deal with unfamiliar situations will enable similar situations to be better handled in the future.

Was the way the changes, temporary or otherwise, were introduced, a factor? Were the workers and supervisors aware that things were different? Were workers and supervisors sufficiently trained/experienced to recognise and adapt to changing circumstances?

Adverse events often happen when there are no safe working procedures or where procedures are inadequate or are not followed. Comments such as 'we've been doing it that way for years and nothing has ever gone wrong before…' or 'he has been working on that machine for years and knows what to do…' often lead to the injured person getting the blame, irrespective of what part procedures, training and supervision – or the lack of them – had to play in the adverse event. What was it about normal practice that proved inadequate? Was a safe working method in place and being followed? If not, why not? Was there adequate supervision and were the supervisors themselves sufficiently trained and experienced? Again, it is important to pose these questions without attempting to apportion blame, assign responsibility or stipulate cause.

Factors that need to be taken into account are:

- Utilisation - use, and usefulness of the procedures
- Content - scope, technical correctness, emergency provisions and exceptions
- Usability - language and layout suitable for the intended user and task
- Validation - review, checking and testing by qualified people
- Control - consistency of versions and document control.

Useful questions may include:

What procedure was in force for the work being undertaken?
How was it developed and communicated?
Was the operator aware of the procedure?
Had they been trained in the procedure?
What other documented processes applied, such as permit to work, job safety analysis or safe operating procedures?
Is a procedure the appropriate way to support the task? Obvious, repeatable tasks can be proceduralised, but tasks involving decion-making should be supported by guidance.

Risk assessments, job safety analyses and safety plans are an important source of data in this category.

The existence of a written risk assessment for the process or task that led to the adverse event will help to reveal what was known of the associated risks. A judgement can be made as to whether the risk assessment was 'suitable and sufficient', and whether the risk control measures identified as being necessary were ever adequately put in place.

GATHERING INFORMATION
ORGANISING USING THE PEEPO CHART

ORGANISATION

The organisational arrangement sets the framework within which the work is done. Here are some examples; there are many more:

- Standards of supervision and on-site monitoring of working practices may be less than adequate
- Lack of skills or knowledge may mean that nobody intervenes in the event of procedural errors
- Inappropriate working procedures may mean certain steps in the procedures are omitted, because they are too difficult and time-consuming
- Lack of planning may mean that some tasks are not done, are done too late or are done in the wrong order
- Employees' actions and priorities may be a consequence of the way in which they are paid or otherwise rewarded
- High production targets and piecework may result in safety measures being degraded and employees working at too fast a pace.

EXAMPLE OF A PEEPO CHART





People	Equipment	Environment	Procedures	Organisation

INTERVIEWING WITNESSES

The purpose of interviewing witnesses and anyone else who was involved is to gather further information not available through inspecting the scene. Interviewing will begin to create a more complete picture of what happened. Sometimes, 'off-the-cuff' remarks made by witnesses during the scene inspection will reveal valuable information. It is important to know how to pursue these sources of information.

> "Unjust responses to failure are almost never the result of bad performance. They are the result of bad relationships. - Sidney Dekker, Just Culture"

SECURING CO-OPERATION

An investigator must explain from the outset that the purpose of the investigation is not to blame individuals, but to ensure that lessons are learned so that similar incidents can be prevented. This will serve to put people at ease, and they will be more likely to share information with you. Witnesses are also more likely to co-operate if they feel involved in the investigation process, and that their contributions are valued.

INTERVIEW LOCATION

It can sometimes be useful to interview people at the scene of the incident, so that they can supplement what they say by showing you what they are referring to. The location may also serve to help clarify memories. People may also be less guarded in an informal setting.

Sometimes, because of privacy issues, or the seriousness of the incident, interviews will be more appropriate in a quiet room, away from other influences.

CLASSES OF WITNESS

You will need to consider the different types of witness an investigator can question:

Witnesses who are the injured or affected persons. They will have an important perception of what happened, but are sometimes difficult to interview if they are receiving medical attention or suffering from psychological trauma.

Witnesses who are people who saw the incident first-hand. They can be very valuable as they may have seen the incident from a different perspective, and noticed things not seen by the injured/affected person(s).

Witnesses who are people who did not actually see the incident, but were around on the day, or were in some way involved with events before the incident, or the post-incident response. They may also be people who can give information about the general working or environmental conditions in the workplace.

GATHERING INFORMATION
INTERVIEWING WITNESSES

QUESTIONING

Good questioning technique is important for interviewing. The idea is to encourage sharing of detailed information through short, simple 'open' questions built around the words "what, where, when, how, who and why."

Some examples of open questions are:

What happened—what did you see?

Where were you standing and where were the others?

What do you think caused the incident, and how?
What activities were being carried out at the time?

When did it happen and when did you suspect something was going wrong?

How exactly did the injury occur (if any)?

Who else saw what happened?

Why do you think it happened?

How do you think it might have been prevented?

GATHERING INFORMATION
INTERVIEWING WITNESSES

Be tactful when asking 'why' questions, as these can easily be misinterpreted as 'blaming questions' e.g.— "Why did you do that?" "Why didn't you do that?" An indicator of good questioning technique is if the interviewee is doing most of the talking.

In some cases, closed questions can also be appropriate. These are questions directed at a subject or object and can be used to encourage the witness to elaborate on something they have mentioned.

Examples of closed questions are:

Was there a chain of events which led to the incident?

Was the risk known at the time? If so, why do you think it was not controlled? If it was not known, why not?

Did the arrangement of the work have any effect on the incident?

Did the work environment have any effect?

Did any work equipment (or lack of) have any part to play?

Was there anything unusual being done at the time?

Were there safe working procedures and were they followed?

GATHERING INFORMATION
INTERVIEWING WITNESSES

Be careful to avoid leading questions, as they tend to encourage responses the interviewer is looking for, rather than information about what actually happened. Examples are:

> You were concerned that a supervisor was not present weren't you?

> Would you say that the vehicle was being driven too fast when it smashed into the other car?

> Would you agree that the procedure is inadequate for this task?

LISTENING

Good active listening technique includes a positive attitude to the interviewee. Try not to jump to conclusions or make judgements as this will affect your attitude and possibly the questions you ask. Make sure you show with your body language and eye contact that you are empathetic and interested in what is being said. Check that you understand what the person means by rephrasing what has been said back to the interviewee. This reduces the chances of misunderstanding and allows the interviewee to refine what they have said.

CONCLUDING AN INTERVIEW

Finish the interview positively by reaffirming the purposes of the interview and thanking the person for their input. Give an indication of what will happen next in the investigation process and when they can expect further updates.

LEARNING TEAMS - AN ALTERNATIVE TO INTERVIEWS

BACKGROUND

Operational Learning is a Human and Organisational Performance[1] based technique of learning from those closest to the work to gain operational intelligence (the detail we are missing from having never experienced the work first hand). Operational Learning has proven to lead to the development of improvement actions that increase system resilience to human error by: addressing deviation prone rules, identifying error traps, and improving or adding defences that reduce the consequences of human error. One method of Operational Learning is conducting a Learning Team. A Learning Team is a facilitated conversation between those that do the work and those that design the work to share operational intelligence between the two groups and improve system design.

WHEN TO USE A LEARNING TEAM

A Learning Team can be used proactively (before we have had a failure) or reactively (after an event has occurred).

HOW TO FACILITATE A LEARNING TEAM

PREPARATION

- Hold the learning team as soon as possible after the incident, event or activity (when information and memory is still fresh).
- Use a good facilitator - someone neutral and who is good at building trust and keeping people on task.
- Have a note taker and use a whiteboard or flip charts so everyone can see.
- Get the right people in the room - everyone involved in the event, including contractors, and technical experts if needed.
- Get the right room for the right time - a spacious, comfortable meeting room works well. Learning teams can take time so make sure you allow enough – experience says a couple of hours. Sometimes a second one is needed if there's a lot to learn. Late morning is probably better than late afternoon for alertness. Plan for breaks.

1 HOP (also called the "New View" in some circles) is a global movement towards using the social sciences to better understand how to design resilient systems.

GATHERING INFORMATION
LEARNING TEAMS

SET THE SCENE

Explain what a learning team is and its purpose. Discuss ground rules and invite the group to agree to ground rules that best resonate with them.

Some examples of Ground Rules:

- Have a positive and curious attitude
- Leave hierarchy at the door
- Actively participate – don't wait to be asked
- Be concise - make sure everyone gets time to talk
- Respect and value diversity of views
- Put mobiles on silent – take calls in breaks
- Don't use 'counter-factual' or blaming language - "should have... , could have... I would have...".

EXPLORE THE WORK

Let people tell their story, perhaps with the help of a timeline. Then try the following questions:

- What happened the way you thought it would?
- What surprised you during the work?
- What hazards did you identify, and which ones did you miss?
- Where did you have to 'make do', or adapt? Why?
- What made the work different to other work?
- What task and environmental conditions were in play at the time and define which ones felt the most important. Why?

WRAP UP THE SESSION

Ask a few questions to summarise the session and pave the way for next steps:

- What are the most important things we have learnt?
- Who else needs to know about this, and how can we share the learning?
- What does good look like and what could be different as a result of these findings?
- Who is going to do what, by when, and how can we get feedback?

HINDSIGHT BIAS

A potential pitfall of all investigations is 'hindsight bias'. Hindsight bias is the tendency to unknowingly see events that have already occurred as being more predictable than they were before they took place.

When carrying out an incident investigation you will already know the outcome, and therefore the job of the investigator is to determine the circumstances that led to that outcome so that they won't be repeated in the future. We must avoid making assumptions about the predictability of actions and events and try to see things as individuals would have seen them at the time.

Guard against hindsight bias by avoiding counter-factual statements such as:

"He should have seen it coming..."

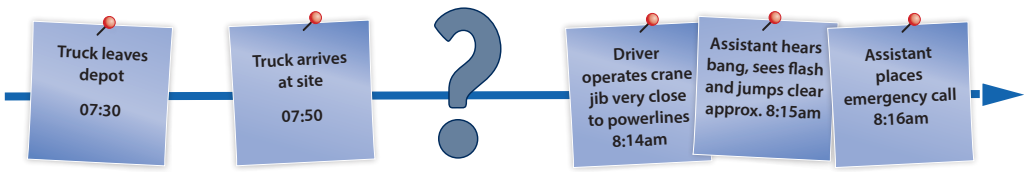
"They could have been more careful!"

"If only they'd done that, the incident wouldn't have happened."

ESTABLISHING THE SEQUENCE OF EVENTS

This involves looking carefully through all the data you have collected (from the PEEPO chart) to see if you can develop an accurate picture, or theory, of what happened and why. As you build the timeline, you will find that some information you have gathered is critical, many other facts may be irrelevant, and most importantly you may find some information is missing.

If gaps in the timeline emerge, it means that the data gathering stage of the investigation (your PEEPO chart) is not complete. You must pursue additional lines of investigation and further interviews or inspections may be required.



A number of analysis methodologies have been developed, and can be applied to investigations. The type of method and level of detail required depends largely on the seriousness of the incident and its consequences. Examples are:

Timelines

- Simple timelines
- Parallel timelines
- Event and condition charts

Flow charts

- 5 Why's
- Event trees

It's important to note that each investigation is different; the number of methodologies and the order in which they are used will change depending on the incident and those investigating it.

The following pages give more detail on how to use these methods.

THE INVESTIGATION
ESTABLISHING THE SEQUENCE OF EVENTS

SIMPLE TIMELINES

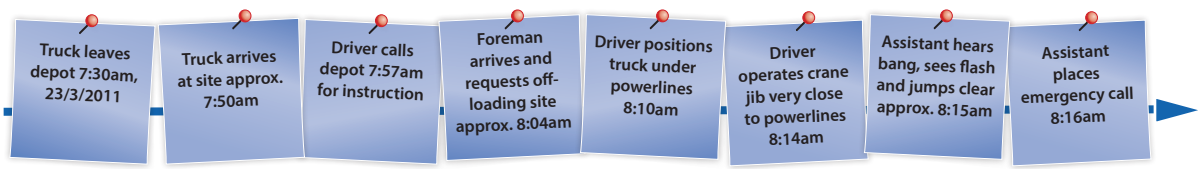
Time is a powerful way to organise the data collected during an investigation. Workplaces can be described as event-driven; activity ebbs and flows as the work tasks and processes change and progress through time. Work demands and pressures also vary through time.

Developing a timeline simply involves identifying events (happenings, what was said or done) in chronological order. Timelines should contain enough detail for you to build a picture of what happened, when and how, so that you can start to reveal the underlying factors which may have contributed to the incident in question. The timeline should also show you the gaps in your data - where you don't know what happened next, or led to an event, and where there are lapses in time where you don't have any data. Often this will mean you have to go back and search for more data.

CHALLENGES

There are two main difficulties you will come across when building timelines:

1. No 'time stamps' - in many cases, it is difficult to identify exactly when something happened; you will sometimes need to search telephone data logs, CCTV records, machine logs and other sources to get accurate data.
2. Where to start - technically, the beginning of an incident doesn't exist, so the best advice is to start with the data you have collected so far. The decision to go back further can be made after you have compiled some of the timeline.



EVENT AND CONDITION CHARTS

This is a good method for setting out the facts you have gathered so far so that you can begin to see relationships between the timings of the events and conditions at the time. It is a good way of attempting to find out what it was like for the people involved as they made sense of the unfolding situation. It allows the investigation team to reconstruct a story of what happened. Information and insights about the conditions of work from the PEEPO chart can be added to the timeline so that it shows not only what happened, but what it was like at the time for those involved. It also combats hindsight bias in the investigation team as the method tries to build a picture of what it was like inside the 'tunnel' of perception of those involved in the incident.

EVENTS

An event is something that happened during the incident sequence. For example, a decision made to act in a certain way, a failure of equipment or movement of machinery. Events should be able to be traced to a single point in time; i.e. 'time-stamped'.

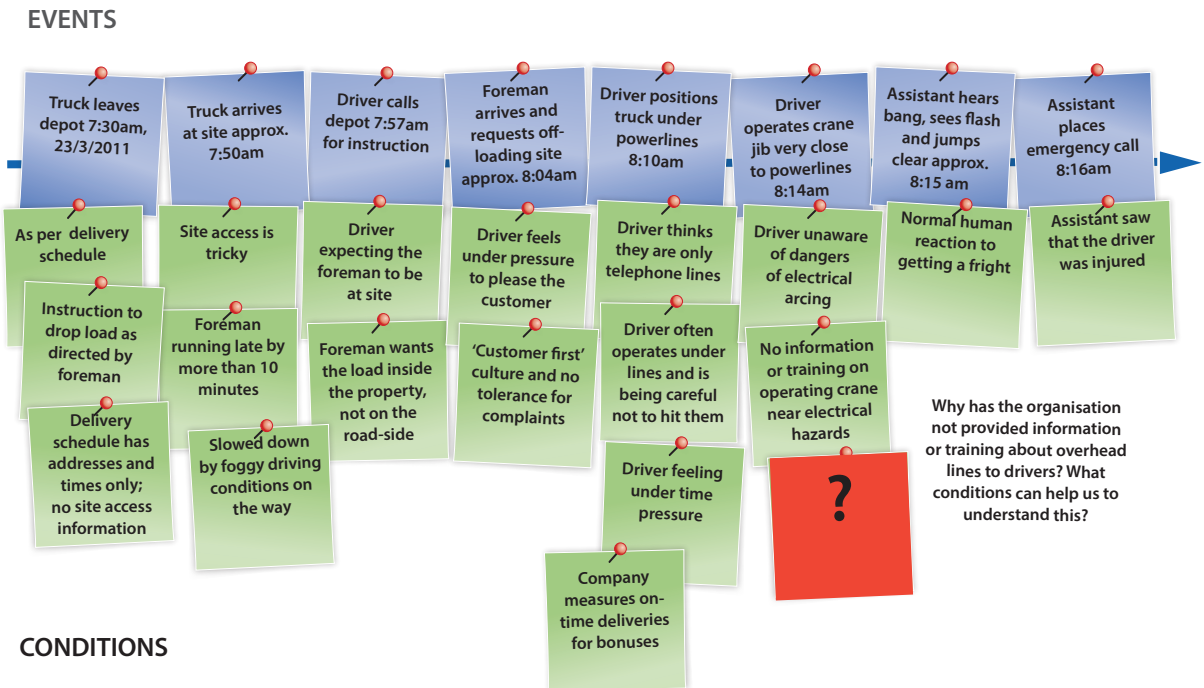
CONDITIONS

Conditions are a state of being during the incident sequence, for example, a toxic atmosphere, high winds, poor lighting, a live electrical circuit or a wet slippery floor. Conditions can also be the result of an event. Some conditions may exist for the entire duration of the incident; others may arise and then cease at various points during the incident sequence.

THE INVESTIGATION
ESTABLISHING THE SEQUENCE OF EVENTS

METHODOLOGY

Write down all the events that happened on post-it notes of one colour and conditions on a second colour post-it note. The example below has used blue and green. (Blue=events, green = conditions). Build the sequence of events using the event post-it notes, in sequential order from left to right. Then, using the perspectives of the people involved at the time, build up a picture of the conditions, and how they changed as the sequence of events progresses.



If gaps in your event and condition chart emerge, it means that the data gathering stage of the investigation (and your PEEPO chart) is not complete. You must pursue additional lines of investigation and further conversations, interviews or inspections may be required.

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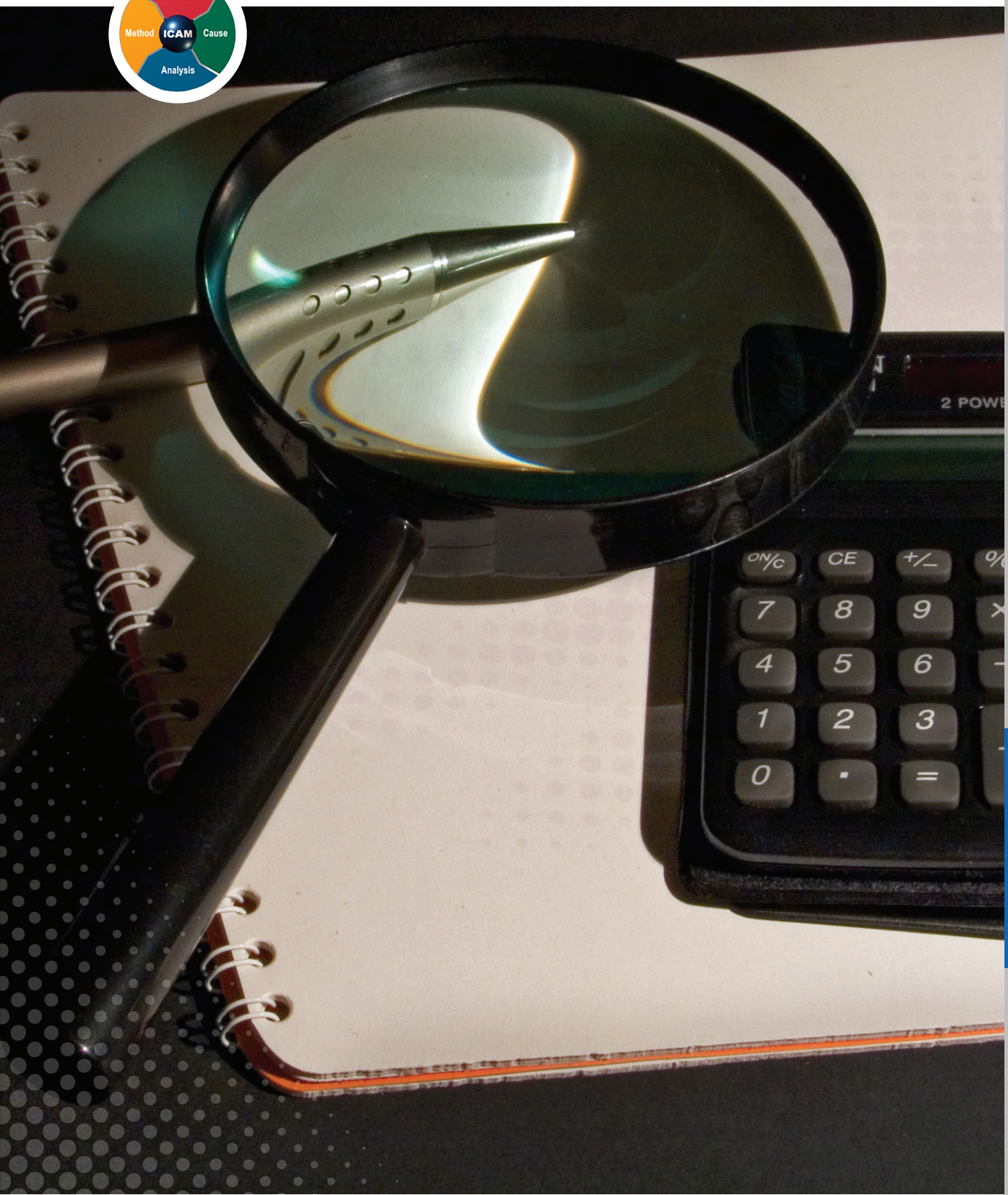
ANALYSING INFORMATION

THE ICAM INVESTIGATIONS MODEL



ANALYSING INFORMATION
MODELS AND THEORIES OF CAUSATION

ANALYSE THE INFORMATION

At this stage, information will have been gathered using multiple techniques and organised using the PEEPO chart and timeline with conditions. The stage of organising the incident information can build a story of HOW the incident happened but not WHY. The analysis stage is about identifying and trying to make sense of factors that contributed to WHY the incident happened and what can be learned.

INCIDENT CAUSATION MODELS

All models are wrong, in that they try to simplify a complex and unknowable reality, but some are nonetheless useful. It's important for organisations and individuals to use evidence-based models to analyse incidents because they:

- Enable a common understanding of incidents by providing a simplified representation of actual events
- Help structure and communicate threats and opportunities in the wake of incidents
- Suppress personal biases and thereby extend the range of potential improvement opportunities
- Guide investigations regarding data collection and analysis
- Provide different perspectives on systems and the interactions between system elements, enabling organisations to look beyond human contributions to incidents.

EVOLUTION IN THINKING ABOUT CAUSATION

From the 1920s to today, incident causation models and thinking has moved through three somewhat overlapping phases:

- Simple linear models
- Complex linear models
- Complex non-linear models.

Each type of model is underpinned by specific assumptions (Hollnagel, 2010).

ANALYSING INFORMATION
MODELS AND THEORIES OF CAUSATION

SIMPLE LINEAR MODELS

The simple linear models such as Domino Theory (Heinrich, 1931) and its successors such as Loss Causation Theory (Bird and Germaine, 1985) assume that incidents and accidents are the culmination of a series of events or circumstances which interact sequentially with each other in a linear fashion and thus can be prevented by removing one of the causes in the linear sequence.

COMPLEX LINEAR MODELS

Complex linear models are based on the presumption that incidents and accidents are a result of a combination of active failures and latent conditions within the system which follow a linear path. The factors furthest away from the accident are attributed to actions of the organisation or environment and factors closest to the accident to humans interacting with work conditions. The resulting assumption is that accidents can be prevented by focusing on strengthening barriers and defences. Examples are epidemiological accident modelling (Benner, 1975), the Swiss Cheese Model (Reason, 1990, 2008), and the Defences Model (Reason, 1997).

COMPLEX NON-LINEAR MODELS

The new generation of thinking about incident and accident modelling theorises that models need to be non-linear; that accidents can be thought of as resulting from combinations of interdependent interacting variables in real world environments. The authors and supporters of these approaches (Nancy leveson, Eric Hollnagel and others) argue that only through seeking to understand the combination and interaction of these multiple factors that accidents can truly be understood and prevented. Examples are Systems-Theoretic Accident Model and Process (STAMP) (Leveson, 2004), and Functional Resonance Accident Model (FRAM) (Hollnagel, 2004).

DEFENCES AND SYSTEMS SAFETY

The analysis stage of ICAM uses tools and concepts based on James Reason's Defences Model. This is a 'complex linear model' of incident causation. At IMPAC, we have adapted this model and included additional concepts and tools so that investigations can benefit from the most recent developments in non-linear models while retaining the functionality of linear models.

These additional concepts and tools include:

- Drift into failure
- Just culture
- Hindsight bias and other heuristics in decision-making
- Memory and attention phenomena such as 'change blindness'
- The Learning Teams approach to gathering information and group sense making.

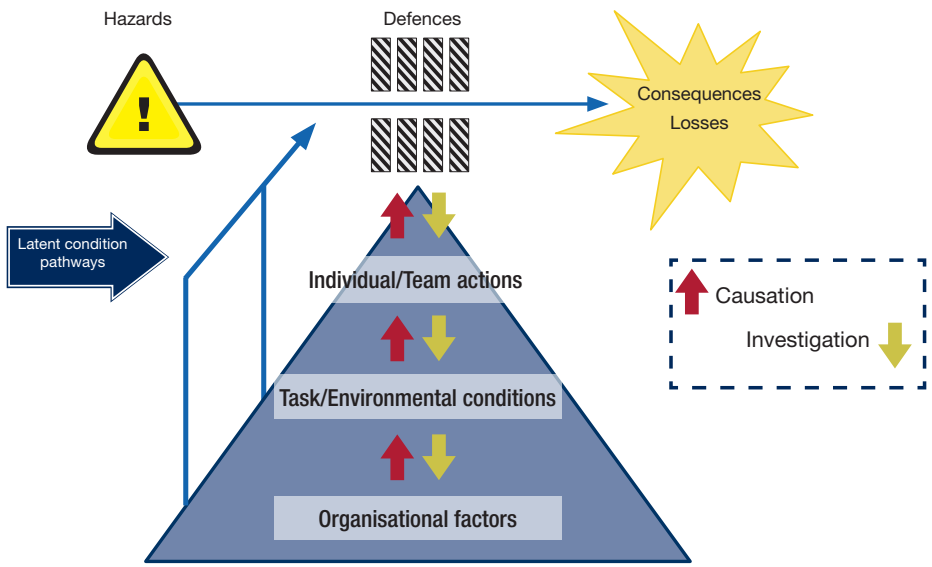
THE DEFENCES MODEL

The Defences Model depicts layers of defences (also called barriers or controls) which sit between operational hazards and potential targets for harm (people, the environment, product etc.) and are intended to prevent adverse events and consequences. The model shows that defences don't exist by themselves, but are dependent on and supported by systems and system elements (shown in the triangle). These exist at the level of the frontline worker and the actions of individuals and teams, as well as the task and environmental conditions they work in. Underpinning both are 'organisational factors' - the elements of the organisation's internal and external context, and its management systems and structures.

The effectiveness of defences is supported or eroded by interactions between individual/team actions, task and environmental conditions, and organisational factors. Latent condition pathways exist, where aspects of the organisation, and/or task and environmental conditions, can have an impact on the effectiveness of defences that is delayed in time and/or distant in space.

DEFENCES MODEL

James Reason, (1997)



THE ICAM CHART

The ICAM Chart is a workspace based on the Systems Safety and Defences Models of causation. It helps to map out and display information to help understand contributory factors and learning opportunities.

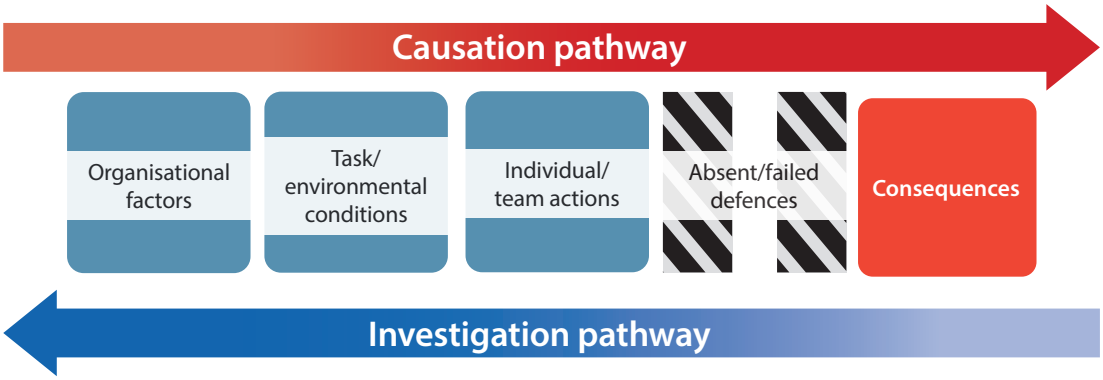
Organisational factors	Task/ environmental conditions	Individual/ team actions	Absent/failed defences	Consequences
• Hardware • Training management • Incompatible goals • Management of change • Management of Procedures • Maintenance management • Risk management • Design • Contractor management • Organisational culture	• Work conditions • Time pressures • Resources • Tool availability • Job access • Task complexity • Fitness for work • Workload • Task planning	• Slips and lapses • Mistakes • Violations	• Interlocks • Isolations • Guards • Barriers • Safe Operating Procedures • Job Safety Analysis • Awareness • Supervision • Emergency response • Personal Protective Equipment	• Incident • Near hit • Equipment failure • Production loss

Learning from incidents

Continuously improving organisational factors	Task and environmental conditions suited to workers	High levels of human performance	Resilient defences and resources which allow for safe failure	**Organisational objectives achieved** ✓

ANALYSING INFORMATION
THE ICAM CHART

The investigation pathway tends to lead us from the incident itself and the consequences, to absent or failed defences, to individual/team actions, to task/environmental conditions, and finally to organisational factors. The ICAM model helps us to understand that the causation pathway runs the opposite way, starting with organisational factors as the root causes.



We will now examine each column and contributing factor category shown by the ICAM chart, following the natural investigation pathway which starts with the incident itself and its consequences and work back towards contributing factors deep within the organisation or even the wider system.

ABSENT OR FAILED DEFENCES

Defences are essentially the controls that an organisation puts in place to prevent hazards from causing harm and to mitigate/reduce adverse consequences. These controls include 'hard defences' such as items of warning or detection equipment, guards, barriers, fail safe devices and protective equipment, as well as 'soft' defences such as information, instruction, training, supervision, experience, and knowledge. Post-incident defences such as escape and rescue planning and resourcing are also important to consider.

An investigation must first identify from the facts gathered, which defences are relevant to the incident, and whether they were absent altogether, or were present but inadequate to prevent harm.

There are five categories of defences.

It's important to note that sometimes defences can be linked together in such a way that if one fails, (e.g. awareness) then all will fail. An incident may quickly spiral out of control even though there are several defences in place and the situation looks safe.

ANALYSING INFORMATION
ABSENT OR FAILED DEFENCES

Defence Category	Explanation	May result in
Awareness	To understand the nature and severity of the hazardous conditions present at the work site. Examples of defences include the provision of information, training, instruction and supervision, on-going communications and effective hazard identification and risk assessment processes.	› Hazard not understood to be present or relevant › Lack of appreciation of risk or danger
Detection	These defences are put in place to provide clear warning of both the presence and the nature of a potentially hazardous situation. Examples include warning lights and sirens, signs and notices, atmospheric hazard detectors, danger alarms, audible signals, fire detectors.	› Hazard not detected or detected too late › No warning given
Control and Interim Recovery	To control access to hazards and restore people or equipment to a safe state with minimal injury or damage. Examples include guarding and barriers, pressure relief valves, shut down systems, circuit breakers, residual current devices, trip switches and interlocks	› Hazard exposed or free to cause harm › Hazard not rendered harmless under dangerous conditions
Protection and Containment	These defences limit the consequences of any unplanned release of mass, energy or hazardous material. They are designed to protect and contain and to prevent escalation of the problem. Examples are Personal Protective Equipment, fire fighting media, spill kits, bunded areas, first-aid.	› Hazard targets not protected › Hazard releases not contained › Casualties not treated
Escape and Rescue	The defences here are designed to ensure that we are able to evacuate all potential victims from the hazardous area as quickly and as safely as possible. Examples include emergency escape routes, emergency planning, organisation of evacuations, emergency communications and rescue capability.	› People unable to escape danger › Confusion during escape › Casualties unable to be rescued

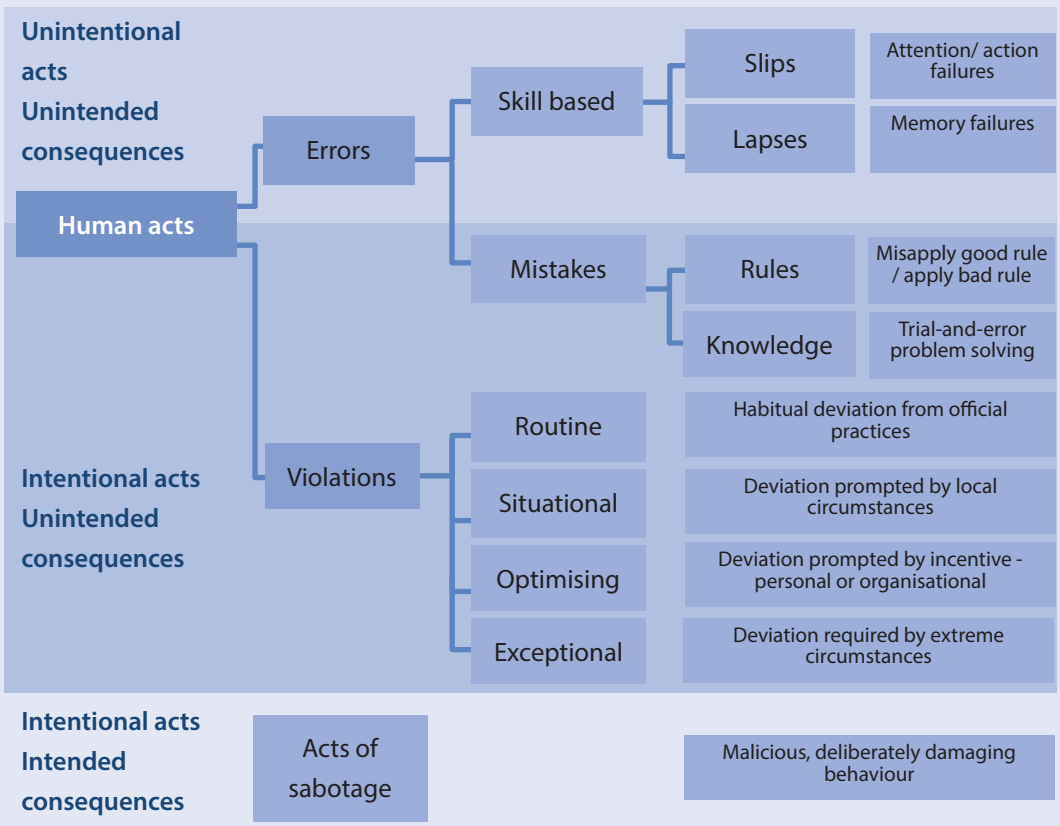
INDIVIDUAL/TEAM ACTIONS

These are actions of individuals or teams which were identified as part of the incident sequence of events. They are typically associated with people doing or not doing something and in hindsight these actions and/or inactions contributed to the incident. A course of action or inaction usually makes sense at the time to the people caught up in the sequence of events. The investigators' role is to attempt to understand why people did what they did. Questions of blame and culpability must be distanced from the investigator; the aim is to assist organisational learning, not take disciplinary action against individuals.

There are two different types of human failures:

Error—an action or decision involving a deviation from an accepted standard, which leads to an undesirable outcome. They can be unintentional acts, or intentional acts with unintended outcomes.

Violation—a deliberate deviation from a rule or procedure, essentially 'breaking the rules'.



ERRORS

Errors fall into three further categories: **slips, lapses and mistakes**.

SLIPS AND LAPSES

Slips and lapses tend to happen when workers are performing familiar 'skill-based' tasks without much need for conscious attention. Slips and lapses can happen if attention is distracted, even driving a car is a typical and familiar skill-based task. Slips and lapses can be made by even the most experienced, well-trained and highly-motivated people. The best way to avoid slips and lapses is in the design of equipment and tasks, and in early detection. We can also try to increase the opportunities to detect and correct such errors. It can be useful to make employees aware that slips and lapses can and do happen to everyone.

Slips are failures to do with the actions of a task—unintended deviations from the required way of doing something.

Typical slips, include:

- Performing an action too soon in a procedure or leaving it too late
- Leaving out a step or series of steps from a task
- Carrying out an action with too much or too little strength (e.g. over-torquing a bolt)
- Performing the action in the wrong direction (e.g. turning a control knob to the right rather than the left, or moving a switch up rather than down)
- Doing the right thing but on the wrong object (e.g. switching the wrong switch); and
- Carrying out the wrong check but on the right item (e.g. checking a dial but for the wrong value).

Lapses are when we forget to carry out an action, lose our place in a task or even forget what we were doing. Tasks which take some time to complete or involve periods of waiting are especially prone to lapses. Lapses can be reduced by minimising distractions and interruptions, and by using reminders such as checklists. Task and equipment design can also help.

ANALYSING INFORMATION
INDIVIDUAL/TEAM ACTIONS

MISTAKES

Mistakes are a more complex type of human error where we do the wrong thing believing it to be right. They are failures of mental processes which control how we plan, assess information, and judge consequences. There are two types of mistakes; rule-based and knowledge-based.

Rule-based mistakes occur when our behaviour is based on remembered rules or familiar procedures. We have a strong tendency to use familiar rules or solutions even when these are not the most convenient or efficient.

Knowledge-based mistakes involve incorrect assessments, diagnoses or miscalculations when we are faced with unfamiliar circumstances. In these situations we have to consciously make new goals, plans or procedures, based on principles or similar experiences. Even people who are experienced and trained make mistakes from time to time, but are more likely when people don't have the right training, experience, knowledge or information. Misunderstandings and gaps in information are often the result of poor communication. Shift hand-overs are a particularly vulnerable time for communication failures.

VIOLATIONS

Violations are deliberate deviations from rules, procedures, instructions and regulations. Violations of health and safety rules or procedures are a major cause of many incidents and injuries at work. Removing the guard on dangerous machinery or driving too fast will clearly increase the risk of an incident. Health risks are also increased by rule breaking. For example workers who deliberately don't use hearing protection, increase their risk of occupational deafness.

Rules are broken for many different reasons. Research has shown that violations are usually motivated by a desire to complete a task which is constrained in some way. Very rarely are they wilful acts of sabotage or vandalism.

ROUTINE VIOLATIONS

Routine violations describe situations where breaking the rule or procedure has become a normal way of working within a group. This can be due to:

- Rules which are not understood or perceived as too restrictive
- Cutting corners to save time and energy
- The belief that the rules do not apply
- Lack of enforcement of rules; and
- New workers being led or pressured into following group norms.

SITUATIONAL VIOLATIONS

Situational violations are when rules are broken due to pressures from the job. Common examples are:

- Time pressure
- Lack of resources or personnel
- Lack of the right equipment for the job; or
- Extreme weather conditions.

In some situations, it may be very difficult or even unsafe to comply with a rule in a particular situation. Hazard identification and risk evaluation exercises often help to identify the potential for these violations. Open and honest communication and consultation is also an effective way to reduce situational violations.

OPTIMISING VIOLATIONS

These are deliberate actions taken because the individual or team thought there would be some benefit - either to the organisation or themselves personally. These violations may be encouraged by incentives, and can be an indicator of incompatible goals where safety may be sacrificed to achieve other targets or objectives.

EXCEPTIONAL VIOLATIONS

Exceptional violations are rare, as the term implies. They usually occur when something has gone wrong unexpectedly, or in emergency situations. To solve a new problem or deal with a situation, workers may decide to break a rule even though they are aware that there is risk involved. There is usually a belief that the benefits of breaking the rule outweigh the risks.

ACTS OF SABOTAGE

These are not violations; they are better described as wilful acts with malicious intent - either against the organisation or an individual. The key difference between acts of sabotage and other types of violation is that the consequences are intended; they do not come as a nasty surprise. If there is evidence of sabotage, the investigation should be handed over to the Police. The incident now has a criminal element to it.

ANALYSING INFORMATION
INDIVIDUAL/TEAM ACTIONS

JUST CULTURE

Just culture is a concept that seeks to understand how two often conflicting needs can be met in the wake of incidents and mistakes: **Accountability and Learning**.

A just culture protects people's honest mistakes from being seen as culpable. But the question remains: *what is an honest mistake, or rather, when is a mistake no longer honest?* It is too simple to demand that there should be consequences for those who cross the line. Lines don't just exist by themselves, objectively guiding people's actions. People construct these lines, and they consist of specific expectations and value judgements.

To complicate matters further, people draw the line in different places all the time, depending on:

- The social or professional context
- The language we use to describe errors and violations
- Hindsight bias (when we know outcomes after the event, that were hidden from those caught up in the incident as it unfolded)
- Local culture, history, tradition, and a host of other factors.

WHO DRAWS THE LINE?

What really matters is not where the line goes, but who gets to draw it. If we leave that to chance, or to prosecutors, and fail to tell operators honestly about who may end up drawing the line, then a just culture may be very difficult to achieve.

Perceived unjust responses to incidents and human error can:

- Obstruct safety investigations by fostering suspicion
- Promote fear rather than mindfulness in people who do safety-critical work
- Make organisations more bureaucratic rather than more careful
- Cultivate professional secrecy, evasion, and self-protection.

Those in leadership positions must take active steps to define the lines within their organisations. The absence of a just culture in an organisation, in an industry, in a country, hurts both justice and safety.

JUST CULTURE AND SAFETY CULTURE

A just culture is critical for the creation of a safety culture. Without honest and trust-led reporting and investigation of failures and problems, without openness and information sharing, a safety culture cannot flourish.

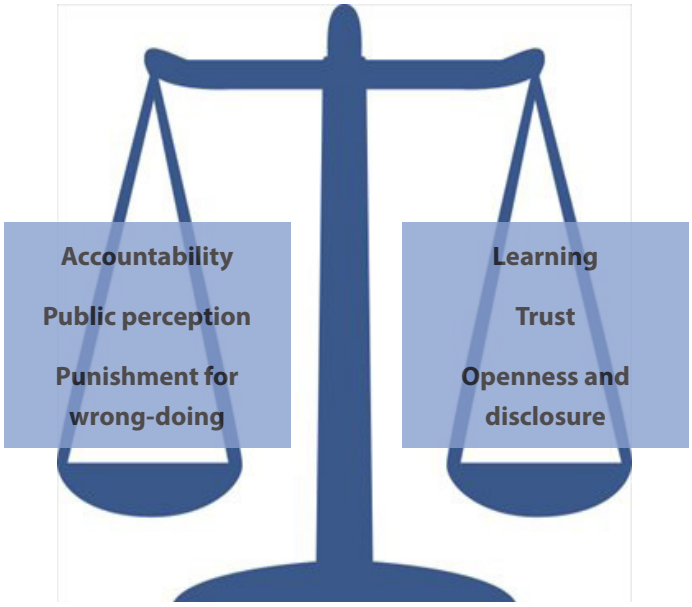
ANALYSING INFORMATION
INDIVIDUAL/TEAM ACTIONS

JUST CULTURE IN PRACTICE

Organisations may build a just culture through clearly drawing the line between acceptable and unacceptable behaviour. This must be effectively communicated, along with the consequences of behaviour. Most importantly, this 'line ' must then be applied consistently at all levels to build trust and acceptance.

Examples of possible key points to define when mapping out the 'line' are:

- Exemplary actions - showing creativity and initiative to improve safety
- Expected actions - following expected good practices
- Human error - slips, lapses and mistakes committed as part of the normal process of learning and improving, admitted to honestly with the intention of avoiding a repeat
- Unintended violations - unsafe acts arising from a lack of knowledge or awareness
- Organisational optimising violations - unsafe acts committed in an effort to get the job done, for the benefit of the organisation
- Personal optimising violations - committed for personal benefit - "it was easier for me"
- Recklessness - knowing and deliberate disregard for consequences.



TASK/ENVIRONMENTAL CONDITIONS

Task and environmental conditions describe 'life inside the tunnel'; what it was like for those involved at the time of the events. These are the environmental, work activity, and psychological states that promote or directly cause active failures through influencing human and equipment performance. They are conditions in existence immediately prior to or at the time of the incident, and can be embedded in task demands, the work environment, individual capabilities and personal factors. Many task and environmental conditions are known to make errors and/or violations more likely.

Common predictors of errors:

- Challenging work environment e.g. extremes of heat or cold, high humidity, noise, vibration, poor lighting, restricted space
- Task demands e.g. high workload, high concentration requirements, repetitive and unstimulating tasks, distractions and interruptions
- Social and organisational stressors: insufficient staffing levels, inflexible work schedules, peer pressure, conflict with co-workers
- Individual stressors such as inadequate training and experience, impairment through fatigue or substances, ill-health, social problems outside of work
- Equipment stressors: confusing displays and controls, inaccurate information or procedures.

Common predictors of violations:

- Expectation that rules have to be bent to get the work done
- Feelings of powerfulness, that the rules don't apply to an individual
- Opportunities for short-cuts and easier ways of getting a task done
- Planning not done or incomplete, resulting in work done 'on the fly'.

ERROR FACTORS, VIOLATION FACTORS AND COMMON FACTORS

Appendix 1 contains a full list of common Task and Environmental Conditions. They are categorised into **Human Factors and Workplace Factors**. Within these two categories are factors that can promote the commission of **errors**, factors which are likely to promote **violations**, and **common factors** which may promote both errors and/or violations.

ANALYSING INFORMATION
TASK/ENVIRONMENTAL CONDITIONS

The following table illustrates how **Individual/Team actions** are influenced and promoted by **Task and Environmental conditions.**

Error type	Description	Possible contributing factors	Task/Environmental condition
Slip	Unintended deviation from a correct plan of action	› Attention failure › Mis-timing	› Distraction from task › Preoccupation with other tasks
Lapse	Omission/repetition of a planned action	› Memory failure	› Change in nature of task › Change in task environment
Mistake (rule-based)	Intended action inappropriate to the circumstances	› Sound rule applied in inappropriate circumstances › Application of unsound rule	› Failure to recognise correct area of application › Failure to appreciate rule deficiencies
Mistake (knowledge-based)	Erroneous judgement in situation not covered by rule	› Insufficient knowledge or experience—immaturity › Time/emotional pressures	› Organisational deficiency › Inadequate training

ANALYSING INFORMATION
TASK/ENVIRONMENTAL CONDITIONS

Violation type	Description	Possible contributing factors	Task/Environmental condition
Routine violation	Habitual deviation from required practice	› Natural human tendency to take path of least effort	› Indifferent environment (no penalties, no rewards for compliance)
Situational violation	Rules are broken to overcome an operational difficulty	› Feeling that no other option exists but to break the rule	› Production pressures or time pressures, lack of planning
Optimising violation	Rules are broken for perceived benefit either organisational or personal	› Long periods of monotonous work when rules are perceived to be restrictive or outdated	› Monotony, boredom › Risk and reward › Attitude to the system › Job dissatisfaction
Exceptional violation	One-off infringement of regulated practice	› Unexpected emergency situation › Regulated practice is in conflict with human nature	› Particular tasks or circumstances not planned for

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

LOOKING BEYOND ACTIVE FAILURES

The ICAM approach is designed to ensure that the investigation is not restricted to the errors and violations of operational personnel, or the immediate failure of plant or equipment. It identifies the local factors that contributed to the occurrence and also the **latent systems conditions (organisational factors) within the organisation.**

ORGANISATIONAL FACTORS

Organisational factors are the features of the organisation and how it functions, that have contributed to the incident. These organisational-level contributions represent powerful improvement opportunities. The ultimate intent of an incident investigation is to identify these **latent system conditions.** Once they are identified they should be aggregated to identify systemic trends over time.

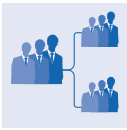
A defining characteristic of organisational factors is that they are always present before the onset of an incident sequence. Incident-producing organisational factors may lie dormant within normal work for a long time only becoming evident when they combine with other contributing factors to become part of an incident.

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

THERE ARE SIXTEEN ORGANISATIONAL FACTORS

1 Hardware **(HW)**

2 Training **(TR)**



3 Organisation **(OR)**

4 Communication **(CO)**

5 Incompatible Goals **(IG)**

6 Management of Change **(MC)**

7 Procedures **(PR)**

8 Maintenance Management **(MM)**

9 Risk Management **(RM)**

10 Design **(DE)**

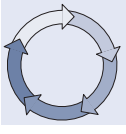
11 Contractor Management **(CM)**

12 Organisational Culture **(OC)**

13 Regulatory Influence **(RI)**

14 Organisational Learning **(OL)**

15 Critical Risk Management **(CRM)**



16 Management Systems **(MS)**

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

1 HARDWARE (HW)

Failures of facilities, equipment or tools due to inadequate quality of materials or construction, non-availability, and failures due to ageing (position in the life-cycle). Does not include problems with poorly designed equipment or failures caused by inadequate maintenance.

Specific examples of evidence:

- Poor storage or cleaning processes
- Financial constraints or time pressures
- Ineffective supply/stock ordering systems
- No regular evaluation and updating of hardware specifications
- Theft
- Tools and equipment not fit for purpose
- Poor selection of tools for tasks

May result in...

Challenging task and environmental conditions such as:

- Inadequate use of tools and equipment including improvisation
- Tools, equipment and materials not available
- Tools, equipment and materials of poor quality

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

2 TRAINING (TR)

Deficiencies in the system for providing the necessary awareness, knowledge or skill to an individual or individuals in the organisation. In this context, training includes on-the-job coaching by mentors and supervisors as well as formal courses.

Specific examples of evidence:

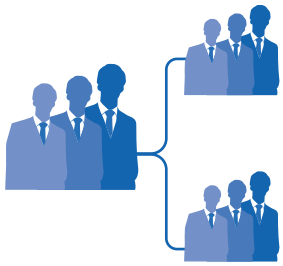
- Inadequate management of training
- Poor employee selection processes (matching right person to the job)
- Poor training needs assessment
- Training not given or ineffective
- Right training given to wrong person
- No or ineffective evaluation of training outcomes
- Training not focused at skills/competency

May result in...

Challenging task and environmental conditions such as:

- High supervision time requirements
- Poorly performed tasks
- Employees unable to perform their tasks
- Activities taking longer and of poorer quality
- Excessive time spent training
- Mis-match of abilities

ANALYSING INFORMATION
ORGANISATIONAL FACTORS



3 ORGANISATION (OR)

Deficiencies in either the structure of the organisation or the way it conducts its business that allow safety responsibilities and accountabilities to become ill-defined and warning signs to be overlooked.

Specific examples of evidence:

- Poorly defined departments or sections
- Unclear accountability, responsibility or delegation
- Poorly defined objectives and planning processes
- Poorly defined organisational structure in terms of policy making, managerial, supervisory, and operational levels
- Too much bureaucracy
- Many re-organisations and restructures

May result in ...

Challenging task and environmental conditions such as:

- Big hierarchy which is slow to respond to changes
- Deferred decisions
- No one or wrong person held accountable (only held responsible)
- Rules and procedures not enforced
- Poor control or management of events

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

4 COMMUNICATION (CO)

Failure in transmitting information necessary for the safe and effective functioning of the organisation to the appropriate recipients in a clear, unambiguous or intelligible form.

Specific examples of evidence:

- Lack of clear communication structure
- Language or cultural problems
- Inadequate feedback/confirmation from the receiver
- Inability to communicate with the correct person
- Unreceptive receiver

May result in ...

Challenging task and environmental conditions such as:

- Misunderstanding or incorrect interpretation
- People not knowing what to report or to whom
- Right information not being communicated to right people in whole or in part
- Failure to find information

5 INCOMPATIBLE GOALS (IG)

Failure to manage conflict; between organisational goals, such as safety and production; between formal rules such as company written procedures and the rules generated informally by a work group; between the task requirements of individuals and their personal preoccupations or goals.

Specific examples of evidence:

- Conflict between safety and production
- Conflict between formal and informal processes
- Imbalance between safety requirements and financial constraints
- Conflict between work and personal priorities
- Management being unclear on importance of safety

May result in ...

Challenging task and environmental conditions such as:

- Overruling, or short-cutting procedures
- Putting people under pressure
- Operating close to or outside of normal control limits
- Failure to communicate information about hazards

6 MANAGEMENT OF CHANGE (MC)

The absence or failure of systematic assessment and implementation of change; to operations, processes, personnel, plant and equipment, products and services, premises etc. Change should be assessed for risk and appropriate planned action should be taken to ensure existing performance levels are not conceded.

Specific examples of evidence:

- Change process inadequate or poorly conducted
- Objectives and scope of change not clearly determined
- Inadequate cost/benefit assessment of the impact of change
- Poor change implementation planning
- Poor communication of change
- Speed of change implementation - too fast or too slow
- Approval of proposed change absent or inappropriate
- Inadequate monitoring of the effects of change to existing performance levels

May result in ...

Challenging task and environmental conditions such as:

- Adverse impact on production and safety performance
- Risk levels above ALARP, regulatory breaches
- Unexpected near-misses, incidents and incidents
- Gaps in organisational structures and responsibilities
- Mismatch between equipment, procedures and training
- Insufficient staffing levels, confusion and low morale
- Increase in equipment breakdown or damage
- Mismatch between policy, procedures and practice

ANALYSING INFORMATION
ORGANISATIONAL FACTORS

7 PROCEDURES (PR)

Unclear, unavailable, incorrect or otherwise unusable standardised task information that has been established to achieve a desired result.

Specific examples of evidence:

- Inadequate knowledge of the writer
- Little or no feedback on practical usefulness of procedures
- No structure in the way procedures are written, tested, documented and implemented
- Difficulty in finding procedures
- Gaps in what procedures are required
- Procedures written for political rather than operational reasons
- Unclear scope of procedures

May result in...

Challenging task and environmental conditions such as:

- Procedures not in place for safety critical activities
- Overlapping or conflicting procedures
- Procedures not being able to be accessed by users
- Failure to communicate new or existing procedures
- Toleration for violations
- Ambiguous, incorrect, or out of date procedures in place

8 MAINTENANCE MANAGEMENT (MM)

Failures in the systems for ensuring technical integrity of facilities, plant, equipment and tools, e.g. maintenance systems, condition surveys, corrosion controls and function testing of safety and emergency equipment.

This does not include issues relating to the execution of maintenance activities.

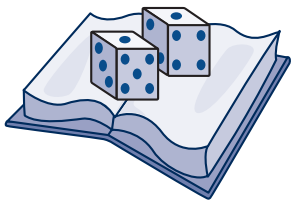
Specific examples of evidence:

- Inadequate planning, control, application and recording of activities
- Financial constraints or time pressures
- Ineffective communication of state of equipment to relevant person
- Lack of specialised maintenance personnel
- Lack of maintenance protocols/manuals and other relevant documentation
- Wrong maintenance strategy applied

May result in...

Inadequate maintenance management may result in:

- Defective or malfunctioning plant or equipment
- Makeshift or reactive (unplanned) maintenance
- Plant and equipment not operable in intended manner



9 RISK MANAGEMENT (RM)

Deficiencies in the process of identifying, assessing and prioritising risks, followed by a co-ordinated application of resources to minimise risks to ALARP, as well as the ongoing monitoring of risk levels. Risk, defined by ISO 31000 is the effect of uncertainty on objectives, and can take the form of undesired events or uncontrolled changes.

Specific examples of evidence:

- Inadequate or poorly conducted risk management process
- Goals, objectives, scope and boundaries of risk management activity not clearly determined
- Level of risk analysis inappropriate for the degree of risk or phase of life-cycle
- Risk identification not systematic or thorough
- Lack of appropriate competencies and experience
- Inappropriate selection or poor implementation of risk control measure
- Inadequate monitoring of risk control effectiveness

May result in...

Challenging task and environmental conditions such as:

- Risk levels above ALARP
- Uncontrolled hazards and consequences
- Unexpected incident and accident rate
- Inappropriate risk ranking and allocation of risk control resources
- Incomplete, inadequate or out of date Risk Register
- Breach of local regulatory requirements

10 DESIGN (DE)

Deficiencies in layout or design of facilities, plant, equipment or tools that lead to misuse or unsafe acts, (often increasing the chance of particular types of errors and violations). Many design failures result from the physical and professional separation of the designer and end user.

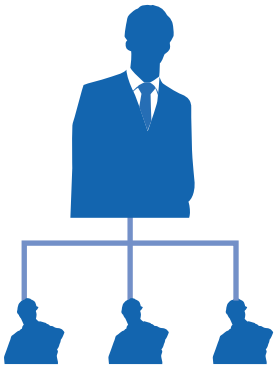
Specific examples of evidence:

- No standardisation of equipment or use of it
- Not assessing or adapting to the needs of the end user
- Financial constraints or time pressures
- Procurement design standards not set or monitored

May result in...

Challenging task and environmental conditions such as:

- Improvised usage
- Exposure to hazards
- Poor access/layout
- Complex training requirements
- Equipment/process not being able to be used properly
- Additional effort needed to complete the job



11 CONTRACTOR MANAGEMENT (CM)

Deficiencies in the evaluation, selection, control and monitoring of contractor activities including personnel, equipment and materials. The lack of review of contractor activities post-contract.

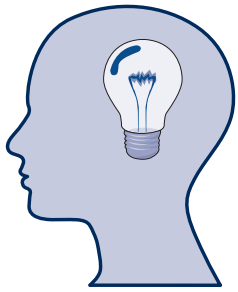
Specific examples of evidence:

- Poor or no contractor management processes
- Lack of communication
- Contract work poorly specified
- Inadequate time and resources to complete contract work
- Unclear roles and responsibilities
- Mis-match of company and contractor safety standards
- Poor monitoring and compliance processes
- Poor contractor selection processes

May result in...

Challenging task and environmental conditions such as:

- Incompatible goals where production is given a disproportionate priority over safety
- Misunderstanding of safety rules
- Contractors under resourcing for safety
- Poor safety performance standards
- Poor competency and manning levels for job completion
- Under-reporting of incidents



12 ORGANISATIONAL CULTURE (OC)

Organisational culture or sub-cultures may not be supportive towards health and safety, or may even be adversarial. Culture is the psychologically safest way to operate, shaped by the shared beliefs, values, norms and fundamental assumptions of a group.

Specific examples of evidence:

- Competing or obscure company policy
- Ineffective management decisions about policy
- Diverse and conflicting values and beliefs
- Poor relationships, low levels of trust and goodwill
- Factions and politics
- Unaddressed employee fears and anxieties
- Unnecessary risk taking passively allowed by leadership
- Poor, weak or authoritarian leadership
- Inconsistency between organisation's values and actions
- Lack of compliance, performance monitoring and review

May result in...

Challenging task and environmental conditions such as:

- Poor communications between divisions
- Failure to complete tasks and rule-breaking normalised
- Poor commitment to safety, environment and community
- Reluctance for voluntary resolution of identified hazards
- Low incident occurrence reporting
- Low staff morale and motivation
- Miscalculation of the level of acceptable risk
- Ambiguous expectations of behaviour requirements

13 REGULATORY INFLUENCE (RI)

The potential negative influence on safety culture of regulation. This can include defining and controlling the health and safety management framework within which the organisation is required to operate.

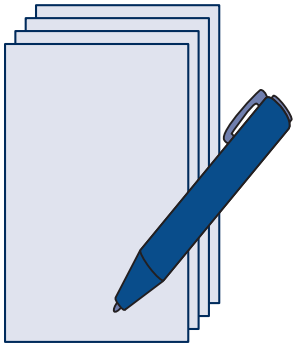
Specific examples of evidence:

- Ambiguous regulations
- Duplicated safety practices
- Multiple overlapping requirements for documentary evidence
- Conflicting regulatory requirements from different sources
- Lack of knowledge regarding regulatory requirements
- Regulators with a poor knowledge and understanding of industry requirements

May result in...

Challenging task and environmental conditions such as:

- Delays in meeting regulatory requirements
- Additional resources to meet regulatory requirements
- Prescriptive regulatory requirements
- Restrictive work practices
- Difficulties in interpreting regulations
- Under-reporting of incidents due to fear of enforcement action
- Inability to demonstrate compliance or satisfy other legal requirements
- Loss of operating licence or other regulatory sanctions



14 ORGANISATIONAL LEARNING (OL)

The failings in the strategies applied by organisations to ensure that lessons are learnt and remembered for the future. They can include investigation reports, corrective action implementation, audit findings, risk management processes, and reviews.

Specific examples of evidence:

- Not reporting and investigating occurrences systematically
- Failure to communicate lessons to all relevant parties
- Poor evaluation of effectiveness of corrective actions
- Lack of awareness of organisational risk exposure
- Audit recommendations being ignored or down-played
- Lack of leadership/commitment to learning
- Lack of resources (financial and human) to take action
- Inadequate safety records/data systems and analysis

May result in...

Challenging task and environmental conditions such as:

- Poor communication about the causes of failure
- Failure to complete tasks and corrective actions
- Poor commitment to safety, well-being and environment
- Lack of clear management structures/processes
- Low staff morale and motivation
- Miscalculation of the level of acceptable risk
- Ambiguous expectations of behaviour requirements
- Slow acceptance of change, restricting continual improvement process
- Unsafe work conditions not addressed

15 CRITICAL RISK MANAGEMENT (CRM)

Weaknesses in the system for identifying and managing low probability, high consequence events.

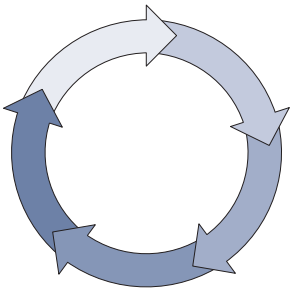
Specific examples of evidence:

- Absence of specific critical risk registers
- Lack of formalised critical risk management standards
- Performance measures relating to high probability low consequence events used as a measure for all risks

Challenging task and environmental conditions such as:

- Over-optimism about the capability of the organisation to manage critical risks
- Lack of awareness of critical risks
- No consistent or clear approach or resources available to manage a critical risk

ANALYSING INFORMATION
ORGANISATIONAL FACTORS



16 MANAGEMENT SYSTEMS (MS)

Management systems are the integrated framework of processes and procedures used to ensure that an organisation can fulfil all tasks required to achieve its objectives.

Specific examples of evidence:

- No alignment with a recognised standard such as ISO45001
- Lack of clear, systematic and comprehensive hazard and risk management processes
- Lack of goal setting, planning, documentation and measuring performance against goals
- Lack of visible commitment from management
- Inadequate resources to address and manage safety
- Lack of systems to encourage open communication
- Action not being taken or not subject to evaluation

May result in...

Challenging task and environmental conditions such as:

- Erosion of operational safety margins
- Increase in errors/incidents
- Identified hazards not being managed
- Lack of reporting of hazards and near misses
- Decrease in morale and productivity
- Poor communication between management and other areas
- Poor safety culture and standards
- Inadequate monitoring and review of safety actions
- Increased economic consequences due to costs
- Legal non-compliance

CONSTRUCTING THE ICAM CHART

Now that all the facts have been gathered and the information has been collated we need to go back and extract the key findings and classify them against the ICAM investigation model.

Successful use of the ICAM technique depends on you identifying the underlying or root causes of an incident and the conditions (contributory causes) which made the failure possible.

1

IDENTIFY THE ABSENT OR FAILED DEFENCES

Defences are those measures designed to control hazards and prevent the consequences of a human act or component failure producing an incident. Defences are equipment or procedures for detection, warning, recovery, containment, escape and evacuation, as well as individual awareness and protective equipment. In other words these are the defences that were put in place to prevent and/or limit the consequences of an adverse event.

2

IDENTIFY THE INDIVIDUAL/TEAM ACTIONS

Sometimes referred to as 'active failures' these are the errors and/or violations of the people involved. They tend to be the 'unsafe acts or omissions' of individuals that lead directly to an adverse incident. When these 'unsafe acts or omissions' are committed in the presence of an uncontrolled hazard they can lead to injury and/or damage to plant and equipment.

At all times we are endeavouring to understand why the individual did what they did and what were the circumstances (task/environmental conditions) that triggered their behaviour.

3

IDENTIFY THE TASK/ENVIRONMENTAL CONDITIONS

These are the conditions in existence immediately prior to or at the time of the incident that directly influences human and equipment performance in the workplace. These are the circumstances under which the errors and violations took place and can be embedded in task demands, the work environment, individual capabilities and human factors.

4

IDENTIFY THE ORGANISATIONAL FACTOR TYPES

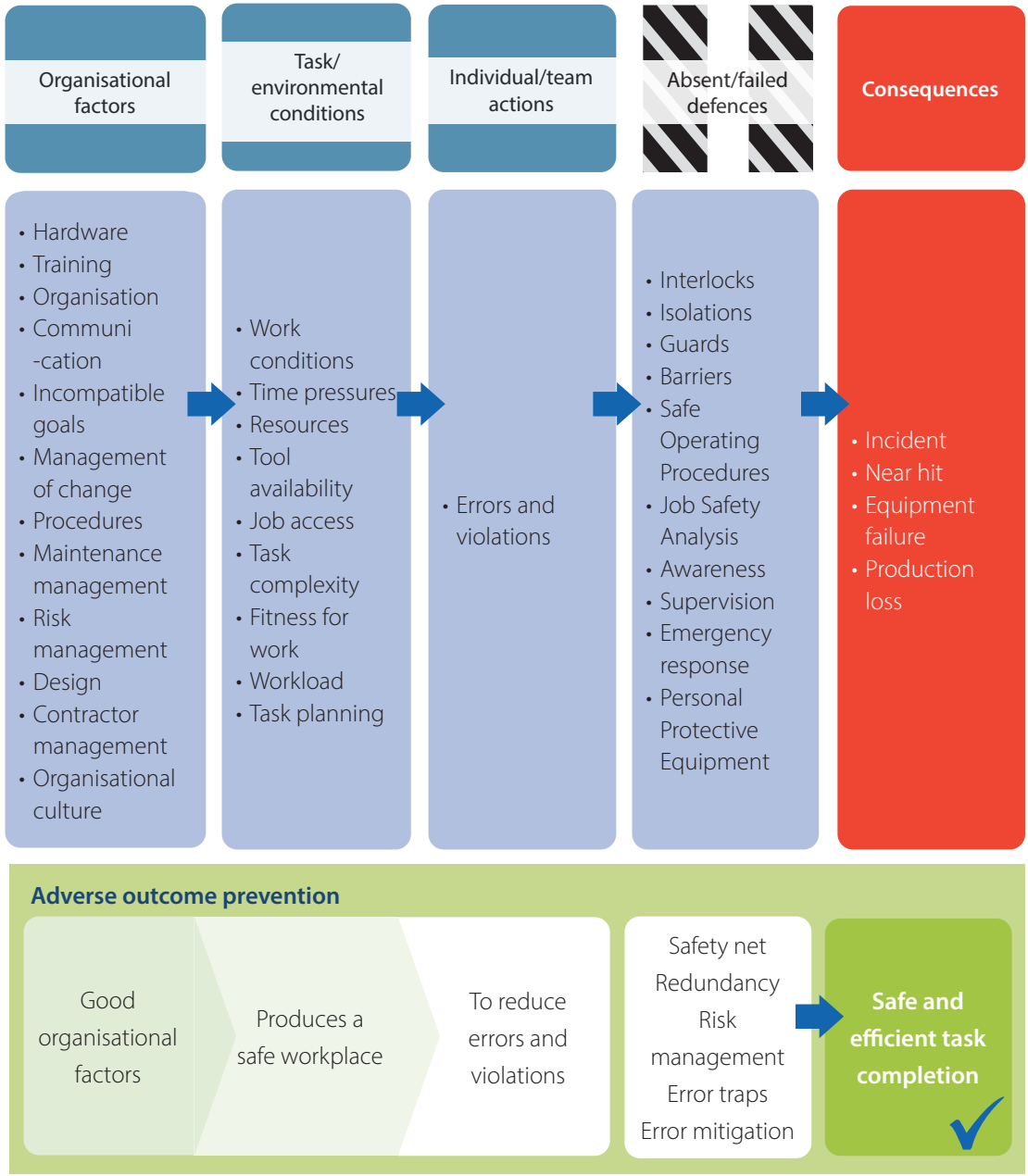
These are the underlying organisational factors that produce the conditions that affect performance in the workplace. They may lie dormant or undetected for a long time within an organisation and only become apparent when they combine with other contributing factors that lead to the incident. These may include management decisions, processes and practices.

The methodical approach adopted in the analysis stage will enable failings and possible solutions to be identified. These solutions need to be systematically evaluated and only the optimum solution(s) should be considered for implementation. If several risk control measures are identified, they should be carefully prioritised as a risk control action plan, which sets out what needs to be done, when and by whom. Assign responsibility for this to ensure the timetable for implementation is monitored.

THE ICAM CHART

The ICAM chart brings together the results of the analysis of data. It organises the facts and shows logically the journey from root causes to contributing factors to the incident and consequences.

It is important to note that some of the data gathered will not necessarily be identified as contributing factors. They are not included in the ICAM chart.



CORRECTIVE ACTIONS

THE RISK CONTROL ACTION PLAN

CORRECTIVE ACTIONS
THE RISK CONTROL ACTION PLAN

IDENTIFY RECOMMENDATIONS AND CORRECTIVE ACTIONS

Your analysis of the adverse event will have identified a number of risk control measures that either failed or that could have interrupted the chain of events leading to the adverse event, if they had been in place. You should now draw up a list of all the alternative measures to prevent this, or similar, adverse events.

The first possibility to consider must always be whether the risk can be eliminated altogether, by avoiding or completely removing the risk source. If this is not reasonably practicable, then consider other options and risk minimisation and control measures.

Some of these measures will be more difficult to implement than others, but this must not influence their listing as recommendations. The time to consider these limitations is later when choosing and prioritising which measures to implement.

Evaluate each of the possible risk control measures on the basis of their ability to prevent recurrences and whether or not they can be successfully implemented.

In deciding which risk control measures to recommend and their priority, you should choose measures in the following order, where possible:

Measures which eliminate the risk, e.g. use 'inherently safe' products, such as a water-based product rather than a hydrocarbon-based solvent.

Measures which combat the risk at source, e.g. provision of guarding.

Measures which minimise the risk by relying on human behaviour, e.g. safe working procedures, the use of Personal Protective Equipment.

In general terms, measures that rely on engineering risk control measures are more reliable than those that rely on people. This is the concept of the '**safe place**' rather than the '**safe person**'.

CORRECTIVE ACTIONS
THE RISK CONTROL ACTION PLAN

DO SIMILAR RISKS EXIST ELSEWHERE?

IF SO, WHAT AND WHERE?

Having concluded your investigation of the adverse event, consider the wider implications:

Could the same thing happen elsewhere in the organisation, on this site or at another location?

What steps can be taken to avoid this?

Adverse events might not have occurred at other locations yet, but make an evaluation as to whether the risks are the same and the same or similar risk control measures are appropriate.

HAVE SIMILAR ADVERSE EVENTS HAPPENED BEFORE?

Give details.

If there have been similar adverse events in the past why have they been allowed to happen again?

The fact that such adverse events are still occurring should be a spur to ensure that action is taken quickly. You will be particularly open to criticism if you as an organisation ignore a series of similar incidents.

Remember that there is value in investigating near-misses and undesired circumstances: it is often only a matter of luck that such incidents do not result in serious injuries or loss of life.

THE ACTION PLAN AND ITS IMPLEMENTATION

Which risk control measures should be implemented in the short and long term?

THE RISK CONTROL ACTION PLANS

ICAM produces two separate but interlinked action plans: one to manage implementation of **immediate actions**, and another for **longer term actions**. Actions must be written as SMART objectives, i.e. Specific, Measurable, Agreed, and Realistic, with Time scales.

WHO TO INVOLVE

Deciding where and how to intervene requires a good knowledge of the organisation and the way it carries out its work. Management, safety professionals, employees and their representatives should all contribute to a constructive discussion on what should be in the action plans. At this stage in the investigation, senior management, who have the authority to make decisions and act on the recommendations of the investigation team, should also be involved. **Immediate actions will typically be owned by local or site management, while longer term actions will be owned by senior or corporate management.**

IMMEDIATE ACTIONS

These are actions needed to address the absent and failed defences identified. The following are critical questions to ask when developing an immediate action plan:

What is essential to securing the health and safety of the workforce today?

What cannot be left until another day?

How high is the risk to employees if this risk control measure is not implemented immediately?

If the risk is high, you should act immediately.

CORRECTIVE ACTIONS
THE RISK CONTROL ACTION PLAN

LONGER TERM ACTIONS

Longer term actions address the organisational factors identified as having contributed to the incident under investigation. They are learning and improvement opportunities at the systemic level within an organisation. While immediate actions are important for managing specific risks faced by workers, longer term actions are needed to manage high-level risks to the organisation.

INTERLINKING IMMEDIATE AND LONGER TERM ACTIONS

Immediate and longer term actions are interlinked, but must be designed to achieve very different outcomes. The following example illustrates this:

A leak developed in a piping system carrying a toxic substance. The findings of the investigation determined that the gaskets (made of material 'A') used in the piping system reacted with the toxic substance over a long period. The gradual breakdown of gasket material 'A' allowed the toxic material to leak.

Immediate action

Replace all gaskets with a type made of material that will not react with the toxic substance.

Longer term action

Redesign the organisation's procurement policy and processes to include risk management principles and practices, as well as practical tools such as hazard and operability studies.

The example presents an immediate action that will manage the operational risk of this specific toxic substance leaking again from similar gaskets in this plant. The longer term action is however designed to manage the wider organisational risk of under-specified or under-rated plant and equipment procurement.

CORRECTIVE ACTIONS
THE RISK CONTROL ACTION PLAN

ACTION PLAN MANAGEMENT

Each risk control measure should be assigned a timescale and a person made responsible for its implementation.

It is crucial that a specific person, preferably a director, partner or senior manager, is made responsible for ensuring that the action plan as a whole is put into effect. This person doesn't necessarily have to do the work themselves but they should monitor the progress of the risk control action plan.

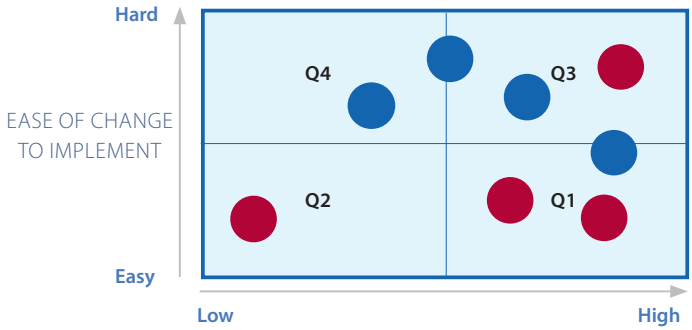
Progress on the action plan should be regularly reviewed. Any significant departures from the plan should be explained and risk control measures rescheduled, if appropriate. Employees and their representatives should be kept fully informed of the content of the risk control action plan and progress with its implementation.

WHICH RISK ASSESSMENTS AND SAFE WORKING PROCEDURES NEED TO BE REVIEWED AND UPDATED?

All relevant risk assessments and safe working procedures should be reviewed after an adverse event. The findings of your investigation should indicate areas of your risk assessments that need improving. It is important that you take a step back and ask what the findings of the investigation tell you about your risk assessments in general. Are they really suitable and sufficient?

COST BENEFIT ANALYSIS

Cost Benefit Analysis can be done using a payoff matrix used for determining corrective action priority. It is a systematic process for comparing Ease of Change (implementation) vs Degree of Payoff/Impact. Corrective actions that fall in Quadrant 1 should be completed first, then 2, 3 and 4.



Red = Absent/failed defence

Blue = Organisational factor

CONCLUDING THE INVESTIGATION

Not only must the investigation team possess the skills and training to initiate an investigation, they must also be aware of when the investigation is complete. The following guidance is provided:

✓	Review all documentation to ensure that it will support the corrective actions and exclude any issues that are not relevant to the investigation
✓	Determine if additional information or documentation is required. Review with other investigators (external and regulatory) the findings and conclusions and proposed corrective actions. Have answers to any issues they may present
✓	Review interview summaries to ensure that all issues have been addressed
✓	Ensure that those individuals who have been interviewed are able to provide answers to any outstanding issues for which information has not been provided
✓	Determine if the corrective actions can be made informally through a briefing or require a formal submission (report)
✓	Remember that proposed corrective actions should be feasible, realistic and will clearly remedy the deficiency
✓	Determine if there are any items that require follow-up, such as corrective action that management may have taken that will preclude formal recommendations
✓	Determine if identified deficiencies are isolated to that specific facility or part of a company-wide trend
✓	Develop a draft report of investigation and disseminate, for comment, to other parties to the investigation

INVESTIGATION REPORT

INTRODUCTION

The incident investigation is a closed loop process that consists of gathering information, evaluating and organising the information and formulating various hypotheses to explain how the incident occurred. This process continues until the team fully understands how and why the incident occurred and is satisfied that all significant discrepancies and inconsistencies are resolved. Once this process is complete, one or two members of the team are assigned to the first draft of the report.

GENERAL RECOMMENDATIONS

The following should be considered when preparing an investigation report:

✓	The report should be factual, concise and conclusive, avoiding emotive and counter-factual language
✓	Interpretations of findings should be based on the facts as identified during the investigation
✓	Unsubstantiated speculation should be avoided
✓	Assessment of contributing factors should be made based on an analysis of the findings
✓	Events or conditions that are major contributing factors to the incident should be clearly identified as such
✓	The report should be readable as a stand-alone document. References to other documents not open to inspection by others, i.e. the general public should be avoided
✓	Strict document control procedures should be in place and previous drafts of the report should be destroyed
✓	A reference to all documents and records relevant to the incident should be established

REPORT CONTENTS

1.0 EXECUTIVE SUMMARY

The Executive Summary is normally placed at the beginning of the report so that the findings are readily available to readers of the report, in particular those managers who will determine whether the recommendations are to be carried out.

2.0 EVENT NOTIFICATION

The main recorded facts of the incident, usually captured by the incident reporting system. This will typically include:

- Time, place and date of the incident
- An overview of the incident, including what happened and how
- Details of the injured person(s)
  - Status - employee, contractor or third party
  - Name, age, position held, time in the position
  - Length of service
  - Nationality and family status
- Details of injuries sustained
- Details of damage
  - Description of the extent of direct damage
  - Estimate of loss value
  - Estimate of consequential damage
- Initial corrective actions completed (if any)

3.0 INCIDENT DESCRIPTION

A statement of the facts immediately surrounding the incident, covering the period from the initiating events until the situation was under control and identifying, where possible, the sequence of events. In this context, maps, drawings or photographs should be used as illustration to support the narrative.

CORRECTIVE ACTIONS
THE INVESTIGATION REPORT

Items to include in the incident description:

- A short narrative which sets the scene of the incident
- Description of the operation in progress
- Events leading up to the incident
- Preparations made for the work (procedures, instructions, work permits, supervision etc)
- Personnel and equipment involved
- Environmental conditions
- Activities taking place at the scene of the incident
- Activities of key persons prior to the day of the incident that could have affected their actions
- Consequences (both actual and potential) of the incident, including harm to people, the environment, and business operation.

4.0 ANALYSIS

This section should demonstrate that the investigation was carried out in sufficient depth to support the conclusions that follow. It should include, where relevant, references to verifiable sources of data.

The report should make use of the ICAM chart to structure the analysis, including:

- Absent/failed defences
- Individual/team actions
- Task/environmental conditions
- Organisational factors

The report should also include a completed ICAM chart as a summary of the analysis.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The conclusions section should summarise and clarify the results of the analysis. It is a distillation of the key findings, the significant factors identified - those factors (failures, errors or omissions) that, if removed from the sequence would have prevented the occurrence. There should be no new material introduced in this section of the report. Every conclusion must be clearly stated, identified and supported within the analysis section. The investigation conclusions should permit the reader to arrive at, and agree with, the logical processes and results of the investigation.

The recommendations flow from the conclusions; for each conclusion there must be a logically argued and clearly presented recommendation on what must now be done to avoid a reoccurrence.

Conclusions and recommendations must:

- Be tested for logic, relevance and importance before inclusion
- Be listed in a chronological sequence
- Be clear and provide a brief explanation whenever conclusions cannot be made
- Clearly identify matters of safety and systemic issues, especially links to the erosion of safety standards, procedures and systems
- Address issues which might be refuted, controversial, ambiguous or speculative. These instances should provide clear statements and the source of expressions of opinion.

6.0 CORRECTIVE ACTIONS

This section presents an action plan which interprets the recommendations into specific, measurable, achievable, relevant and time-bound actions, which are assigned to individuals for action. Each action must also state how progress towards completion will be monitored, and how successful completion will be measured.

Corrective actions should identify corrective measures for as many of the listed causes as possible and may be related to:

- Eliminating the causes
- Minimising possible consequences
- Improving rescue or damage containment measures
- Emphasising that all causes identified should be eliminated
- Action parties and a time schedule for implementation should be identified.

7.0 MANAGEMENT REVIEW AND SIGN-OFF

Before the report is distributed, the appropriate level of management must review the investigation report for completeness, quality of the investigation and to endorse recommended corrective actions.

The report should then be signed off by an appropriate range of representatives from both management and employees.

This section should also include brief information under the following headings:

- Distribution
- Implementation of corrective actions
- Monitoring of implementation
- Analysis of effectiveness
- Document archival.

8.0 APPENDICES

For any other pertinent information considered necessary for the understanding of the report to include witness statements, photographs, maps and drawings to supplement and clarify the report.

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CORRECTIVE ACTIONS
MANAGEMENT REVIEW

MANAGEMENT REVIEW

It is best practice for an investigation report to be reviewed by someone in a suitable senior management position before final sign-off and general distribution. This person should have a general understanding of the investigation process and the ICAM method of analysis.

The purpose of the review is to check the investigation report for completeness, quality of analysis, and logic of key findings and corrective actions. The reviewer will either endorse the report or suggest changes. The review is best conducted as an open discussion between the reviewer and the investigation team.

The following table provides a guide for thorough review of an investigation report.

Report content	Standard expected
Key information	Accurate and complete facts, backed up with evidence, including date, time, location, people and equipment involved.
Incident description	Readable and logical narrative giving a detailed picture of what happened and how, including the sequence of events leading up to, during and immediately after the incident.
Consequences of the event	Thorough examination of actual and/or potential consequences of the incident, including impacts on people, the environment, and the business operation.
ICAM analysis - findings on causation	Every contributing factor is clearly stated and supported by evidence and logical argument. These include absent/failed defences, individual/team actions, and task and environmental conditions. Organisational factors identified as root causes are logical and clearly traceable as connected to the incident.
Conclusions and corrective actions	All contributing factors and root causes are addressed. Recommendations are effective in preventing a reoccurrence and based on the hierarchy of control measures. Cost-benefit and payoff is justified. Legal considerations are satisfied.

CORRECTIVE ACTIONS
IMPLEMENTATION AND FOLLOW UP

MANAGEMENT SUPPORT

Effective incident investigation requires strong management commitment and involvement. Management must support the investigation process and demonstrate this by acting on the results. Where corrective actions have been agreed and assigned it is the responsibility of those persons to complete the actions in the timeframe outlined.

Completion of each corrective action must be recorded and signed off by the appropriate person. Target dates must be realistic so that no excuses can be proffered in relation to non-completion.

It is ultimately the responsibility of the assigning manager to follow-up and ensure completion targets are met. They may also be the subject of discussion and follow-up by the site safety committee. Completion of all corrective actions should be communicated to all recipients of the investigation report and the workforce in general.

DISTRIBUTION

To maximise the preventative potential of the investigation, the findings and conclusions of the report should be distributed as widely as practicable internally within the organisation and externally to industry bodies.

IMPLEMENTATION OF CORRECTIVE ACTIONS

Corrective actions should be formally presented to the responsible line manager for implementation. An action plan and timeframe shall be agreed and endorsed by the appropriate level of management.

IMPLEMENTATION MONITORING

The completion of corrective actions must be documented and communicated by the highest levels of management. Where corrective actions have not been fully implemented, on-going monitoring should be maintained until implementation is complete.

EFFECTIVENESS ANALYSIS

The effectiveness of the corrective actions should be evaluated by a review of safety performance and through audit.

DOCUMENT ARCHIVAL

Investigation data and reports should be archived in accordance with company and regulatory guidelines.

GLOSSARY OF TERMS

The following definitions are relevant to this training manual:

ALARP

As Low As Reasonably Practicable

ABSENT/FAILED DEFENCES

The last line of defence stopping a hazard from causing harm (e.g. Personal Protective Equipment. These defences may be inadequate or missing altogether.

COMMON FACTORS

Workplace or human factors that can promote the occurrence of either errors or violations.

CONDITION AND CAUSAL FACTORS CHART

A sequencing methodology which combines a time line with question analysis (5 whys).

CONTRIBUTING FACTORS

Actions, inactions and conditions that are directly connected to the incident and if removed would affect the outcome of the incident.

CONSEQUENCES

The outcomes of an incident including injury, illness, damage to plant and equipment, environmental harm, business losses and more.

CONTINUAL IMPROVEMENT

The process of identifying and implementing opportunities for improvement, including monitoring the effectiveness of interventions.

CORRECTIVE ACTIONS

Actions to prevent the same or similar incidents from happening again.

DEFENCES

Information, knowledge, detection and warning systems, equipment, and work procedures which normally prevent harm from occurring or limit the consequences of an event.

GLOSSARY OF TERMS

ERROR FACTORS

Workplace or human factors that can increase the likelihood of human error.

ERROR TRAPPING

Control measures designed to contain predictable errors without consequence.

FACTS

Information that can be objectively measured, described and verified.

HAZARD

A potential source of harm - to people, the environment and/or the business operation.

HIERARCHY OF CONTROL

The preferred or legally prescribed order of priority given to hazard control measures.

HUMAN FACTORS

The study of human behaviour, abilities and limitations in relation to the operational environment.

HUMAN FAILURE TYPES

Slips, lapses, mistakes, and violations.

ICAM

Incident Cause Analysis Method - a systematic and objective incident investigation tool.

INDIVIDUAL AND TEAM ACTIONS

Actions taken by individuals and/or teams that contributed to the incident in some way.

LAPSE

A memory or attention failure resulting in missing out a required action.

GLOSSARY OF TERMS

LATENT CONDITIONS

In contrast to active failures, latent conditions are problems (incident root causes) which can lie dormant in an organisations for long time periods before combining with a number of contributing factors to cause an incident. Latent conditions may result in many different incidents over time unless corrected.

Failures in judgement, usually a result of applying a rule incorrectly to a situation, using the wrong rule, or due to a lack of relevant knowledge.

ORGANISATIONAL FACTORS

The management decisions and processes which create or influence an organisation's operational defences. They are often the 'root causes' of incidents, and in many cases are also 'latent conditions'.

RISK

The combination of the likelihood of occurrence of an incident and the severity and extent of the consequences.

SLIPS

Human error caused by an unintended and incidental action, despite the right intention or plan.

TASK/ENVIRONMENTAL CONDITIONS

Conditions which exist immediately before or at the time of an incident and that have a direct influence on human and equipment performance. They are the circumstances in which human failures occur and include task demands, the work environment, individual capabilities and human factors.

TIME LINES

A tool for arranging facts as a sequence of events in order to understand how an incident unfolded and what may have influenced events. Time lines are also useful for checking for gaps in data where no facts are known over a defined time period.

GLOSSARY OF TERMS

VIOLATIONS

The deliberate actions of people, which may or may not be motivated by good intentions. They can be further categorised into:

- Routine - where the violations are commonplace and have become implicitly accepted as part of normal activity
- Situational - when rules are broken due to specific task pressures, such as time pressure and lack of resources
- Exceptional - one-off violations which occur when something has gone wrong unexpectedly, or in emergency situations. To solve a new problem or deal with a situation, workers may decide to break a rule even though they are aware that there is risk involved.

VIOLATION FACTORS

Workplace or human factors which can promote or increase the likelihood of violations occurring.

WORKPLACE FACTORS

The workplace context in which identified errors and violations took place, such as time pressure, lack of training and knowledge, insufficient information, lack of authority, inadequate supervision, and poor physical working conditions.

APPENDIX 1

HUMAN FACTORS

ERROR FACTOR	DEFINITION
Attention capture	How and when attention is diverted away from a primary goal towards an irrelevant or unexpected event.
Memory failures	A momentary or longer-term inability to recall an item of experience or instruction from the long-term memory store.
Strong motor programmes	Concerned with the way in which our brains control our movements. When we do something in a certain way repeatedly in response to a stimulus or context it builds a strong motor response that can override other newer or less frequently used action sequences.
Perceptual set	This is the expectation of a person to see or perceive something based on prior experience.
False sensations	Sensation is the process where external stimulus is received by the sense and converted to a signal which the brain interprets. False sensations are incorrect interpretations of sensory input by the brain. An example is when you are sure you heard your phone ring or felt it vibrate but it didn't, or when pilots feel their aircraft is still climbing but they are actually flying straight.
False perceptions	Perception is the process in which we understand sensory information. We can misinterpret sensory information and perceive information incorrectly. An example is thinking that your phone is ringing but in reality it is someone else's phone.
Confirmation bias	A tendency for a person to search for information that confirms one's perceptions, and ignore information that contradicts it.
Situational bias	Tendency to focus on one thing (a particular part of a situation) to the exclusion of others.

APPENDIX 1

Incomplete knowledge	Not enough knowledge to be able to compile a complete mental picture, to fully understand a situation, to appreciate consequences, to make correct decisions etc.
Inference and reasoning	Inference is about logically drawing conclusions based on perceived data. We do this all the time, mostly automatically. Reasoning is the conscious application of thinking ability to a problem or some other subject.
Stress and fatigue	Stress is a collection of psychological, physical and social symptoms promoted by excessive pressure. Stress is experienced very differently by different people. Fatigue is related to physical and mental tiredness and lack of rest.
Disturbed sleep patterns	This can be connected to shift work and jet-lag, as well as stress, as well as disruptions (baby, car alarm).
Error proneness	Research suggests that people who are vulnerable to becoming stressed under pressure are also more likely to make errors.

VIOLATION FACTOR	DEFINITION
Age and gender	Younger males tend to be more likely to break rules.
High risk target	Researchers (e.g. Kahneman) have shown that when people are faced with high-risk decisions in difficult situations (where there is a high risk that things will end up going wrong) people tend to become more risk seeking in the hope of avoiding the loss. So when things look really bad, people will often try anything in an attempt to save the situation, even risky options.

APPENDIX 1

Risk and reward	These are decisions where a comparison of risk versus reward seems to indicate lesser risk and greater reward. The optimistic bias can influence decision-making here, with people tending to overestimate their chances of a positive outcome and underestimate the risk of the situation, relative to other people. *"I think I'm more likely to pull this off and get away with it than the average person."*
Violations normalised	Breaking a rule is the normal way to do the task for the individual or the peer group. This can indicate 'procedural drift' where rules governing work are no longer valid or are unworkable because of gradual incremental changes in the work environment and what is needed to get the job done. It can also occur when there is no sanction for rule-breaking, so people feel they can 'get away with it'.
Personality	Certain personality types are more likely to violate rules. A common example is the 'powerful' personality, who gains power through rule-breaking. These can be both social rules (e.g. politeness) and work rules *"the rules don't apply to me because I'm different; I have authority and special skills."*
Perceived behavioural control	This refers to people's perceptions of their ability (ease or difficulty) to perform a given behaviour. "I believe I can do it, and that it will work". It helps explain why there can be a big difference between intended/ planned actions and actual outcomes. *"I thought I would have no trouble balancing on the top of that ladder to do that job, and it was a big surprise when I lost my balance and fell."* Further reading see Icek Azjen.
Low morale	Violations can be more likely when there are problems to do with motivation (Reason, 1995). Lack of motivation is related to morale, mood, job satisfaction, attitude and self-esteem.
Bad mood	
Job dissatisfaction	
Attitude to the system	
Low self-esteem	

APPENDIX 1

Mis-perception of the hazard/risk	Simply an underestimation of the likelihood of something going wrong and the severity of the consequences, in relation to breaking a rule.
Learned helplessness	When people learn that attempts to change something are fruitless and they give up trying - "the energy and will to resolve problems drains away" Reason (1997).

COMMON FACTORS	DEFINITION
Lack of ability	Ability is the capacity to perform a task. Ability is a talent or quality that enables you to do something. Ability can be physical and mental.
Lack of skill	Skill is the learned capacity to perform a task effectively. Abilities must be developed to become skills.
Skill overcomes danger	A belief that high levels of skill are sufficient to overcome the vagaries of chance. In most situations, success depends on both skill and good fortune. People who are highly skilled can sometimes become over-confident and underestimate danger and the role of good/bad luck in outcomes.
Over-confidence	The overconfidence bias is the tendency of people to be more confident than is objectively justified by their abilities and characteristics. For example, most people believe that they are better than the average driver. But this is statistically impossible. Over-confidence can get people into difficult situations due to lack of care and careful thought – situations where they are out of their depth and therefore far more prone to errors and violations.
Unfamiliarity with task	When a task is new to us or is done infrequently, this can result in both errors (messing up, getting it wrong) and violations *"I'm not sure how to do it, so I'll just do it the way that looks best to me".*

APPENDIX 1

Poor judgement	The fact that people's intuitive decisions are often strongly and systematically biased has been firmly established over the past 50 years by literally hundreds of empirical studies. Psychologist Daniel Kahneman received the 2002 Nobel Prize in Economics for his work in this area. The conclusion reached by Kahneman and his colleagues is that people use unconscious shortcuts, termed heuristics, to help them make decisions. *"In general, these heuristics are useful, but sometimes they lead to severe and systematic errors".*
Performance anxiety	People can become anxious when they feel their performance is being critically monitored. This state of anxiety can have effects on cognitive and motor (physical) ability. Studies have shown that error rates increase with greater anxiety, but others have shown that anxiety can produce a state of heightened vigilance and improved ability to identify errors.
Time pressures	Under time pressure, performance degradation occurs in complex tasks due to the shortage of cognitive resources, thus leading to the adoption of simple strategies and increased performance errors. Zakey (1993). Essentially, under time pressure people feel they have less time to think, to check, and to generally be thorough and careful. This results in errors and violations through making mistakes, slips and lapses, and deliberately bending the rules and taking short-cuts. Other studies have shown that time pressure can exaggerate errors that tend to occur anyway without time pressure.

APPENDIX 1

Monotony/Boredom	Boredom is the aversive state that occurs when we (a) are not able to successfully engage attention with internal (e.g., thoughts or feelings) or external (e.g., environmental stimuli) information required for participating in satisfying activity, (b) are focused on the fact that we are not able to engage attention and participate in satisfying activity, and (c) attribute the cause of our aversive state to the environment. (Eastwood et. Al 2012) Essentially, boredom is about motivation to pay attention to something. Tasks which are monotonous and not interesting and engaging require a lot of cognitive effort and discipline from the operator to remain engaged and vigilant. People are much more likely to commit errors or to violate rules when asked to complete these types of tasks. Boredom is most dangerous when safety depends on constant vigilance.

APPENDIX 2

WORKPLACE FACTORS

ERROR FACTOR	DEFINITION
Change in routine	Departures from routine and changes in the circumstances in which actions are normally performed constitute a major factor in absent-minded slips of action. Slips and lapses occur during the largely automatic performance of some routine tasks, usually in familiar surroundings. They are almost invariably associated with some form of attentional capture, either distraction from the immediate surroundings or preoccupation with something in mind. They are also provoked by change, either in the current plan of action or in the immediate surroundings.
Negative transfer between tasks	Temporary cognitive or decision confusion caused by obstruction of or interference with new learning because of previous learning. For example, you've always driven cars with the indicator on the left of the steering column, but you're in a hire car with the indicator on the right. Unless you carefully concentrate, you will default to your learned pattern of behaviour when driving and turn on the wipers every time you wish to indicate.
Poor signal to noise ratio	When the level or intensity of a desired signal or message is weak or similar in comparison to the level of background noise, interference or distraction. An example is a workplace with lots of busy signage and visual messages – critical messages may get lost if they are also visual.
Poor human system interface	The human-system interface includes displays, controls, alarms, communication, workstations, software programs and many other related aspects. When these are not designed from an understanding of human factors and how humans work, then problems can and do arise.

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Designer/user mismatch	This occurs when the designer has a different world view to the end user, and the differences are reflected in the system and system interface. An example was the on-board flight computers installed into passenger airliners in the 70s and 80s – the designers worked in decimals but pilots use degrees. So a half a degree is understood as .3 by the user but indicated as .5 by the designer.
Educational mismatch	Both over and under-education can increase the chances of injury and error. The mechanism for over-education is related to boredom, and under-education is related to both knowledge and skills-based mistakes.
Hostile environment	Difficult working conditions make errors more probable. Working conditions can include the physical e.g. noise, lighting, temperature, humidity, exposure to weather, visibility etc. but also non-physical e.g. complicated devices, new 'unruly' technology, tight time schedules, information overload and other demands.
Domestic problems	Problems at home often impact on attention and concentration at work, resulting in the condition of 'presenteeism'. This can be a big problem when operators are asked to perform safety critical tasks which demand high levels of attention.
Poor communication	A very general category which includes a huge list of culprits. The basic closed-loop model of communication involving a sender and receiver connected by a message, a medium and a feedback loop is a good place to start to appreciate all the different ways in which communication can break down.

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Reliance on undocumented knowledge	Knowledge is more than data or information. It is the result of experience, ideas and memories, conclusions and understandings about how things work, about connections and relationships. It results in beliefs, expectations and predictions. Errors (in particular knowledge-based mistakes) are more likely when people are operating with inadequate or incomplete knowledge. While it is of course impossible to know everything there is to know about something, it is important to have enough knowledge to reasonably avoid known error-producing conditions. When knowledge remains undocumented, it is much more of a challenge to disseminate and discuss it.
Poor shift patterns and overtime working	This essentially results in fatigue and disruptions to the natural circadian cycle of the human body. It affects our ability to perform both physical and cognitive tasks effectively.

VIOLATION FACTOR	DEFINITION
Violations tolerated	When managers and supervisors 'turn a blind eye' to infringements and ignore violations, they are implicitly giving permission for these activities. *"The standard you get is what you are prepared to walk past".*
Compliance goes unrewarded	This is the other side of the coin to tolerating violations. When compliance consistently remains unrewarded and unacknowledged, this can send a message that it is not valued.
Procedures protect the system not the individual	Procedures can often be written in a way which results in the requirements of the 'system' i.e. work and how it is done being prioritised over the needs of individuals. A common example is seen in shift patterns, where the system design requires unsocial working hours.

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Little or no autonomy	Work autonomy is the degree to which employees feel they can make their own decisions and influence what happens on the job. It is closely linked to job satisfaction and morale, as well as stress. It influences violations in that when tasks are tightly bound by rules, but the situation changes, the individuals involved are pushed into committing violations in a bid to adapt to the new situation.
Macho culture	A macho culture encourages risk-taking behaviour and discourages diligence and care. It can also encourage violations as rule-breaking is a way of seeming more powerful.
Perceived licence to bend the rules	Similar to toleration of violations. Has to be balanced against individual autonomy.
Adversarial industrial climate	An 'us and them' culture where management and worker are in opposition and the relationship is antagonistic. Characterised by a lack of 'good faith', it can increase violations because rules are seen as mechanisms of unfair management control.
Low operator pay Low operator status	Similar to the effects of low morale, low self-esteem and low job dissatisfaction, but in this context they are elements of the workplace rather than human factors.
Unfair management sanctions	Can increase the likelihood of violations due to increasing tensions and lack of goodwill between management and workers.
Blame culture	As above, but a blame culture can also create a climate of deceit and dishonesty, where deliberate deviations from standard practice (violations), which would otherwise be openly discussed and evaluated, are instead covered up by workers. This can result in 'procedural drift': a gradual and undetected widening of the gap between formally accepted procedures, and what is actually done in practice to get the job done.

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Poor leadership example	Similar to toleration of violations, but perhaps more powerful. This is when managers and supervisors adopt a *'do as I say, not as I do'* approach.
Task allows for easy shortcuts	Task and equipment design which does not take well-known human factors research into account.

COMMON FACTORS	DEFINITION
Time shortage	Essentially, under time pressure people feel they have less time to think, to check, and to generally be thorough and careful. This results in errors and violations through making mistakes, slips and lapses, and deliberately bending the rules and taking short-cuts. Other studies have shown that time pressure can exaggerate errors that tend to occur anyway without time pressure.
Inadequate tools and equipment	Mistakes and rule-breaking can be more likely when people don't have the right tools and equipment at hand to do the job. For example, when the step-ladder is stored on the other side of the building and you need to get things from an above-head-height storage space every day, you are likely to use a chair instead.
Poor procedures and instructions	Similar to poor communication, but specifically related to written or verbal instruction on how to do a task.
Poor tasking	Tasking involves the design and allocation of roles, responsibilities and actions for on-going jobs or one-off tasks. Poor tasking, or poor task design, can lead to both errors and violations if people become over or under-burdened, if there are inadequate resources available, or if interactions between other responsibilities have not been taken into account.

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Inadequate training	When people are insufficiently trained for their work, there tends to be an increased chance of errors as they do not possess the skills, or understand the relevant rules, or possess adequate depth of knowledge. Violations are also more likely as people will deviate from required practice in an attempt to get by when they are not sure what to do.
Hazards not identified	Unidentified hazards become nasty surprises as tasks are completed. These will put pressure on operators and push them towards having to adjust under unexpected conditions. This can increase the chances of errors and violations.
Under-staffing	Understaffing is a resource scarcity which can drive people to be less thorough, to accept greater risks, and consequently to produce more errors and commit more violations.
Inadequate supervision	Supervision functions as a set of checks and balances against work practices drifting away from safer and more thorough execution and towards practices that reflect the competing drives of competitiveness, efficiency and profit. When supervision is poor or lacking, operators may suffer from lack of a 'wider' perspective and higher risks may be normalised. Errors and violations that may have been picked up by supervision and learned from are instead normalised.
Poor supervisor/worker ratio	Poor supervision ratios can result in the same issues as inadequate supervision.
Inadequate mix of experience and inexperience	An inadequate mix of experience and inexperience in a team could create conflict and dissention, distraction and pressures which in turn could influence the likelihood of errors and violations.

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Poor access to job	When the physical space the task is to be completed in is difficult to access (e.g. inside a confined space) then there can be an increased likelihood of both errors and violations. This may be due to psychological factors such as anxiety, and practical physical factors such as reduced space to move and adopt comfortable body postures.
Poor housekeeping	A cluttered, dirty environment can cause distraction and frustration which can in turn influence the likelihood of errors and violations.
Poor working conditions	Poor working conditions include environmental factors such as ambient temperature, radiated temperature, humidity, damp, ventilation, air quality, lighting levels, glare and reflections, noise, vibration, odours etc. These can cause distraction, frustration and fatigue, which in turn influence the chances of errors and violations.

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