DRAFT v.5

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3CA

FORM C
GRAPHICAL

Control Change Cause Analysis

Investigator's Manual

Produced by

The Noordwijk Risk Initiative Foundation

In partnership with

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Preface

The Noordwijk Risk Initiative was founded to promote sharing of knowledge in the field of risk management. Based on the belief that a virtuous circle exists between making tools and developing theoretical understanding, the Foundation develops tools for risk management and maintains them in the public domain.

Purpose of this document

The Noordwijk Risk Initiative Foundation publishes this document to encourage the efficient and effective investigation of incidents. It is intended for line managers and supervisors, as well as specialists in various disciplines such as occupational safety, environmental protection and quality management.

The NRI Foundation intends to maintain this manual in the public domain. Our motivations are:

1. to help decision-makers identify from unwanted events the lessons they need to learn;
2. to provide a reference point for investigators, tool developers, researchers and students.

Status of this manual

3CA was produced to provide supervisors and line managers in industry with an easy-to learn, easy-to-apply method for identifying the underlying causes of accidents and incidents.

3CA now comes in three versions, Forms A, B and C. The manual for the A-form of 3CA was produced in 2002 following a co-operative project run in 2000 by Humber Chemical Focus and the UK Health & Safety Executive (HSE). The manual for the A-form is available at www.nri.eu.com/NRI3.pdf.

In 2008, the NRI Foundation and HSE worked in partnership to produce the B-form of 3CA. Initially, this project aimed at revising the original 2002 manual. However, the revision process produced sufficient changes in the method itself for the result to be considered as something new. This is the origin of the B-form of 3CA. The manual for the B-form is available at www.nri.eu.com/NRI5.pdf.

In 2009/10, the NRI Foundation developed a graphical worksheet to support the B-form of 3CA. This was written-up (a worksheet and a procedure) as an appendix to the B-form manual. However, as the graphical approach is for some users the main way of applying 3CA routines, the authors decided to produce a dedicated manual – the C-form of 3CA.

Acknowledgements

The C-form of 3CA is based closely on the B-form to which many people contributed. Our particular thanks go to the project workers at the UK Health and Safety Executive, Dr Celeste Jacinto (New University of Lisbon, Portugal), and; Dr Mark Cooper (European Institute of Health Studies, Surrey University).

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Forward

3CA began in 2000 as a method to help first-line supervisors in the UK Chemical Industry. The aim was to make a tool that helped supervisors to analyse root causes of incidents. They wanted a tool that was quick to learn and that helped them produce insightful and useful findings quickly. The result is still available, albeit slightly refined and now called "Form A".

Eight years later, NRI published a new version of 3CA (Form B). This time, we had safety professionals in mind, but still wanted a method that could be used by others. We took the opportunity to make the process more thorough and less prone to judgmentalism. The new form prompts the user to see things from the point of view of the individuals involved. 3CA also cues the user to think about how the wider culture may have influenced the decisions of those individuals. These insights set the scene for evaluating the system of management controls.

The other innovation was to help the analyst to avoid certain problems associated with "counterfactual reasoning". This type of reasoning is not bad as such, in fact it is essential, but it is easily biased. Looking at someone else's choices in the cold light of day, from your own perspective, and with the benefit of knowing how those choices turned out, is difficult to do fairly and thoroughly. It is especially easy to focus on what the person did not do. One problem with the "did not" type of explanation is that it is biased towards reinforcing rules. Often there is more to an accident than disobedience. Moreover, a preoccupation with what people did not do can block gaining insights that come from examining what they actually did. 3CA analysis is designed to help the analyst to understand why an accident happened even though relevant rules existed.

In training situations, we saw that people could use 3CA to produce insightful analysis and good questions. However, in practice, many would-be analysts found the tabular worksheet got in the way. For some, it imposed a "form filling" mentality; an inflexible, linear approach which stemmed the flow of their creative, analytical thought.

The solution to this problem emerged during a training session. When training new users, I explain the concepts of 3CA using a set of graphics. "Why…" suggested one such user in early 2009, "don't you create a worksheet around those graphics"? After a Homer Simpson, "D'oh!" moment of realisation, the trainers set about testing the idea. After nine months and trials involving some 200 users, we decided the format for the new worksheet and added it as an appendix to the Form-B, 3CA manual.

This new graphical format, unlike its tabular cousin, invites users to move back and forth between the various headings. In this way, analysts explore the issues using 3CA routines as guidelines and the 3CA worksheet as a notepad. Another advantage seems to be that people who have not been involved in the investigation and who don't know 3CA can intuitively follow the information recorded on a 3CA worksheet. So you might find it useful as a briefing tool, as well.

We hope you find this new approach to 3CA simple and helpful. Let us know how you get on and how 3CA can be improved. If you find 3CA useful, perhaps you might consider making a donation to the NRI Foundation: we are a not for profit organisation and every little helps.

John Kingston, 12th June 2010.
Noordwijk Risk Initiative Foundation

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Analysing incidents using 3CA

3CA analysis is designed to help you to:

- *thoroughly examine a significant event from a number of perspectives;*
- *record your thinking, insights and questions.*

Using 3CA is an iterative process. As you analyse the facts, questions will emerge. You will need to revise your analysis in the light of the answers. For these reasons, do not expect to complete the analysis at one sitting.

It's best to start the analysis as soon as you know the basic facts about what happened. You are more likely to find answers early on in the investigation than later.

1 Before you start the analysis

You will need to make sure that you have everything in place to make the process efficient. This means having the right people involved, a suitable place to work and the right equipment; these are discussed below. You also need to budget enough time. 3CA is not a heavy tool, but even so, each significant event will take about 30-60 minutes to analyse. It is usual to analyse two, or sometimes, three significant events, each on a separate graphical worksheet. So a half-day is realistic when breaks and other interruptions are taken into account. Bear in mind that you might want to spend some more time later on revising your analyses in the light of new information.

1.1 Team Requirements

Analysis is about applying knowledge to facts. You need to make sure that you have knowledge of the:

- technical standards that apply to the activity under investigation;
- procedures and policies of the organisations(s) involved in the incident;
- structure of the organisation, its culture and management systems;
- 3CA procedure.

One person generally can't cover all these bases and so you will need to put together a team. A team approach also helps to explore the issues through discussion and it will often improve the quality of the analysis.

A team approach is often effective but needs to be managed to ensure efficiency. Try to balance airing ideas with making progress. In particular, note down questions on the worksheet. This captures good ideas without getting bogged down in speculation.

Even when addressing issues systematically, it is possible to miss points or make unwarranted assumptions. So, consider having the analysis challenged by a 'critical friend'.

1.2 Physical Requirements

3CA analysis doesn't require anything unusual, but try to ensure that you have:

- arranged a room with suitable security where you can work undisturbed and without disturbing others;
- documents on hand for ready reference (e.g. witness statements, reports, diagrams and photographs etc.).
- 3CA worksheets (use complete sentences)
  - If working with pen and paper, use A3 sized copies of the 3CA worksheet[1]. Colour is not essential, but might help;
  - If working via a computer[2], a suitable (e.g. quiet, bright, high resolution) data projector can help team work;

It is VITAL to make notes during the discussion, otherwise you'll forget points. The 3CA worksheet is designed for this purpose.

Write in complete sentences, that way others will be able to understand your analysis and you'll be able to reconstruct your reasoning when reporting your findings.

Remember to note-down questions as well as facts.

1.3 Information about the accident

Start the 3CA process as soon as you have the basic facts about what happened. It is useful, though not essential, to have applied a systematic sequencing method before starting 3CA. Sequencing methods like STEP and ECFA+ help to describe actions, identify actors and to identify any gaps in the factual picture of what happened.

2 Choose subjects to analyse

Your investigation may require several 3CA analyses, one for each significant event that you decide to include. Starting with the highest priority, analyse one significant event following the steps described below. Repeat the process for any other significant events that require analysis, each on a different graphical worksheet.

A significant event is one that significantly increases risks or decrease control, or both. **Identify all the significant events in the accident sequence.** Be careful not to miss events that are not yet obvious; the sequencing methods mentioned earlier are one way of support this.

Choose which significant event to analyse first. One way is to order the whole set in one go and then to work your way through the list. This allows you to work-out how much time will be needed for the whole set of analyses. Another way is to choose the most significant event, analyse it, and then repeat the selection process to choose the next significant event that you think warrants analysis.

[1] Blank forms can be downloaded from NRI
[2] Use the word-processing template available from NRI.

It is difficult to be precise about the criteria for prioritising significant events, but the box below gives examples found from practice. The effect should be to put effort into events that you believe hold the most potential for learning.

Criteria for prioritising events for analysis

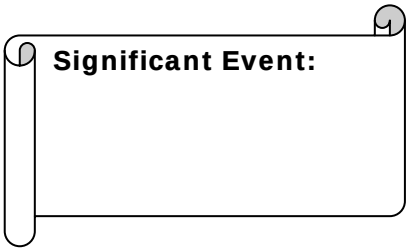
- *the size of the change in risk or control created by the event;*
- *the extent of risk reduction achievable by the expected way of working;*
- *the currency and importance in other settings of the expected way of working;*
- *the potential for identifying valuable lessons to be learned;*
- *the extent to which the investigators are surprised by the facts of the event.*

3 Describe the significant event

3CA analysis has two parts, the first part is *descriptive*. 3CA analysis uses a method of "contrasting statements": a statement of what actually happened is contrasted with a statement of what is expected to happen. The second part of the analysis flows from trying to *explain* why the actual situation was different from what was expected.

3.1 State the Significant Event

In the scroll-shaped box on the worksheet, describe the significant event. State what or who is acting (e.g. the person or machine) and what was done.



3.2 Describe the Actual Performance

In the relevant box, describe what the actor actually did. Phrase your description to include the actor and the action. Make this a simple, positive statement. If you have used ECFA+, use the phrase from the ECFA+ event.

Often this description starts out worded exactly as it appears in the "significant event" scroll box. As your analysis goes on, you may recognise other contextual facts to be important. These extra details should be added to the description. Actual Performance can include facts about the situation, not just facts about behaviour. The aim is to provide an accurate and meaningful snapshot of the event you are analysing.

It is **very important to avoid** statements of the type 'did not', 'failed to', etc. These statements:

- discourage investigators to look into why people acted as they did;
- over-emphasise individual responsibility;
- under-emphasise the relevance of context.

3.3 Describe the Expected Performance

The significant event will contain an actor and an action; focus on the action: **in the relevant box, describe what performance was expected**.

There may be one or more alternative expectations; **write down every option** that can be justified.

You will have two types of expected performance:

- 'Prescribed' options that are normal requirements; those that 'should' have been in place according to some regulation or procedure.
- 'Non-prescribed' options that are not obligatory but which nonetheless might be justified in the context in which the accident occurred.

To help you identify 'non-prescribed' options, take a 'first principles' approach[3]. Develop a list of possible options, and then crop it down to only those options that you can justify.

If the significant event is describing a moment in which harm or injury occurs (or is a near miss) you could use the list below to identify non-prescribed options:

1. *Do not use…*
2. *Use less of…*
3. *Use safer form of…*
4. *Prevent build-up of (or divert)…*
5. *Barrier on…*
6. *Barrier between…*
7. *Separate in time or space.*
8. *Use stronger…*
9. *Evasion by…*
10. *Less people exposed*
11. *Use less valuable thing…*

3.4 State the Standard/Benchmark that justifies the expectation

Refer to a specific standard, code, procedure or documented good practice that justifies each statement of expected performance. This is to ensure that only legitimate comparisons are made between actual and expected performance.

If relying on a general code or standard, you should also explain how this relates to the specific context of the significant event. As well as providing a defendable basis for your analysis, this may also deepen your insight into the context of the accident.

What if you are not sure? If you don't know how a general code relates to the specific context of the accident, write this as a question. Similarly, write a question if you believe that an expectation is plausible, but you do not have enough information to evaluate its practicality.

[3] *The list shown is applicable if the significant event is an accident or near-miss. The list is adapted from: Haddon, J. (1973) Energy Damage and the Ten Countermeasure Strategies. Human Factors, 355-366, August 1973*

4 Explain the difference between actual and expected performance

In this part of the analysis, the goal is to explain why the actual performance was different from the expected performance. You need to explain the difference in terms of the individuals involved, the culture and organisation in which they work and management systems:

- Individuals' goals and their knowledge at the time they acted;
- any relevant cultural patterns (e.g. set by individual's peer group) and the influence of organisational factors;
- the systems of control that could have pre-empted, detected and corrected the significant event or its circumstances.

As well as gaining insights under each of these three headings, look for interactions between the headings. For example, if the difference between the expected and actual performance has become established as a cultural pattern, try to explain under the heading of 'systems' why the pattern had become established.

More than one option for Expected Performance?

Consider each option of expected performance singly. This is to avoid the confusion created by explaining the difference between actual performance and two or more options of expected performance simultaneously.

Teamwork may be helpful to the analysis; group discussion naturally makes conversational connections between topics.

4.1 Original Logic

In the relevant box, identify (or pose questions about) why it made sense to the individual to do the job this way.

State whose reasoning is the subject of discussion. Often this is a person named in the significant event. Try to discriminate "original logic" from post-accident rationalisations and alibis.

More than one decision-maker?

Sometimes, the significant event is the outcome of several decisions made by different people. The logic for each decision needs to be considered, as does the context of the decision (i.e. in terms of culture, organisational factors and management system).

A non-human actor (e.g. a machine) acts in the significant event?

Often the 'original logic' to be considered is that of the person who 'acted' in the significant event. But not always. If the actor is a machine or a component, consider the logic of the machine's designer and/or controller.

4.2 Cultural patterns and organisational factors

Normally an actor is influenced by existing attitudes or patterns of behaviour in their peer group.

In the relevant box, describe attitudes or behaviours in the actor's peer group that may have established a pattern for the actual performance.

Describe any organisational factors that may explain his/her individual logic or behaviour. Organisational factors include properties such as management structure, leadership, politics, and change.

4.3 Systems

Identify each system relevant to the significant event. For each system, explain, or ask, why it did not ensure that the actual performance would be the same as the expected performance.

Try to go "a spade deeper" in your explanations. Suppose, for example, that you concluded that the difference between actual and expected performance was due to over-prescriptive procedures. Try also to explain what it is about the system(s) that allowed them to produce this problem. In the example given, you could look into how the procedure was researched, developed, tested and maintained. In this way, you can identify general lessons for the organisation.

An illustrative list of Generic Systems

- *Verifying Readiness before use/start of work*
- *Housekeeping*
- *Briefings and task allocation*
- *Personnel selection*
- *Competence Assurance*
- *Inspection*
- *Maintenance*
- *Motivation*
- *Co-ordination between groups*
- *Supervision*
- *Design of Hardware and premises*
- *Procurement and Supply*
- *Risk Assessment*
- *Procedures & Technical Information*
- *Planning*
- *Budgeting*
- *Monitoring*
- *Change control systems*
- *Emergency systems*
- *Audit and review*

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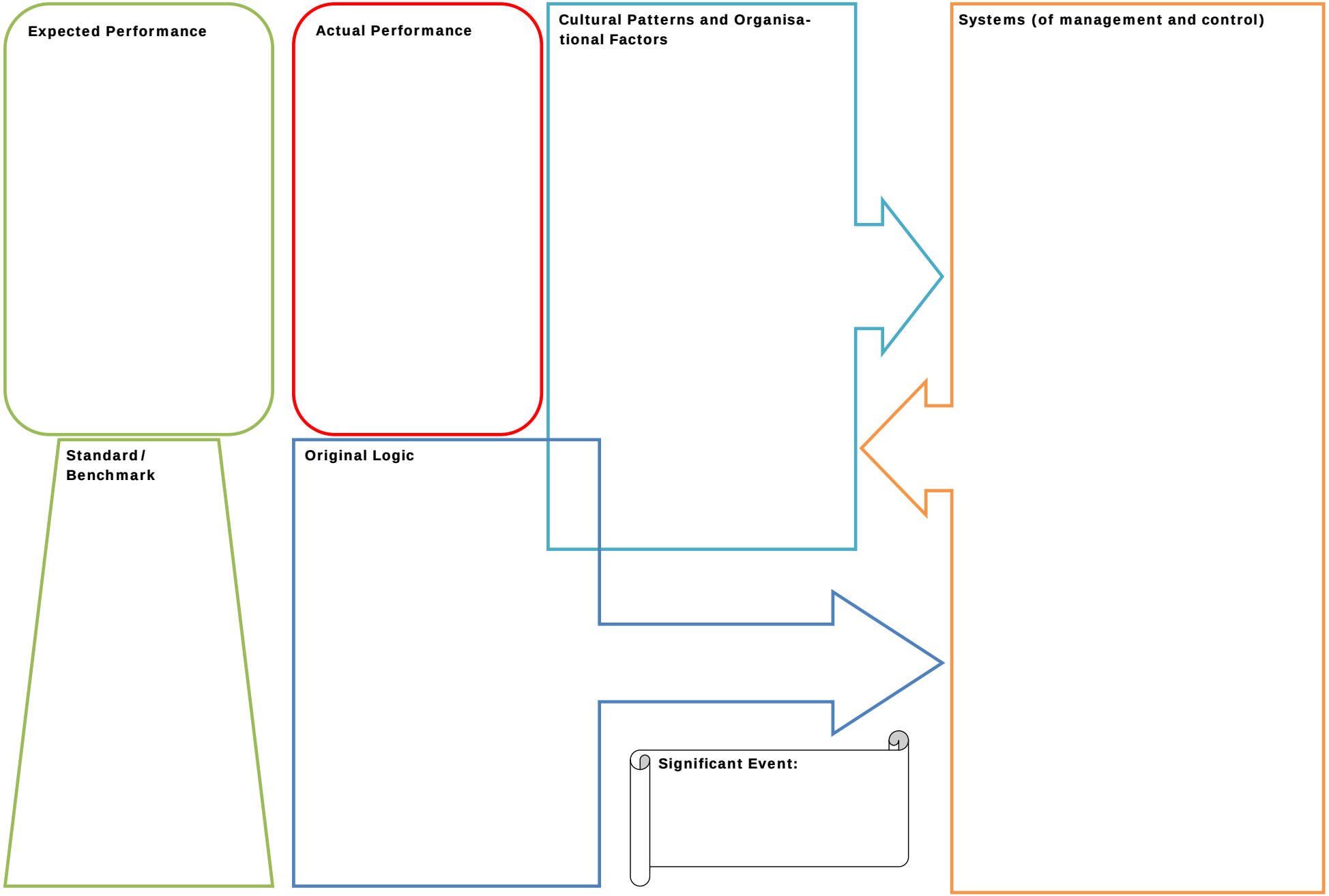
Appendix 1: Example of Blank Worksheet



Graphical worksheet [paper and pencil version] for use with 3CA (Form C) Manual, available www.nri.eu.com/NRI6.pdf

Appendix 1 (Ready Reference)

Expected Performance

Insert text here (and delete below)

The significant event will contain and actor and an action; focus on the action and describe what performance was expected. Note the basis for this expectation in the "Standard" box.

If there is more than option, describe each of the alternatives.

Write questions if you need to.

Actual Performance

Insert text here (and delete below)

Describe what the actor actually did. Phrase your description to include the actor and the action. Make this a simple, positive statement.

NOTE: Often this description is exactly same as the "significant event", but sometimes it is different.

Cultural Patterns and Organisational Factors

Insert Text here (and delete below)

Describe attitudes or behaviours in the actor's peer group that may explain his/her individual logic or behaviour.

Sometimes an actor's "original logic" is truly unique and without precedent, but normally he or she is influenced by existing attitudes or patterns of behaviour in their peer group.

Describe ORGANISATIONAL factors that may explain his/her individual logic or behaviour. (e.g. management structure, leadership, politics, change).

To help you make a note of your thinking, use COMPLETE SENTENCES. Write questions if you need to.

Systems (of management and control)

Insert text here (and delete below)

Identify each system relevant to the problems noted. For each system, explain why the system did not pre-empt, detect or correct the problems. To help you make a note of your thinking, use COMPLETE SENTENCES. Write questions if you need to.

Systems include:-

- *Verifying Readiness before use/start of work*
- *Housekeeping*
- *Briefings and task allocation*
- *Personnel selection*
- *Competence Assurance*
- *Inspection*
- *Maintenance*
- *Motivation*
- *Co-ordination between groups*
- *Supervision*
- *Design of Hardware and premises*
- *Procurement and Supply*
- *Risk Assessment*
- *Procedures & Technical Information*
- *Planning*
- *Budgeting*
- *Monitoring*
- *Change control systems*
- *Emergency systems*
- *Audit and review*

Standard / Benchmark

Insert text here (and delete below)

Describe your justification for believing that the performance stated in the "expected performance" is reasonable and relevant to the actor's situation. Justification might include reference to a procedure, expert opinion of good-practice, a regulation, or other types of norm. It must be something for which you can provide evidence.

Write questions if you need to.

Original Logic

Insert text here (and delete below)

Describe the perceptions and reasoning of the actor (or the controller or designer, if the actor is a thing). This should explain why the 'actual performance' seemed (to the actor) to be a good course of action.

To help you make a note of your thinking, use COMPLETE SENTENCES.

Write questions if you need to.

Significant Event:

Insert text here (and delete below)
Describe the event; say what is acting (e.g. the person or machine) and what action is being performed.

2 Appendix: Comparison between the 3CA Graphical and Tabular worksheets

The tabular and graphical formats support the 3CA method in different ways, although the underlying logic is the same.

For some people, filling-in a table imposes an inflexible, linear approach and stems the flow of their creative, analytical thought. A graphical format, in contrast, invites users to move back and forth between the various headings and encourages divergent thinking. Also, the graphical worksheet can handle only just one significant event, and this may help users to stay focused. There, NRI has developed a graphical worksheet as a way of improving the usability of 3CA.

2.1 Handling multiple significant events

The tabular format allows several significant events to be seen together, compared and connected to common themes. The graphical format allows only one significant event to be considered at a time. To conduct a full 3CA analysis, which may need to consider several significant events, the user will need several graphical sheets, one for each significant event.

Themes common to two or more significant events

The tabular format allows several significant events to be analysed on the same page. This means that themes common to more than one significant event need be written only once. This is particularly relevant for issues noted by the analyst in columns 5(a) to (c) of the B-form.

The graphical format limits the analyst to considering one significant event on each worksheet. It is possible for the analyst to cross-refer between sheets. If more than one sheet is used, the user will need to develop a system for doing this.

Overview of the full set of significant events

Analysis using 3CA table results in a list of significant events. This constitutes a concise summary of the accident. Users of the graphical format should consider making first a comprehensive "master list" of the significant events.

Prioritisation occurs 'off-the-page'

Using graphical format means that any prioritisation of significant events occurs 'off-the-page'. Whether the analyst is going to consider all the significant events, or just a selection of them, prioritisation still needs to occur in the tabular or graphical format.

2.2 Handling 'Could' and 'Should' Barriers and Controls

In the tabular form of 3CA, the analyst is prompted to consider barriers and controls that could have prevented or mitigated a significant event. This list will include two sorts of options:

1) 'prescribed' options that are normal requirements, those that 'should' have been in place according to some regulation or procedure.
2) 'non-prescribed' options that are not obligatory but which nonetheless might be justified in the context in which the accident occurred.

In the graphical form of the method, identifying 'non-prescribed' options for preventing or mitigating significant events needs to be done 'off-the-page'. In practice, this is done when analysing "expected performance" by taking a 'first-principles' approach.

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