

BS EN 62740:2015



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Root cause analysis (RCA)

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The UK participation in its preparation was entrusted to Technical Committee DS/1, Dependability.

A list of organizations represented on this committee can be obtained on request to its secretary.

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(IEC 62740:2015)

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(IEC 62740:2015)

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(IEC 62740:2015)

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Foreword

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Endorsement notice

The text of the International Standard IEC 62740:2015 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60300-1	NOTE	Harmonized as EN 60300-1.
IEC 61025	NOTE	Harmonized as EN 61025.
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IEC 61163-1	NOTE	Harmonized as EN 61163-1.
IEC 62508:2010	NOTE	Harmonized as EN 62508:2010 (not modified).
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Annex ZA
(normative)**Normative references to international publications
with their corresponding European publications**

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
IEC 60050 Series	-	International Electrotechnical Vocabulary (IEV)	-	-

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INTRODUCTION

Root cause analysis (RCA) refers to any systematic process that identifies factors that contributed to a particular event of interest (focus event). RCA is performed with the understanding that events are addressed by understanding the root causes, rather than the immediately obvious symptoms. RCA aims to reveal root causes so that either the likelihood of them occurring, or their impact if they do occur, can be changed.

An important distinction to make is that RCA is used to analyse a focus event that has occurred and therefore analyses the past (a posteriori). However, knowledge of the root causes of past events can lead to actions that generate improvements in the future.

This International Standard is intended to reflect current good practices in the conduct of RCA. This standard is general in nature, so that it may give guidance across many industries and situations. There may be industry specific standards in existence that establish preferred methodologies for particular applications. If these standards are in harmony with this publication, the industry standards will generally be sufficient.

This standard is a generic standard and does not explicitly address safety or accident investigation although the methods described in this standard may be used for this purpose.

ROOT CAUSE ANALYSIS (RCA)

1 Scope

This International Standard describes the basic principles of root cause analysis (RCA) and specifies the steps that a process for RCA should include.

This standard identifies a number of attributes for RCA techniques which assist with the selection of an appropriate technique. It describes each RCA technique and its relative strengths and weaknesses.

RCA is used to analyse the root causes of focus events with both positive and negative outcomes, but it is most commonly used for the analysis of failures and incidents. Causes for such events can be varied in nature, including design processes and techniques, organizational characteristics, human aspects and external events. RCA can be used for investigating the causes of non-conformances in quality (and other) management systems as well as for failure analysis, for example in maintenance or equipment testing.

RCA is used to analyse focus events that have occurred, therefore this standard only covers a posteriori analyses. It is recognized that some of the RCA techniques with adaptation can be used proactively in the design and development of items and for causal analysis during risk assessment; however, this standard focuses on the analysis of events which have occurred.

The intent of this standard is to describe a process for performing RCA and to explain the techniques for identifying root causes. These techniques are not designed to assign responsibility or liability, which is outside the scope of this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60050 (all parts), *International Electrotechnical Vocabulary*

3 Terms, definitions and abbreviations

For the purposes of this document, the definitions given in IEC 60050-192, as well as the following, apply.

3.1 Terms and definitions

3.1.1

cause

circumstance or set of circumstances that leads to failure or success

Note 1 to entry: A cause may originate during specification, design, manufacture, installation, operation or maintenance.

[SOURCE: IEC 60050-192:2014, 192-03-11 modified – addition of the words “circumstance or” and “or success” in the term]

3.1.2**causal factor**

condition, action, event or state that was necessary or contributed to the occurrence of the focus event

3.1.3**contributory factor**

condition, action, event or state regarded as secondary, according to the occurrence of the focus event

3.1.4**event**

occurrence or change of a particular set of circumstances

Note 1 to entry: An event can be one or more occurrences, and can have several causes.

Note 2 to entry: An event can consist of something not happening.

Note 3 to entry: An event can sometimes be referred to as an "incident" or "accident".

[SOURCE: ISO Guide 73:2009, 3.5.1.3, modified – Deletion of Note 4 [1]]¹

3.1.5**failure <of an item>**

loss of ability to perform as required

Note 1 to entry: A failure of an item is an event that results in a fault of that item.

Note 2 to entry: Qualifiers, such as catastrophic, critical, major, minor, marginal and insignificant, may be used to categorize failures according to the severity of consequences, the choice and definitions of severity criteria depending upon the field of application.

Note 3 to entry: Qualifiers, such as misuse, mishandling and weakness, may be used to categorize failures according to the cause of failure.

Note 4 to entry: This is failure of an item, not more generally of behaviour.

[SOURCE: IEC 60050-192:2014, 192-03-01, modified – Introduction of new Note 4]

3.1.6**failure mechanism**

process that leads to failure

Note 1 to entry: The process may be physical, chemical, logical, psychological or a combination thereof.

[SOURCE: IEC 60050-192:2014, 192-03-12, modified – the word "psychological" has been added]

3.1.7**focus event**

event which is intended to be explained causally

3.1.8**immediate causal factor**

condition, action, event or state where there is no other causal factor between this causal factor and the focus event

¹ Numbers in square brackets refer to the Bibliography.

Note 1 to entry: There may be more than one immediate causal factor.

3.1.9

necessary causal factor <of an event or state>

condition, action, event or state, that resulted in the given event or state, without which the given event or state would not have occurred

3.1.10

human error

discrepancy between the human action taken or omitted, and that intended or required

Note 1 to entry: The first edition of IEC 60050-191:1990 identified "mistake" as a synonym for "human error", but a mistake is a type of human error.

Note 2 to entry: The term human error applies to any situation where the outcome is not as intended whether the intent of the person was correct or not.

[SOURCE: IEC 60050-192: 2014 192-03-14, modified – Omission of the example, addition of Note 1 and 2]

3.1.11

item

subject being considered

Note 1 to entry: The item may be an individual part, component, device, functional unit, equipment, subsystem, or system.

Note 2 to entry: The item may consist of hardware, software, people or any combination thereof.

Note 3 to entry: The item is often comprised of elements that may each be individually considered.

[SOURCE: IEC 60050-192: 2014, 192-01-01, modified – omission of internal references and Notes 4 and 5]

3.1.12

root cause

causal factor with no predecessor that is relevant for the purpose of the analysis

Note 1 to entry: A focus event normally has more than one root cause.

Note 2 to entry: In some languages, the term root cause refers to the combination of causal factors which have no causal predecessor (a cut set of causal factors).

3.1.13

root cause analysis

RCA

systematic process to identify the causes of a focus event

Note 1 to entry: IEC 60050-192:2014, definition 192-12-05 provides the following more restrictive definition "systematic process to identify the cause of a fault, failure or undesired event, so that it can be removed by design, process or procedure changes". This standard uses an extended definition to allow a wider applicability of the process.

Note 2 to entry: This note applies to the French language only.

3.1.14

stakeholder

person or organization that can affect, be affected by, or perceive themselves to be affected by a decision or activity

[SOURCE: IEC 60300-1:2014, 3.1.15] [2]

3.1.15**stopping rule**

reasoned and explicit means of determining when a causal factor is defined as being a root cause

3.2 Abbreviations

BGA	Ball grid array
CAST	Causal analysis using STAMP
CCT	Causal completeness test
CT	Counterfactual test
CTM	Causes tree method
ECF	Events and causal factors
EEM	External error mode
FTA	Fault tree analysis
GEMS	Generic error modelling system
HFACS	Human factor analysis and classification scheme
IEM	Internal error mode
MES	Multilinear events sequencing
MORT	Management oversight and risk tree
PEM	Psychological error mechanism
PSF	Performance shaping factors
RCA	Root cause analysis
SOL	Safety through organizational learning
STAMP	Systems theoretic accident model and processes
STEP	Sequentially timed events plotting
TRACER	Technique for retrospective and predictive analysis of cognitive errors
WBA	Why-because analysis

4 RCA – Overview

RCA refers to any systematic process that identifies the cause or causes that contribute to a focus event. The immediate or obvious cause of a focus event is often a symptom of underlying causes and may not truly identify the root cause or causes that should be identified and addressed. RCA provides a greater understanding about why events have occurred. RCA may identify the following:

- a) a single root cause;
- b) multiple root causes in which the elimination of any cause will prevent the focus event from occurring;
- c) root causes which are contributory factors where elimination will change the likelihood of the focus event occurring but may not directly prevent it;
- d) root causes of successes.

By addressing the root cause or causes it is possible to make decisions regarding appropriate actions that will generate better outcomes in the future; implementing appropriate actions based on RCA are more effective at preventing the same or similar events with negative

outcomes occurring or increasing the probability of repeating events with positive outcomes, when compared with just addressing the immediately obvious symptoms.

RCA can be applied to any focus event whether success or failure, for example:

- 1) investigation for technological, medical and occupational focus events;
- 2) failure analysis of technological systems, to determine why an item failed to perform as and when required;
- 3) analysis of quality control and business processes;
- 4) analysis of successful outcomes.

RCA can be carried out at various levels of decomposition, for example, from system to component level or by selecting different events or outcomes as a starting point. The level appropriate to conduct the analysis will be dependent on the focus event.

RCA is used to analyse focus events which have actually occurred and is therefore applicable during the testing and operational phases of a project or product life cycle. RCA can identify problems of process including design, quality control, dependability management and project management.

The benefits of performing RCA include:

- obtaining a greater understanding into what has happened;
- finding the source of problems so corrective action can prevent future events;
- identifying the causes of events with beneficial outcomes so they can be repeated;
- identifying more effective actions to address the causes of focus events;
- achieving the objectives of focus event investigations more effectively;
- supporting traceability between focus event investigation evidence and conclusions;
- increasing consistency between investigations of similar focus events;
- increasing objectivity of focus event analysis.

5 The RCA process

5.1 Overview

To be effective, RCA should be performed systematically as an investigation, with the root causes and conclusions backed up by documented evidence. To achieve this, RCA should include the five steps shown in Table 1 and illustrated in Figure 1.

Table 1 – Steps to RCA

Step	Concepts and tasks to be performed
Initiation	Based on the knowledge available on the focus event, determine the need to carry out RCA and define the purpose and scope
Establishing facts	Collect data and establish the facts of what happened, where, when and by whom
Analysis	Use RCA tools and techniques to ascertain how and why the focus event occurred
Validation	Distinguish and resolve the different possibilities as to how and why the focus event was caused
Presentation of results	Present the results of the focus event analysis

RCA is iterative in nature, especially for data collection and analysis, in that data is collected on 'what' happened, which is then analysed in order to determine what other data needs to be collected. Once gathered, further analysis is conducted and any gaps identified for further

further data is collected. This process is repeated until the purpose of the analysis is fulfilled and the root causes identified. The outputs of the RCA will be dependent on its purpose and scope.

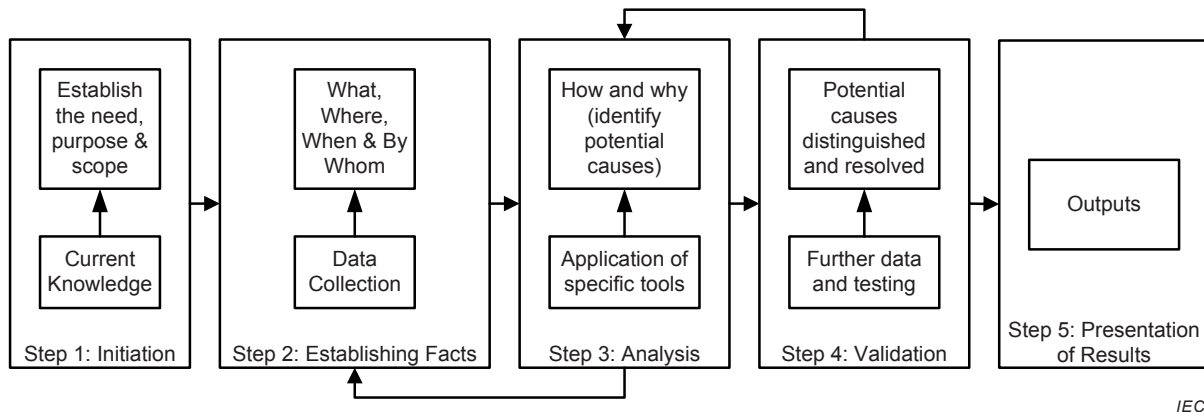


Figure 1 – RCA process

5.2 Initiation

The first step initiates the RCA process by evaluating the need to carry out RCA. It defines the purpose and scope of the analysis, in response to the focus event, and establishes a team and resources to carry out the RCA.

There is usually some criterion which is used to determine when an RCA is required, which may include:

- any single event with a large effect;
- multiple similar undesirable events;
- a parameter moving out of a defined tolerance level;
- failures or successes (whatever the level of effect) that involve critical items of equipment or activities.

When defining the type of events that require the conduct of RCA, it is important to consider that an event with a large effect may have common root causes to events with minor effects. Analysing and addressing root causes for events with minor effects may prevent a large effect event occurring. Examples of events where RCA may be required include: completion of a project (successes and failures), failures that result in unacceptable costs, injury or fatality, unacceptable performance or delays, large contractual consequences and equipment breakdown.

If a RCA is required, the focus event(s) to be analysed is/are described and an appropriate team appointed for the analysis. The description should include the background and context in which the focus event(s) occurred. A good description of a focus event is short, simple and easy to understand and should not be biased towards a specific solution. This description is used to identify appropriate members of the analysis team and ascertain where to start collecting data.

The purpose and scope of the RCA should be determined, taking into account knowledge of system, functions, interfaces etc. In some cases, the purpose of the analysis is to identify the causes of the focus event. In others, the purpose may be broader, for example, to also identify matters of concern outside those that led to the focus event.

There are in general two different types of RCA that have different objectives and should not be mixed up. These two types can be described as follows:

- 1) analysing a focus event using only verifiable factual information;
- 2) analysing a focus event to obtain hypotheses of sequences of events and cause.

The first version focuses on observed facts only. It may be an analysis "per se" according to the purpose of the study and no hypothesis about event occurrence is acceptable for this analysis. The second can be implemented when sufficient factual information is not available and hypotheses of potential causes are acceptable for the purpose of the analysis.

The outputs required of the RCA should also be identified. Examples are as follows:

- provide a description of each root cause along with sufficient background information to allow the identification of suitable actions;
- recommend actions that, taken together, prevent further occurrences of similar events with adverse consequences and improve the likelihood of successes;
- identify, implement and review actions to address root causes.

RCA can include the analysis of systems in which the boundaries continually evolve and interact with their environment; this interaction can take the form of information, energy, or material transfer. Therefore, the scope should specify the boundary of the analysis (what is included and what is excluded).

The scope of the analysis should where possible include a definition of the 'stopping rule', which is the point at which action can be defined or additional proof of cause is no longer necessary for the purpose of the analysis. For example, the last point where corrective action can be identified, before factors that cannot be influenced e.g. weather. It may however be more appropriate to ascertain the stopping rule at review points that determine whether further analysis is required.

RCA can be effectively carried out by one person provided that person is experienced with the causal analysis technique, is a domain expert (or has immediate access to domain experts) and has access to all the data required. However, it is more common to conduct RCA as a team. The team members for the analysis should be selected based on the specific expertise needed to analyse the focus event. The team should include:

- a person or persons who among them can provide a complete systems overview and knowledge of the programme or project and focus event;
- a facilitator skilled in the causal analysis technique, desirably trained or experienced in the facilitation of the causal analysis technique.

Team members can change depending on the activity being conducted, e.g. team members responsible for data collection will not necessarily be the same as those conducting the analysis. Team members can include engineers, technicians, operators, sales representatives and managers. The use of external parties should be considered to provide an independent perspective and avoid blind spots that may exist in the organization. Additional team members should be included for specific activities during the investigation to either bring expertise into the team or to increase the influence of the team. The role of these additional team members is to support the investigation so that it is not halted for technical or organizational boundary reasons. It is not appropriate for persons who may have had a role in causation of the focus event to be part of the team. Their input should be collected during the first two steps.

5.3 Establishing facts

This step includes all the activities necessary to prepare for the analysis. Establishing the facts is usually the largest part of the RCA. Facts should be determined on 'what' happened, 'where', 'when' and 'by whom'.

Data should be collected, before it is lost (e.g. before evidence is disturbed or removed, or memories fade). In general data collected would include:

- a) the context in which the focus event occurred;
- b) the conditions before, during and after the focus event;
- c) personnel involvement including actions taken (or not taken) and decisions made;
- d) context data about the surroundings, including environmental data;
- e) how the organization operates including organization charts, processes and procedures, training and skills;
- f) historical data relating to similar events or precursors;
- g) deviations from the expected;
- h) interactions with other items and personnel;
- i) equipment involved, its operating state and compliance with requirements.

The following lists examples of data that may be relevant:

- 1) Inspection of physical evidence such as failed components and failure reports. Generally, it is experience that will determine what physical evidence is required. If there is doubt, the evidence should be retained. It is also important to preserve the evidence.
- 2) Photographs and videos taken by monitoring cameras. Photographing the area of the occurrence from several views will also be useful in the analysis phase.
- 3) Operational data, recorded by monitoring systems, control systems, alarm and event loggers etc. Operator logs can be critical to understanding the operating conditions at the time of failure and since they are typically dated (or clocked), they are ideal for generating a timeline of events.
- 4) Personal testimony gathered by conducting interviews. Interviews should concentrate on data collection, e.g. building a consistent timeline etc; any premature discussion of the causes of the failure may adversely impact the interview process. Questions should be prepared before the interview to ensure that all necessary information is obtained. Interviews should be conducted with those people, who are the most familiar with the focus event, however, consider interviewing other personnel e.g. people who have performed the job in the past. All interviews should be documented.
- 5) Documentary evidence of relevant procedures, operating environment and regulatory environment.

This step can include failure analysis which examines failed components using a wide array of methods including microscopy, spectroscopy and non-destructive testing or models on the development of failure such as fire modelling or crash modelling.

Once all the data associated with the focus event has been collected, the data should be reviewed for correctness and suitability, missing data should be obtained and any inconsistencies should be resolved to ensure a clear and consistent picture of the focus event is determined.

The outcome of this step is information and understanding, supported by physical evidence and witness statements, concerning

- what happened including the circumstances that lead to the focus event,
- the time sequence of events which lead to the focus event,
- the location of the focus event,
- actions of people associated with the focus event,
- any necessary conditions for the focus event,
- the consequences of the focus event.

5.4 Analysis

5.4.1 Description

Having determined 'what' happened, 'where', 'when' and 'by whom', this step establishes 'how' and 'why' the focus event occurred. The objective of this step is to understand the focus event and its causes by structuring the data that has been collected into a form that allows root causes to be systematically derived.

RCA normally analyses facts to identify the causes that were necessary for the focus event to occur, referred to as "necessary causal factors". However, in some cases, for example where sufficient facts are not available, the analysis may propose one or more hypotheses for cause and may also identify contributory factors and prevailing conditions which were possibly associated with the focus event, but cannot be proven to be necessary causal factors.

Analysis involves the following:

- organizing the physical evidence and witness statements concerning actions, events, conditions and outcomes;
- seeking how and why the focus event occurred using the data collected to justify conclusions. Models of causation, laboratory testing, check lists and taxonomies or statistical analysis of data may be used to assist this process;
- looking beyond the immediate causal factors to why they occurred. The aim is to seek all causal factors that contributed, not only the obvious causes;
- continuing this process until the stopping rule is invoked and root causes identified. There may be multiple root causes which can be independent or correlated.

In general, causal factors may involve technical issues, human aspects and factors relating to the physical or psycho-social environment in which the focus event occurred. All of these should be considered in seeking root causes. People with expertise in these areas should therefore be involved in the analysis.

Causal factors should be described clearly and unambiguously. Where a human action, omission or decision is identified as a causal factor, the nature of the act or decision should be specified, e.g. "the operator switched off the wrong power switch" and not just "human error".

The analysis of the causes (depending on the purpose and scope of the analysis) can consider:

- how the focus event occurred, i.e. the physical, chemical, psychological or logical process that was involved;
- preceding events or conditions that were necessary for the focus event to occur;
- relationships between causal factors including how they combined to cause the focus event and how a root cause leads to the focus event;
- organizational and management influences and human factors that were involved in the focus event or in the events and conditions leading up to it;
- prevailing conditions that may have contributed to the event occurring but were not necessary causal factors;
- matters of concern that could lead to other focus events (these are not strictly causal factors but may be an outcome of the analysis).

A structured analysis technique should be used to perform the analysis. Several formal techniques exist ranging from those that are based on a checklist of causes to techniques that guide the analyst through consideration of causes and graphically present the results. The techniques range from simple to complex and require suitably skilled practitioners or facilitators to conduct the analysis. Some techniques are based on particular models of causation.

focus event occurs and hence give a particular emphasis to the results. The different models are based on different hypotheses with regard to the causation therefore they tend to lead the investigator to identify different contributory factors.

In some cases it is appropriate to use more than one technique or to take into account considerations of more than one model to identify all root causes.

Models of causation are described in Annex B and analysis techniques are described in Annex C. The most appropriate technique will be dependent on the focus event and the purpose and scope of the analysis (see Clause 6).

The analysis may indicate that further data is required. Requests for such data should be expected to occur throughout the analysis to resolve inconsistencies or complete gaps in the analysis. The analysis should continue until a 'stopping rule' is invoked.

5.4.2 The analysis team

A leader should be appointed for the analysis step, who is responsible for the following preparatory work:

- a) obtaining copies of the agreed role and responsibilities of the team, and purpose and scope of the analysis;
- b) obtaining copies of the focus event description and the facts established;
- c) deciding the analysis technique(s) to be used;
- d) converting the focus event description and facts established into a suitable format for use in the analysis technique selected;
- e) developing an analysis plan;
- f) forming the analysis team;
- g) facilitating or arranging for training of team members in the analysis technique selected;
- h) selecting software tools or other templates for use during the analysis;
- i) arranging for a search to be made of databases, media, legal proceedings, etc. to identify focus events of a similar nature, or which may have occurred with the same or similar technologies.

The leader should review the information available to determine what analysis technique(s) should be applied and what skills are required. Expert advice in the field of RCA may need to be obtained regarding the selection of the analysis technique. The leader may also require an expert RCA facilitator for all or part of the analysis, depending on the complexity of the focus event, the complexity or volume of evidence and data or analysis technique selected.

The analysis is usually carried out by a team, with each team member being chosen for their experience and skills. The analysis team should be as small as possible, consistent with the relevant technical and operating skills and experience being available. Where input will be required from multiple parties, stakeholders or entities, the analysis team should contain representatives of each. It is the leader's responsibility to ensure the relevant stakeholders are informed, so that adequate stakeholder representation is available during the analysis.

The role and responsibilities of the analysis team members should be determined and milestones established at the outset of the analysis. A programme of meetings should be developed which reflects the objectives and milestones provided to the analysis team. This will ultimately enable any recommendations to be carried out in a timely fashion.

The leader should develop an analysis plan, which should contain the following:

- 1) focus event description;
- 2) agreed roles and responsibilities of the team, and the purpose and scope of the analysis;

- 3) a list of team members and the stakeholders to be represented;
- 4) time, date and location of the analysis meetings;
- 5) a summary of the data available;
- 6) analysis technique(s) to be used;
- 7) arrangements for training the analysis team in the selected analysis technique (if required);
- 8) the form of recording of the analysis and the analysis results, including reference to any templates or software tools to be used.

Adequate room facilities with visual and recording aids should be arranged by the leader for the efficient conduct of the analysis meetings. A briefing package consisting of the analysis plan and any essential pre-meeting reading or references should be sent to the analysis team members in advance of the first meeting, to allow them to familiarize themselves with the information available and the selected analysis technique.

The leader should ensure that an appropriate communication system is in place for informing and transferring the results of the analysis to those responsible for the next step of the RCA process (see 5.5).

5.5 Validation

A number of review activities are conducted throughout the RCA process to determine whether data collected is relevant and the analysis is representative of the data collected. This step tests whether the causes identified in the analysis can be substantiated and may be interleaved with the analysis or conducted as a separate activity.

An independent review can be carried out to assess whether the analysis is complete and correct and to determine whether the purpose of the analysis has been fulfilled. The review method will be dependent on the analysis technique used and on the focus event. In some cases experiments can be performed to repeat the occurrence of the focus event; where appropriate, statistical methods should be used to assess the degree of confirmation of the hypothesis of cause. If the causes are validated with the help of simulation, care should be taken to ensure the simulation is representative.

During the analysis there may be several alternative hypotheses of how the event could have happened. If the objective is to produce a factual report of the causes then at the completion of the analysis the causes should be validated and only a single conclusion should remain.

This step may require further data collection to seek direct evidence to support or refute the causes identified. Evidence may not always be available to fully validate all potential causes.

5.6 Presentation of results

The results of the analysis will depend on the purpose of the analysis. For example, if the purpose of the analysis is to identify the actions that, taken together, prevent further occurrences of similar events, the analysis results should identify corrective actions which break the causal network and prevent the focus event occurring again. If the purpose of the analysis is to repeat successes, then actions that enhance the likelihood or the consequences of the focus event should be proposed. The effectiveness of the analysis results is dependent on the quality of the analysis.

An agreed format for presenting the results of the RCA should be developed that summarizes the analysis and captures the required outcomes from the analysis, e.g. recommended actions. If the expected outcome of the RCA is to produce recommended actions, the summary should include the following as a minimum:

- a) a general description of each cause requiring action along with sufficient background information and detail, to ensure the need to address each cause is understood and actions to be taken can be identified;
- b) a set of options for treatment actions and, where practicable, and within the scope, a summary of the benefits and costs of each;
- c) recommended actions to address each of the causes identified.

Recommended corrective actions should be evaluated for effectiveness and realism. In general, corrective actions aim to achieve the following:

- change the likelihood of the focus event and/or its consequences (i.e. reduce the likelihood or consequence of undesirable events or increase the likelihood or consequence of successful events);
- not to introduce new unacceptable risks, e.g. the safety of other systems must not be degraded by the proposed corrective action.

Where actions are identified they should be reviewed prior to implementation to determine whether they have not only addressed the root causes, but also not introduced new unexpected consequences and will therefore function as intended. Also reoccurrence of the same or a similar event should be monitored in order to evaluate the effectiveness of actions taken.

6 Selection of techniques for analysing causes

6.1 General

Formal techniques have been devised to help analysts identify causal factors and eventually root causes. Analysis techniques may perform one or more of the following functions:

- organize data and provide structure to the analysis and identify where further evidence is needed;
- provide a visual display of the evidence relating to the focus event, for example the time sequence of events or causal chains;
- conduct statistical analysis of the data, particularly from multiple similar events, to identify common causal factors;
- provide guidance to identify possible causal factors for further investigation and comparison with data (such methods include check lists and methods based on models of causation);
- guide the analysts through the causal chain to a set of root causes.

6.2 Selection of analysis techniques

RCA is undertaken in varying degrees of depth and may use one or several analysis techniques ranging from simple to complex. The depth of the analysis and technique(s) used should exhibit the following characteristics:

- be justifiable and appropriate to the focus event under analysis and the scope and the purpose of the analysis;
- provide results that enhance the understanding of the root causes of the focus event;
- be capable of use in a manner that is traceable, repeatable and verifiable.

The analysis techniques to be used are selected based on the applicable factors such as

- characteristics of the analysis technique,
- characteristics of the focus event e.g. severity or potential severity or complexity,