

# INTERNATIONAL STANDARD

## NORME INTERNATIONALE



Root cause analysis (RCA)

Analyse de cause initiale (RCA)

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## ROOT CAUSE ANALYSIS (RCA)

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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.

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## 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]]<sup>1</sup>

### 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

<sup>1</sup> 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 IEC 62740:2015
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 single root cause;
- multiple root causes in which the elimination of any cause will prevent the focus event from occurring;
- root causes which are contributory factors where elimination will change the likelihood of the focus event occurring but may not directly prevent it;
- 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 which