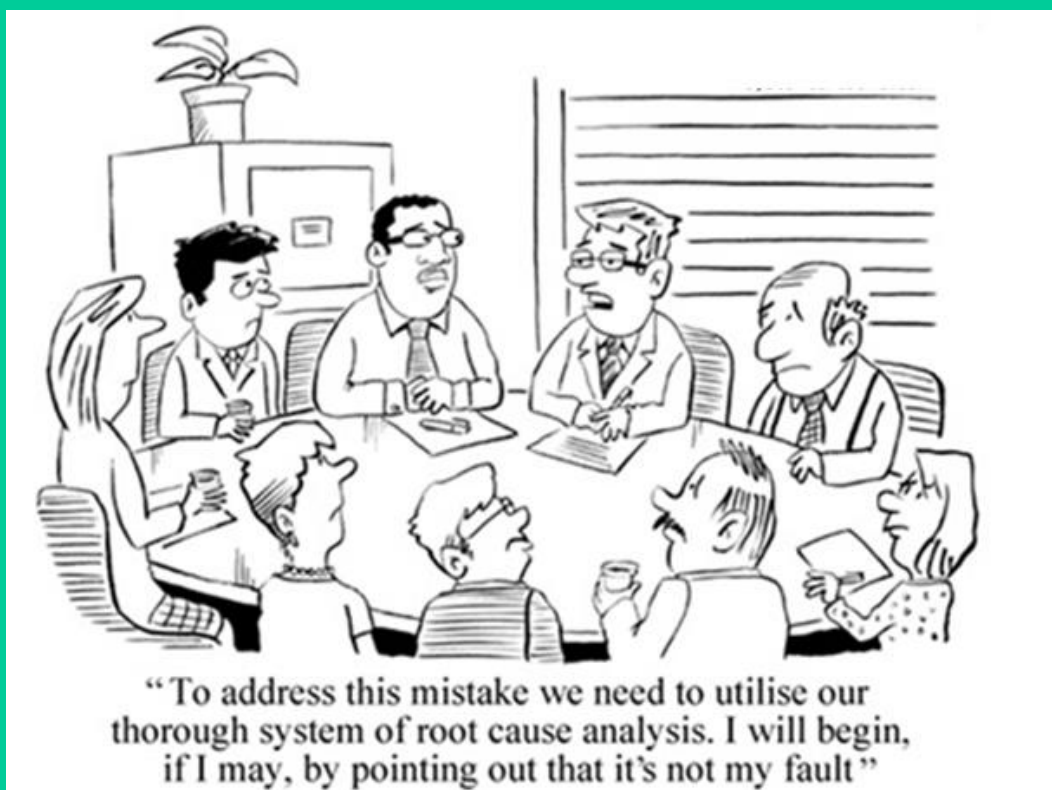


# Guidelines for investigation of logistics incidents and identifying root causes



ISSUE 1 - JULY 2015

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## DISCLAIMER

This document is intended for information only and sets out guidelines for investigation of logistics incidents and identifying root causes. The information provided in these guidelines is provided in good faith and, while it is accurate as far as the authors are aware, no representations or warranties are made with regards to its completeness. It is not intended to be a comprehensive guide for investigation of logistics incidents and identifying root causes. No responsibility will be assumed by the participating associations (Cefic, ECTA, Fecc) in relation to the information contained in these guidelines. Each company should decide based on their own decision-making process to apply the guidance contained in this document, in full, partly or to adopt other measures.

*The cartoon on the front page is used by courtesy of Royston Robertson.*

## Introduction

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An accident is a sudden event that is not planned or intended and that causes damage or injury. An incident is a sudden event that is not planned or intended and that causes damage or injury or has the potential to do so.

In this guideline both words are used interchangeably because the process to investigate and to take corrective actions is the same.

There exists plenty of guidance on how to investigate incidents. Most chemical companies have identified and developed their own standard method for investigating on-site events. There is however a need for industry guidance for the investigation of off-site logistics events, to assist Logistics Service Providers (LSP's) in carrying out incident investigations. The availability of industry guidance should promote more uniformity and provide a common methodology for LSP's independent of the customer. It will help both transport companies and chemical companies in continuously improving their safety performance by learning from incidents.

## Scope and objective

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This guideline focuses on the investigation of incidents and near incidents (near misses) that happen in the off-site transport and related handling of chemical products. It covers all modes of transport, loading/unloading and operations at terminals, warehouses and tank cleaning stations.

Most chemical manufacturers have identified their investigation method of choice for on-site events. They can, depending on the nature of the incident, decide to use their on-site incident investigation method for on-site logistics events or use the logistics-specific method described in this document.

The objective of this document is to provide guidance on how to carry out an incident investigation, identify the root causes and the corrective actions to prevent reoccurrence.

The guideline is aimed for use by all parties in the supply chain: chemical manufacturers, transport companies, distributors, storage companies, tank cleaning stations, etc.

## 1. Incident investigation

### 1.1 What is an incident investigation and root cause analysis

An **incident investigation** is a process conducted for the purpose of incident prevention which includes the gathering and analysis of information, drawing of conclusions, including determination of causes and, when appropriate, making of safety recommendations.

A **root cause analysis (RCA)** is a method that allows identification of the true causes of incidents, with the aim of preventing these root causes so that they are not repeated over and over again. It helps to move from goals to clear action plans.

The investigation of an incident should always include a root cause analysis.

### 1.2 Why perform an incident investigation and root cause analysis

There are a number of reasons why an incident investigation and root cause analysis is performed after an incident:

- Eliminating the root cause means stopping it from happening again
- It is a structured problem solving technique - an agreed approach that determines underlying causes
- It provides permanent solutions

It should also be:

- Part of the policy and goals of the organization
- A process to provide long term improvement
- A powerful vehicle for training people

The analysis of a root cause is a mind-set, it takes more time at first but is a 'high return on investment', eliminating on-going fire-fighting.

Applying the incident investigation process, including RCA, will structurally lead to an improvement cycle of a company's management system, processes and barriers used to manage its health, safety, security and environmental risks.



### 1.3 When to perform an incident investigation and root cause analysis

#### 2 days – 2 weeks rule

The root cause analysis needs to be initiated after no more than two days. The first hours will be used to perform the emergency response and to secure the incident location. Meanwhile the mind needs time to settle into a no-blame mode necessary for a successful incident investigation.

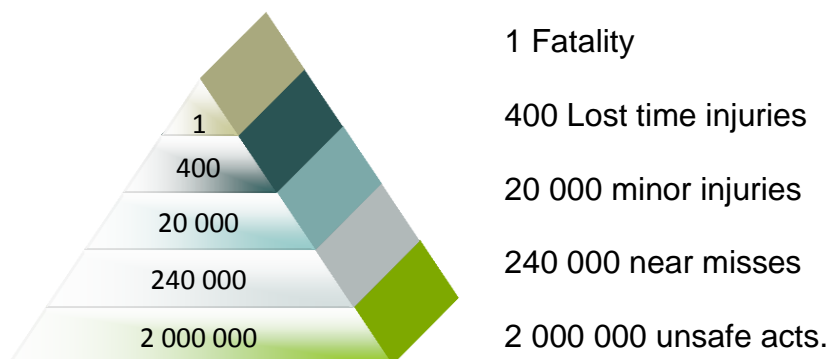
The incident investigation needs to be concluded and reported within 14 days. After 14 days the feedback becomes more guesswork than factual as witnesses will start forgetting important elements and will start 'remembering' things that are actually assumptions.

Each organization should have a clear policy as to which level of root cause analysis is needed depending on the severity of an event. This policy is related to the effects that an incident has for the company in question, like injuries, damage to the environment, material damage or damage to reputation.

The policy defining at which level a root cause analysis is performed should be part of the company's Safety Management System. A detailed RCA should not only be carried out for severe incidents, but also for 'high potential incidents' or 'high learning value incidents'.

### 1.4 Incident severity and categorization

According to the Pareto logic, incidents with increasing severity occur with decreasing frequency in a cascaded design.



Sources: Heinrich, HSE, John Ormond

The Pareto concept also recognizes that 20% of the incidents cause 80% of the damage. By combining those 2 concepts, incidents can be categorized in several classes. An example of categorization of severity could be:



- Major
- Moderate
- Minor
- Near misses
- Unsafe circumstances or acts

Incidents commonly cause more than one effect. One can group effects in categories such as:

- Human impact
- Environment impact
- Property and equipment loss.

In addition, incidents can result in effects such as:

- Financial impact to other parties
- Media attention
- Reputational damage
- Public disruption.

For each of the selected categories, clear definitions of severity need to be defined by the company.

High potential incidents are incidents which could have caused more severe consequences. These potential consequences are to be considered as well. Investigation of near misses is an obvious application of this principle.

More information can be found in different books and on the internet.

See for example the DuPont website (the real cost of safety):

[http://www2.dupont.com/Personal\\_Protection/en\\_GB/assets/PDF/MI/Kevlar%C2%AE%20Real%20Cost%20of%20Safety.pdf](http://www2.dupont.com/Personal_Protection/en_GB/assets/PDF/MI/Kevlar%C2%AE%20Real%20Cost%20of%20Safety.pdf)

## 2. The incident investigation process

When an incident occurs the first step should always be to mitigate the risk of consequential damage, but if possible also to secure the information from the incident as soon and completely as possible.

The second step is to inform the other parties involved in the operation related to the incident. In a logistics operation there is typically more than one company affected by the incident (e.g. the chemical supplier of the product, the customer, the sub-contractor in charge of the operation). The number of different companies that are involved can be a constraint to the incident investigation process. The process should be designed so that it leads to good learning from the incident for all the parties involved.

Based on the criteria defined by the company as described in section 1, it should be determined to what extent the incident needs to be investigated and analysed.

### 2.1 Parties involved

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In logistics incidents there is always more than one party involved. All of them need to be involved in the incident investigation or as a minimum be informed about the outcome.

The organization that is in control of the operation when the incident occurs is the party that should lead the incident investigation, unless otherwise agreed. For fatal incidents and for incidents on the public road, the authorities may carry out an official investigation. In this case all parties will be expected to cooperate in that investigation.

In case of an incident, any liability must be determined via the claims process. The claims process can negatively influence the incident investigation process because both processes have a different focus, possibly opposite to each other. Whereas the claims process is looking for the possibility to attribute liability and blame, the incident investigation process is aiming to prevent the incident from happening again and this goal can only be reached if the notion of blame is left aside.

The first step is to define which parties are involved in a particular incident, who is directly impacted and who needs to be informed. Parties should agree on a common description of the issue, agree upon the type of root cause analysis that needs to be conducted and who should undertake it.

A communication process between the different parties involved must be agreed upon along with the methodology of the incident investigation.

### 2.2 Setting up an incident investigation team

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Agreement on the incident investigation team composition is essential. A multifunctional team with appropriate skills and ownership should be convened. It can consist of a core team with additional supporting team members.

There must be an “owner” of the incident investigation process in the organization. The “owner” should ensure an effective team composition:

- Define who in the chain leads the incident investigation. The leader should be close to, but not part of the line of responsibility for the incident.
- Team members must be aligned to the business process.
- The resulting corrective actions should be discussed with the operational leader of the unit where the incident took place.
- Include a trained facilitator for the root cause analysis process independent and not involved in the incident itself.
- The incident investigation team members have to be sufficiently trained or guided through the process.
- People involved in the incident should never be part of the team but should be interviewed as part of the investigation process.

For small companies, fulfilling all the above requirements can be an issue. Depending on the severity of the incident, support could be sought from the consigning chemical company or from an independent external investigator.

There are different commercial training courses in the market for root cause analysis. Most of them are linked to a certain methodology.

Any root cause analysis method is based on the sequence of events leading up to the incident and should look at the facts and evidence in a structured manner. A distinction between direct causes and root causes should be made.

### 2.3 Description of the incident

A detailed description of the incident is essential to ensure a comprehensive analysis and to provide the basic input for the final documentation. The report model of RID/ADR section 1.8.5 can be used as guidance for that purpose.

The incident description should contain the following elements:

- When, where, what happened and who was involved:
  - affected operation
  - date/time and location of occurrence
  - environmental conditions such as topography and weather conditions
  - description of the incident as accurate and complete as possible, formulated in a way that it can be understood by anyone who is not involved: what occurred and the primary effect.
- Affected elements:
  - product involved and estimated quantity of loss of product
  - type and material of containment (steel tank, plastic drum, ...)
  - type of failure of the means of containment

- Consequences:
- personal injury
  - loss of product
  - material/environmental damage
  - evacuation of persons, closure of public roads
  - impact on production and supply performance (delay, customer satisfaction)

## 2.4 Gathering evidence and facts

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If it is safe and possible, the evidence should be gathered at the scene of the incident. Look for evidence in people, processes, paper and parts. When gathering evidence:

- Keep an open mind on all the potential activities, situations or circumstances that can lead to the effect without jumping to conclusions.
- Obtain a factual and as complete as possible description of the incident by gathering evidence.
- Record only facts, not opinions, and do this as soon as possible.
- People involved in the incident are a very important information source.
- Pictures are a helpful tool. Include CCTV and on board camera recording, if available.
- Make a drawing of the incident scene.
- Unusual or substandard information requires further investigation.

It is important not to allocate blame during the evidence gathering process in order to ensure that facts and real root cause(s) are identified.

## 2.5 Root cause analysis

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After the fact finding process, in which the investigator should refrain from 'jumping to conclusions', it is time for the actual analysis of the facts: the root cause analysis. It is important that this stage of the investigation is performed as a team effort. The team plays an important role and all core team members should be present to perform the incident investigation. The effectiveness of the preventive and corrective actions that will be decided upon will depend on this.

In the supply chain process multiple parties are involved and they are not always part of the investigation team. The investigation is performed on the process of the party carrying out the investigation. If during the investigation it is found out that information from another party is relevant for the investigation of the root cause, this should be reflected in the report without jumping to conclusions on the process of the other party involved. Support should be sought from the consignor or contract party for further investigation.

During the analysis, it is possible that not all evidence is available. In that case one should go back to the previous step (2.4 Gathering evidence and facts)

The analysis can lead to multiple causes, as well as 'contributing factors'. Ask the question: is it necessary and sufficient to contribute to the incident? All causes should be investigated up to a level where there is certainty that they are/are not contributing. In

this phase an open mind should be retained. When the process is finished, these events can be put into a schedule which can serve as reporting tool. It should result in the description of a chain of events that were necessary and sufficient to lead to the incident and the effects.

## **2.6 Corrective and preventive actions**

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When the root cause(s) are identified, corrective and/or preventive actions should be defined. The actions must be such that the root cause(s) are prevented from happening again. Once the corrective actions have been identified, an implementation plan should be established and communicated.

For examples of corrective and preventive actions see Section 4. The actions must be SMART (Specific, Measurable, Assignable, Realistic, Time-related) and reasonably practical to implement.

The effectiveness of the action should be reviewed within a defined timeframe after implementation.

## **2.7 Reporting an incident investigation to the parties involved**

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Intermediate, final and complete reports should be shared with the stakeholders. The report should be written such that it is easy to understand for a non-specialist or someone who was not involved in the incident investigation. The level of detail should be such that any common industry practice is sufficiently challenged.

It should offer a basis to improve the safety management of the organization. After the root cause investigation is completed, the risk assessment of the logistics processes should be reviewed to add the learning.

Legal departments should be consulted on which information can or cannot be shared with third parties. If an investigation is performed by the authorities this can also raise limitations on what can be reported.

A standardized reporting and documentation of the incidents and the related root causes is essential to facilitate a systematic analysis across incidents and to evaluate and cluster common causes.

The following reports should be issued:

- An immediate incident notification to the stakeholders
- An investigation report for the stakeholders
- A report for sharing the learning via Cefic (optional)

### **2.7.1 Immediate incident notification to the stakeholders**

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The immediate incident notification to the customer (chemical manufacturer) is usually a quick call which is followed up within 24 hours by the 'first incident report'. It is necessary to cover the following basic information about the incident (this applies both for dangerous and non-dangerous goods):

- Affected transport mode
- Date, time and location of occurrence
- Topography and particular weather conditions
- Short description of occurrence (5 to 10 lines of text)
- Product(s) involved
- Consequences, e.g. personal injury, loss of product and if appropriate the estimated quantity of spilled product, material/environmental damage, evacuation of persons, closure of public traffic routes

The format of the report might be specified by the charterer or the authorities. For dangerous goods the ADR/RID demands a report of the incident using a form as specified in section 1.8.5 which can also be used to report the incident to the chemical manufacturer (both for dangerous and non-dangerous goods incidents) in the absence of any prescribed reporting format.

### 2.7.2 Investigation report to the stakeholders

For the reporting of the root cause analysis and the applied corrective actions for risk mitigation, it is recommended to follow the structured approach as described in sections 3 and 4 of this Guidance.

It is recommended that the report is supported by pictures and drawings and to present the different kind of causes as well as other contributing factors.

The report can be used to share the findings with the stakeholders. The format to present findings and conclusions from the report should be adapted to the audience.

The content of the report should include:

- a) The updated information included in the immediate incident notification to the stakeholder
- b) Immediate actions
- c) Impact of the incident (see section 1.4)
- d) For high potential incidents: description of potential consequences
- e) Chronology and description of events, circumstances and facts with clarifying illustrations (pictures, plans, drawings)
- f) Root cause analysis: clarifying all elements that were both necessary and sufficient for this incident to occur (see section 2.5)
- g) Corrective actions and action plan

### 2.7.3 Reporting of learning to Cefic

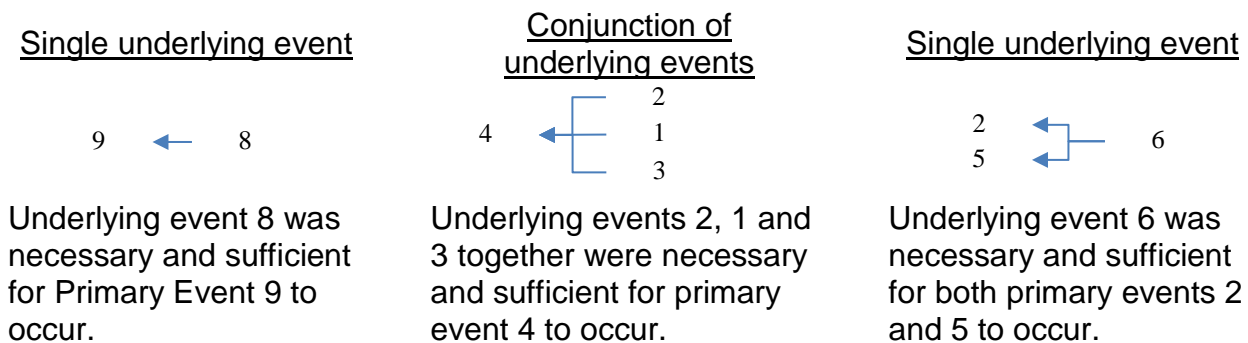
The chemical company should report the incident to Cefic using the format included in the Cefic website.

### 3. The root cause analysis method for logistics operations

The RCA requires a sequence of steps to identify the causes to avoid the recurrence of the incident. Examples illustrating the use of the method are included in section 5.

The following steps should be followed:

- a) An incident could be the result of more than one event. In order to identify the immediate/direct causes and the basic/root causes it is recommended to first build an event tree. The investigation team identifies whether one or more underlying events triggered the primary event being analysed. The underlying event is plotted in connection with the primary event. If there is more than a single underlying event, a conjunction of underlying events is plotted in connection with the primary event. The events should be chosen using the list of section 3.1.



- b) Each event should be investigated using a separate tree. Each tree identifies relevant causes as listed in 3.2, by answering the following questions:

- What was needed for that event to happen?
- Was it necessary?
- Was it sufficient?

The choices made should be supported by evidence that has been gathered according to section 2.4.

- c) To find the root causes it is necessary to dig deeper. For each direct cause go to the basic/root causes list (see section 3.3). The investigation team should identify at least one of these causes as the root cause of the incident, by asking the following questions:

- What was needed for that immediate cause to happen?
- Was it necessary?
- Was it sufficient?

The choices made should be supported by evidence that has been gathered according to section 2.4.



- d) Corrective actions on organizational causes: go to the list in 4.2 and select the action(s) that correct(s) the basic/root cause(s) identified in the previous step
- e) Corrective actions on human causes: go to section 4.3.

### 3.1 Type of events

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- 3.1.1 Person / object caught between/in/on
- 3.1.2 Collision of persons / equipment
- 3.1.3 Human exposure to (electricity, heat, cold, chemicals, etc.)
- 3.1.4 Container / tank implosion
- 3.1.5 Equipment failure
- 3.1.6 Explosion
- 3.1.7 Fall from height
- 3.1.8 Fire
- 3.1.9 Leaving the road / derailment
- 3.1.10 Loss of containment (leaks, spills, etc.)
- 3.1.11 Overfilling / overflowing of tanks
- 3.1.12 Overturning / Roll over / Tipping over
- 3.1.13 Slip and fall / trip over
- 3.1.14 Struck against / by / into
- 3.1.15 Unintended mixture (for example (un)loading in the wrong tank)
- 3.1.16 Chemical reaction
- 3.1.17 Object falling off
- 3.1.18 Unintended moving of cargo

## 3.2 Immediate/direct causes

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- 3.2.1 Non-standard operation
- 3.2.2 Weather conditions
- 3.2.3 Equipment / material failure
- 3.2.4 Instrument failure
- 3.2.5 Instrument not calibrated
- 3.2.6 Failing to use PPE properly
- 3.2.7 Too high speed
- 3.2.8 Inappropriate loading of truck (overweight / underweight / uneven load distribution)
- 3.2.9 Incorrect (un) loading
- 3.2.10 Incorrect lifting
- 3.2.11 Incorrect position for task
- 3.2.12 Incorrect cargo securing
- 3.2.13 Incorrect storage / placement
- 3.2.14 Lack of coordination between operator and driver
- 3.2.15 Lack of instrument
- 3.2.16 No warning
- 3.2.17 Non-compliant documentation
- 3.2.18 Non-compliance with legislation
- 3.2.19 Non-compliance with site rules
- 3.2.20 Physical obstacle
- 3.2.21 Operating equipment without permission
- 3.2.22 Human failure (operator and/or driver)
- 3.2.23 Overriding safety devices
- 3.2.24 Using defective equipment
- 3.2.25 Improper route

### 3.3 Basic/root causes

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#### 3.3.1 Organisational causes

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##### 3.3.1.1 Inadequate training / coaching programme

- i) Inadequate communication (omission / misunderstanding / wrong information)
- ii) Inadequate guidance / supervision / monitoring / coaching
- iii) Inadequate / lack of training (driver not familiar with load / route, inadequate skills, lack of knowledge, etc.)
- iv) No BBS programme (including defensive driving / roll-over prevention)

##### 3.3.1.2 Inappropriate (use of) procedures/processes

- i) No/incomplete or incorrect risk analysis
- ii) No/inadequate procedure
- iii) Task design inadequate (competence requirements not well defined, responsibility not clear, repetitive tasks, excessive length of shift, etc.)
- iv) Corrective action not implemented
- v) Procurement process failure (inadequate specifications, inadequate receiving/inspection, inadequate contractor selection)
- vi) Quality assurance / quality control failure

##### 3.3.1.3 Incorrect contractor management

- i) Inappropriate selection process
- ii) Inadequate definition or communication of requirement
- iii) Inadequate monitoring and reviewing of requirements

##### 3.3.1.4 Inadequate fitness to work

- i) Inadequate physical / mental condition, sick, misuse of drugs, fatigue

##### 3.3.1.5 Incompatible goals

- i) Task planning inadequate
- ii) Work pressure too high

##### 3.3.1.6 Incomplete Management of Change (MOC)

- i) Inadequate MOC

##### 3.3.1.7 Inadequate design

- i) Design failure / weak design

##### 3.3.1.8 Inadequate equipment

- i) Deficient construction / fabrication / installation

##### 3.3.1.9 Work environment inadequate

- i) Defective housekeeping, inadequate lighting, excessive noise, etc.
- ii) Workplace layout inadequate

### 3.3.1.10 Inadequate maintenance / inspection / testing

## 3.3.2 Human causes

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### 3.3.2.1 Intentional behaviour

- i) Wrong attitude (not respecting safety rules, horseplay, etc.)
- ii) Cutting corners

### 3.3.2.2 Unintentional behaviour – human error

- i) Did not see, hear ...
- ii) Forgot to do, ask, check
- iii) Poor or wrong judgement (thought this was Ok)
- iv) Wrong action

## 4. Corrective Actions

### 4.1 Introduction

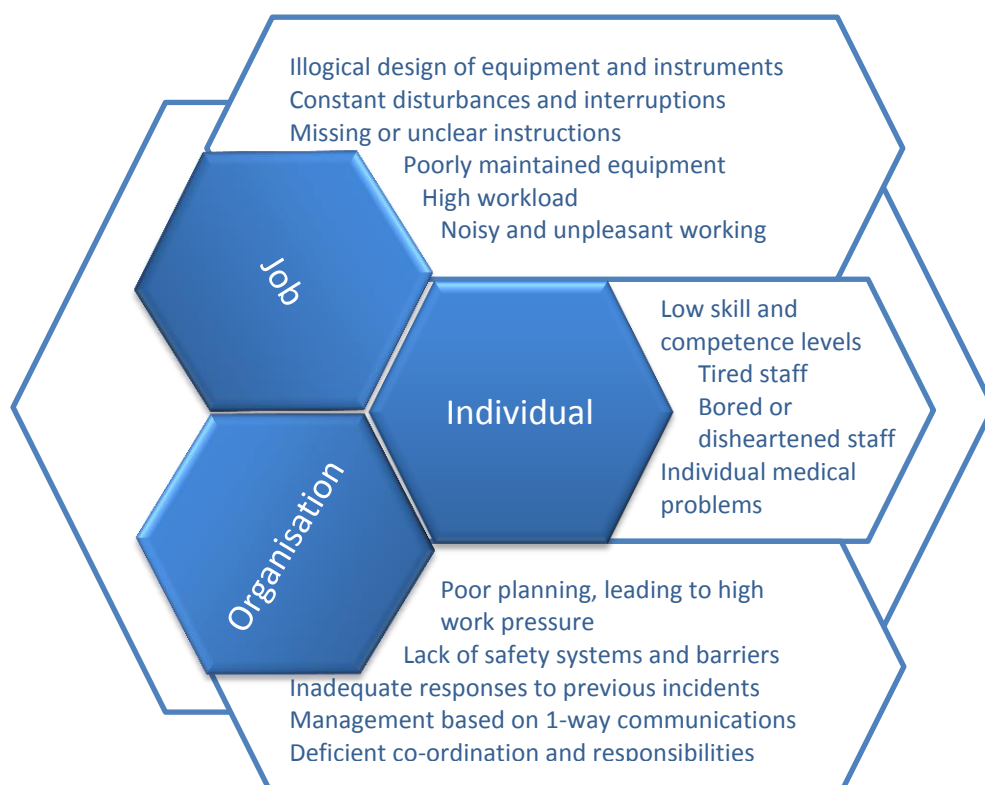
The identification of the event and the root cause can be used for learning, but corrective and preventive actions must be implemented in order to prevent re-occurrence.

When corrective and preventive actions are in engineering, the solution is straightforward and often implemented by the time the root cause investigation is done. Ask yourself why the organization did not fix this engineering problem before the incident occurred? You will often find an organizational cause behind it.

Through a failure a person can directly cause an incident. However, people tend not to make errors deliberately. We are often 'set up to fail' by the way our brain processes information, by our training, through the design of equipment and procedures and even through the culture of the organisation we work for.

Human factors refer to environmental, organisational and job factors, and human and individual characteristics which influence behaviour at work in a way which can affect health and safety.

A simple way to view human factors is to think about three aspects – the job, the individual and the organisation – and how they impact people's health and safety-related behaviour.



1. Matching the job to the person will ensure that employees are not overloaded and contribute most effectively to the business results. It includes the design of the workplace and working environment, information- and decision-making requirements, as well as perception of the tasks and risks.
2. People bring to their job personal attitudes, skills, habits and personalities (both strengths and weaknesses). Individual characteristics influence behaviour in complex and significant ways.
3. Organisational factors have the greatest influence on individual and group behaviour, yet they are often overlooked during the design of work and during investigation of incidents. Organisations need to establish their own safety culture promoting involvement and commitment and emphasising that deviation from safety standards is not accepted.

Careful consideration of human factors at work can reduce the number and severity of incidents and can also pay dividends in terms of a more efficient and effective workforce.

When the identified cause of the incident is **organizational**, use the list in section 4.2 as a reminder.

If the cause is **human failure**, no list can capture the type of analysis required. Therefore it is necessary to analyse the human error and define the corrective actions as described in section 4.3.

## 4.2 Corrective actions on organizational causes:

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- 4.2.1 Implement HSE management systems
- 4.2.2 Improve visible and felt (senior) management commitment to HSE
- 4.2.3 Carry out risk analysis and implement mitigation measures accordingly.  
See examples below of mitigation measures:
  - 4.2.3.1 BBS training/refreshing training
  - 4.2.3.2 Fatigue risk management
  - 4.2.3.3 Installation of interlock systems to avoid human error
  - 4.2.3.4 Near-misses and unsafe acts and conditions reporting
  - 4.2.3.5 Preventive maintenance
  - 4.2.3.6 Road information systems
  - 4.2.3.7 Route familiarization training
  - 4.2.3.8 Subcontractors selection (for example through SQAS) and follow up of gaps and performance issues
  - 4.2.3.9 Task analysis
  - 4.2.3.10 Investigate if working at height can be avoided or provide fall protection
  - 4.2.3.11 Improve lighting
- 4.2.4 Clarify responsibilities
- 4.2.5 Define/implement/improve procedures
- 4.2.6 Implement Management of Change
- 4.2.7 Improved engineering
- 4.2.8 Follow up of corrective actions from previous incident

- 4.2.9 Implement work permit systems (entry into confined spaces, working at height, hot work, breaking of containment, working with electrical equipment, etc.)
- 4.2.10 Improve communication
- 4.2.11 Improve housekeeping
- 4.2.12 Improve competence requirement definition
- 4.2.13 Provide training / refresher training (detect training needs, provide training, evaluate effectiveness)
- 4.2.14 Improve recruitment procedure (jobs description, pre-employment checks, induction training)
- 4.2.15 Improve route selection
- 4.2.16 Install technology upgrades on trucks (truck overturning warning systems, forward distance alert system, lane departure system, etc.)
- 4.2.17 Promote safety by incentives (bulletin boards, individual / group awards and recognition)
- 4.2.18 Initiate improvements with external sites: (un)loading, cleaning stations, terminals, etc.
- 4.2.19 Improve site design

#### 4.3 Corrective actions on human causes

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Historical data suggest that in many cases the root cause analysis will eventually point to individual human failure, even more so in logistics than in manufacturing as the work processes are more labour intensive.

Where human failure is identified as root cause, dismissal or re-training are the usual corrective actions. This typical but often short-sighted response ignores the fundamental failures which led to the incident.

In this section, rather than giving a list of common corrective actions, a classification of human failures is provided together with an approach to establish corrective actions.

Human failure could be classified under two categories:

- Intentional behaviour: the behaviour of the person (but not the result of the action) was intentional. This kind of behaviour is also known as violation
- Unintentional behaviour: the person made an unintentional mistake

A specific behaviour can be identified as intentional if:

- The person announced his/her intention to behave in that way, prior to the behaviour
- It can be demonstrated that the person knew what should be done
- The behaviour led to some positive consequences for him/her
- He/she intended the behaviour (not the effect of course!)

A specific behaviour can be identified as unintentional if:

- The person can explain how the error occurred, but not why – he / she is puzzled by his / her own action
- Colleagues have done similar things unintentionally
- During the interview the person still doesn't understand why he / she made that mistake

There is no standardised method to deal with human failure.

For behaviours where actions (not the result of the action) were intentional, disciplinary action might be appropriate, depending on whether the violation is judged reasonable. The potential role of the manager of the person who made the error should also be considered.

For unintentional human behaviour, disciplinary action is ineffective as indeed the behaviour was not intended.

Training is just one possible corrective action of a myriad that can successfully avoid reoccurrence of human failures. Before considering training, it is recommended to review the list of organizational corrective actions listed in section 4.2.

## 5. Examples

### 5.1 Example 1

#### 5.1.1 Incident description



Whilst exiting a parking zone of a cleaning station, the driver had to turn right onto the road. The turn was taken too sharply and the rear wheels passed onto the grass verge. The wheels slid and drove down the banking, leading to the tip and roll-over of the vehicle.

#### 5.1.2 Facts gathering

1. This was the first time the driver visited this cleaning station. The driver used a gate/road he/she was unfamiliar with
2. The incident happened during the dawn. The visibility was reduced
3. The turn was to the right and the driver sat on the left
4. The driver misjudged the road corner
5. The driver was not injured and there was no leakage
6. The driver had loaded at another site the evening before and stayed overnight on the parking of the cleaning facility
7. There were more drivers leaving through the same gate, but these vehicles were empty (cleaned)
8. There were tyre marks on the grass
9. Interviews were held with relevant people. The outcome was the following:
  - a) Driver: "Thought it was ok, there was someone leaving just before me taking the same turn. This was the most obvious way to leave, because it was in the direction I had to go and there were no signs to warn about soft sides off the road"
  - b) Planner: "We often send drivers to that cleaning facility to clean or to park a loaded vehicle"
  - c) SSHEQ manager of the transport company: "I visited that facility to inspect the cleaning station but I did not inspect the parking place and exit"
  - d) Site manager: "We have an operational permit, including the parking entrances and exits"

- e) Municipality representative: “Yes, we issued the operational permit. We do not have to check the design of entrances and exits”

#### 5.1.3 Incident categorization (see section 1.4)

Impact category: damage to transport vehicle, loss of product

Severity category: major

#### 5.1.4 Type of events (see section 3.1)

3.1.9 Leaving the road. This is the main event to be investigated

3.1.12 Roll-over. This is the consequence of the vehicle leaving the road

#### 5.1.5 Immediate/direct causes (see section 3.2)

3.2.1 Non-standard operation: the parking is normally not used for loaded vehicles

3.2.16 No warning: there is no sign or other warning that the exit should not be used to turn right

3.2.22 Human failure: the driver followed the example of drivers of empty trucks. The driver could have stopped to assess the sharp turn

#### 5.1.6 Basic/root causes (see section 3.3)

##### **Organisational causes**

3.3.1.2 i) Incomplete risk analysis: the transport company did not inspect the site for parking of loaded trucks. The cleaning station did not assess the exit of the parking area. Inadequate routing on the site

3.3.1.7 i) Inadequate design: the design of the exit was not adequate. There were no warning signs that vehicles should not turn right

3.3.1.9 i) Work environment inadequate: inadequate lighting of the parking exit

##### **Human causes**

3.3.2.2 iii) Unintentional behaviour. Poor judgment: The driver decided to try the sharp turn, following the example of other drivers

During the analysis the investigation team wondered if it was possible to turn right safely and decided to go to the site to gather more evidence. The team concluded that it is not possible to turn right safely: the driver made an unintentional human error.

#### 5.1.7 Check: was it necessary / was it sufficient?

Were all root causes necessary and sufficient?

Necessary: yes, if any of them have not been happened the incident would have not led to a roll-over.

Sufficient: yes, the combination of these causes will result in a repetition of the incident.

#### 5.1.8 Corrective Actions (see section 4)

There are two parties involved that should take corrective actions to prevent future incidents: the cleaning site and the transport company.

##### **Actions for the cleaning site:**

4.2.3 Carry out risk analysis and implement mitigating measures accordingly

4.2.3.4 Introduce a “near-miss and unsafe acts and conditions reporting system” at the cleaning site (other drivers used this exit before)

4.2.3.6 Road information systems (close the exit or clearly indicate that vehicles are not allowed to turn right)

4.2.3.11 Improve lighting

4.2.19 Improve design of site exit

##### **Actions for the transport company:**

4.2.3 Carry out risk analysis and implement mitigation measures accordingly

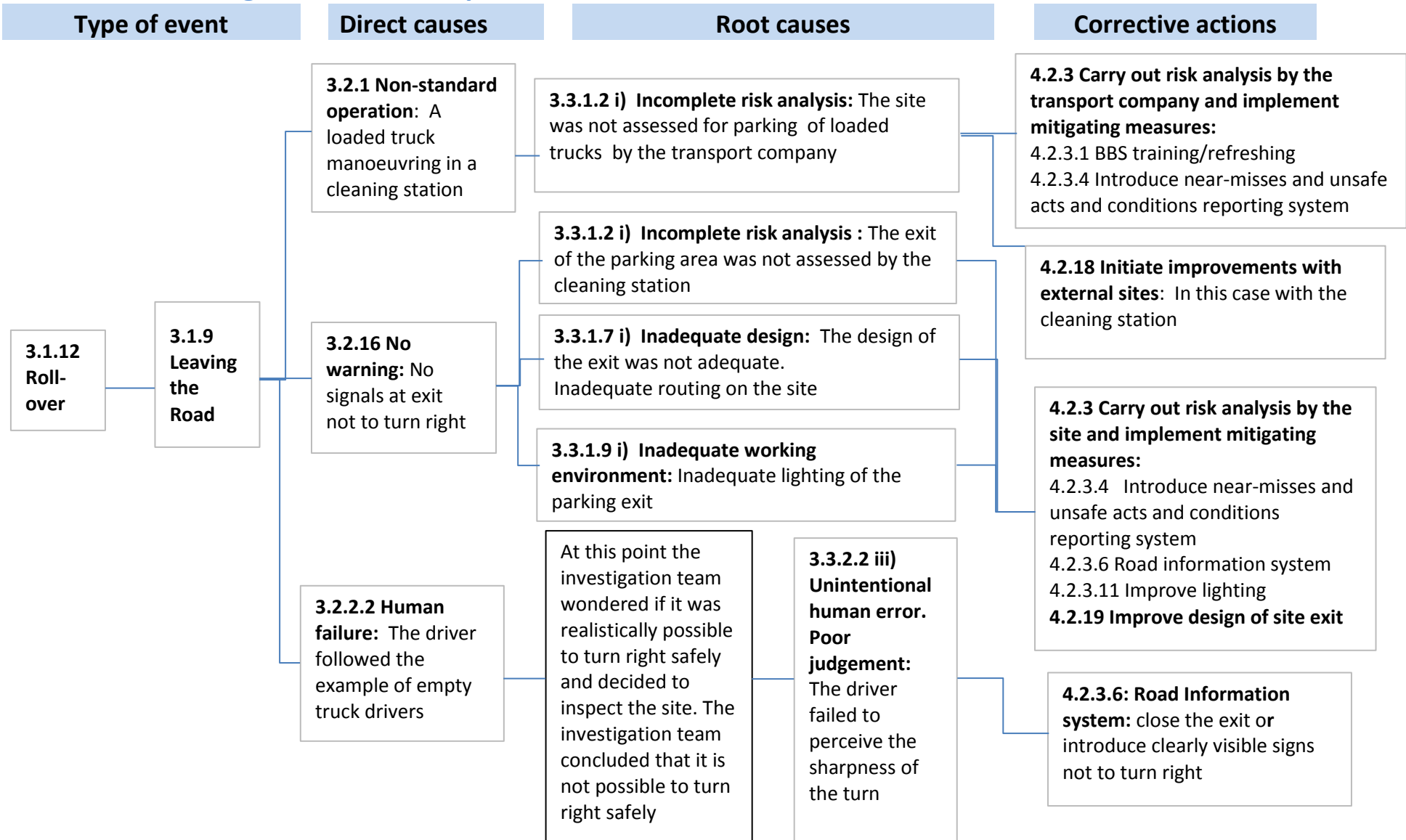
4.2.3.1 BBS training/refresher training

4.2.3.4 Introduce a “near misses and unsafe acts and conditions reporting system” in the transport company (other drivers used this exit before)

4.2.18 Initiate improvements with external sites (in this case the cleaning station)

Human behaviour: the analysis of the human behaviour shows that the driver did not make this mistake intentionally. The analysis demonstrates that similar incidents could be prevented by the corrective actions from the site.

## Accident Investigation Tree example 1



## 5.2 Example 2

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### 5.2.1 Incident Description

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At about 10:00 in the morning on the main road to the town a truck missed a bend and ended up in a ditch on the other side of the road. The truck was transporting bags with chemicals which were spread over the road. The authorities had to close the road for further traffic. Towing the truck and clean-up of the road took till 20:00 before the authorities could open the road for traffic again. Despite the traffic at the moment of the accident, no other cars were involved and nobody was injured. However the truck was total loss. The customer did not receive the replacement goods in time.

### 5.2.2 Facts gathering

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1. The road was wet and slippery
2. The accident happened during stormy weather
3. Long brake traces on the road indicated that speed was not adapted to the road and weather conditions
4. The driver was the transport company's maintenance technician
5. The driver planned for this transport didn't show up and reported sick later in the morning
6. All available drivers were already occupied on other transports for other customers.
7. The transport company's maintenance technician has a truck driver's license but has little mileage or experience
8. The transport company's manager had called the transport company's operational planner the evening before and had told him that this transport had to take place without delay
9. The chemical company's manager had met a few days before with the haulage company's manager and had requested him to ensure that this new delivery location would be served promptly

### 5.2.3 Incident categorization (see section 1.4)

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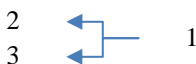
Impact category: loss of transport vehicle and product

Severity category: major

### 5.2.4 Type of events (see section 3.1)

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Several linked events took place.



1. The truck missed a bend, ended up in a ditch and overturned
2. The truck's cargo of packed dry chemicals fell off the truck and was spread over the road
3. The road remained closed for traffic for a full day to tow the truck and to clear the road

- 3.1.9 Leaving the road (1)
- 3.1.12 Overturning (1)
- 3.1.10 Loss of Containment (2)
- 3.1.17 Object falling off (2)
- 3.1.18 Unintended moving of cargo (2)

#### **5.2.5 Immediate/direct causes (see section 3.2)**

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- 3.2.2 Weather conditions: stormy weather, slippery road
- 3.2.7 Too high speed: long brake traces indicated that speed was not adapted to road conditions.

#### **5.2.6 Basic/root causes (see section 3.3)**

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##### **Organisational causes**

3.3.1.2.i No/incomplete risk analysis. The planner selected a driver with low experience. Was the driver aware of the risks during this trip? Further investigation is needed

3.3.1.1.iii Inadequate/lack of training. The driver had little mileage or experience. The team did not follow this through since the technician was not supposed to be trained as a driver. This is an organisational opportunity but outside the scope of this incident investigation

3.3.1.1.iv No BBS programme. The company did not include the technician in the BBS program because he is not supposed to be a driver

3.3.1.2.iii Task design inadequate: All drivers were occupied

3.3.1 5.i Incompatible goals. Task planning inadequate

The chemical company's manager had met a few days before with the transport company's manager and had requested him to ensure that this new delivery location would be served promptly. The transport company's manager had called the transport company's operational planner the night before and told him that this transport had to take place without delay. The driver planned for this transport didn't show up and reported sick later in the morning. All available drivers were already occupied on other transports for other customers. There was no back-up plan for unforeseen events (illness of driver). If no back-up is possible because of the limited number of available drivers, the transport company should not accept urgent (JIT) orders

3.3.1.5 ii) Incompatible goals. Work pressure too high: The planner was told that the load had to be delivered without delay

### **Human causes**

3.3.2.1. ii) Intentional behaviour. Cutting corners: The planner selected a maintenance technician with low experience

3.3.2 2.iii Unintentional behaviour. Poor or wrong judgment. No proof but driver was probably driving too fast for the conditions, not likely to be on purpose. This is dead end; it is not expected that the technician needs to be trained as a driver

### **5.2.7 Check: was it necessary / was it sufficient?**

Were all causes necessary and sufficient?

Necessary: Yes, if any of them had not happened the incident would have not led to the incident.

Sufficient: Yes, a combination of all these causes will result in a repetition of the incident.

### **5.2.8 Areas for corrective actions (see section 4.1)**

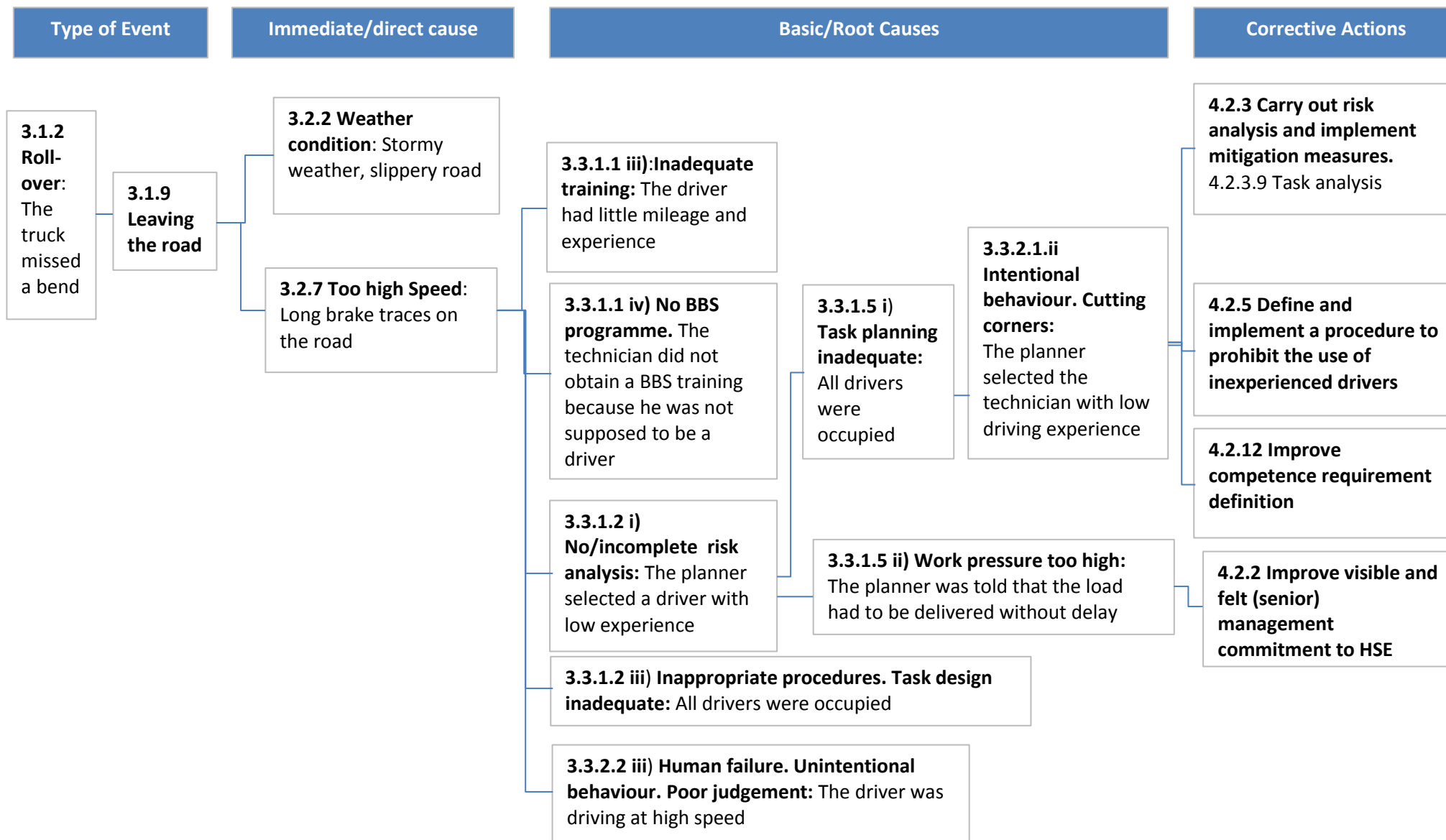
4.2.2 Improve visible and felt (senior) management commitment to HSE

4.2.3 Carry out risk analysis and implement mitigation measures accordingly. A driver with little mileage or experience was selected for the task. The risk analysis was not properly carried out

4.2.5 Define and implement a procedure to prohibit the use of inexperienced drivers

4.2.12 Improve definition of competence requirement

## Accident Investigation Tree Example 2





## Contact list



**Maayke Van Noort**  
ES&S Transportation Manager Benelux  
Dow Benelux BV  
T +31 115 671 334  
mjvannoort@dow.com



**Marc Cabuy**  
EMEAF Liquids Logistics SSHE Advisor  
ExxonMobil Chemical  
T +32 2 722 4063  
marc.cabuy@exxonmobil.com



**Leo Rupert**  
Global HSSE Advisor  
Shell Chemicals Europe B.V.  
Tel +31 10 4416292  
M +31 6 25017275  
[leo.rupert@shell.com](mailto:leo.rupert@shell.com)



**Alain Delzenne**  
SOLVAY SA - Industrial Function / HSE  
Corporate Transport Safety Manager  
T +32 2 264 2767  
M +32 475 55 47 12  
[alain.delzenne@solvay.com](mailto:alain.delzenne@solvay.com)



**Jan Hendrik Leopold**  
SSHEQ Manager  
R.M.I. Global Logistics Services  
T +31 10 283 11 00  
[janhendrik.leopold@nl.rmi-global.com](mailto:janhendrik.leopold@nl.rmi-global.com)



**Steve Rowland**  
SHEQ Manager, UK, Europe and Americas  
Suttons Transport Group  
T +44 151 420 2020  
M +44 7713 230 047  
[stephen.rowland@suttonsgroup.com](mailto:stephen.rowland@suttonsgroup.com)



**Gernot Knoth**  
Transport Safety  
BASF SE  
T +49 621 60-71797  
[gernot.knoth@basf.com](mailto:gernot.knoth@basf.com)



**Thorsten Bauer**  
Evonik Industries AG  
Logistics Manager  
Logistics Safety  
T +49 2365 49-19470  
[thorsten.bauer@evonik.com](mailto:thorsten.bauer@evonik.com)



**Patrick De Block**  
Business SHE Manager  
INEOS Oxide  
T +32-3-250 9005  
[patrick.de.block@ineos.com](mailto:patrick.de.block@ineos.com)



**Victor Trapani**  
SQAS Manager  
Cefic  
T +32 2676 7385  
M +32 499 580 610  
[vtr@cefic.be](mailto:vtr@cefic.be)



**Peter Newport**  
CEO Chemical Business Association  
T +44 1270 258200  
[peter.newport@chemical.org.uk](mailto:peter.newport@chemical.org.uk)



**Marc Twisk**  
Managing Director  
Responsible Care Coordinator  
T +32 2 741 86 81  
M +32 498 580608  
[marc.twisk@ecta.com](mailto:marc.twisk@ecta.com)