NRI-1 (2009)

NRI MORT User's Manual

For use with the Management Oversight & Risk Tree analytical logic diagram

Second Edition

Produced by

The Noordwijk Risk Initiative Foundation

In Partnership with

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2nd Edition

for use with the
Management Oversight & Risk Tree
analytical logic diagram

20th December 2009

Based on the original manual (three revisions 1978-1992) prepared by Norm W. Knox and Robert W. Eicher on behalf of the System Safety Development Centre, EG&G Idaho, Inc. Idaho Falls, Idaho 83415 for the US Department of Energy.

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Intended for use with the
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Preface to the first edition

In 1971, William G. Johnson and I started the "trials at Aerojet": proving and further developing ideas that would eventually comprise the MORT Safety Assurance System. These trials were part of a project headed by Bill, which aimed to improve safety management in the US nuclear industry. We produced a system of ideas that sought to draw together Bill's lifetime of experience and the best practices of organisations such as those in the National Safety Council (NSC) network, a web in which Bill was richly connected. Using the expertise of our team and the test-bench of the Aerojet trials, we wove this into a coherent model of safety management. Bill wrote the result up in a report entitled "MORT: The Management Oversight and Risk Tree"[1]. This document succeeded in capturing much of the content of the project but only a little of the dynamism that animated the ideas. Nonetheless, it was enough to establish the organisation – the Safety System Development Centre (SSDC) – that served as the platform for our subsequent work in the industry and beyond. Initially, the mission of SSDC was the subject of a contract with the Atomic Energy Commission (AEC) and continued with ERDA, the Energy Research and Development Agency, and ultimately, DOE – the US Department of Energy.

The contract from the AEC is worthy of comment, it placed on us a requirement to make available in the public domain the knowledge developed within the project; this was a visionary step. It created a motor that drove innovation, in which success bred success. Through our tools, documents, training and consultancy, we established a reputation beyond the nuclear industry and attracted opportunities to help solve new problems through collaboration with the Military, World Bank and others. The experience we gained and the ideas that we jointly developed, were fed back directly into our mission and this was reflected in our public domain output. We used "MORT" as the collective term for this canon of work on risk management, to which the MORT diagram is the index.

From an early stage, MORT, the investigation method, developed a life of its own. During the original project (1969 to 1972), both senior line management and safety specialists warmly welcomed the investigation method. The public domain orientation of the SSDC meant that people outside the nuclear industry got to hear of MORT. In 1975, when the AEC was replaced by ERDA, and the mission broadened from nuclear to strategic energy (including oil and gas reserves), the international networks of these industries brought many new people to our door and several fruitful collaborations.

My connection to NRI has a number of strands. In 1975, I met Rudolf Frei at the Los Alamos National Laboratory. His PhD was the first connected to MORT, another was produced by John Kingston ten years later; both of these gentlemen later joining the board of the NRI Foundation. These two examples of collaboration are drawn from a pool of similar instances that affirm my view that intellectual generosity is in fact a wise investment! Since its inception in 1998, I have been pleased to advise the Foundation and to continue the dialogue about risk management. I am delighted that these investments are still showing a good return and look forward to the reading the ensuing chapters of the MORT book of knowledge that myself, Bill Johnson and our colleagues started penning some thirty years ago.

Dr Robert J. Nertney
December 2002

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[1] MORT - The Management Oversight and Risk Tree, Prepared For The U.S. Atomic Energy Commission, Division of Operational Safety, Under Contract No. AT(04-3)-821, Submitted to AEC February 12, 1973 (San 821-2). Downloadable from www.nri.eu.com

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Preface to the Second Edition

When NRI published the first edition of MORT User’s Manual and Chart in 2002, the only version of the manual then available in the public domain was that written for the United States Department of Energy. Understandably, the DoE edition of the manual was written in American English and referred to documents and organisations that were relatively unknown to people outside of the intended readership. The manual was also ten years old.

The first edition of the NRI MORT User’s Manual provided European users of MORT with a question set in British English. The revisers kept to the structure of the 1992 version of the MORT Chart and stayed close to the concepts of the original (1973) MORT text. The publication of the first edition also meant that the MORT method stayed available in the public domain and accessible via the internet.

This second edition arose from a project to translate the MORT user’s manual and MORT chart into Dutch. This project was undertaken by the NRI Foundation in partnership with the Royal Dutch Navy. Early on in the project, the members of translation team realised that they were investing considerable effort to clarify – in English – the concepts behind some of the questions posed in the manual. In effect, the team were revising the English manual as a necessary prelude to producing a Dutch text. Furthermore, some of these clarifications suggested that changes were needed to the structure of the MORT Tree. To consider these structural changes, the Foundation formed a second team. Over a period of two years, these two teams have reviewed each other’s ideas until consensus was reached about the changes to the MORT tree and the phrasing of the questions in the manual. In this way, a translation became a revision with a scope wide enough to justify the result as a second edition rather than as a minor revision.

The Board,
Noordwijk Risk Initiative Foundation
1st October 2009

Users Manual Part 1:
MORT and its Application

1 Introduction

The Management Oversight and Risk Tree (MORT) method is an analytical procedure for inquiring into causes and contributing factors of accidents and incidents. The MORT method reflects the key ideas of a 34-year programme run by the US Government to ensure high levels of safety and quality assurance in its energy industry. The MORT programme started with a project documented in SAN 821-2, W.G. Johnson, February 1973[2].

The MORT method is a logical expression of the functions needed by an organisation to manage its risks effectively. These functions have been described generically; the emphasis is on "what" rather than "how", and this allows MORT to be applied to different industries. MORT reflects a philosophy which holds that the most effective way of managing safety is to make it an integral part of business management and operational control.

This document describes how to apply MORT to incident and accident investigation. It is intended for use with the NRI MORT diagram, dated August 2009 available from "www.nri.eu.com". This manual is provided as a general guide to the investigative use of MORT, but it is in no way a replacement for a proper training in accident investigation. It is published to encourage the use of MORT and to promote the discussion of root cause analysis.

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[2] SAN 821-2 can be downloaded from www.nri.eu.com

1.1 What is MORT

The acronym MORT is used to refer to four things:

1. a safety-assurance programme which ran between 1968 and 2002;
2. the body of written material which documented the programme;
3. a logic tree diagram: the Management Oversight and Risk TREE;
4. a method for helping investigators probe into the systemic causes of accidents and incidents.

This manual describes the item 4, the MORT Method, and is designed to be used with the MORT TREE (which can be found on the internet at www.nri.eu.com/NRI2EN.pdf).

The connection between these various senses of the term MORT is as follows. The project which started the MORT programme was documented in a report written by W.G. Johnson in 1973 (it is often referred to by its reference code, SAN 821-2; it is available from the NRI website). In the report, Johnson sets out the ideas that were incorporated into the MORT programme after a very wide survey of risk management practices in different industries around the world. Historically, the MORT diagram served as a graphical index to that report, arranging the ideas hierarchically in functional groups. This diagram was used by investigators and quality assurance specialists to systematically review a work activity or process. They were expected to know the material in SAN 821-2, and the body of documentation that accrued during the lifespan of the MORT programme, to which the chart was a ready-reference.

To help investigators, especially novices, the 500+ pages of the original report were distilled into question set of 40 pages. The questions are the main component of the MORT User's Manual. MORT as a method is now independent of MORT as a programme, certainly in Europe. In practice, the MORT programme documents (especially, SAN 821-2) have become disassociated from the MORT chart, leaving the MORT User's Manual as the most common reference for applying the MORT tree.

1.2 How is MORT applied to accidents and incidents

The MORT method consists of three steps:

Step 1:	define the events to be analysed;
Step 2:	characterise each event in terms of unwanted transfers of energy;
Step 3:	evaluate the hypothesis that the unwanted transfers of energy were the result of how risks were being managed in the activity in which the accident occurred.

Step 1 is supported using a procedure called *Energy Trace and Barrier Analysis*, which you will find described on page xix. In this step the analyst is trying to identify a complete set of events comprising the incident or accident, and to define each event clearly. It is very difficult to use MORT, even in a superficial way, without first performing an Energy Trace and Barrier Analysis.

In Step 2, the analyst looks at how the energy was exchanged with the person or asset. This way of characterising accidents – as a series of 'energy exchanges' –was proposed by William Haddon[3] as a means of analysing accidents scientifically. There may be several different energy transfers that need to be considered in the same investigation. In this step, the analyst aims to understand how the harm, damage or danger occurred.

In Step 3, the analyst considers how the activity was managed. This step involves the analyst looking at the 'local' management specific to the activity and resources. The analyst also looks "upstream" to find management and design decisions about people, equipment, processes and procedures that are relevant to the accident. To help make this analysis systematic, the analyst uses the MORT chart; this lists the topics and allows an analyst to keep track of his/her progress.

Each topic on the MORT chart has a corresponding question in Part 2 of this manual. The questions in MORT are asked in a particular sequence, one that is designed to help the user clarify the facts surrounding an incident. The analyst, focussed on the context of the accident, identifies which topics are relevant and uses the questions in the manual as a resource to frame his/her own inquiries.

Like most forms of analysis applied in investigations, MORT helps the analyst structure what they know and identify what they need to find out; mostly the latter. The accent in MORT analysis is on inquiry and reflection by the analyst.

[3] This was reprinted in: Injury Prevention 1999;5:231–236.

2 Description of the MORT Tree

The MORT tree shares some of the conventions of Fault Tree Analysis, but other symbols and systems are also used.

2.1 Inputs, outputs and logic gates

Fault Trees are composed of *inputs* connected to *outputs* through *logic gates*. These inputs and outputs are generally called *events*. For example, in Figure 1, the output event, "Fire" is connected to the three input events, "Fuel Present", "Source of Ignition", and "Oxygen present".

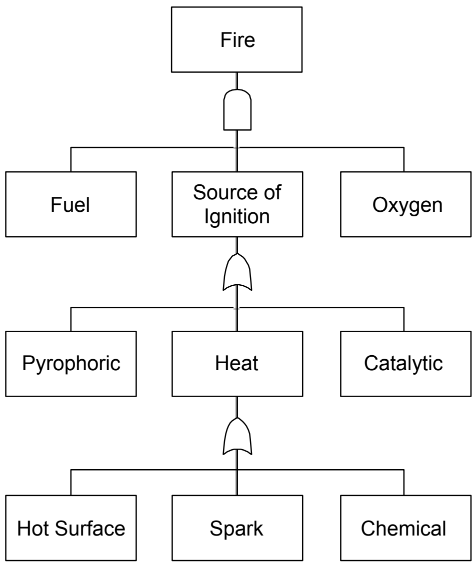


Figure 1. Example of Hierarchical Logic

The MORT chart uses logic gates. However, when using MORT in an investigative setting, the logic gates make little contribution to the analysis: they can safely be ignored.

In a theoretical setting, the logic gates have more significance. There are 93 logic gates in the MORT chart[6], only two of these are AND gates. The first of these AND gates remind the reader that although accidents are often produced by "Oversights and Omissions" these problems arise not just in the specific control of the activity, but also in the relevant management systems. This is illustrated in Figure 2.

[6] Not counting gates that are repeated by transfers (which account for another 180 or so)

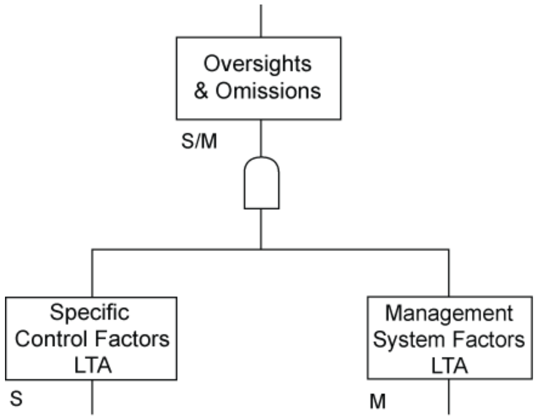


Figure 2: Oversights & Omissions arise from Specific Control Factors AND Management System Factors.

2.2 Sequences of energy exchanges

The second AND gate in the MORT tree comes from Haddon's energy exchange model of accidents, introduced earlier (page x).

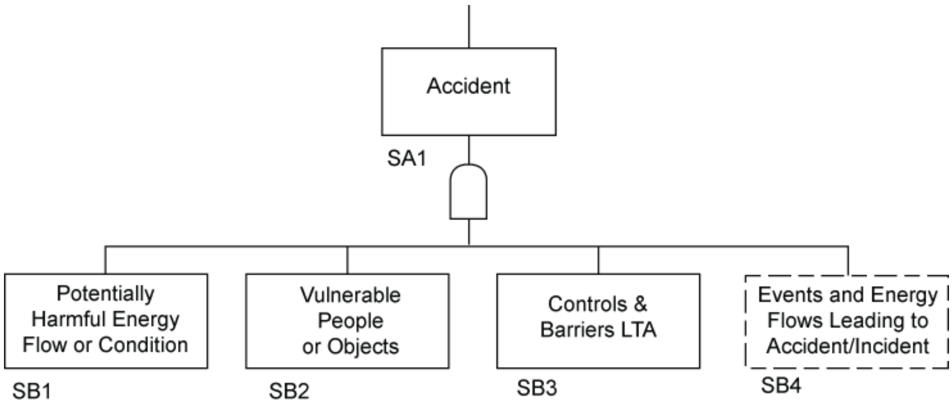


Figure 3. The elements of accident causation

In Figure 3, the AND gate is used to emphasise the point that an accident will occur only if certain elements are present; the accident would not happen were any one of these elements absent. Haddon's concept of "energy exchange" is shown as a triad in which

a potentially harmful energy flow is present, when
vulnerable people or objects are exposed, and
barriers and controls are not adequate to achieve protection.

Energy exchanges, Haddon argued[3], occur in sequences. This requirement is included as the fourth event input: *Events and Energy Flows Leading to Accident/incident*. Figure 3 shows this text enclosed within a dashed rectangle. These dashes symbolise two points for the analyst: first, that this input event is not analysed as part of the

MORT tree, but that; second, all of the events and energy flows need to be identified. This identification is done using Energy Trace and Barrier Analysis; described in in sub-section 3 (page xviii).

2.3 Systems of reference

The MORT chart uses several types of referencing: to link one part of the chart to another; to refer to the questions in Part 2 of this manual, and; to allow every item in the chart to be identified uniquely. All of these types of references are illustrated in Figure 4.

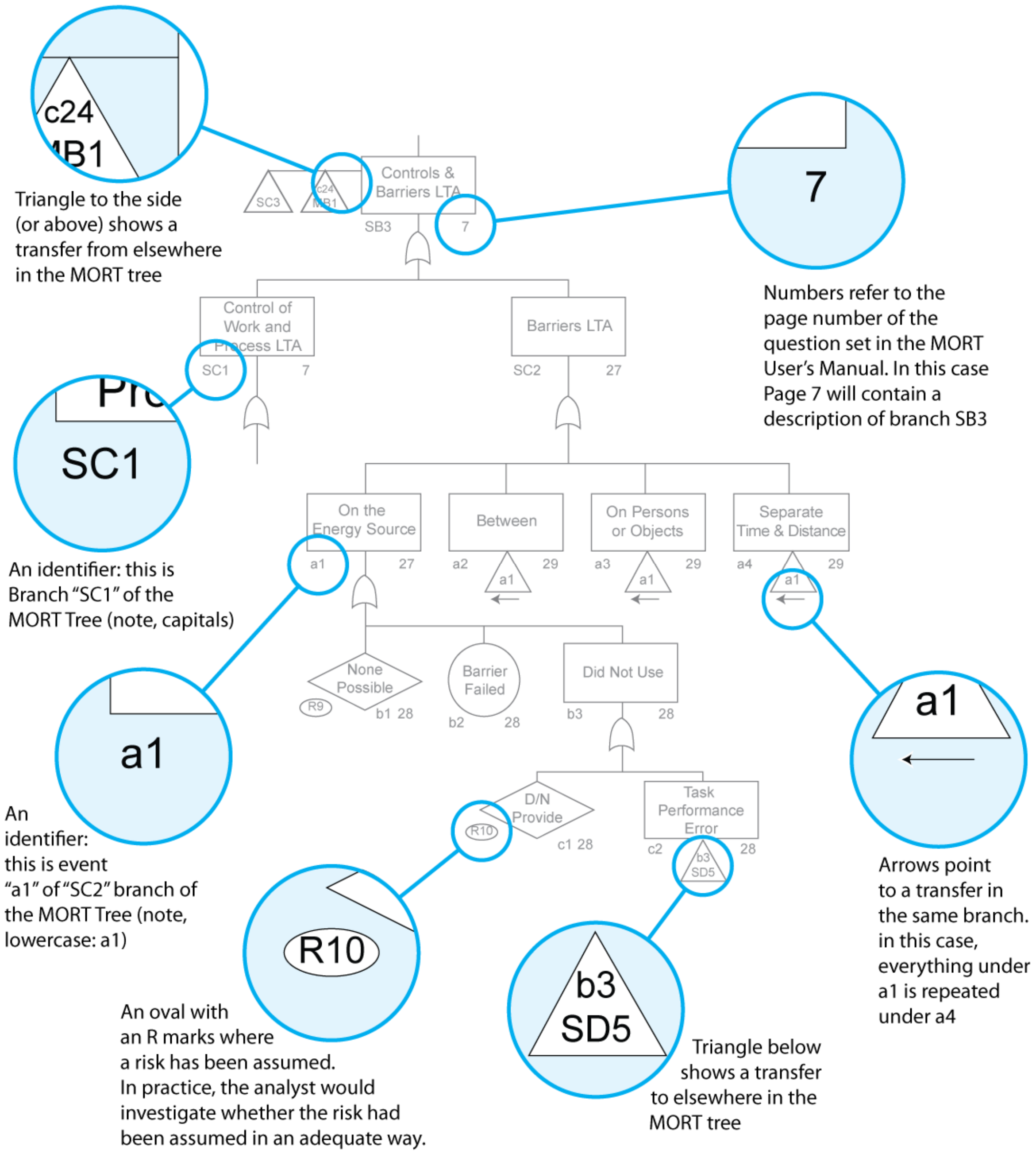
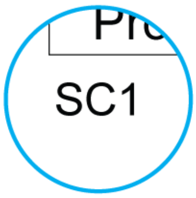
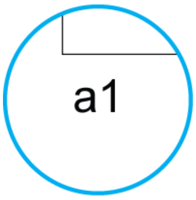


Figure 4. Examples of different reference types

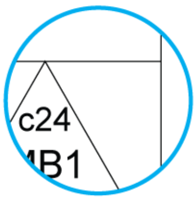


Every item on the MORT diagram has two references, an identifier (e.g. "SC2" is the identity of the MORT branch "Barriers LTA") and a reference to the relevant page of this manual. MORT identifiers follow a hierarchical scheme, reflecting the structure of the chart. The MORT chart can be divided into halves, "Specific Control" and "Management System". Identifiers use capital letters to show that the item is the top of a main branch. A main branch is one that can be regarded as having a distinctive theme, its own identity as it were. For these branches, a two-letter code is used. The first letter will be an 'S' or 'M' depending on whether it is the 'Specific Control' or the 'Management System' half of the MORT tree. The second letter will be an A, B, C or D, these letters corresponding to the tier, or level, of the branch in the tree. 'A' denotes a branch that is one tier down, 'B' a branch that is two tiers down, and so on. For example, in the case of MORT branch SC2, these conventions mean that it is a main branch that is three tiers down in the 'Specific Control' half of the MORT tree. The number 2 (of SC2) means that it the branch starts second from the left at the C-tier of the 'Specific Control 'half of the MORT tree. The numbering is methodical, and reflects the sequence in which the branches should be considered by the analyst. The main branches of the MORT tree are shown in Figure 5 on page xvii.

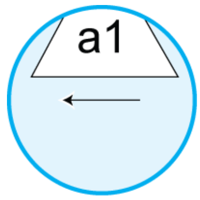


Within the branches of the MORT tree, the twigs or leaves are distinguished using lower case letters, 'a', 'b', 'c', and so on. As before, the choice of letter reflects the level in a hierarchy: 'a' identifies items at the first tier of a main branch, 'b' the next, and so on. The identifiers also have a number which reflects the sequence in which the analyst should work through the branch. For example, in Figure 4, 'b3' "Barrier Failed" is the third item in its tier. Most of the identifiers at the 'twig and leaf' level of the MORT tree are used many times in the tree as a whole. For instance, there are twelve instances of items called 'b3'. However, each instance is unique to its main branch. Hence, to refer to a specific 'twig or leaf', the identifier of the main branch is also given. In the case of leaf 'b3' "Barrier failed", this would be referred to as b3-SC2.

Transfers are another important type of reference system used in the MORT tree. In common with Fault Trees, the MORT tree contains branches that are repeated several times. Rather than draw the repeated branches in full, it is the convention to draw the branch just once and indicate where it is repeated with a triangle. The triangle is used because it resembles the shape of a fault tree. Figure 4, contains a number of transfers; item 'c2' (Task Performance Errors) serves as an example. Item 'c2' deals with the possibility that people did not use a barrier, even though it was provided. There may be many explanations for this, and the analyst needs to look into the relevant possibilities. To help the analyst, a set of questions has been developed; these correspond to the 'twigs and leaves' of the tree referred to as b3-SD5 (a different branch of the Tree from c2). The triangle below 'c2' is labelled "b3-SD5"; this means that the 'twigs and leaves' below c2 can be found at b3-SD5.



Triangles below an item like c2, are called "transfers-out" and every transfer-out to another part of the MORT tree has a corresponding "transfer-in". In Figure 4, two transfers-in are shown by the triangles connected by lines to 'SB3', "Controls & Barriers LTA".



A variation on the use of triangles-to-show-transfers occurs when the repeated part of the tree is within the same branch as the transfer-out. In Figure 4, there is a triangle below 'a4', "Separate Time and Distance". This triangle, which is labelled "a1", has a left-pointing arrow drawn underneath it. The arrow is a reminder that the transfer is to another twig in the same branch, in this case 'a1'. Hence, at 'a4' when considering why a "separate time & distance" barrier (e.g. segregation of pedestrians from an area traversed by forklift trucks) did not prevent an incident, the analyst would take into account all the items mentioned below 'a1', namely b1, b2, b3, c1 and c2. Within-branch transfers-out do not have a corresponding triangular symbol showing the transfer-in.

The last type of reference used in the MORT tree is for "assumed risks". These are marked using an oval containing an 'R' plus a number; there is an example at 'c1' in Figure 4. At its highest level, MORT has two hypotheses to explain why loss may have occurred. The first is the "oversights & omissions" hypothesis, in which the analyst investigates whether the system, in its broadest sense, has not controlled its risks adequately. The second is the assumed risk hypothesis, in which the analyst investigates the possibility that the loss is the manifestation of a risk that had been properly managed and controlled, albeit at a probability greater than zero. In MORT tree analysis, the analyst may find one or more instances where an "assumed risk hypothesis" needs to be evaluated. A typical example can be seen at c1-SC2 in Figure 4, which deals with the possibility that a barrier was deliberately not provided. If the analysis reveals that c1-SC2 is relevant, the analyst needs to investigate the adequacy of the relevant decisions (i.e. to not provide the barrier and, probably, to control the risk in other ways). The analysis of assumed risks is discussed further in the next sub-section.

2.4 Provisional Assumed Risks

In MORT analysis, losses can arise from two distinct sources: risks that have been identified and accepted correctly (called “assumed risks”) and risks that have not been managed correctly (so-called “oversights and omissions”). In some accidents, there will be contributions from both of these sources.

MORT contains several referrals to the “Assumed Risk” branch. As you can see in Figure 5 (page xvii), the assumed risk branch occurs at the highest level in the MORT tree. In sub-section 2.3, it was described how the analyst might identify relevant assumed risks and that the decision-making surrounding these needs to be investigated. To avoid interrupting the analysis, the analyst can record assumed risks in the table provided on the MORT chart and follow them up later.

MORT Ref.	Description	Adequacy of Decision-making?
b2-SB1	Corrosive effect of salt water on steel pipework	
c1-a3-SC2	Did not coat outside of pipe with salt-proof layer	
d9-SD5	Did not undertake a job safety analysis because job judged to present only low potential risks	

Table 1. Example of entries in a Provisional Assumed Risk Table

2.4 Structure of the MORT Tree

The MORT tree structure is derived from a fault tree analysis of the event “losses”. Note that loss is a very general term can apply to anything of value and any type of risk. The first tier answers the general question, “what types of risk would produce losses”? There are two possibilities: risks that were not adequately managed (Oversights and Omissions) or, risks that were adequately managed. Because the tree structure is explored in a set order – top to bottom, left to right – the next question is, “what would produce oversights and omissions”? The answer is given in the second tier of the tree: oversights and omissions arise from the control of the activity (Specific Control Factors) and how the risks of the activity are managed in general (Management System Factors). The rest of the tree is derived in the same way, with each tier “producing” the tier above it. Figure 5 is an overview of the main structure.

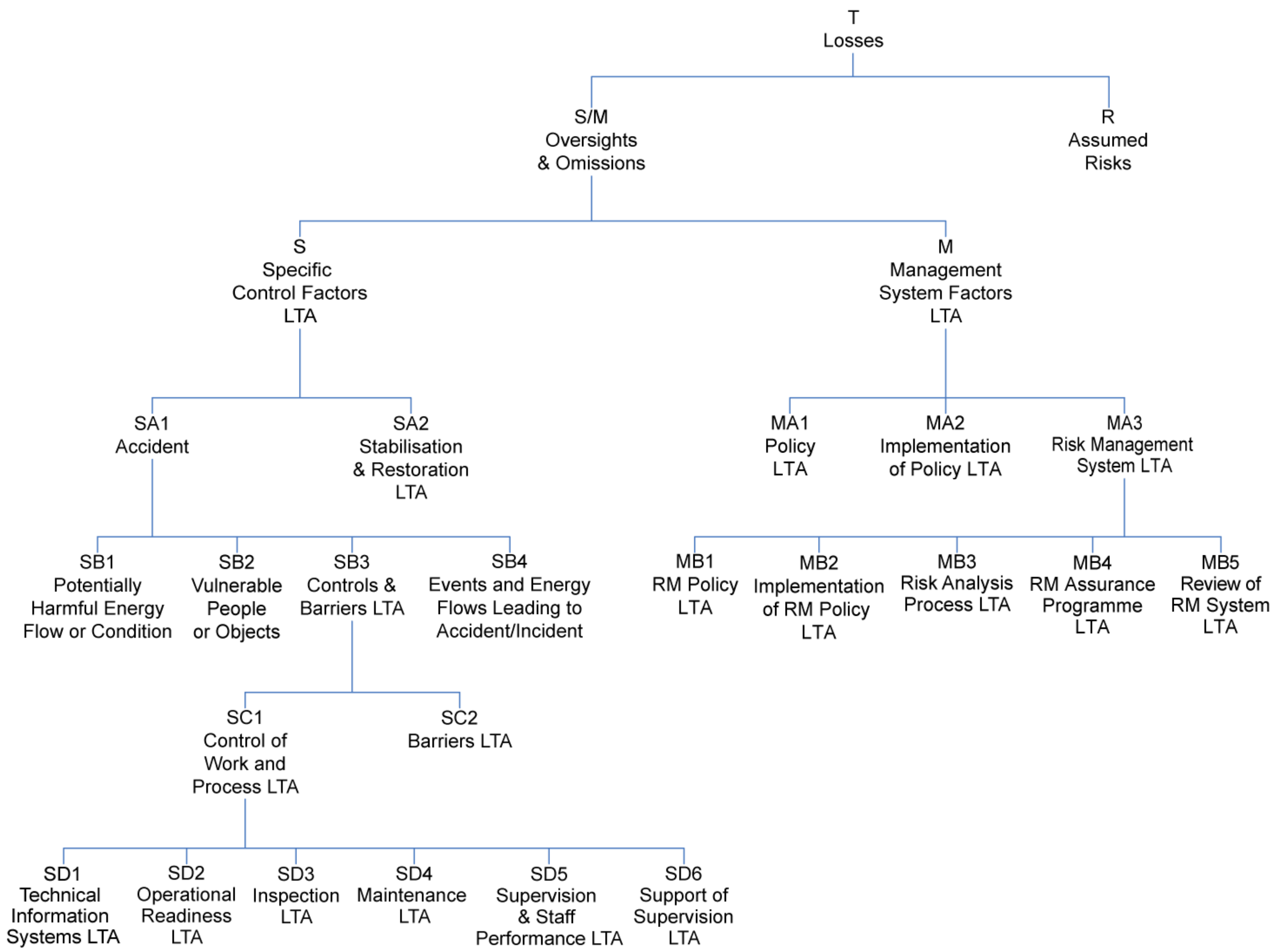


Figure 5.The Main Branches of the MORT Tree

3 Application of MORT to Investigations

Good investigations are built on a secure picture of what happened. MORT analysis needs this as a basis. Analysis using an appropriate "sequencing" method such as Events & Conditional Factors Analysis (ECFA+) can be effective and provides a detailed picture of the events comprising the accident. Using Energy Trace and Barrier Analysis is the way to connect MORT analysis to the events of the accident. Therefore, as soon as the factual picture allows it, carry out an Energy Trace and Barrier Analysis.

3.1 Energy Trace & Barrier Analysis

Energy Trace & Barrier Analysis (ETBA), or "Barrier Analysis" as it is usually called, is used to produce a clear set of episodes, or subjects, for MORT analysis. It is an essential preparation for MORT analysis.

Energy Flow or harmful Agent, adverse environment condition	**Target** Vulnerable person or thing	**Barriers & Controls** to separate Energy and Target

Table 2. Barrier analysis format

"Energy" refers to the harmful agent that threatens or actually damages a "Target" that is exposed to it. Although "Energy" and Energy-Flow are the terms most often used, harmful agents can include environmental conditions (e.g. biohazards, limited oxygen).

"Targets" can be people, things or processes – anything, in fact, that should be protected or would be better not disturbed by the "Energy". MORT defines an accident in terms of loss, so at least one of the targets in the accident sequence has to be valuable. However, incidents (sometimes called near-misses or near-hits) are also of interest.

The “Barrier” part of the title refers to the means by which “Targets” are protected from “Energies”. As well as barriers (the nature of which is purely protective), the analysis also focuses on work/process controls as these also provide protection by directing energies (and targets) in a safe manner.

Very often, an accident reveals a number of events where energies met targets in unwanted interactions; Barrier Analysis seeks to trace meticulously all of these interactions and make them available to analysis. This means that a Barrier Analysis table may have have several rows, each row corresponding to a distinct episode of energy interaction with a target.

3.2 Procedure for Barrier Analysis

Requirements: Technical understanding of the system in which the incident occurred and enough information about the sequence of events to allow analysis to begin.

Objective: To account for all unwanted exchanges of energies and to make these available to subsequent analysis within the investigation.

Description:

1) Familiarise yourself with available information (including site if accessible)
2) Determine scope: limit to just those interactions producing harm/damage or include near-misses as well?
3) Create three columns (as shown in table 3)
4) Start in the TARGET column and identify a target that was harmed or damaged (or, if you are looking at near-misses, a target exposed to harm). Identify the energy flow (or harmful agent…) that is acting and describe it simply and with precision in the ENERGY FLOW column.
5) Next, consider the BARRIERS and CONTROLS that should have stopped or limited the interaction between Energy and Target.
6) Repeat this process for another unwanted energy exchange.
7) Review the list of targets for any omissions.
8) Number rows (each row is an episode of energy flow threatening or damaging a target) in chronological order. There should be continuity: do the events follow from one another?
9) Prioritise rows for analysis using MORT (e.g. *** = most important, * = least important)

Energy Flow or harmful Agent, adverse environment condition	**Target** Vulnerable person or thing	**Barriers & Controls** to separate Energy and Target
These may be energies (and harmful agents…) designed to do work in the work process or extraneous energies that act from outside the process. Be meticulous as this stage of the analysis. Energy exchanges can be in the 'reverse direction' (e.g. exposure to cold, loss of pressure). If there are multiple targets for a given energy flow, state each interaction in a separate row.	Targets can be valuable (i.e. a person or asset) or not. The reason for including targets that have no intrinsic value is to ensure the continuity and completeness of the analysis. Try to identify *all* targets involved in the incident (this leads to a clear insight into the state of risk control). Every target mentioned should be accompanied by a word or phrase that identifies the attribute altered. E.g. "Smith (bruised arm)", or "Car (near-side door crumpled)". Note that the object or actor that corresponds to a target at one point in the analysis may also play other roles.	Barriers are means of separation present solely for protective purposes. Controls are means of channelling energy or substances to do work (and provide protection as a by-product). Controls also limit the exposure of targets. It is most effective to identify <u>physical</u> barriers (including time & space barriers) and controls that have their effect at the coal face/shop floor. MORT analysis will tease out the procedural and upstream issues; do not force them. Include *absent* barriers & controls that <u>should</u> have been present according to an explicit standard or justification.

Table 3. Barrier Analysis Headings, annotated with guidance

3.3 Procedure for MORT Analysis

Requirements:

- Two people (ideally)
- Technical Understanding of system in which incident occurred
- Sufficient description of sequence of events to allow analysis to begin
- MORT Charts and coloured pens – Red, Blue, Green
- Means to keep notes of: "blue" items for further enquiry; justification for"red" and "green" items.

Objective: To understand how specific targets were exposed to harm, damage or unwanted change and to explain this in terms of risk management.

Description

1) Choose an event from your Barrier Analysis and write it on the MORT chart above SA1 "Incident"
2) Perform SA1 analysis
   a) Begin at SB1 ("Harmful energy flow…")
   b) Above SB1, state the energy flow
   c) Proceed through chart top to bottom, left to right, as shown in Figure 6
      i) Code RED or GREEN only with evidence and an explicit standard of judgement
      ii) Code BLUE if evidence or required standard is uncertain
      iii) Maintain your list of further enquiries as you go
      iv) Write any provisional Assumed Risks into the table on the MORT Chart
   d) Explore M-branch either
      i) Ad-hoc, during SB3 analysis, or
      ii) When SB3 ("Controls & Barriers LTA") completed
3) If needed, choose another event from your Barrier Analysis
   a) Use fresh MORT chart
   b) Repeat step 2
4) When all required SA1 analyses are complete
   a) Note on the barrier analysis an events that have not been subject to MORT analysis
   b) Move to SA2 – Amelioration
   c) Move to M-Branch and explore (ad hoc or in sequence) in the light of the SA2 analysis
   d) Review Provisional Assumed Risks
5) Review MB4 (Risk Management Assurance Programme) in the light of the analysis so far
6) Review the M-branch issues, taking the overview

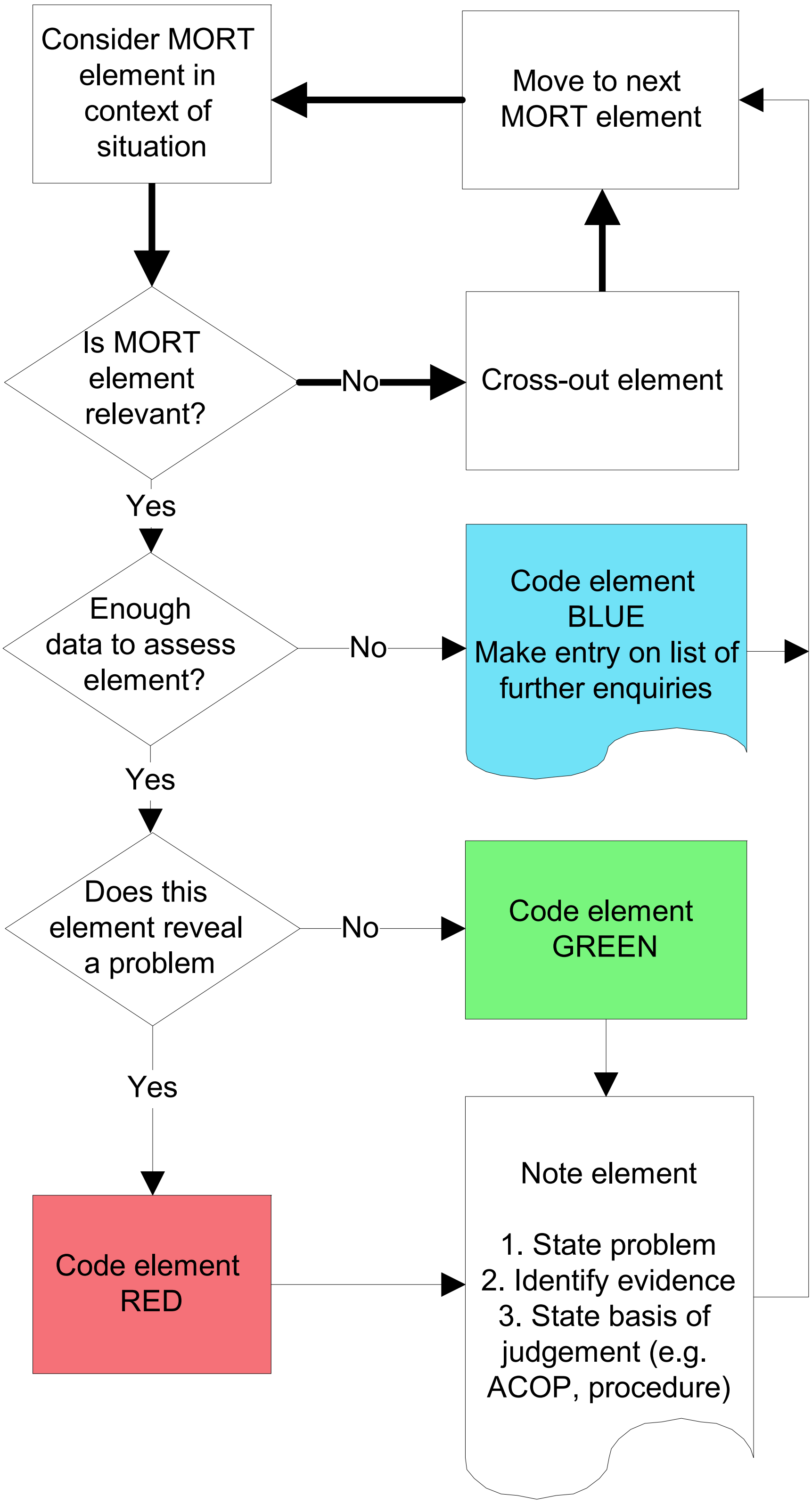


Figure 6. Sequence for work though the MORT Chart

(Note: ACOP, Approved Code of Practice)

Users Manual Part 2:
MORT Question Set

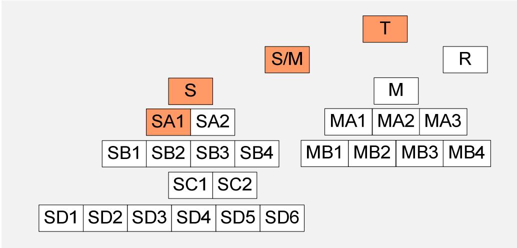
Intended for use with the

MORT Chart, 2nd Edition, 2009

CONTEXT

T Fundamental questions
S/M Oversights and Omissions
S The Accident

SB1 The potentially harmful energy flow/environmental condition



T Fundamental Questions (the Top event)

- What happened?
- What was the sequence of events including the initiating event that marked the movement of the work/process from adequately controlled to uncontrolled?
- Describe the extent of harm and losses (including intangible assets such as reputation, customer confidence, employee morale).

Subsequent analysis will seek to establish

- *why the harm or loss occurred;*
- *what future undesired events could result from the problems identified.*

S/M. Oversights and Omissions

This tree considers two explanations for the incident. The first explanation to be evaluated is that the incident was due to problems in the planning, design or control of work/process. The second explanation considered in this branch is that the incident was an acceptable outcome of the risk management process – an assumed risk.

S. Specific Control Factors

This half of the MORT tree addresses:

- *the specific controls upon harmful energies*
- *the specific controls upon vulnerable people and assets*
- *the barriers between energies, and people and assets*
- *how emergency actions contributed to the final outcome of the accident.*

As you go through the analysis, consider the future possible effects of the control problems identified. This helps to assess the seriousness of the control problems.

SA1. Accident

MORT analysis may involve more than one sweep through SA1. You are advised to decide at the outset how many energy-flow/target interactions (also called 'energy transfers') you intend to include in your analysis.

SA1 analysis leads naturally to:

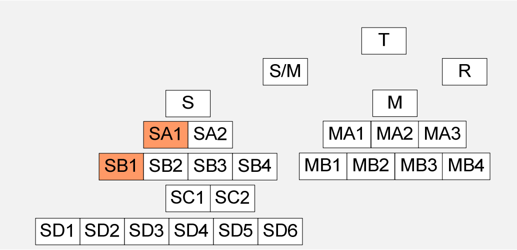
- *consideration of the Management System Factors, and*
- *judgement about whether decisions to accept risks were appropriate or not.*

SB1. Potentially Harmful Energy Flow or Environmental Condition

This branch considers the harmful energy/environmental condition in question. The purpose here is to gain a clear insight into the control issues.

To make this applicable to a wider range of circumstances, 'energy flow' has been extended to include harmful environmental conditions, e. g. a lack of oxygen in a confined space.

SB1 is considered for one energy flow (and associated barrier failures and damage) at a time. The analysis will need to be repeated for other energy flows within the event sequence describing the accident.



a1. Non-functional Energy

Consider this branch if the energy flow or environmental condition causing the harm was not a functional part of or product of the system.

A non-functional energy flow is an energy flow which is not meant to be there or did not contribute to the intended purpose or function of the system.

When deciding whether the energy flow was or was not intended, you will need to consider whose perspective to adopt. For example, the intentions of designers, managers, operators and observers may differ.

b1. Control of Non-functional Energy LTA

- Was there adequate control of non-functional energy flows and environmental conditions?

You need to think about what is adequate given the circumstances.

b2. Control Impracticable

- Was such control practicable?

Note that event b2 is flagged with R1 assumed risk symbol. If the control was not used because it was judged impracticable, the decision to leave the risk uncontrolled needs to have been "assumed" correctly. A decision to assume the risk must have been taken by an appropriate person in a suitable manner.

If you are using colours to mark-up a MORT chart, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation (see page 56, and section 2.4, page xvi in the introduction).

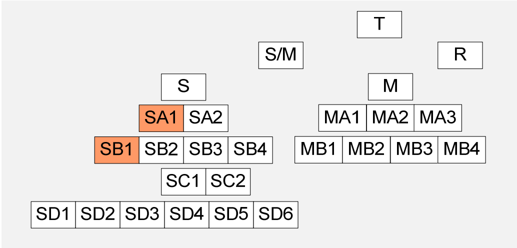
The event cannot be closed until justification for assuming the risk has been evaluated. Justification may be very different in different circumstances.

a2. Functional Energy

Consider this branch if the energy-flow (or environmental condition) was functional, but was used without adequate barriers in place.

Functional energy flow is an energy flow which is meant to be there and contributes to the intended purpose or function of the system.

MORT assumes that energy should only be applied if the barriers are adequate, if the barriers are inadequate, energy should not be applied or used only in reduced amounts.



b3. Control of Use LTA

- Was the energy applied at the right time and in the right amount?
- If not which controls of the energy were less than adequate?

b4. Diversion LTA:

- This branch considers diverting harmful functional energy away from vulnerable people or objects.

c1. Control of Functional Energy LTA

- Was there adequate diversion of harmful energy flows or environmental conditions?

c2. Diversion of functional Energy LTA

- Was diversion impracticable?

Note that event c2 is flagged with an R2 assumed risk symbol. See page 56, and section 2.4, page xvi in the introduction.

SB2. Vulnerable People or Objects

This branch considers who or what was exposed to the harmful energy flow or environmental condition. The purpose here is to gain a clear insight into the control issues.

SB2 is considered for one energy flow (and associated barrier failures and damage) at a time. The analysis will need to be repeated for other energy flows within the event sequence describing the accident. Section 2.1 in Part 1, discusses the number of energy flows to be considered.

For loss to occur something of value must be damaged or someone must be hurt. However, MORT can also be used to consider incidents where loss does not occur (e. g. near misses) but where energy was out of control.

a1. Non-functional

Consider this branch if the person or object exposed to harm was not a functional part of the system.

b1. Control LTA

- Was there adequate control of non-functional persons and objects?

b2. Control Impracticable?

- Was such control practicable? (Note that event b2 is flagged with R3 assumed risk symbol)

A non-functional person or object is one which was not meant to be there. That is, someone or something that did not contribute to the intended purpose or function of the system or is not intended to be part of the system under consideration.

Example - personnel passing through a worksite to reach an adjacent worksite

When deciding whether the presence of the person or object was or was not intended, you will need to consider whose perspective to adopt. For example, the intentions of designers, managers, operators and observers may differ.

a2. Functional

Consider this branch if the person or object was functional, but was exposed without adequate barriers in place.

b3. Control of exposure LTA

- Were the people or objects in place at the right time?
- If not, what controls to prevent persons or objects from being exposed were less than adequate?

b4. Evasive action LTA

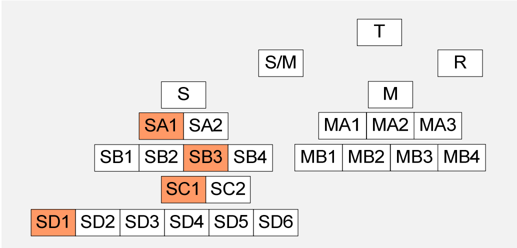
- This branch considers the evasion of harmful energy flows and environmental conditions.

c1. Means of Evasion LTA?

- Given that people and assets could be present, were the means provided to allow people or assets to avoid the harmful energy flow or dangerous conditions adequate?

c2. Evasion Impracticable

- Was evasion impracticable?



SB3. Barriers and Controls LTA

This branch considers whether adequate barriers and controls were in place to prevent vulnerable persons and objects from being exposed to harmful energy flows and/or environmental conditions.

Barriers are purely protective. They need to be designed to fit the characteristics of the energy flows involved and the targets that could be exposed. Examples include machinery guards, PPE, firewalls, blast walls and pipe-work integrity.

Controls are "controls of work and process" which may also serve to offer protection. Examples include safe operating procedures, toolbox talks, permits to work and isolations.

SC1. Control of work and process LTA

This branch considers the adequacy of the control system for the work activity or process in question. Six aspects of the control system are considered:

- *Technical information systems [SD1]*
- *Verification of operational readiness [SD2]*
- *Inspection [SD3]*
- *Maintenance [SD4]*
- *Supervision [SD5]*
- *Supervision support [SD6]*

At this point, you should be able to clearly describe the work activity, equipment or process in question. Diagrams and technical expertise may be needed to support this.

SD1 Technical Information Systems LTA

This branch is about the adequacy of the information system designed to support the work/process in question. This is considered in three ways:

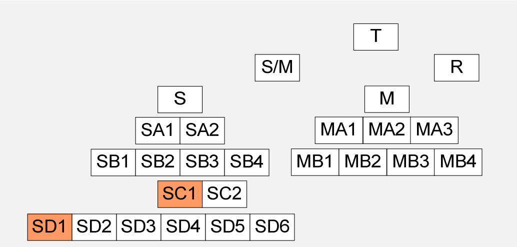
- *Providing information about the technology, activities and materials deployed; Examples – Toolbox talks, formal operator routines, task work pack containing necessary information on codes, standards and safety critical issues.*
- *The monitoring systems that measure the behaviour and efficiency of the "work flow process";*
- *Actions triggered by the results of the monitoring process (e.g. triggering of Risk analysis).*

a1. Technical Information LTA:

This branch considers the contribution of technical information to the control of the work flow process in question.

You need to consider:

- *the timing of information;*
- *the format of information;*
- *the capability for triggering necessary actions;*
- *who will be receiving/exchanging information;*
- *the availability of expertise and technical guidance.*



b1. Knowledge LTA:

This branch is about whether the people making decisions about this work/process were adequately knowledgeable or had access to adequate knowledge.

> *This includes people managing or supervising the work and people doing the work.*

c1. Based upon existing knowledge

This branch considers the application of existing knowledge about the energy flow and/or problem in question.

> *You will need to find out whether or not there is precedent for the unwanted energy flow.*

d1. Application of Codes and Manuals, LTA?

- Were the work/process and related issues adequately addressed by codes and manuals; and,
- Did individuals making decisions adequately apply the knowledge from codes and manuals?

d2. List of Experts LTA

- Was the list of experts (to contact for knowledge) adequate?

> *When deciding the adequacy of the list of experts, you need to consider:*
>
> - *Accessibility*
> - *Availability*
> - *Applicability*
> - *Any constraints*

d3. Local Knowledge LTA

- Was any relevant but unwritten knowledge about the work flow/process known to the "action" person (the action person is the individual, or individuals, undertaking the work task/process)?

d4. Solution Research LTA

- Was there any research directed to the solution of known work flow/process problems and was this adequate?

c2. If there was no known precedent:

- (meaning: no known precedent for the unwanted energy flow and its prevention)

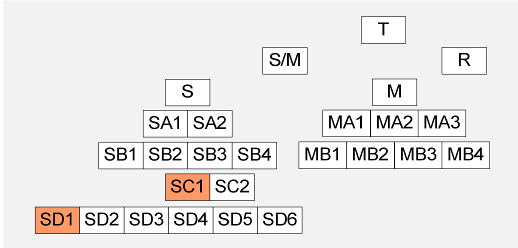
> *Consider this branch if the problem in question has <u>not</u> been experienced before within the organisation or elsewhere.*

d5. Previous investigation and analysis LTA?

- Have there been previous similar accidents or incidents, or risk assessments of this work/process?
- Were these investigations or assessments adequate?

d6. Research LTA?

- Was there any research directed to the identifying and solving work flow process problems? Was this adequate?



b2. Communication LTA:

This branch considers the adequacy of communication of knowledge about the specific problem in question

c3. Internal Communication LTA

This branch considers the adequacy of internal communication of knowledge about the specific problem in question

Consider:

- *the magnitude of hazard involved;*
- *the relevant people, and their different roles in relation to the work/process;*
- *the range of communication channels e.g. procedures, training, supervision, task risk assessment, etc.*

d7. Internal Network Structure LTA

- Was the structure of the internal communication network adequate?

d8. Operation of Internal Network LTA

- Was operation of the internal communication adequate?

c4. Was the external communication LTA?

- This branch is about the adequacy of communication between the organisation and any relevant external sources of knowledge.

Consider:

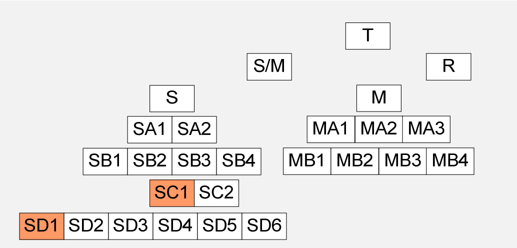
- *all types of network, formal/informal, including verbal, written and IT*
- *Who needed to know what information and when?*
- *Did people know how to get information if they had a problem?*

d9. External Network Definition LTA?

- How well had the organisation identified external sources of knowledge relevant to the work/process?
- How well was the organisation connected to any relevant external sources of knowledge?

d10. External Network Operation LTA

- Was information obtained from these external sources in an effective way?



a2. Data collection LTA

This branch considers how the organisation captures data about its own operating experience.

The purpose of collecting this data is to provide feedback to improve the work/process.

The focus here is not only data current to the problem under consideration but also the collection of relevant data before the incident to detect problems at an early stage.

b3. Monitoring Plan LTA?

- Was there an adequate plan for monitoring the workprocess and conditions?

b4. Independent Review LTA?

- Did an independent organisation/person review the work/process to identify high potential hazards? Was the review done adequately?
- If no review, should one have been undertaken?

b5. Use of Previous Accident/Incident Information LTA?

- Was information about relevant problems from earlier incidents/accidents used adequately?
- When there are relevant previous incidents:
  - had the work/process been improved in the light of findings and recommendations?
  - were improvements documented?
  - had relevant information been made available to people employed within the work/process?

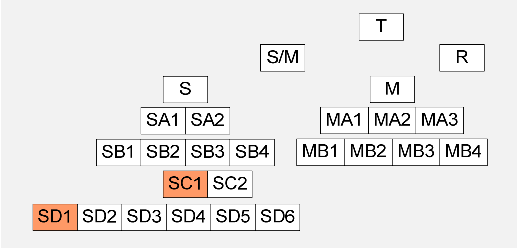
b6. Learning from employee/contractor's personnel experience LTA

- Was there an adequate method for gaining insights into operating experience of the work/process?
- Might it have provided information to identify the problem in question?
- Was there a plan for undertaking research to identify insights? Was it adequate?
- Was there an adequate system for collecting and using employee suggestions?

It is rare that problems are entirely new, but awareness of them may not have reached people in a position to solve them. In view of this, methods such as critical incident studies aim to provide an opportunity to operating personnel to relay their concerns relating to a specific work activities and processes.

b7. Were routine inspections of the work/process LTA?

- Did they adequately consider safety, health and protection of the environment?



b8. "Upstream" process audits LTA

- Was an adequate system in place to assure the quality of the planning and design of the work/process?

b9. Health monitoring

- Was the monitoring of the general health of operational personnel in the work/process LTA?

"Upstream" work processes include design, construction, selection and training, etc.

Audits of planning and design these processes need to include examination of the three basic work ingredients - hardware, procedures, and people.

a3. Data analysis LTA

This branch considers whether data relevant to the work/process had been adequately analysed.

b10. Priority problem list LTA?

- Is the problem in the work/process included on the priority problem list?
- Should it have been?
- Is the absence of the problem in question from the list, an indication that the list is not up-to-date?

A priority problem list (a list of the highest risks) is a statement of the most serious risks assumed within the organisation. These are residual risks that have been accepted for on-going operations after review and reduction measures. The purpose of this list is to maintain awareness of these problems at the appropriate management level.

Each level of management may have its own priority problem list. You should consider whether this is appropriate in the organisation that you are considering.

Data are not informative without analysis. Furthermore, certain forms of analysis can detect patterns not otherwise discernible, for example trend analysis and other forms of projection. Graphical analyses are particularly useful.

Analyses should provide decision-makers with adequate information and interpretation to make appropriate decisions about risk.

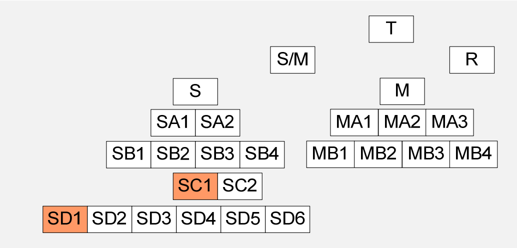
Analysis is a continuous process that should aim to provide the best understanding based on the most current and relevant information.

b11. Statistics and Risk projection LTA?

- Were the available status statistics, predictive statistics and projections adequate? Would they have alerted management to the problem in the work/process?

b12. Status Display LTA

- Was there an adequate single information display point for managers to help them keep abreast of current problems, analyses, and results?



a4. Triggers to Risk Analysis LTA

This branch considers whether problems in the work/process should have triggered the risk analysis process before the incident in question.

> *Triggers are related to change. Planned change will involve pre-set triggers, for example introducing new equipment or new working methods should be informed by risk analysis. Unplanned change needs to be detected by monitoring and analysis, these in turn need to be designed to trigger risk analysis where appropriate. Risk analysis should then initiate appropriate action to reduce risk.*

b13. Sensitivity LTA

- Was the technical information system sensitive enough to trigger risk analysis for the individual problem (within the work/process in question)?

b14. Priority Problem Fixes LTA:

- If this was a problem on the Priority Problem List? Did the technical information system trigger the risk analysis process?
- If not, does this indicate less than adequate trigger arrangements?

b15. Planned Change Controls LTA

> Planned changes relates both to changes to plant and procedures

- If there had been a planned change in the work/process, did the people volved in making that change adequately recognise the need for risk analysis?
- Were the pre-set triggers to initiate risk analysis adequate?
- Was the fact that the risk analysis process was not used, evidence of inadequacies in the change control process?

b16. Unplanned Change Controls LTA

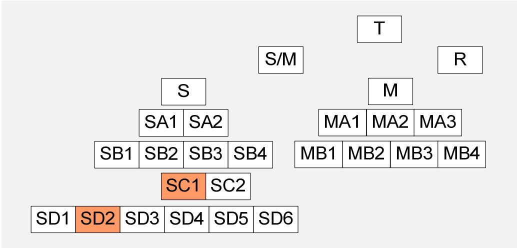
- If there has been unplanned change in the work/process, were the people involved in making that change adequately aware of the need for risk analysis?
- Were there adequate pre-set triggers to initiate risk analysis?
- Was the fact that the risk analysis process was not used, evidence of problems in the change control process?

b17. New Information Use LTA

- Were risk analysis process triggers from research, new standards, etc. , adequately recognised and used?

a5. Independent Audit and Appraisal LTA:

- Was the technical information system subject to adequate review?



SD2. Operational Readiness LTA

This branch considers the adequacy of efforts to ensure that work/process or site was ready to be used or occupied. If operational readiness was not assured, control of the work/process may have been inadequate. Consider readiness in terms of:

- *plant/hardware;*
- *procedures/management controls; and,*
- *personnel.*

This branch deals with "Here & Now Readiness" the purpose of which is to ensure that the requirements specified by planners and designers are met when the work/process or equipment is actually used.

Examples – isolation certificates, hand-over certificates, work permits and inspection of the worksite.

Later in the M-branch (branch b14-MA3), you will consider the second component, "Specification of Operational Readiness". This is the outcome of a task, equipment or process design activity.

a1. Verification of operational readiness LTA

This branch considers whether verification of the operational readiness of the facility and work process was adequate.

b1. Did not Specify Check

- Was an operational readiness check specified for this work/process?
- Would an adequate operational readiness check have identified the problem in question?

b2. Readiness Criteria LTA

- Were the criteria used to check operational readiness, adequately specified?

b3. Verification Procedure LTA

- Was the required procedure for determining operational readiness adequate? Was it followed adequately?

b4. Competence LTA

- Were the personnel who made the decision on operational readiness adequately skilled, competent and experienced?

b5. Follow-up LTA

- Were all actions - identified through operational readiness checks - adequately followed up?
- Were all outstanding actions resolved before start-up of the work/process?

a2. Technical Support LTA:

- Was adequate technical support provided to assuring the readiness of the work/process?

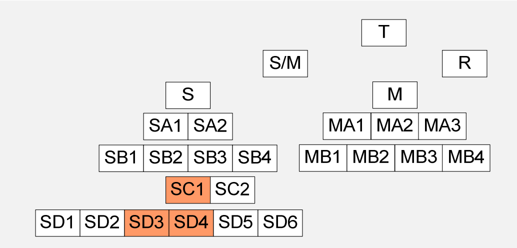
Technical support (e.g. by scientists and engineers) at the work site is particularly important to ensure readiness.

a3. Interface between Operations and Maintenance or Testing Activities LTA:

- Was the interface between operations personnel and testing or maintenance personnel adequate?
- Could procedures have prevented misunderstandings about the state of operational readiness?

a4. Configuration LTA:

- Was the actual physical arrangement or configuration of the work/process identical with that required by latest specifications and procedures?



SD3. INSPECTION LTA

Inspections are done to determine the state of equipment, processes, utilities, operations, etc.
Questions are the same as Maintenance LTA (SD4)

SD4. MAINTENANCE LTA

This branch considers the contribution of maintenance (or inspection) of equipment, processes, utilities, operations, etc relating to the problem in question.

Maintenance or inspections may be carried out by the organisation directly or by agents (e.g. contractors) acting on its behalf.

a1. Planning Process LTA:

This branch considers whether the scope of the (inspection or) maintenance plan adequately considered all the areas relevant to the problem in question.

Was management aware of any aspects relevant to the problem in question not included in the plan?

b1. Specification of Plan LTA:

This branch considers whether the problem in question is related to how the maintenance (or inspection) plan was specified.

c1. Maintainability (Inspectability) LTA:

- Is the problem in question a result of inadequate maintainability (inspectability)?

c2. Completeness of the Plan LTA:

- Is there an adequate inventory of what is to be maintained (or inspected)?

c3. Schedule LTA:

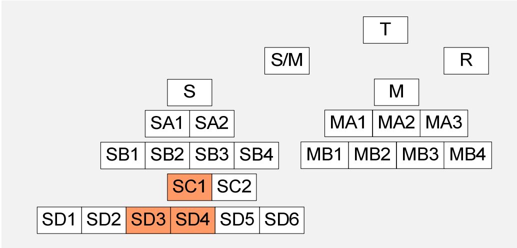
- Did the plan schedule maintenance (inspections) frequently enough to prevent or detect undesired changes?
- Was the schedule readily available to the maintenance (inspection) personnel?

c4. Co-ordination LTA

- Did the (inspection or) maintenance plan adequately address methods for minimising problems with disruption to equipment, processes, utilities, operations, etc. when they are undergoing maintenance (or being inspected)?
- Was the schedule co-ordinated with operations to minimise conflicts?

c5. Competence LTA:

- Was personnel competence adequately specified/developed for the maintenance tasks (inspection tasks) in question?



b2. Analysis of Failures LTA:

- Have previous relevant failures of equipment/process been subject to adequate analysis for cause?
- Were such analyses adequately specified by the plan?
- Did an appropriate individual or group adequately act upon the results of such analysis?

Previous near-miss or incident investigations may also have high-lighted the need for maintenance (or in-spection) plans to be modified.

a2. Execution LTA:

This branch looks at whether the problem in question is a result of how the maintenance (or inspection) plan was exe-cuted.

b3. "Point of Operation" Log LTA:

- Is the problem in question connected to whether a log of maintenance (in-spections) was available at the point of operation of the piece of equip-ment, process, or activity?

A "point of operation log" can be a document that is kept with the equipment concerned to allow ease of examination. Alternatively, the log can be made available using e.g. handheld computing devices that provide local (to the equipment) access to the necessary records.

Logs need to be read out in order to function.

b4. Failure caused by maintenance (inspection) activity:

- Was the problem in question the result of a failure introduced by mainte-nance (inspection) of the work/process?

b5. Time LTA:

- Was the time specified in the plan's schedule sufficient to adequately per-form each task?
- Was the time allocated for personnel adequate to fulfil the schedule? Was the time actually made available?

b6. Task Performance Errors:

- Were the individual tasks (as set out in the plan) performed properly?
- If not, identify who is performing which task and the nature of the errors made. Then refer to further questions in Task performance errors (SD5 , this begin on page 18).

SD5. Supervision and Staff Performance LTA

This branch is about the role of supervision and staff performance in the control of work/process in question.

a1. Time LTA:

- Did the supervisor have sufficient time to thoroughly examine the work/process?

a2. Continuity of Supervision LTA:

- Were there any gaps or confusions in the transfer or hand-over of supervisory tasks related to the problem in question?
- If the supervisor was recently transferred to the job, was there procedure for transfer of risk information from the old to the new supervisor?

Hand-over includes shift changes, new employees and hand-over of responsibility for a location. Examples include:

- ❖ *hand-over logs between supervisors back-to-back on shifts*
- ❖ *transfer of responsibility on a permit-to-work, or suspension and re-instatement of permits.*

The purpose of supervision is to ensure that an activity or process is working, or will work, smoothly.

It is supervision that is under examination - the emphasis is on what not who. You will need to consider what constitutes supervision, in terms of:

- ❖ *Hierarchical levels*
- ❖ *Boundaries and interfaces of supervision*
- ❖ *Duties and motivations*
- ❖ *For any one supervisor, the prevailing circumstances at the time in question. This will often include exploring the supervisor's workload around the time in question*

a3. Detection/Correction of Hazards LTA:

This branch considers whether the supervisor's efforts in detection and correction of hazards were systematic and adequate.

b1. Detection of Hazards LTA:

This branch considers whether the problem in question was related to pre-existing hazardous conditions which went undetected by the supervisor.

c1. Checklists LTA:

- If there was a checklist of hazards in the specific work/process, was it used correctly?
- Did the absence of such a checklist contribute to the problem in question?

c2. Detection Plan LTA:

This branch considers whether there was a systematic approach to uncovering hazardous conditions in the work/process.

d1. Logs, Schematics LTA:

- Was there adequate information available at the point-of-operation to help the supervisor to inform his risk detection?
- Were maintenance and inspection logs available at the equipment concerned adequate?
- Were work diagrams adequate?
- Was the use of labels/tags to signify changed equipment or settings adequate?
- Was the point-of-operation posting of warnings, emergency procedures, etc., provided for?

"Point-of-operation" means the equipment, workstation or area in question.
If relevant, a permit-to-work system should feature the posting of warnings and emergency procedures. Where PTW is not relevant, "General Detection Plan" is the catch-all phrase for ensuring that warnings and emergency information is established and maintained at the point-of-operation.

d2. Supervisor's Monitoring Plan LTA:

- Would the problem in question have been detected by a planned approach to inspecting and monitoring the status of the work/process (i.e. equipment, procedures, and personnel)?

In evaluating this issue you need to consider how the organisation guided and supported the supervisor's efforts. Also consider whether he was given guidance on detection of individual personnel problems, such as alcoholism, drug use, personal problems etc.

d3. Review of Changes LTA:

- Were any changes involved in the work/process, whether planned or unplanned, known to the supervisor? Was his response adequate?
- Was the supervisor's method of detecting and reviewing change adequate?

d4. Did not Relate to Prior Events:

- If there were problems in the work/process before the incident, did the supervisor consider the impact these might have on quality and safety?
- Was the supervisor aware of other signs or warnings that the work/process was moving out of control?

For example, a machine that continuously blocks may provoke users to clear the blockage without turning off the machine.

c3. Time LTA:

- If the problem in question was not identified before the incident, had the supervisor adequate time to detect the hazards?

> *Consider the supervisor's workload, especially if this is spread over a number of locations. It may be necessary to find out when the supervisor last inspected the area, and if any unsafe condition present in this accident/incident was also present at the time of this inspection.*

c4 Workforce Input LTA

- If the workforce already knew about the problem in question, was this information passed on to the supervisor?

> *Knowledge of hazards is often available from the work force. The supervisor must be receptive, accessible and must act constructively on suggestions. As a rule, it is preferable to involve the people who will be involved or who are already familiar with the work/process in question in task specific risk assessment.*

b2. Correction of Hazards LTA:

This branch considers whether the problem in question was related to detected hazards which went uncorrected by the supervisor.

c5. Interdepartmental Co-ordination LTA:

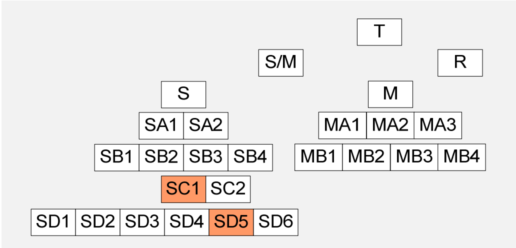
- If the work/process involved two or more departments, was there sufficient and unambiguous co-ordination of activities between the departments?

> *Interdepartmental co-ordination is a key responsibility supervision and line management. It should not be left to work level personnel.*

c6 Postpone

- Was the supervisor's decision to accept the risk associated with postponing the correction adequately reached?

> *Event c6 is flagged with R5 assumed risk symbol. It was an assumed risk only if it was a specific named event, analysed, calculated where possible, evaluated, and subsequently accepted by the supervisor who was properly exercising management-delegated, decision-making authority.*
>
> *The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue.*



c7. Did not Correct in Time:

This branch considers whether the problem in question could have been corrected if the supervisor had acted in time. The scope of action includes acting directly or referring the problem to an appropriate authority.

d5. Authority LTA

- Was the supervisor's decision to delay hazard correction made on the basis of limited authority to stop the work/process?

d6. Budget LTA

- Was the supervisor's decision to delay hazard correction made on the basis of budget considerations?

d7. Time LTA

- Was the supervisor's decision to delay hazard correction made on the basis of time considerations?

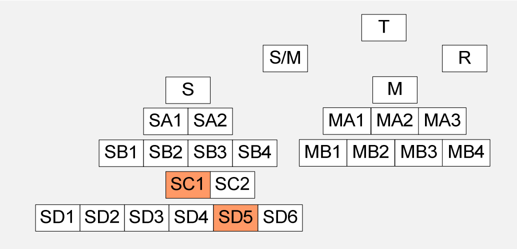
c8. Housekeeping LTA:

- Would adequate housekeeping have prevented the problem in question?
- Was the storage plan for unused equipment adequate?

c9. Supervisory Judgement:

- Was the judgement exercised by the supervisor (not to correct the detected hazard) adequate considering the level of risk involved?
- Has a precedent been established that the supervisor does not act in such circumstances?

Review the supervisor's decision not to act on the hazard. Reasons include perceived ownership, authority to act on hazard, risk perception (underestimating risk, overestimating cost of correction).



a4. Performance Errors:

This branch considers how errors made by front-line personnel contributed to the problem in question.

b3. Task Performance Errors:

When using this branch, you need to have in mind specific errors that contributed to the problem in the work/process.

c10. Task Assignment LTA:

- Was the problem in question a result of how the task was assigned by the supervisor to the member of staff?
- Was the assigned task properly scoped with steps and objectives clearly defined?
- Was the task one an employee should undertake without specific instructions from the supervisor?

There are few "unsafe acts" in the sense of blameworthy frontline employee failures. Assignment of "unsafe act" responsibility to a frontline employee should not be made unless or until the following preventive steps have been shown to be adequate:

- *risk analysis;*
- *management of supervisory detection; and*
- *review of procedures for working safely;*
- *Human factors review of*

c11. Task Specific Risk Assessment Not Performed:

This branch considers whether a task specific risk assessment should have been carried out for the work/process in question. This is of particular concern in situations where a task specific risk assessment has not been applied despite the existence of significant risks.

MORT analysis proceeds on the premise that a task specific risk assessment should always be made for tasks assessed as having high hazard potential. Pre-Job Analysis is an example of how tasks can be surveyed step-by-step to determine hazard potential and therefore the level of risk assessment to be applied to the task/job.

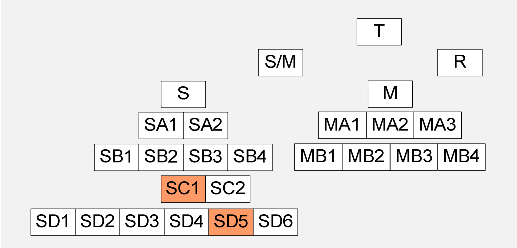
d8. High Potential was not Identified

This branch assumes that a high potential for harm or damage arising from the work/process in question has not been identified by screening.

e1. Task Analysis Not Required

- Did management require a pre-job-analysis to be performed for the work/process in question?

Ordinarily, MORT assumes that a structured process e. g. Pre-Job-Analysis should be applied to screen the work/process for hazards and identify the need for a risk assessment. The structured process should identify the potential for error, injury, damage, or for encountering an unwanted energy flow



e2. Task Analysis LTA

- If required, was the pre-job-analysis adequate for the work/process in question?

e3. Task Analysis Not Made:

- This branch considers the failure to do a pre-job-analysis that was required for the work/process in question.

Task Analysis is an example of how tasks can be surveyed step-by-step to determine hazard potential and therefore the level of risk assessment to be applied to the task/job.

f1. Authority LTA

- Was the Task analysis not carried out because of lack of authority or because the duty had not been assigned for the work/process in question?

f2. Budget LTA

- Was it because of budget reasons?

f3. Time LTA

- Was it because of time constraints?

f4. Supervisory Judgement LTA

- Was the pre-job analysis not carried out for the work/process in question because of an inappropriate decision by the supervisor?
-

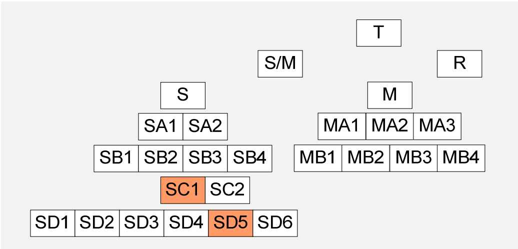
You will need to consider who was in a position to do the analysis and when they could have done it.

d9. Low Potential:

- Was the work/process in question identified as one involving low risk potential? Was this a reasonable assessment?
- Was the supervisor the right person to make this decision?
- Note the event is flagged with R6 assumed risk symbol.

Event d9 is flagged with R6 assumed risk symbol. If the criteria for risk identification and assessment were properly met, this event transfers to the Assumed Risk branch.

The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue. See page 56, and section 2.4, page xvi in the introduction.



c12. Task Specific Risk Assessment LTA:

This branch considers whether the task specific risk assessment for the work/process in question was adequate and scaled properly for the hazards involved.

> *The effort that is directed to task specific risk assessment, should be proportionate to the magnitude of the risk posed by the task. In order to determine the magnitude of the risk, some sort of analysis, e.g. pre-job analysis, needs to have been carried out.*

d10. Task Specific Risk Analysis LTA:

This branch considers whether the quality of the task specific risk analysis contributed to the problem in question.

e4. Knowledge LTA:

- This branch considers whether there was adequate knowledge available to the task specific risk analysis in question.

f5. Use of Workers' Suggestions and Inputs LTA:

- Were workers' suggestions and inputs adequately used in the task specific risk analysis?

f6. Technical Information Systems LTA:

- This branch considers whether the task specific risk analysis was adequately supported by technical information.
- Analysis of the possible reasons for inadequacy is shown under SD1.

> *Technical information relevant to risk aspects of the work/process often exists but is not available to the "action" persons carrying out the task specific risk assessment.*
>
> *Your evaluation of SD1 should be from the perspective of developing a risk assessment.*

e5. Execution LTA

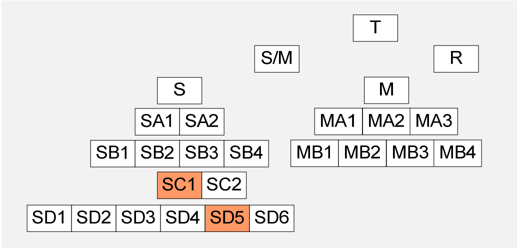
- This branch considers the quality of the task specific risk analysis.

f7. Time LTA:

- Was there sufficient time to adequately perform the task specific risk analysis for the work/process in question?

f8. Budget LTA:

- Was there a sufficient budget?



f9. Scope LTA:

- Were the scope and detail of the task specific risk analysis sufficient to cover all risks related to the work/process in question?

f10. Analytical Skill LTA:

- Were the experience and skill of the supervisor and other participants adequate to accomplish the required task specific risk assessment?

f11. Hazard Selection LTA:

This branch considers the omission of a hazard relevant to the problem in question. Hazard selection is critical to the adequacy of the task specific risk analysis.

g1. Hazard Identification LTA

- Were the criteria used to identify hazards for adequate?

g2. Hazard Prioritisation LTA

- Were the methods used in prioritising the identified hazards adequate?

d11. Recommended Risk Controls LTA:

This branch considers whether the problem in question was related to the adequacy of controls recommended by the task specific risk assessment.

Risk controls in the work/process in question could involve facilities, equipment, procedures and personnel.

e6. Clarity LTA:

- Were the recommendations from the task specific risk assessment sufficiently clear to permit their easy use and understanding?

e7. Compatibility LTA:

- Were the recommended controls compatible with existing controls and requirements that apply to the work/process in question?

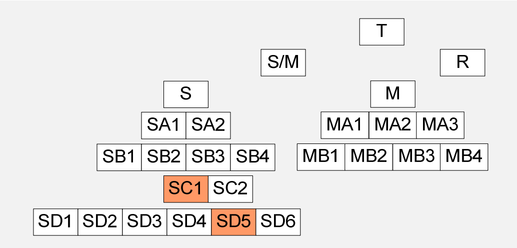
e8. Testing of Control LTA:

- Were recommended controls tested in situ for effectiveness before being implemented?

e9. Directive LTA:

- Was the directive for use of the recommended controls adequate?

Was the directive explicit and impossible to misunderstand?



e10. Availability LTA:

- Were the recommended controls available for use by personnel involved?

e11. Adaptability LTA:

- Were the recommended controls designed in a way that allowed them to be adequately adapted to varying situations?

e12. Use Not Mandatory:

- Was use of the recommended controls mandatory?

> *Event e12 is flagged with the R7 assumed risk symbol. If use of the recommended controls was optional, you need to evaluate whether the failure to use them was a correctly assumed risk or a management system failure.*
>
> *The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue; and make an entry made in the "Provisional Assumed Risk" table drawn up for this investigation.*

c13. Pre Task Briefing LTA:

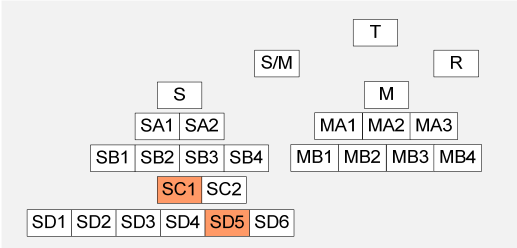
- Was the workforce given an adequate pre-task briefing (prior to performing the task)?

> *For example, did the briefing include new hazards, the effect of recent changes, such as changes arising through maintenance, new equipment, etc.?*

c14. Fit between Task Procedures and actual Situation LTA

- Did the procedure, whether oral or written instruction, fit with the actual requirements or circumstances of the work/process in question?

> *Aspects of the situation that were not adequately addressed by the procedure should be noted. In practice, you will need to review the relevant procedure.*



c15. Personnel Performance Discrepancy:

This branch considers whether the failure of individuals to perform their individual task assignments contributed to the problem in question.

Possible causes of performance discrepancy should be considered for each individual whose performance was judged to vary from correct practice.

d12. Personnel Selection LTA:

This branch considers how selection contributed to the problem in question.

e13. Criteria LTA:

- Did the definition of job requirements result in the selection of an individual who was unable to perform the task in question reliably?

e14. Testing LTA:

- Was an adequate (i.e. valid and reliable) method used to test the candidates against the criteria established for the job.
- Had there been a timely re-examination of the individual against the requirements established for the task?

d13. Training LTA:

This branch considers whether the training of the individual contributed to the performance error.

e15. No Training

- Was the individual trained for the task he or she performed?

Event e15 is relevant if the task required training to achieve reliable performance

e16. Criteria Training LTA:

- Was the individual unable to perform the task in question correctly because of inadequate definition of his or her training needs?

e17. Methods LTA:

- Did the methods used in training adequately prepare the individual to meet the requirements established for the task?

Consider methods such as realistic simulation, programmed self-instruction, and other special training in addition to basic initiation, plant familiarisation, etc.

e18. Trainer Skills LTA:

- Did inadequacies in the professional skills of the trainers compromise the performance of the task in question?

e19. Verification LTA:

- Was the verification of the person's current competence adequate?
- Were re-training and re-qualification requirements of the task adequately defined and enforced?

Did the verification process include initial testing and later assurance of task performance to ensure that the standards established for the task were met?

d14. Consideration of Deviations LTA:

This branch considers whether the supervisor was adequately alert to earlier personnel performance and variability.

e20. Normal Variability:

- Was the individual's performance within the range of normal variability?

e21. Changes:

- Did the supervisor detect individual personnel problems, such as alcoholism, drug use, and personal problems?

Some degree of variability is normal and expected. Normal personnel performance variability is viewed as manageable through appropriate equipment design, good planning, training, and application of human factors.

Consider this question (e21) if the individual's performance in the task in question was significantly different from the performance standard needed for the task.

Some degree of change is normally expected to occur. Significant change may be associated with illness, fatigue, personal problems, etc. These factors may result in individual performance beyond the normal range of variability. MORT assumes that the supervisor will be alert to such changes.

e

e22. Supervisor Observation LTA:

- Did the supervisor observe the individual performing incorrectly (i.e. extreme variability or significant change in the individual)?

e23. Supervisor Correction LTA:

- This branch is concerned with whether the supervisor's actions to correct the individual's performance were adequate.

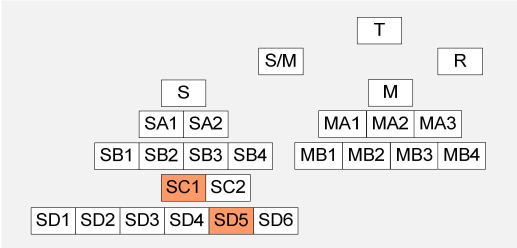
f12. Re-instruction LTA:

- Did the supervisor adequately re-instruct the person as to the correct performance?

f13. Enforcement LTA:

- Did the supervisor enforce established correct rules and procedures?
- Were disciplinary measures ordinarily taken against personnel who wilfully and habitually disregarded rules and procedures?

Enforcement –You need to consider the work environment. Where rule-breaking has become acceptable, isolated enforcement action by the supervisor may not be either effective or fair.



d15. Employee Motivation LTA:

This branch considers whether employee motivation contributed to the incorrect performance of the task in question.

You may better understand how the organisation failed to motivate the individual to perform the work to the required standard by looking at why the individual made the choices he or she made. To do this we need to consider the situation, in particular the rewards and punishments, from the individual's perspective.

e24.Leadership and Example LTA:

- Was the individual poorly led?

e25. Time Pressure:

- Was enough done to limit time pressure and workload to a for the individual acceptable level?

  Consider this question if time pressure was perceived by the individual who made the performance error.

e26. Correct Performance is Punished:

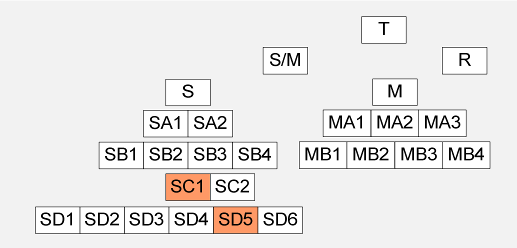
- In the past, was the employee "punished" for performing the task in question correctly?
- Was the supervisor sufficiently alert to this factor?

From the viewpoint of the employee, sometimes there is an undesirable consequence to the person doing a good job.

Punishment does not have to be something intended by supervision, it can be the product of poorly designed work and processes. To understand this, you will need to consider the situation from the individual's perspective.

Leadership and example are difficult to measure but you will need to consider their adequacy, particularly within the line organisation. Aspects of leadership relevant to the task performance issue might include:

- *the consistency through different levels of management;*
- *whether managers decisions and actions match the values they espouse, do they they 'walk the talk'*
- *the visibility of management concern to the individual whose task performance you are considering; and*
- *the vigour with which management expresses its concern.*



e27. Incorrect Performance is Rewarded:

- Did the employee find the consequence of doing the task in question incorrectly more favourable than doing it correctly?
- Was the supervisor sufficiently alert to this factor?

e28. Job Interest Building LTA:

- Does performing the task well really matter to the individual performing it?
- Did management adequately foster the individual's interest in the work?

e29. Group Norms Conflict:

- Did management make adequate efforts to actively engage the individual/group in activities likely to promote agreement about what is important (i.e. policy issues and goals of task performance)?

Consider the question of group norms conflict (e29) if there was disagreement between management and the workforce about the performance of the task

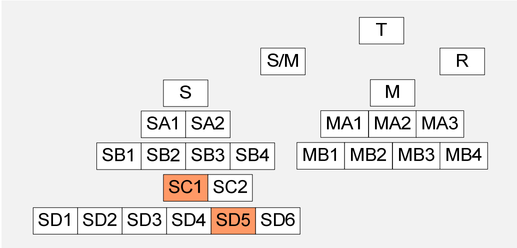
Activities might include participation in implementation of new equipment and working practices, training, projects and investigations.

Attitudes and experiences, particularly those held in common within a peer group (norms), will influence how people interpret task requirements. Performance errors may result from differences in norms between those designing or managing task re-

e30. Obstacles Prevent Performance:

- Were there obstacles that prevented the individual from performing the task to an acceptable level?

Obstacles need to be considered from the individual's perspective. They might be physical or situational in nature.



e31. Personal Conflict:

This branch considers the contribution of individual personal conflicts to the performance error in question.

f15. [Conflict] with Supervisor:

- Was the relationship between the individual and the supervisor obstructive to adequate performance of the task in question?

You will need to explore the work relationships between the individual concerned and co-workers and supervisors.

You will need to consider that there may be a range of people providing supervision to this individual.

f16. [Conflict] with Others:

- Was the relationship between the individual and other workers in the work environment obstructive to adequate performance of the task in question?

f17. Deviant:

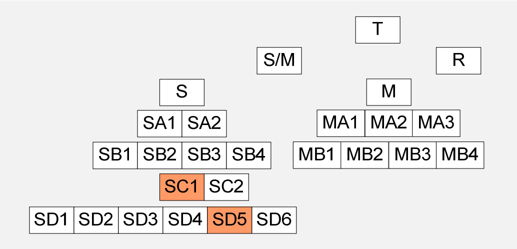
- Were the psychological traits exhibited by the individual judged acceptable when considered in the context of the task requirements and related risks?

Event f17 is flagged with the R8 assumed risk symbol. Individuals exhibiting high levels of social maladjustment, emotional instability, and conflict with authority may be more unpredictable and unreliable than others. You need to evaluate whether the decision to employ the individual was a correctly assumed risk or a management system failure. The event cannot be closed until justification for assuming the risk has been evaluated.

If you are using colours, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation. See page 56, and section 2.4, page xvi in the introduction.

e32. General Motivation Programme LTA:

- Was there adequate use of motivational programmes to develop desired behavioural change in individuals?



b4. Performance Errors in unrelated tasks:

This branch considers whether the control of the work/process in question was compromised by activities that are not directly part of the task.

c16. Allowed activities:

- Did an allowed activity, unrelated to the work/process in question, contribute to a problem in the control of the work/process?

"Allowed" meaning that the activity was not in conflict with the rules. Examples are going to or from the work area, authorised work break, lunch, etc.

c17. Prohibited activities:

- Did a prohibited activity, unrelated to the work/process in question, contribute to a problem in the control of the work/process?

A prohibited activity is one in violation of rules, such as horseplay. If the prohibited activity been performed in the past without impinging on the control of the work/ process, you will need to consider what was different that made it a problem on this occasion.

b5. Emergency Shutoff Performance Errors:

Use this branch if an emergency was in progress at the time in question. It considers the contribution of errors made during emergency shutdown resulting in:

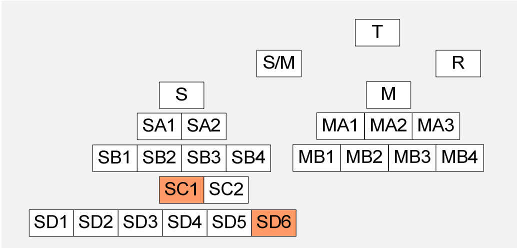
- failure to restore control of the work/process in question; and/or
- interference with the control of other work/processes (i.e. shutdown causes a new problem).

c18. Task Performance Errors:

- Did the incorrect execution of an intentional shutdown contribute to the control failure in the work process?
- If the emergency shutdown was not error-free, what were the performance errors? Consider these errors using the questions in branch SD5 b3 (Task Performance Errors). These begin on page 18.

c19. Unrelated Task Errors:

- Did an error in an unrelated activity compromise the execution of a planned shutdown sequence?



SD6. Support of Supervision LTA

This branch considers whether upper level management supported their organisation adequately.
Consider the following questions in the light of any supervisory problems identified through earlier stages of your analysis.

a1. Help and Training Supervisors LTA:

- Is the problem in question connected to the on-going help and assistance given to supervisors to enable them to fulfil their roles?
- Was the feedback to the supervisor about his/her performance adequate?
- Had the supervisor been given adequate training in general supervision?
- Had the supervisor been given adequate training in safety and risk management?

a2. Research and Fact-Finding LTA:

- When needed, was information concerning the control of the work/process researched and provided for the supervisor?

a3. Information Exchange LTA:

- Did a lack of open and frank communication between upper and lower levels contribute to problems in the control of the work/process in question?
- Was communication always verified through feedback?
- Is there a history of shared responsibility (between the supervisor and people providing support) for resolving problems?

a4. Standards and Directives LTA:

- Where codes, standards, and regulations (internal or external) did not cover the control of the work/process in question, did management develop adequate standards and issue appropriate directives?

a5. Resources LTA:

This branch considers whether inadequate resources for supporting the supervisor contributed to the problems in the control of the work/process in question.

b1. Training LTA:

- Was there sufficient training to update and improve needed supervisory skills?

b2. Access to Expertise

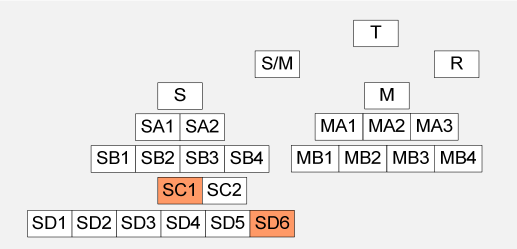
- Did supervisors have their own technical staff or access to individuals with technical expertise?
- Was technical support adequate for their needs?

b3. Access to Equipment & Materials LTA:

- Did supervisors have sufficient access to relevant equipment, materials and other services?

b4. Co-ordination of Resources LTA:

- Were resources adequately managed to avoid conflicts between different users and prevent duplication of effort?



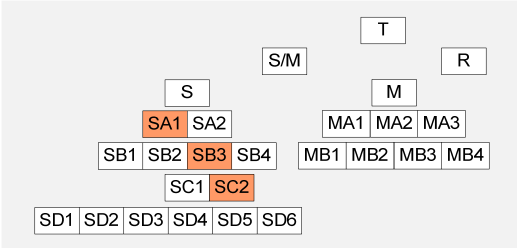
a6. Deployment of Resources LTA:

- Did ineffective use of the available resources contribute to the problems in the control of the work/process in question?
- Was the means of prioritising the use of resources adequate?

Event b21-MB3 (see page 53) considers management arrangements for immediate action on hazardous and otherwise serious problems

a7. Referred Risk Response LTA:

- Was management adequately responsive to problems referred from lower levels?
- Should the issue in question have been dealt with as a matter of urgency?
- Was there a process for dealing with urgent situations or high risks that had been newly recognised? Was the control problem in question already the subject of a referral from lower levels to management?



SC2. Barriers LTA

This branch will prompt you to identify each barrier that was in place, or that should have been. MORT considers four classes of barrier, but you do not need to be overly concerned with the accuracy of your classification, as the classes are just there help you consider the range of barriers that could have been used.

If a barrier was absent or not used you need to state the reference that requires it. References may include a technical standard, a regulation, a risk assessment.
An ETBA (barrier analysis) will facilitate the identification of barriers that you will consider in this branch.

A Barrier is any device or method designed to protect vulnerable "targets" from sources of harm. Targets include people or objects. Vulnerability of a target is specific to the energy or particular environmental condition concerned.

a1. On Energy Source

This branch considers the adequacy of barriers on the energy source.

Barriers of this type are protective devices and systems that were or could be applied to the energy source or environmental condition. The adequacy of the barrier depends upon the nature of the energy and vulnerable target in question.

Note all lower tier development under this event also transfers to events a2, a3, and a4. This means that, if needed, you should ask the questions stated in events b1 to b3, c1 and c2 when evaluating a2, a3 and a4.

Examples – isolations, insulation, fall protection.

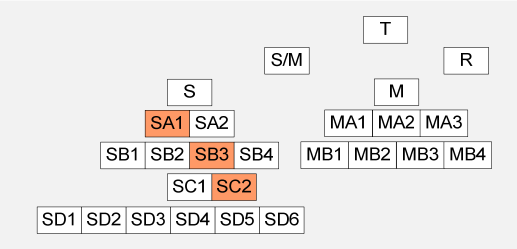
b1. Barriers None Possible:

- Was such a barrier impossible?

Event b1 is flagged with R9 assumed risk symbol. This indicates that the appropriate management must assume the risks when they accept work/processes where no barriers were possible.

The event cannot be closed until justification for assuming risk has been evaluated.

If you are using colours, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation. see page 56, and section 2.4, page xvi in the introduction.



b2. Barrier Failed:

- Did the barrier function as intended?

If the barrier did fail, you will need to have a clear understanding of how it failed. As well as necessary for your investigation report, this understanding will be necessary for later MORT analysis (especially at MB3, when risk assessment and design will be considered).

b3. Did not Use:

The branch applies to barriers that were possible but were not used.

c1. Did not Provide:

- Were barriers provided where possible?
- Note the event is flagged with R10 assumed risk symbol.

Event b3 is flagged with R10 assumed risk symbol. This indicates that the appropriate management must assume the risks when they accept work/processes where no barriers were possible.

The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation. See page 56, and section 2.4, page xvi in the introduction.

c2. Task Performance Errors:

The branch considers errors associated with using provided barriers.

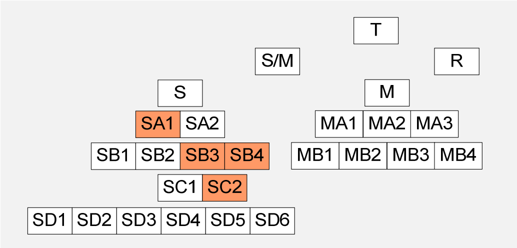
Note that all the lower tier development under event SD5 b3 transfers to this event also. If the barrier failed due to task performance errors, you should ask the questions stated under SD5 b3, these begin on page 18.

a2. Between energy source and target

This branch considers the adequacy of barriers between the energy and the target. The events and questions associated with this branch transfer from a1.

Barriers of this type are protective devices and systems that have been or that could be applied between the energy source or environmental condition and the person/object. The adequacy of the barrier depends upon the nature of the energy and vulnerable target in question.

Examples – handrail, fire wall, machinery guards.



a3. On persons or objects

This branch considers the adequacy of barriers on persons and/or objects.

The events and questions associated with this branch transfer from event a1.

Barriers of this type are protective devices/systems that have been or could be applied to the person or object. The adequacy of the barrier depends upon the nature of the energy and vulnerable target in question.

Examples – PPE, paint, armour.

a4. Separate time and distance

This branch considers the adequacy of "time and space" barriers.

The events and questions associated with this branch transfer from a1.

Barriers of this type work by ensuring the separation of energy and targets in time or space. Obedience to a procedure may accomplish separation by time or space. The adequacy of the barrier depends upon the nature of the energy and vulnerable target in question.

Examples – clearing people from an area for pressure testing, an evacuation, a traffic light.

SB4. Events and Energy Flows Leading to Accident Incident

In analysis of an accident or incident, there are usually several energy/target interactions to analyse. When using MORT, each interaction needs to be analysed separately. The various interactions that could be analysed with MORT are identified via ETBA (barrier analysis). This branch serves as a reminder to the analyst of the need to account for these precursors. At this point in your analysis, you need to decide which (if any) further energy/target interactions you wish to consider next. See page xxi for help on this subject.

Whereas branches SB1 to SB3 were concerned with a specific energy flow, branch SB4 refers to any other energy flows which may also need to be analysed.

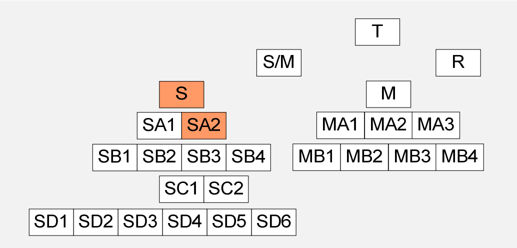
On the MORT diagram, branch SB4 is shown enclosed in a dotted box. This is because the analysis of each energy flow should be done using a fresh chart.

SC3. Barriers and Controls LTA

Were barriers and controls on energy transfers and other events (leading to conversion of a hazard to an actual accident) less than adequate?
These events need to be identified via ETBA (barrier analysis).

SC4. Energy Transfers

What were the precursor energy transfers that resulted in the conversion of a hazard to an actual accident?
These energy transfers need to be identified via ETBA (barrier analysis).



SA2. Stabilisation and Restoration LTA

This branch is intended to evaluate events following a serious accident.

After an accident, efforts should be directed to limiting the consequences the accident and, whenever possible, to reducing the impact of those consequences.

When evaluating this branch, consider whether actions were pre-planned as opposed to occurring fortuitously at the time of a particular accident.

a1. Prevention of Follow-on Accident LTA:

This branch considers the adequacy of actions to prevent a follow-on accident.

Note all lower tier development under this event also transfers to events a2 and a3.

For example a second person entering an enclosed place without adequate preparation to rescue a first.

b1. Plan LTA:

- Was the plan for stabilisation and restoration adequate?
- Was the performance of people and equipment significantly different from the assumptions made in the plan?

b2. Execution of Plan LTA:

This branch considers whether the plan was executed as intended.

c1. Notification LTA (Trigger):

- Was notification made to relevant services correctly and without delay?
- Were employees adequately instructed on how to notify these services?
- Was there an alternative means of notification and was this pre-planned and trained for?

Consider whether the notification process was easy to do, especially during the stress of an emergency.

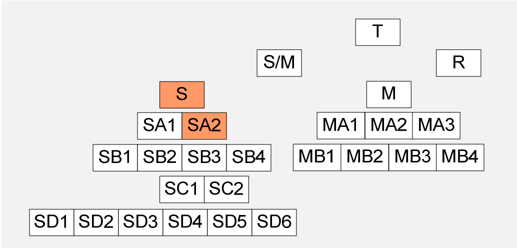
c2. Training & Experience LTA:

- Was there adequate training and experience of the various assignments required by plan?
- Was it realistic?

c3. Personnel and/or Equipment Changes:

- Had adequate counter-changes been considered and introduced to balance any changes in personnel or equipment?

Some degree of change is normally expected to occur. MORT assumes that managers and supervisors will be alert to relevant changes outside the norm.



c4. Logistics LTA:

- Was there adequate availability of transport for services to and from the accident scene (and injured people to medical facilities)?
- Did logistical arrangements worsen the harm suffered by victims of the accident?

You need to consider whether logistics, including the provision of catering and hygiene facilities, was handled adequately.

c5. Task Performance Errors:

This Branch considers errors in the performance of the plan. Consider these errors using the questions in branch SD5 b3 (Task Performance Errors). These questions begin on page 18.

c6. Response delay:

- Was the response time adequate?

Event c6 is flagged with R10 assumed risk symbol. If the response was likely to involve a delay (e.g. because of the form of transport chosen and the distance accepted) the risk involved in this response plan needs to have been "assumed" correctly. A decision to assume the risk must have been taken by an appropriate person in a suitable manner.

The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation. See page 56, and section 2.4, page xvi in the introduction.

a2. Emergency Action (Fire-fighting, etc.) LTA:

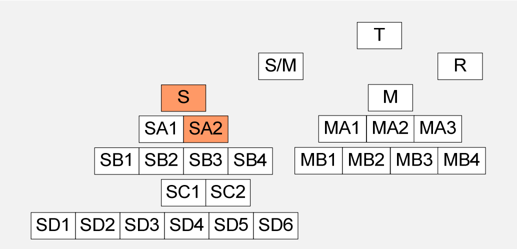
This branch considers whether the emergency response to the first incident was prompt and adequate. The events associated with this branch transfer from a1; you will need to use those questions to evaluate the adequacy of emergency action.

a3. Rescue and Salvage LTA:

This branch primarily considers whether victims were satisfactorily removed to a safe area. The events associated with this branch transfer from a1; you will need to use those questions to evaluate the adequacy of rescue and salvage after the accident.

You should also consider:

- *the salvage of objects and policy of resolving conflict between rescuing people vs. objects and associated insurance concerns*
- *how rescuers balanced the risk of a follow-on accident against the ability to lessen the severity of injuries to victims, before entering a hazardous area*
- *the evacuation of employees or the public from potentially hazardous areas*



a4. Medical Services LTA:

This branch considers the adequacy of medical assistance and the harm suffered by victims of the accident. The events associated with this branch transfer from a1; use those questions to evaluate the adequacy of medical services.

Medical services include: near-by hospitals, on-site first aid, ambulance services, or general practitioners.

You should consider whether:

- *adequate First Aid was immediately available at the scene*
- *adequate medical treatment was available en route and at the medical facilities*

a5. Dissemination of information LTA:

This branch considers the contribution made by the organisation informing adequately all relevant parties about the accident.

The events associated with this branch transfer from a1; use those questions to evaluate the adequacy of information dissemination.

You should consider in particular whether the following people and groups were adequately informed:

- *Relatives of those injured*
- *Employees*
- *Officials*
- *Customers and Suppliers*
- *Public and Media*
- *Other Stakeholders*

a6. Restoration and Rehabilitation LTA

This branch considers whether people and assets were adequately returned to their pre-accident condition.

b3. Operational Continuity LTA

- Were actions to maintain a basic level of operational continuity adequate?

b4. Rehabilitation LTA

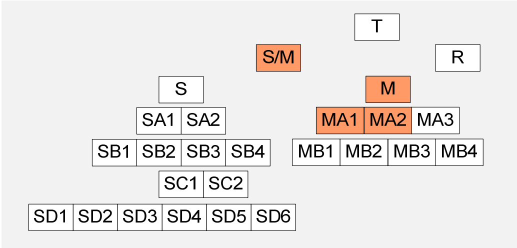
- Were people given adequate support to restore them to full health and employment?
- Were they provided with equivalent employment?

b5. Restoration LTA

- Were assets, including third party, returned to their pre-accident condition or replaced with equivalent alternatives?

b6. Absorb Loss

- Were the losses resulting from the accident accepted before the accident?
- *Note the event is flagged with R12 assumed risk. The event cannot be closed until justification for assuming risk has been evaluated.*



M. Management System Factors LTA

This branch considers the design, planning or policy formulation processes that may have contributed to the incident or accident and its consequences.

Here you will consider, in the light of what you have revealed through S-branch analysis of this accident, which aspects of the management system allowed the S-branch factors to be LTA.

MORT assumes that all issues in the S-branch are tied to issues in the M-Branch. The relationship between these is such that the M-branch designs and governs the S branch. The emphasis here is on processes rather than people. There may be several instances where a function in the "M" branch is the responsibility of a person who does not have "manager" as part of their title or job-description.

MA1. Policy LTA

"Policy" refers to a specific policy subject identified during previous analysis. You will need to bear this subject in mind when considering the questions below.

Concerning a specific policy subject:

- *was the policy clearly stated?*
- *was the policy up-to-date?*
- *was policy formulation adequate?*
- *was the policy of sufficient scope to address the major issues and problems likely to be encountered?*
- *was this policy adequately integrated with other policies?*

Policies are the declared values and intentions of the organisation. The job of policy is to define what is important and what is wanted relative to a particular issue.

Although a policy is specific to a particular issue, it needs to accommodate basic corporate responsibilities (such as duties to staff, the public and the environment, legal compliance, as well as quality and efficiency goals).

Note that Risk Management policy is considered separately at MB1

MA2. Implementation of Policy LTA

This branch considers whether the problem in question is a result of how the relevant policy was implemented.

a1. Planning Process LTA:

This branch considers the relevance of how implementation was planned.

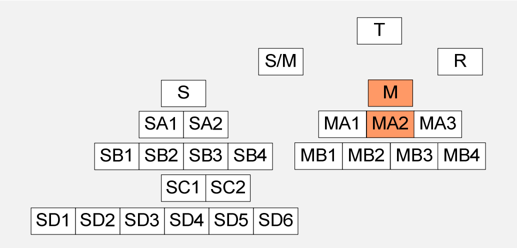
b1. Specification of Plan LTA

This branch considers whether the policy implementation plan was adequately specified.

c1. Methods, Criteria, Analyses LTA:

- Were adequate methods used to plan policy implementation?
- Did accountable management require adequate planning procedures to minimise problems?

Note that in MORT planning is seen as an open-ended process in which plans are adapted in the light of new information gained in the execution phase.



c2. Specification of Responsibilities LTA

This branch considers the adequacy of how responsibilities were assigned for implementing the policy.

d1. Definition of Line Responsibility LTA

- Was there a clear, written statement of duties, derived from the policy, for each person in the line organisation to whom it applied?
- Did each person concerned understand and accept their responsibility?
- Was this verified in an adequate fashion?

Events d1 and d2 make a distinction between line and staff. "Line" refers to the operational part of an organisation, which delivers the service for which the organisation exists. "Staff", refers those parts of the organisation which exist to facilitate the work of the line.

d2. Staff Responsibility LTA

- If the implementation of policy relied upon more than one department, was adequate provision made to assign specific duties to the departments concerned?

d3. Task Assignment LTA

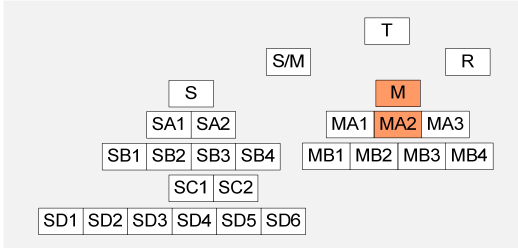
- Was the problem in question a result of how the task was assigned by the supervisor to the member of staff?
- Was the assigned task properly scoped with steps and objectives clearly defined?
- Was the task one an employee should undertake without specific instructions from the supervisor?

c3. Schedule LTA

- Did the plan schedule planning cycles frequently enough to prevent or detect undesired changes?
- Was the schedule readily available to the personnel?

c4. Budgets LTA

- Was the budget adequate to support the planning process in the department or group owning the policy?
- Were the budgets of other departments and groups adequate to support the planning process?



c5. Communication Plan LTA

This branch considers whether implementation of policy may be supported by a planned approach to communication.

d4. Information Flow LTA

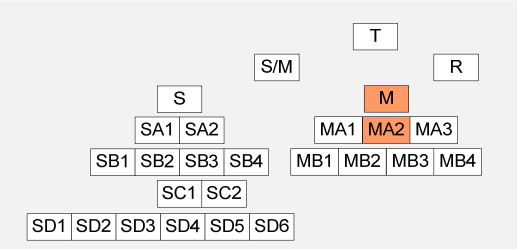
- Did management adequately specify the types of information it needed to communicate about policy implementation?
- Did management establish adequate communication arrangements to transmit this information through the organisation?
- Did management support implementation with adequate response to requests for information by lower organisational levels?
- Was adequate provision made for feedback about problems encountered when communicating about policy?

d5. Guidance and Directives LTA

- Did guidance and directives, aimed at communicating the policy, adequately emphasise risk management approaches (such as risk analysis, monitoring, review)?
- Were these directives published in a style conducive to understanding?
- Were the directives constructed to ensure continuity across interfaces between different departments and processes?

b2. Use of Feedback LTA:

- Did the plan encourage people to report problems or better ways of doing things?
- Have previous relevant problems of policy implementation been subject to adequate analysis for cause?
- Were such analyses adequately specified by the plan?
- Did an appropriate individual or group adequately act upon the results of such analysis



a2. Execution of Policy Implementation Plan LTA

This branch looks at whether the problem in question is a result of how the implementation plan was carried out.

b3. Leadership LTA

- Did senior management and other influential people provide adequate leadership?
- Did their behaviour reflect the importance of the implementation of the policy in question?

b4. Capability LTA

This branch considers the organisation's ability to execute the policy implementation plan

c6. Authority LTA

- Were specific duties adequately assigned to named individuals to execute the plan?
- Did the people involved have adequate authority to carry out all aspects of the plan?

c7. Accountability LTA

- Was there adequate accountability of the named individuals involved in carrying out the plan?
- Was there adequate performance feedback to these individuals?

c8. Task Performance LTA

- Were the individual tasks (as set out in the plan) performed adequately?
- *If not, identify who is performing which task and the nature of the inadequacies. Then refer to further questions relating to Task Performance Errors (SD5 b3); these begin on page 18.*

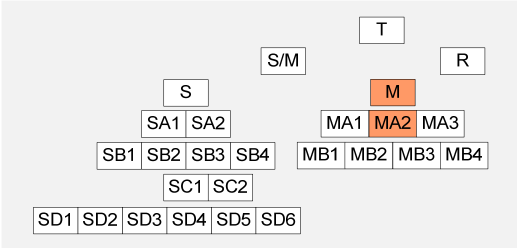
b5. Practical Support LTA

This branch considers whether management supported implementation with adequate services and guidance.

The events associated with this branch follow the same logic as SD6 branch, ask the questions set-out there to evaluate the adequacy of the support

b6. Time and Budget LTA

- Were the time and budget specified in the plan's schedule sufficient to adequately perform each task?
- Were the time and budget allocated for personnel adequate to fulfil the schedule?
- Were the time and budget actually made available?



b7. Delays

- Were solutions to problems of implementation introduced early enough?
- If not, was the delay made known to someone who was able to expedite a solution and assume the risk of continued delay?

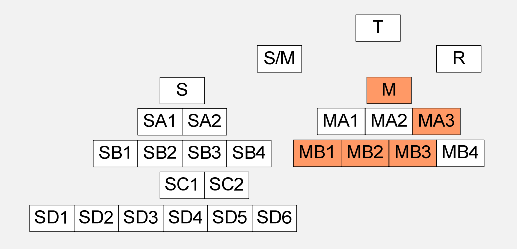
> *Event b7 is flagged with R13 assumed risk symbol. If implementing the policy needed to be delayed, the risk created by the delay needs to have been "assumed" correctly. A decision to assume the risk must have been taken by an appropriate person in a suitable manner.*
>
> *The event cannot be closed until justification for assuming risk has been evaluated. If you are using colours, this event should be provisionally coded blue; and an entry made in the "Provisional Assumed Risk" table drawn up for this investigation. See page 56, and section 2.4, page xvi in the introduction.*

b8. Caused Failure

- Did the implementation of the policy introduce new problems even when the plan was carried out "to the letter"?

a3. Monitoring LTA

Was there adequate monitoring of the implementation process?



MA3. Risk Management System LTA

This branch considers the adequacy of the risk management system.

MB1. Risk Management Policy LTA

This basic event considers the adequacy of the risk management (RM) policy.

- was it clearly stated?
- was it up-to-date?
- was it formulated adequately?
- was it of sufficient scope to address the major issues and problems likely to be encountered?
- was it adequately integrated with other policies?
- was it subject to adequately review?

MB2. Implementation of Risk Management Policy LTA

This branch considers whether the problem in question is a result of how the risk management policy was implemented.

The events associated with this branch follow the same logic as MA2 branch. Ask the questions listed there, pages 37-41,with Implementation of the Risk Management Policy as the subject.

MB3. Risk Analysis Process LTA

This branch considers risk analysis and the design and development of specific work activities and processes.

a1. Concepts and Requirements LTA:

This branch considers the adequacy of the risk analysis process and its definition by the organisation.

b1. Technical Information System LTA

This branch considers how the technical information system may have failed to provide adequate support to risk analysis.

Refer to the SD1 branch (p. 5-10) and ask the questions from the perspective of the risk analysis process.

b2. Definition of Goals and Tolerable Risks LTA:

This branch considers the definition of goals and tolerable risks within the organisation

c1. ES&H Goals and Risks not Defined:

- Did the ES&H goals state what level of risk should be attained and when?
- Are tolerable direct and indirect ES&H risks defined and actual risks quantified?

ES&H: Environment, Safety and health.

c2. Performance Goals and Risks Not Defined:

- Have goals been set for performance, efficiency and productivity?
- Have tolerable risks for lost efficiency and productivity been identified and actual risks quantified?

Examples – part of the business plan includes business risk and contractual arrangements with partners

b3. Risk Analysis Criteria LTA:

This branch considers the specification of risk analysis.

c3. Plan LTA:

- Was the plan that describes "who does what and when" in risk analysis, study, and development, adequate?

c4. Change Analysis LTA:

- Was there an adequate method for analysing the effects of planned change? Was it adequately applied?

Whatever method of change analysis was used, it should have:

- *included the impact of the change upon people, procedures and plant/equipment;*
- *been scoped to review arrangements until no change was demonstrated (i.e. the full ramifications should have been identified).*

c5. Other Analytical Methods LTA:

- Was adequate use made of appropriate analytical techniques?
- If not, does this reflect inadequacies in the skills available to the organisation (internally or externally)?

You need to be clear about what methods would have been appropriate to the matter in question.

c6. Scaling Mechanism LTA:

- Was an adequate mechanism established to measure the seriousness/severity of different events?
- Did this mechanism adequately support the evaluation of the work/process in question?

There are several types of scaling mechanisms, for example:

- *Severity x frequency matrices*
- *Ranking by hazard potential*
- *Ranking by amount of energy*

Providing review by experienced people and applying actuarial data may also be relevant here.

c7. Required Alternatives LTA:

- Did management insist on presentation of alternative solutions in its bases for choices and decisions?

Proposals to decision makers tend to state a strong, positive case. Negative aspects may not be emphasised or well presented. A requirement for alternative proposals and/or benchmark analyses, may help to expose problems and obstacles.

c8. Solution Precedence Sequence LTA:

- Was the selection of solutions prioritised by:
  (1) Design,
  (2) Protective Devices,
  (3) Warning Devices,
  (4) Human Factors Review (ergonomics),
  (5) Procedures,
- (6) Personnel, and
  (7) Acceptance of residual risks (after considering the preceding six items)?

This sequence is in order of effectiveness and reliability. Design can wholly remove a problem, whereas other options attempt to control the effects.

The sequence also reflects the lifecycle and hence cost effectiveness: early solutions are typically less costly and more effective.

b4. Criteria for Procedures LTA:

- Were criteria for writing procedures specified adequately and communicated to staff involved in producing them?
- Were criteria for reviewing new and revised procedures adequately specified and applied?

These criteria should remind engineers and designers of the limitations and issues relevant to writing procedures for operating personnel. Assuring adequate readability and usability is especially important.

b5. Specification of Requirements LTA:

This branch considers the search for and application of criteria relevant to the work system/process or project in question.

c9. Stakeholder/customer requirements.

- Were the requirements from stakeholders or customers taken into account?

> *'Stakeholders' includes partners, workforce, customers, government agencies, etc.*

c10. Statutory codes and regulations

- Were statutory requirements (such as taken into account?

c11. Requirements of other National and International codes and standards

- Were the requirements from national and International codes (*e.g. – ISOs, EN codes and standards)* and standards taken into account?

c12. Local Codes and Bylaws

- Were the requirements from regional and local codes and standards taken into account?

c13. Internal Standards

- Were the requirements from Internal standards taken into account?

b6. Information Search LTA:

This branch considers the adequacy of the information search undertaken in support of risk analysis. This issues can be explored using the lower tier events shown in the MORT diagram under SD1 a1 (Technical Information); the corresponding questions are listed on pages 5-7 of this manual.

b7. Life Cycle Analysis LTA:

- Did risk analysis ensure adequate consideration of all phases of lifecycle?

c14. Scope LTA:

- Did the scope include not only the primary work/process equipment and systems, but also ancillary equipment and systems (e.g. ventilation, waste heat recovery, testing, maintenance, cleaning, etc)?
- Did the analysis adequately include the personnel and procedural components of primary and ancillary systems?

> *The lifecycle can be conceived as starting with planning and continuing through design, purchasing, fabrication, construction, operation, maintenance, and disposal.*

c15. Analysis of Environmental Impact LTA:

- Did the lifecycle analysis adequately address environmental impact?

c16. Requirement for Life Cycle Analysis LTA:

- Did the requirement for Life Cycle Analyses (LCA) assure that a thorough LCA was initiated during the planning stage?

c17. Extended Use Analysis LTA:

- If the facility/operation has been extended beyond its original intended life, was there adequate consideration of special requirements, new problems, and other factors that were or might have been encountered?

a2. Design and Development LTA:

This branch considers the design and implementation of work/process controls and related infrastructure.

b8. Energy Control LTA:

This branch considers options for the use and control of energy. This is done in order of effectiveness and reliability, starting with using the safest form of energy and ending with protective barriers.

> *According to this principle, the ideal approach is to limit energy to the minimum needed to accomplish the work/process.*

c18. Safer Energy LTA:

- Did the design use the safest form of energy that will perform the desired function?

c19. Limitation of Energy LTA:

- Was the amount of available energy limited to that which will perform the operation without any unnecessary excess energy?

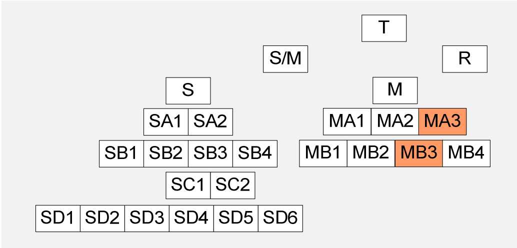
c20. Automatic Controls LTA:

- Were there devices to automatically control the flow of energy and to maintain it in its operating mode? Is use of redundant design adequately employed?

> *Redundancy should also be a feature of any communication systems linking automatic systems. Examples - parallel and back-up transmitters/receivers, channels, optical and electric cabling etc.*

c21. Warnings LTA:

- Were there clear, concise warnings for all situations where persons or objects might unintentionally come into contact with an energy flow?



c22. Manual Controls LTA:

- Were there adequate manually operated controls to maintain the proper energy flow during the normal mode or as a manual override of automatic controls?

c23. Safe Energy Release LTA:

- Had adequate provision been made for safe release of the energy (e.g. electrical earth, pressure relief valve)?

c24. Controls and Barriers LTA:

- Were adequate controls and barriers included as part of the design, plan, or procedure?
- *Refer to the evaluation of controls and barriers analysed through SB3 branch*

b9. Human Factors (Ergonomics) Review LTA:

This branch considers the adequacy of human factors review of the work/process in question.

"Human Factors" is defined here as the application of psychology and physiology to the analysis and improvement of human work performance.

c25. Professional HF Skills LTA:

- Was the minimum level of human factors capability, needed for evaluation of an operation or design, available and was it used?

c26. Task Analysis LTA:

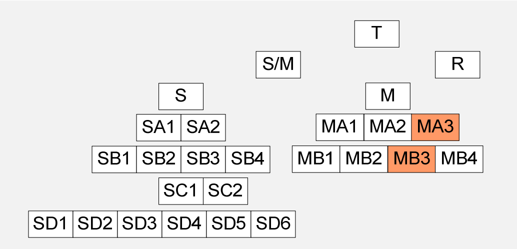
- Was task analysis (TA) adequately applied to the work/process in question.
- Was TA applied early enough in the lifecycle and were the results adequately incorporated into the design?

The preferred HF philosophy is to "fit the task to the person". However, certain tasks require specific characteristics and these must be specifically selected for and/or trained.

c27. Allocation Human/Machine Tasks LTA:

- Did the review adequately ensure the optimum allocation of work/process tasks to people and machines?

Task Allocation: For example, machines excel at tasks requiring high levels of accuracy, strength and repetition. People excel at creative and variable tasks.



c28. Did not Establish Human Task Requirements:

Did the review determine special characteristics or capabilities required of people and machines?

d1. Did not Define Users:

- Was adequate effort made to gain and incorporate knowledge about would be users in the design?
- Was adequate effort made to identify user requirements?

Defining users and their characteristics allows the design to accommodate diversity in the workforce or user population.

d2. Design of Displays LTA:

- Were the work/process displays designed to allow rapid interpretation with high reliability?
- Did the Human Factors review ensure that display stereotypes were used?

Display and Control "Stereotypes" are norms established by design practice: e.g. Red means danger, upward/forward movement indicates increase, etc. Such stereotypes must be adhered to and designers need to be aware of cultural and geographic variations from their own norms.

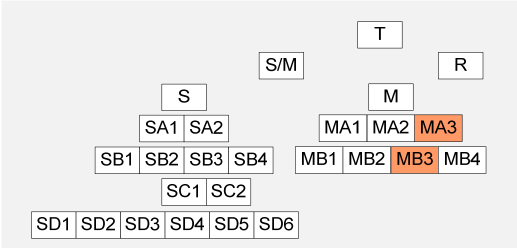
d3. Interpretation LTA:

- Was there adequate review of the likely effects of unreliable interpretation of displays and delays in control actions?

Various psychological and physical factors mediate the interpretation of data available in controls and displays – some degree of error and delay will always be present and this may have consequences.

d4. Design of Controls LTA:

- Were the work/process controls designed to allow rapid use with high reliability?
- Did the Human Factors review ensure that control stereotypes were used and not disregarded?



c29. Did not Predict Errors:

- Was the design process informed by adequate human error prediction and analysis?
- Did the review adequately assess the scope for deliberate errors and other acts of malevolence?

> *The purpose of such analysis is to predict modes and frequencies with which human errors may occur, and so determine preventive action to reduce the overall error rate.*
>
> *Examples of general human error types are:*
>
> - *incorrect act*
> - *act out of sequence*
> - *fail to act*

b10. Inspection Plan LTA:

This branch considers the development of an inspection plan for the operation/facility. The issues can be explored using the lower tier events shown in the MORT diagram under SD3 a1 (Inspection Plan); the corresponding questions are listed on pages 12-13 of this manual.

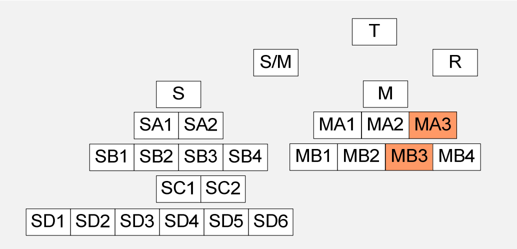
b11. Maintenance Plan LTA:

This branch considers the development of a maintenance plan for the operation/facility. The issues can be explored using the lower tier events shown in the MORT diagram under SD4 a1 (Maintenance Plan); the corresponding questions are listed on pages 12-13 of this manual.

b12. Arrangement LTA:

- Did the design consider problems associated with space, proximity, crowding, convenience, sequence-of-use, freedom from interruption, enclosures, work flow, storage, etc.?

> *At this point you need to consider the following issues should be considered:*
>
> - *How inspectability and maintainability requirements were specified in the design or procurement documents for the operation, facility or equipment in question;*
> - *The adequacy with which inspection and maintenance activities were specified in operational plans;*
> - *How minimum requirements for inspection and maintenance equipment and staffing were arrived*



b13. Environment LTA:

- Did the design adequately minimise physical stresses upon people and objects?

This might include stresses caused by;

- *the physical conditions of the facility,*
- *conditions generated by the operation, or*
- *interactions of one operation with another?*

b14. Specification of Operational Readiness LTA:

This branch considers the operational specification for all phases of the work/process operation. If the specification is adequate and complied with, the work/process can be described as operationally ready. Whereas event SD2 dealt with the verification of operational readiness, this branch deals with the definition of operational readiness for the work/process in question.

Note that specification of operational readiness is an ongoing effort. It will involve many different types of personnel (e.g. designers, engineers, supervisors) at different times, ranging from the design of plant/process to the ad hoc specification of day-to-day jobs.

c30. Test and Qualification LTA:

- Were new/modified work/processes subject to adequate testing and adjustment before full implementation?
- Did this incorporate plant, people, and procedural aspects of operation and the interfaces between these?

Examples – part of the hand-over certificate, including service test, testing under operational conditions, formal review of procedures.

c31. [Specification of] Supervision LTA:

- Were there adequate guidelines for the amount of supervision required, minimum supervisory capabilities needed, and responsibilities of supervisors of the work/process?
- Were there adequate guidelines for the supervisory support of JSA and other risk assessment activities associated with the work or process?

c32. Task Procedures LTA

This branch considers the criteria for work/process procedures.

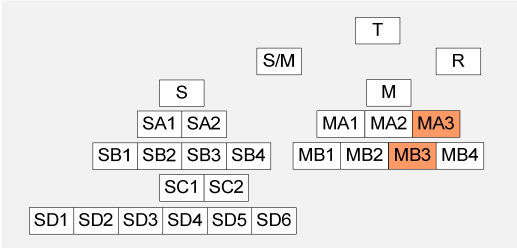
d5. Match to Hardware Change LTA:

- Were procedures revised, if necessary, to correspond with changes in plant or equipment?

d6. Match to Users LTA:

- Were procedures adequately matched to the minimum reading ability and technical competence of the staff who actually used them?

Involving a representative group of users in a structured review of draft procedures can help this.



d7. Match to task/equipment LTA:

- Were procedures adequately checked against applicable criteria and tested under dry run operating conditions?

d8. Emergency Provisions LTA:

- Did procedures give users clear instructions for all anticipated emergency conditions? Are instructions easy to perform under the stress of an emergency?

d9. Cautions and Warnings LTA:

- Were adequate dynamic and static warnings used? Were they located at point of operation as well as in procedures? Was their meaning unambiguous?

Example – advisory/warning signs for non-stereotypical valves or controls.

d10. Task Sequence LTA:

- Did the procedures describe task steps in sequential order where possible?

d11. Lockouts LTA:

- Were lockouts required in the procedure where hazardous situations could be encountered or created by the application of the procedure in question?

Lockouts – physically preventing the use of equipment or access to areas.

d12. Communication Interfaces LTA:

- Where procedures called for communication between users and other individuals, were these interfaces made clear?

d13. Specification of Working Environment LTA:

- Did procedures adequately specify the range of environmental conditions within which the task should be performed? Where a stressful environment is expected, do procedures specify maximum exposure times or other measures to mitigate adverse effects?

c33. Personnel Selection LTA:

- Were adequate criteria and methods for selecting people to undertake the work/process?

Note – consider this, and associated checking/verification, for directly employed staff, contractors and sub-contractors.

Examples – competency standards and assessment, matching the individual to the task in terms of the competence required.

c34. Personnel Training and Qualification LTA:

- Were training methods, qualification criteria and verification process for the people undertaking work/process adequately developed and specified?

> *Examples – National vocational qualifications, passport systems, verified in-company systems for core staff.*
>
> *Personnel training and qualification factors are considered in detail under SD5-c15.*

c35. Personnel Motivation LTA:

- Was motivation adequately considered in the design of the work/process?

> *As part of this, consider whether there was an adequate effort to ensure the rewards and "punishments" perceived by work-level staff were consistent with correct task performance.*
>
> *Personnel motivation factors are considered in detail under SD5-d15*

c36. Monitor Points LTA:

- Did written procedures contain adequate prompts to allow monitoring of key steps of the work/process?

b15. Emergency Shutdown Provision LTA:

- Did the design of plant and equipment provide for safe shutdown and safety of persons and objects during all anticipated emergencies?

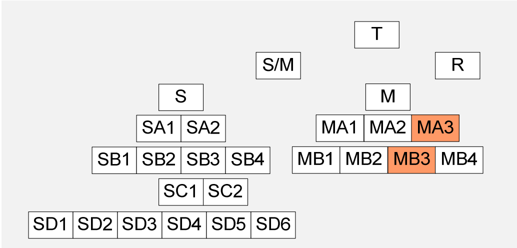
b16 Contingency Planning LTA

- Were all of the emergency functions pre-planned *(rather than left to improvisation)?*
- Did these plans adequately consider the types and severity of accidents to which they applied?
- Were adequate resources allocated to execute the plan properly?
- Were consumable resources subject to an adequate schedule of periodic checks and planned replenishment?

b17. Disposal Planning LTA:

- Did the design adequately minimise disposal problems and hazards associated with the disposal of the plant?

> *Note that lifecycle analysis is considered at b7.*



b18. Independent Review LTA:

- Was there adequate provision of thorough and independent ES&H review at pre-established points in the life cycle?
- Were the risk reduction trade offs documented?
- Was the technical competence of members of the Review Board adequately matched to the level of technology involved?

b19. Configuration Control LTA:

- Was there an adequate programme to assure configuration control throughout the entire life cycle of the facility and/or work process?

> *The aim of configuration control is to ensure the synchronisation of plant, people and procedural subsystems with each other and to specifications.*

b20. Documentation LTA:

- Was there an adequate process to manage, update and authorise documents?
- Were all types of documentation (whether paper or electronic) complete, up to date, and accessible to users?

b21. Fast Action Expedient Cycle LTA:

- Was there an adequate procedure to get an immediate correction of a problem in the work/process?

> *Fast action cycles should be reserved for high hazard or other problems with significant consequences.*

b22. Design Acceptance & Change Control Process LTA:

This branch considers the adequacy of acceptance and control-of-change procedures.

c37. Code Compliance Verification LTA:

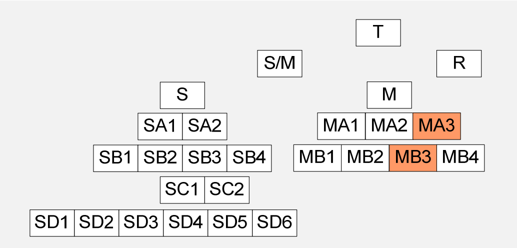
- Was there adequate verification that all codes and standards noted as relevant at the conceptual stage were incorporated into the design?

c38. Engineering Studies LTA:

- Were adequate engineering studies conducted to obtain information not available from codes, standards, regulations, and state of the art knowledge?

c39. Standardisation of Parts LTA:

- Was there an adequate attempt to use proven existing standardised parts where possible, and to design so as to encourage their use?



c40. Design Description LTA:

- Did the design description provide all the information needed by its users in a clear and concise manner?

c41. Acceptance Criteria LTA:

- Were acceptance criteria stringent enough to assure operability /maintainability and compliance with the original design?

c42. Development and Qualification Testing LTA:

- Was there adequate testing during development of the new design to demonstrate that it would serve its intended function?
- Did qualification testing assure that non-standard components satisfied the acceptance criteria?

c43. Change Review Procedure LTA:

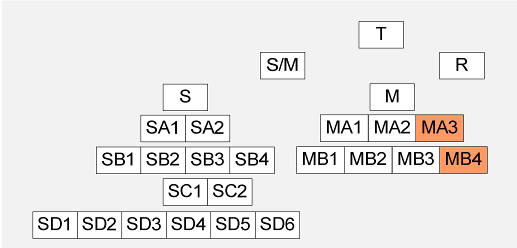
- Was there an adequate procedure for Change Review regarding the work process?
- Did change review include all elements of the system (especially form, fit and function), and continue up to a point where no change was demonstrated?
- Were there change annotations/warnings on drawings and at points of operation?

Change analysis is adequate if the full ramifications of the changes have been found.

c44. Reliability and Quality Assurance (R&QA) LTA:

- Was there an effective reliability and quality assurance programme and was it adequately integrated into the general design process?

In some organisations, the reliability and quality assurance functions are very specifically separated; other organisations combine them. Whether combined or separated, R&QA is a strong complement to HS&E. Close mutual support between HS&E and R&QA should be evident throughout the general design process.



MB4. Risk Management Assurance Programme LTA

This branch considers the adequacy of processes aimed at assuring risk management.

a1. Definition of Aims and Policy LTA:

- Were there adequate assurance policy statements and were the aims of the assurance programme articulated?
- Did this summarise what management should know (and require) of the assurance process?
- Did the aims provide a benchmark against which to measure the risk management programme?
- Were the aims SMART?

This includes ES&H programmes.

SMART – Specific, Measurable, Agreed, Realisable, Time-bound.

a2. Scope LTA:

- Was the scope of the risk management assurance programme set in an adequately forward-looking, future-oriented way? Was the scope adequately informed by best practices?

a3. Documentation LTA:

- Was the risk management assurance process documented adequately?

a4. Assurance Programme Organisation LTA:

This branch considers the organisation of the risk management assurance programme.

b1. Risk Management Assurance Staff Performance LTA:

- Did risk management assurance personnel perform well by both assurance programme and management criteria?
- Were they effective in both technical and behavioural aspects?
- Did they have adequate authority?

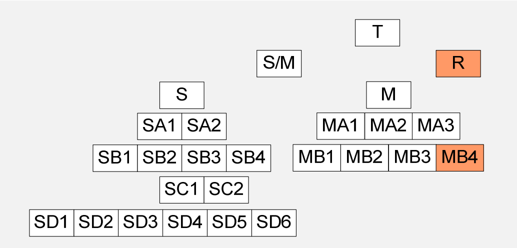
b2. Management Committees LTA:

- Were special purpose and permanent committees (or boards) adequate?
- Were these ongoing groups positive, and orientated towards the resolution of real life problems?

b3. Organisation for Improvement LTA:

- Was the assurance programme adequately designed and managed to produce the desired pace of improvement?

Although ownership of problems in the line organisation is crucial, achievement of significant assurance improvement also requires clear definition of goals and effective organisation efforts, particularly by assurance staff.



a5. Assurance Programme Services LTA:

This branch considers the provision of services and guidance needed to support the activities of the assurance programme.

The events associated with this branch follow the same logic as SD6.

a6. Assurance Activities LTA:

- Did the assurance system adequately compare actual performance with assurance programme aims and objectives?

MB5 Review of Risk Management System LTA

Did the organisation ensure that a review of the risk management system was carried out at periodically?
Was the review adequate to ensure suitability and effectiveness of the risk management system?
Were the reviews adequately documented and acted upon?
Was there adequate external review?

R. Assumed Risk

Questions:

- *What were the assumed risks?*
- *Were they specific, named events?*
- *Were they analysed and, where possible, calculated (quantified)?*
- *Was there a specific decision to assume each risk?*
- *Was the decision made by a person who had [management delegated] authority to assume the risk?.*

A loss can be accepted from an assumed risk only if the risk in question was a specific, named event; analysed, calculated where possible, evaluated, and subsequently accepted by a line manager or supervisor who was properly exercising management-delegated, decision-making authority.

To reach your judgement of whether a risk was properly assumed, you will need to consider:

- *The adequacy with which costs were weighed against benefits of risk reduction;*
- *Uncertainty about the risks themselves*
- *Tolerability of risk;*
- *Adequacy of information and interpretation provided to the person making the decision;*

Document Improvement Proposal

1. Document I.D.	2. Document date	3. Document title
NRI-1 EN 2009	20 December 2009	MUM

4. Recommended improvement (identify page, paragraph and include modified text or graphic, attach pages as necessary)

5. Reason for recommendation

6. Originator of recommendation

Name:	Organisation:	
Address:	Phone: Fax: E-mail:	**7. Date**

8. Send to NRI Secretariat

Name:	***Address:***	
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