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NRI MORT User's Manual

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

Generic Edition

Produced by



**The Noordwijk
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Foundation**

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MORT User's Manual

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

December 2002

Based on the original manual (three revisions 1978-1992) prepared by
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Preface

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

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)

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Trish Sentance, Gordon Stevenson and Graham Spencer of Marathon Oil UK (Aberdeen, UK), and Cara Dawson of CAS Ltd (Rugby, UK). We would like to extend our particular thanks to Dr Bob Nertney, who with W.G. (Bill) Johnson, Jack Clark and Jack Ford, was a member of the original MORT development team.

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Users Manual Part I: MORT and its Application

1 Introduction

The Management Oversight and Risk Tree (MORT) is an analytical procedure for determining causes and contributing factors. This document provides guidance for applying MORT to incident and accident investigation. It is intended for use with the NRI MORT diagram, dated December 2002 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 intended to encourage use of MORT and to promote the discussion of root cause analysis. Please note that this document does not replace the 1992 edition of the MORT Users manual³, but is intended as an alternative version optimised for users outside the U.S. DOE.

1.1 *Purpose of this version*

European users of MORT have reported that the pre-existing version of the Manual (DOE-76-45/4, SSDC-4, Revision 3, February 1992) was not ideally suited to their needs. We believe this is due to a number of factors, notably the style of language used and the need for improved practical guidance. Also, the manual was written for the United States Department of Energy as it was in 1992 and consequently makes references to other documents and support structures not available elsewhere or now, ten years later, in 2002.

This version of the MORT User's Manual aims to:

- rephrase the question set in British English
- improve guidance on the investigative application of MORT
- restore 'freshness' to the 1992 MORT question set
- simplify the system of transfers in the chart
- remove DOE-specific references
- help users tailor the question set to their own organisations

In conclusion, this version seeks to revise the phrasing of the manual whilst staying close to the structure of the 1992 version of MORT and the intentions of the original MORT text.

The Noordwijk Risk Initiative Foundation has produced this document with the sponsorship of Marathon Oil UK. Hosted by Delft Technical University, NRI was founded in 1998 to improve understanding of risk issues

through discussion, research and technology transfer between different domains of risk management. Teams drawn from businesses, academic institutions and public bodies staff the Foundation's projects.

1.2 *What is MORT*

MORT arose from a project undertaken in the 1970s. The work aimed to provide the U.S. Nuclear industry with a risk management programme competent to achieve high standards of health and safety. Although the MORT chart (the logic diagram that accompanies this text) was just one aspect of the work, it proved to be popular as an evaluation tool and lent its name to the whole programme.

By virtue of public domain documentation, MORT has spawned several variants, many of them translations of the MORT User's Manual into other languages. The durability of MORT is a testament to its construction; it is a highly logical expression of the functions required for an organisation to manage 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. The longevity of MORT may also be a reflection of the far-sighted philosophy from which it emerged, a philosophy which held that the most effective way of managing safety is to make it an integral part of business management and operational control.

The MORT programme for assuring safety was written up by W.G. Johnson under the title "MORT: the Management Oversight & Risk Tree" (SAN 821-2, February 1973²). Part of this was a method for investigating incidents and accidents that relied upon a logic tree diagram (the eponymous *tree* of the MORT acronym). The MORT diagram served as a graphical index to Johnson's text, allowing people to apply its contents in a methodical way. To help investigators, especially novices, the original text (which is in excess of 500 pages) was distilled into a forty-two-page question set: the MORT Users Manual³. MORT as a method is now largely independent of MORT as a programme, certainly in Europe. In practice, the MORT text (i.e. SAN 821-2) has become disassociated from the MORT chart, leaving the MORT User's Manual as the most common source of reference.

2 Overview of the MORT Method

This section is divided into two subsections that aim to acquaint new MORT users with the basic concepts and how they apply to analytical investigation. The first sub-section deals with the concepts and provides a sketch of the method. The second subsection describes the conventions of the MORT diagram. Readers

² SAN 821-2 is available from the NRI Foundation website in pdf format.

³ The most recent public domain version of the MORT Users Manual was revision 3, published by EG&G Idaho Inc. for the U.S. Department of Energy. This, at the time of writing, is still available from the U.S. DOE web site: http://tis.eh.doe.gov/analysis/trac/SSDC_doc/10003.txt, as is the corresponding MORT chart http://tis.eh.doe.gov/analysis/trac/SSDC_doc/mort.gif.

who are already familiar with the basics, should move forward to the detailed procedural guidance given in section 3 (page xv).

2.1 *General Approach*

In MORT, accidents are defined as unplanned events that produce harm or damage, that is, losses. Losses occur when a harmful agent comes into contact with a person or asset. This contact can occur either because of a failure of prevention or, as an unfortunate but acceptable outcome of a risk that has been properly assessed and acted-on (a so-called "assumed risk"). MORT analysis always evaluates the "failure" route before considering the "assumed risk" hypothesis.

In MORT analysis, most of the effort is directed at identifying problems in the control of a work/process and deficiencies in the protective barriers associated with it. These problems are then analysed for their origins in planning, design, policy, etc.

To use MORT, you must first identify key episodes in the sequence of events. Each episode can be characterised as:

- a vulnerable target exposed to –
- an agent of harm in the –
- absence of adequate barriers.

MORT analysis can be applied to any one or more of the episodes identified; it is a choice for you to make in the light of the circumstances particular to your investigation. To identify these key episodes, you will need to undertake a barrier analysis (or "Energy Trace and Barrier Analysis" to give it its full title). Barrier analysis allows MORT analysis to be focussed; it is very difficult to use MORT, even in a superficial way, without it.

The MORT process is rather like a dialogue between the generic questions of MORT and the situation that you are investigating. You, the analyst, act as the interpreter between MORT and the situation. The questions in MORT are asked in a particular sequence, one that is designed to help you clarify the facts surrounding the incident. Even so, not every question posed by MORT will be relevant on all occasions. Getting acquainted with MORT is essentially about becoming familiar with the gist of questions in this manual. The chart itself then acts as a prompt list allowing you to concentrate on the issues revealed through the process. It is important for you to make notes as you go, just as it would be if you were conducting an interview. In practice, MORT analysts make brief notes on the MORT chart - enough to capture the issues that arise and their assessment of them. To make this process easier to review, it is customary to colour-code the chart as you go:

- red, where a problem is found;
- green, where a relevant issue is judged to have been satisfactory, and;
- blue, to indicate where you think an issue is relevant but you don't have enough information to properly assess it.

In addition, issues presented by MORT that you judge to be irrelevant, should be crossed-out to show that you have considered them.

The outcomes of a MORT analysis are:

- the creation of new lines of enquiry;
- visibility of causal factors (which are grouped thematically) and;
- increased confidence in the thoroughness of the investigation.

These results are not gained without effort; one sweep through MORT for one episode is likely to take an experienced MORT analyst about one hour. As a general rule, only use MORT when you judge that it will add to your investigation – do not use it just because you can. Furthermore, you need to be familiar with the method and to have performed it at least once on a real investigation, to be in a good position to make this judgement.

The question set that forms Part 2 of this manual, can be tailored to your organisation by illustrating the issues with your own examples. The points in the text where examples might be most useful are identified by the sentence "**Your own examples may help to illustrate this**".

2.2 Conventions of the MORT Diagram

This section introduces the conventions used in the MORT chart, including the symbols. MORT shares some of the conventions of Fault Tree Analysis (FTA). MORT breaks down generic events into their causal components using a hierarchical logic and joins causes to effect with logic gates.

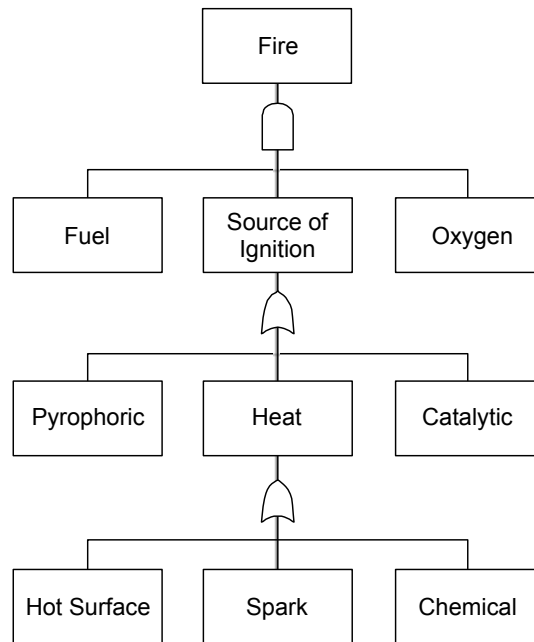


Figure 1. Example of Hierarchical Logic

In Fault Tree Analysis the causal components are referred to as input events and their effect is called an output event. For example, in Figure 1 the three input events: “Ignition Source”, “Fuel” and “Air” produce “Fire” as an output event. Where all the inputs are required to produce the output, as is the case for fire, the input events are joined to the output event by an AND gate. Where just one input is sufficient to produce the output, an OR gate is used. If there is more than one input through an OR gate, the output will still occur⁴. For example, it is conceivable that both sparks and hot surfaces will be present.

Figure 2, which is an extract from the MORT chart, illustrates many of the symbols and conventions used in the rest of the diagram.

⁴ MORT does not differentiate between exclusive and non-exclusive OR gates

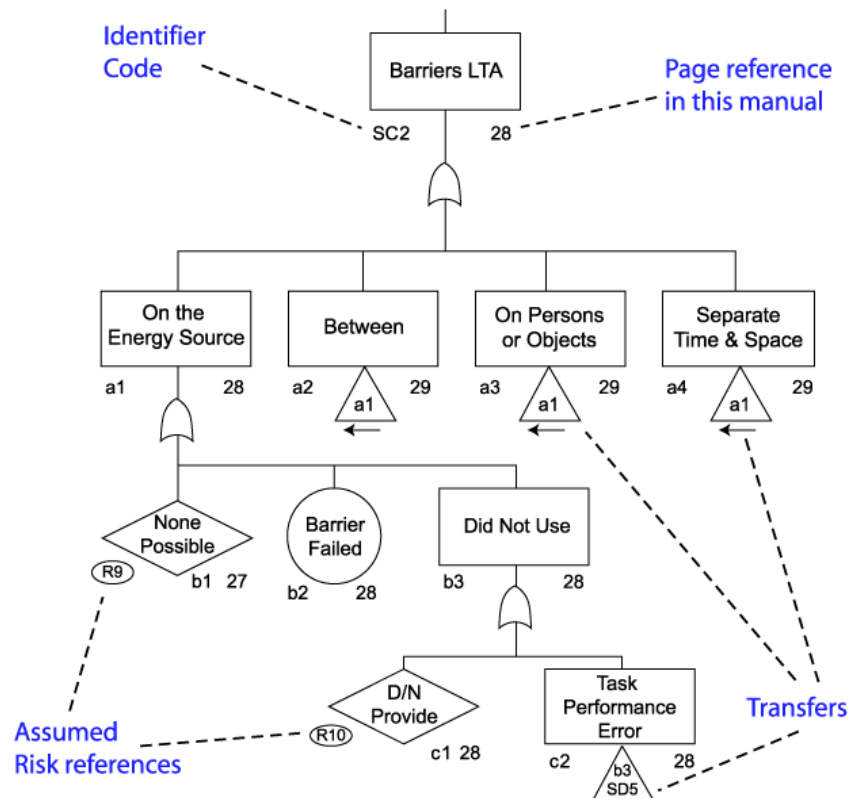


Figure 2. MORT SC2 Branch – "Barriers LTA"

Every item on the MORT diagram has two references – a code (e.g. “SC2” is the identity code of the MORT event “Barriers LTA”) and a reference to the relevant page of this manual. MORT codes follow a hierarchical scheme, reflecting the structure of the chart. Where an event is the output of a significant branch, it is generally identified by a code written in capital letters with an ‘S’ or ‘M’ for a first letter. The ‘S’ indicates that it is a part of the “Specific Control Factors” branch whereas ‘M’ shows that it belongs to the “Management System Factors” side. To uniquely specify a MORT event, it is normal to use an address format. Two (and occasionally three) identity codes linked with a hyphen are all that is needed. For example, to refer to the event “On Persons or Objects” in Figure 2, you would write a3-SC2.

Figure 2 uses a diamond-shaped symbol at two places: b1-SC2 and c1-SC2. When accompanied by a small oval symbol (labelled R9 & R10 in this example) this indicates an assumed risk – a risk that has been identified and accepted on behalf of the organisation responsible for controlling it. Section 2.4, explains assumed risks in more detail.

Like fault trees, MORT uses a system of transfers; for example in Figure 2, below event a2-SC2, is a triangle containing the text “a1”; the triangle is a transfer symbol and is used to save space on the tree. A triangle below an event shows that there are associated events to explore elsewhere in the tree. In this example, when evaluating event a2-SC2 (“between”), the branch underneath a1 needs to be considered just as if it was drawn directly beneath a2-SC2. The transfer below event c2-SC2 connects it with b3-SD5. This means

that the (c2) task performance error that is manifest in (b3) not using a barrier, will be further analysed using the branch at b3-SD5.

2.3 MORT Structure

The top event in MORT is labelled “Losses”, beneath which are its two alternative causes: (1) Oversights and Omissions, or (2) Assumed Risks. All contributing factors in the accident sequence are treated as oversights and omissions unless they are transferred to the Assumed Risks branch (discussed in section 2.4). Input to the Oversights and Omissions event is through an AND logic gate. This means that problems manifest in the specific control of work activities, necessarily involve issues in the management processes that govern them.

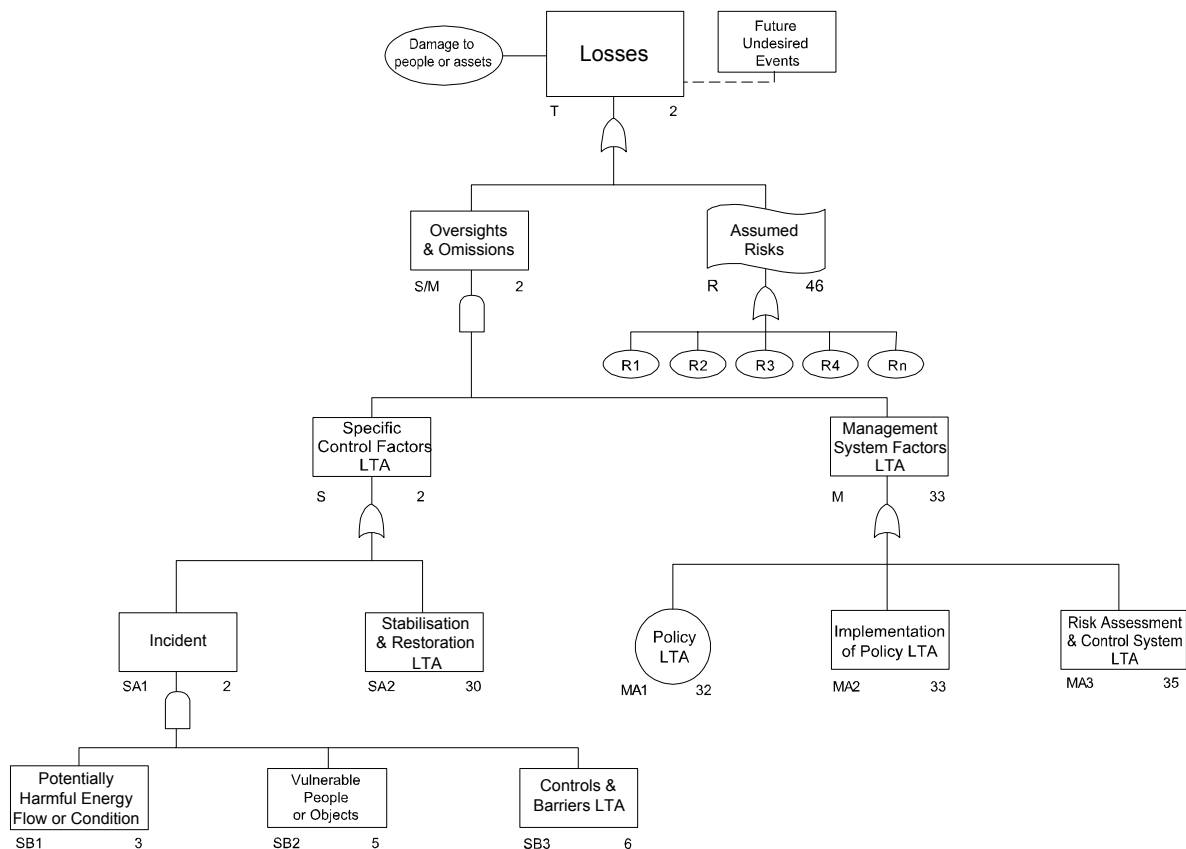


Figure 3. The MORT Treetop

The Specific and Management branches are the two main branches in MORT. Specific control factors are broken down into two classes: those related to the incident or accident itself (SA1) and those related to restoring control following an accident (SA2). These are under an OR gate because either can be a cause of losses.

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 many cases, there will be contributions from both of these sources.

MORT contains several referrals to the “Assumed Risk” branch. For example, at b1-SB2, MORT allows the possibility that a barrier was not provided because it would have been impractical to do so. However, you would need to establish the reasons for this decision to a satisfactory level of evidence. In practice, this will involve reviewing the risk assessment and cost-benefit analyses that support the decision. Sometimes these will be written and extensive, on other occasions no written record will exist and the review will be based on interview with the decision-maker concerned.

To avoid interrupting the analysis, you can record assumed risks in the table provided on the MORT chart and follow them up as a separate exercise. Each referring event in the MORT chart should be provisionally coded blue and should correspond to an entry in the table. The event cannot be closed until justification for assuming risk has been evaluated.

| MORT Ref. | Description | LTA? |
|------------------|--|-------------|
| 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

Each row of the table needs to subject to further enquiries aimed at establishing whether the basis for assuming the risk was adequate. The factors that you need to consider when assessing provisional assumed risk decisions are explained in Part 2 on Page 46.

3 Application of MORT to investigations

Good investigations are built on a secure picture of what happened. Using an appropriate “sequencing” method such as Events & Causal Factors Analysis (ECFA) can be very useful for this. As soon as the factual picture allows it, carry out a Barrier Analysis.

3.1 *Barrier Analysis*

Energy Trace & Barrier Analysis – ETBA, or “Barrier Analysis” as it is usually, called produces a clear set of episodes for MORT analysis. It is an essential preparation for MORT analysis.

“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 undisturbed by the “Energy”. In MORT, an accident has to produce loss, hence 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. An incident can result either from exposure to an energy flow without injuries or damage, or the damage of a target with no intrinsic value. The latter case may still be a valuable focus for analysis.

The “Barrier” part of the title refers to the means by which “Targets” are kept safe from “Energies”. In fact, Barrier Analysis includes not just barriers (the nature of which is purely protective) but also work/process controls as these may provide also provide protection by directing energies (and targets) in a safe manner.

| Energy Flow <i>or harmful Agent, adverse environment condition</i> | Target <i>Vulnerable person or thing</i> | Barriers & Controls <i>to separate Energy and Target</i> |
|--|--|--|
| | | |
| | | |

Table 2. Barrier analysis format

Very often, an accident reveals a number of episodes where energies meet targets in unwanted interactions; Barrier analysis seeks to trace all of these and make them available to analysis. This means that in practice Table 2 may have several rows, each corresponding to a distinct episode of energy interaction with a target.

3.1.1 Procedure for Barrier Analysis

Requirements

- Two people (ideally), paper and pencil
- Technical understanding of the system in which incident occurred
- Enough details about the sequence of events to allow analysis to begin.

Objective

To account for all unwanted interactions between energies and targets 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: just those interactions producing harm/damage or include near-misses?
3. Rule 3 columns on a sheet (as shown in table 3)
4. Start in the TARGET column and identify a target that was harmed or damaged (or exposed to harm, if a near-miss scope is adopted). Identify the energy flow (or harmful agent...) that is acting – be precise in stating it in the ENERGY FLOW column.
5. Next, consider the BARRIERS and CONTROLS that should have stopped the interaction between Energy and Target. Repeat this process for another episode.

| Energy Flow <i>or harmful agent, adverse environment condition</i> | Target <i>Vulnerable person or thing</i> | Barriers & Controls <i>to separate Energy and Target</i> |
|---|--|---|
| <p>These may be energies (and harmful agents...) designed to do work in the work process or extraneous energies that act from outside the process.</p> <p>Be meticulous as this stage of the analysis. Care here pays large dividends later.</p> <p>Energy flows can be in the reverse direction (e.g. exposure to cold, loss of pressure).</p> <p>If there are multiple targets for a given energy flow, state each interaction in a separate row.</p> | <p>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 <i>all</i> targets involved in the incident (this leads to a clear insight into the state of risk control).</p> <p>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)".</p> <p>Note that the object or actor that corresponds to a target at one point in the analysis may also play other roles.</p> | <p>Barriers are means of separation that are 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.</p> <p>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. <i>MORT analysis will tease out the procedural and upstream issues.</i></p> <p>Include <i>absent</i> barriers & controls that <u>should</u> have been present according to an explicit standard (or justifiable judgement).</p> |

Table 3. Barrier Analysis Headings, annotated with guidance

6. Review the list of targets for any omissions.
7. Number rows (each row is an episode of energy flow threatening or damaging a target) in chronological order... Do the events follow from one another?
8. Prioritise rows for root cause analysis (e.g. *** = most important, * = least important)

3.2 Procedure for MORT Analysis

Requirements

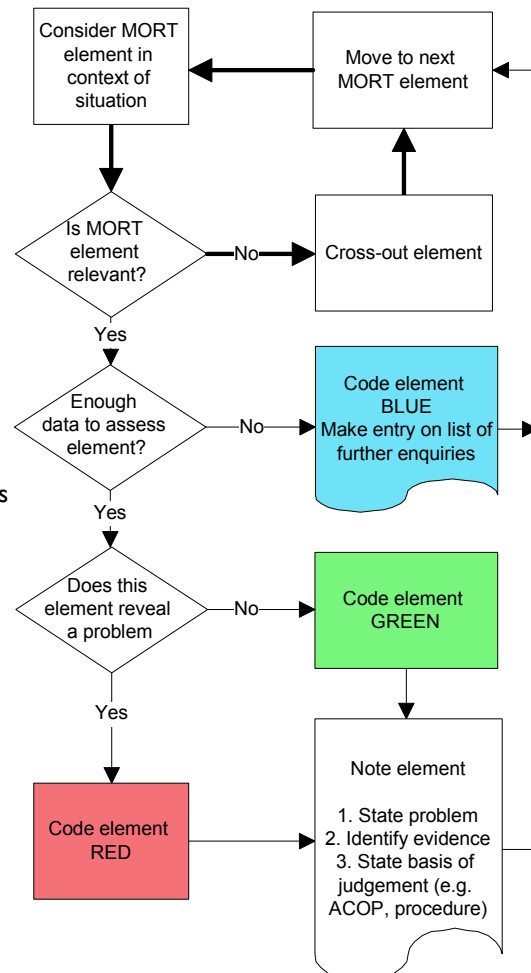
- Technical Understanding of system in which incident occurred
- Sufficient description of sequence of events to allow analysis to begin
- MORT Charts and coloured pens – Red, Blue, Green
- Two people (ideally)
- Notepad to record “blue” items for further enquiry

Objective

To understand how specific targets were exposed to harm, damage or unwanted change.

Description

1. Choose an episode from your Barrier Analysis and write it on the MORT chart above SAI “Incident”
2. Begin at SBI (“Harmful energy flow...”)
 - State the energy flow above SBI
 - Proceed through chart top to bottom, left to right
 - Code RED or GREEN only with evidence and explicit standard of judgement
 - Code BLUE if evidence or required standard is uncertain
 - Maintain your list of further enquiries as you go
 - Note any provisional Assumed Risks into the table
3. When SB3 (“Controls & Barriers LTA”) completed
 - explore M-branch either by:
 - ad hoc exploration of M-branch
 - in sequence – a2-MBI, a1-MBI, MA1, MA2, MB2
4. If needed, select another episode from Barrier Analysis
 - Use fresh MORT chart
 - Repeat steps 3 and 4
5. When all required SAI analyses are complete
 - Note on the barrier analysis episodes that have not been subject to MORT analysis
 - Move to SA2 – Amelioration
 - Move to M-Branch and explore (ad hoc or in sequence) in the light of the SA2 analysis
6. Review Provisional Assumed Risks
 - Explore any that are LTA using a1-MBI
7. Review MB2 in the light of the analysis so far
8. Review the M-branch issues, taking the overview



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User's Manual Part 2: The MORT Question Set

Index of main branches

| Ref. | Page | Ref. | Page | Ref. | Page |
|------|------|--------|------|----------|------|
| SA1 | 2 | SD1 | 7 | MA1 | 33 |
| SA2 | 30 | SD2 | 12 | MA2 | 33 |
| SB1 | 3 | SD3 | 14 | MA3 | 35 |
| SB2 | 5 | SD4 | 14 | a1-MA3 | 35 |
| SB3 | 6 | SD5 | 16 | a2-MA3 | 38 |
| SB4 | 29 | b3-SD5 | 18 | MB | 44 |
| SC2 | 28 | SD6 | 26 | R | 46 |

| I. Questions | 2. Pointers & Examples |
|---|---|
| <u>Before you start</u> | |
| <p>Check that you have the following items in place:</p> <ul style="list-style-type: none"> <input type="checkbox"/> A summary of what you know at this stage about this incident and others similar to it; <input type="checkbox"/> Enough information to begin MORT. A clear picture of <i>what</i> happened is required to support MORT analysis of <i>why</i> they happened; <input type="checkbox"/> Agreement about what constitutes a fact (evidence rules). Do not spend too much time at the beginning trying to specify this precisely as it will become clearer as the analysis proceeds. <input type="checkbox"/> The necessary human resources - build team and assemble the right expertise. You will need access to knowledge about the technology and methods of the work/process involved in the incident. | <p><i>In MORT an ACCIDENT is defined as an unplanned event involving LOSS or HARM. This occurs when a valuable TARGET interacts with a harmful ENERGY FLOW (or adverse environmental condition). This occurs because the controls and barriers in place were not adequate.</i></p> <p><i>An INCIDENT is defined as an unplanned event in which the controls and barriers were inadequate and either:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> a valuable target (person or asset) was exposed but escaped harm or damage, or; <input type="checkbox"/> the target(s) involved were not valuable (and so no loss or harm could be sustained). |

| 1. Questions | 2. Pointers & Examples |
|---|--|
| <u>T Fundamental Questions (the Top event)</u> | |
| <p>What happened?</p> <p>What was the sequence of events including the initiating event that marked the movement of the work/process from adequately controlled to inadequately uncontrolled?</p> <p>Describe the extent of harm and losses (including intangible assets such as reputation, customer confidence, employee morale).</p> <p>Subsequent analysis will seek to establish</p> <ul style="list-style-type: none"> <input type="checkbox"/> why the harm or loss occurred; <input type="checkbox"/> what future undesired events could result from the problems identified. | <p><i>Use these questions to help you familiarise yourself with the available information, but there is no need to go into detail at this point, as you will be returning to the questions later.</i></p> |
| <u>S/M. Oversights and Omissions</u> | |
| <p>MORT considers two explanations for an incident:</p> <ul style="list-style-type: none"> <input type="checkbox"/> First that the incident was due to problems in the planning, design or control of work/process; and, <input type="checkbox"/> Second, that the incident was an acceptable outcome of the risk management process – an assumed risk. <p><i>By working through MORT, you can evaluate both of these. In the second case, this will be prompted by questions that specifically address decisions to accept risk and problems in that process.</i></p> | |
| <u>S. Specific Control Factors</u> | |
| <p>This half of the MORT tree addresses:</p> <ul style="list-style-type: none"> <input type="checkbox"/> the specific controls upon harmful energies <input type="checkbox"/> the specific controls upon vulnerable people and assets <input type="checkbox"/> the barriers between energies, and people and assets <input type="checkbox"/> how emergency actions contributed to the final outcome of the accident. | <p><i>This branch is used from top to bottom and left to right. Hence the next part to be considered is “SA1. Incident” and the last will be “SA2. Stabilisation and Restoration”.</i></p> <p><i>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. Bear in mind what the possible effects that the control problems you identify may lead to in the future.</i></p> |
| <u>SA1. Incident</u> | |
| <p>You should have completed your EBTA before continuing. (See section 3.1, page xv)</p> <p><i>MORT analysis may involve more than one sweep through SA1. You are advised to decide at the outset how many energy-flow/target interactions (abbreviated as ExT's) you intend to include in your analysis.</i></p> <p><i>SA1 analysis leads naturally to:</i></p> <ul style="list-style-type: none"> • <i>consideration of the Management System Factors, and</i> • <i>judgement about whether decisions to accept risks were appropriate or not.</i> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>SB1. Potentially Harmful Energy Flow or Environmental Condition (incident)</p> <p>This branch considers the harmful energy/environmental condition in question. The purpose here is to gain a clear insight into the control issues.</p> <p><i>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.</i></p> <p><i>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.</i></p> | |
| <p>a1. Non-functional</p> <p>Consider this branch if the energy flow or environmental condition causing the harm was not a functional part of or product of the system.</p> <p><i>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.</i></p> <p><i>Your own examples may help to illustrate this</i></p> <p><i>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.</i></p> | |
| <p>b1. Was there adequate control of non-functional energy flows and environmental conditions?</p> | <p><i>You need to think about what is adequate in the circumstances.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>b2. Was such control practicable?</p> <p>Note that the event is flagged with R4 assumed risk symbol.</p> | <p><i>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.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> <p><i>The event cannot be closed until justification for assuming the risk has been evaluated. Justification may be very different in different circumstances.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>a2. Functional</p> <p>Consider this branch if the energy-flow (or environmental condition) was functional, but was used without adequate barriers in place.</p> <p><i>Functional energy flow is an energy flow which is meant to be there and contributes to the intended purpose or function of the system.</i></p> <p><i>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.</i></p> <p><i>The focus of this event is the energy-flow, not the barriers which are considered later.</i></p> | |
| <p>b3. Control of Use LTA</p> <p>Was the energy applied at the right time and in the right amount.</p> <p>If not which controls of the energy were less than adequate?</p> | <p><i>You need to think about what is adequate in the circumstances.</i></p> |
| <p>b4. Diversion LTA:</p> <p>This branch considers diverting harmful functional energy away from vulnerable people or objects.</p> <p><i>Example: Electrical earthing, pressure relief valve. Your own examples may help to illustrate this.</i></p> | |
| <p>c1. Was there adequate diversion of harmful energy flows or environmental conditions?</p> | <p><i>You need to think about what is adequate in the circumstances.</i></p> |
| <p>c2. Was diversion impractical?</p> <p>Note that this event is flagged with R2 assumed risk symbol.</p> | <p><i>If diversion 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.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> <p><i>The event cannot be closed until justification for assuming the risk has been evaluated. Justification may be very different in different circumstances.</i></p> <p><i>Your own examples may help to illustrate this.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>SB2. Vulnerable People or Objects</p> <p>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.</p> <p><i>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.</i></p> <p><i>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.</i></p> | |
| <p>a1. Non-functional</p> <p>Consider this branch if the person or object exposed to harm was not a functional part of the system.</p> <p><i>Non-functional person or object – is a person or object which is not meant to be there or did not contribute to the intended purpose or function of the system or is not intended to be part of the system under consideration.</i></p> <p><i>Example - personnel passing through a worksite to reach an adjacent worksite</i></p> <p><i>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.</i></p> | |
| <p>b1. Was there adequate control of non-functional persons and objects?</p> | <p><i>You need to think about what is adequate in the circumstances</i></p> |
| <p>b2. Was such control practicable?</p> <p>Note that the event is flagged with R3 assumed risk symbol.</p> | <p><i>If no means of control was available because it was judged impracticable to provide it, 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.</i></p> <p><i>The event cannot be closed until justification for assuming the risk has been evaluated. Note - justification may be very different in different circumstances</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>a2. Functional</p> <p>Consider this branch if the person or object was functional, but was exposed without adequate barriers in place.</p> <p><i>MORT assumes that people and assets which contribute to the purpose or function of the system should only be present if the barriers are adequate. If the barriers are inadequate, people and assets should not be exposed or exposed only to a limited degree.</i></p> <p><i>The focus of this branch is the people/objects, not the barriers which are considered later.</i></p> | |
| <p>b3. Control of exposure</p> <p>Were the people or objects in place at the right time?</p> <p>If not, what controls to prevent persons or objects from being exposed were less than adequate?</p> | |
| <p>b4. Evasive action LTA</p> <p>This branch considers the evasion of harmful energy flows and environmental conditions.</p> <p>Examples - use of emergency exits, escape routes, routes to shelters.</p> | |
| <p>c1. Means of Evasion LTA?</p> <p>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?</p> | <p><i>You need to think about what is adequate in the circumstances.</i></p> |
| <p>c2. Was evasion impractical?</p> <p>Note that this event is flagged with R4 assumed risk symbol.</p> | <p><i>The event cannot be closed until justification for assuming the risk has been evaluated. Justification may be very different in different circumstances.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> |
| <p>SB3. Barriers and Controls LTA (Incident)</p> <p>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.</p> <p><i>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.</i></p> <p><i>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.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p><u>SCI. Control of work and process LTA</u></p> <p>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:</p> <ul style="list-style-type: none"> <input type="checkbox"/> Technical information systems [SD1] <input type="checkbox"/> Verification of operational readiness [SD2] <input type="checkbox"/> Maintenance [SD3] <input type="checkbox"/> Inspection [SD4] <input type="checkbox"/> Supervision [SD5] <input type="checkbox"/> Supervision support [SD6] <p><i>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.</i></p> | |
| <p><u>SD1 Technical Information Systems LTA</u></p> <p>This branch is about the adequacy of the information system designed to support the work/process in question.</p> <p><i>This is considered in three main ways:</i></p> <p>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. <i>Your own examples may help to illustrate this.</i></p> <p>The monitoring systems that measure the behaviour and efficiency of the “work flow process”; <i>Your own examples may help to illustrate this.</i></p> <p>Actions triggered by the results of the monitoring process (e.g. triggering of Hazard Analysis). <i>Your own examples may help to illustrate this.</i></p> | |
| <p>a1. Technical Information LTA:</p> <p>This branch considers the contribution of technical information to the control of the work flow process in question.</p> <p><i>You need to consider:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> timing of information; <input type="checkbox"/> format of information; <input type="checkbox"/> adequacy for triggering necessary actions; <input type="checkbox"/> who will be receiving/exchanging information; <input type="checkbox"/> availability of expertise and technical guidance. | |
| <p>b1. Knowledge LTA:</p> <p>This branch is about whether the people making decisions about this work/process were adequately knowledgeable or had access to adequate knowledge.</p> <p><i>These people include those managing or supervising the work and people doing the work.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>c1. Based upon known precedent</p> <p>This branch considers the application of existing knowledge about the energy flow and/or problem in question.</p> <p><i>In practice, you will need to find out whether or not there is precedent for the unwanted energy flow.</i></p> | |
| <p>d1. Application of knowledge from Codes and Manuals, LTA</p> <p>Was the work/process and related issues adequately addressed by codes and manuals; and</p> <p>Did individuals making decisions adequately apply the knowledge from codes and manuals?</p> | |
| <p>d2. Was the list of experts (to contact for knowledge) adequate?</p> | <p><i>When deciding the adequacy of the list of experts, you need to consider:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Accessibility <input type="checkbox"/> Availability <input type="checkbox"/> Applicability <input type="checkbox"/> Any constraints |
| <p>d3. Was any existing but unwritten knowledge about the work flow/process known to the "action" person?</p> | <p><i>The action person is the individual (or individuals) undertaking the work task/process.</i></p> <p><i>Your own examples may help to illustrate this.</i></p> |
| <p>d4. Was there any research directed to the solution of known work flow/process problems and was this adequate?</p> | |
| <p>c2. If there was no known precedent:</p> <p><i>(meaning: no known precedent for the unwanted energy flow and its prevention)</i></p> <p>Consider this branch if the problem in question has <u>not</u> been experienced before within the organisation or elsewhere.</p> <p><i>In practice, you will need to find out whether or not there is precedent.</i></p> | |
| <p>d5. Previous investigation and analysis LTA</p> <p>Have there been previous similar accidents or incidents, or risk assessments of this work/process?</p> <p>Were these investigations or assessments adequate?</p> | <p><i>If you do not have this information to hand – provisionally code this event blue and make it an entry on your list of further enquiries.</i></p> |
| <p>d6. Was there any research directed to the identifying and solving work flow process problems? Was this adequate?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>b2. Communication LTA:</p> <p>This branch considers the adequacy of communication of knowledge about the specific problem in question</p> <p><i>Consider:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> The magnitude of hazard involved; <input type="checkbox"/> Who the relevant people are and their different roles in relation to the work/process; <input type="checkbox"/> The range of channels of communication e.g. procedures, training, supervision, task risk assessment, etc. | |
| <p>c3. Internal Communication LTA</p> <p>This branch considers the adequacy of internal communication of knowledge about the specific problem in question</p> | |
| <p>d7. Was the definition of the internal communication network adequate?</p> | <p><i>These might include verbal, written and IT networks that allow people to share information.</i></p> <p><i>Consider:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Who needed to know what information and when; <input type="checkbox"/> Did people know how to get information if they had a problem? |
| <p>d8. Was operation of the internal communication network adequate?</p> | <p><i>As well as, formal networks, consider informal networks.</i></p> |
| <p>c4. Was the external communication adequate?</p> <p>This branch is about the adequacy of communication between the organisation and any relevant external sources of knowledge.</p> <p><i>You need to think about who or what are the relevant sources of knowledge about the work/process, and who in the organisation needs to be connected with them.</i></p> <p><i>Example: Trade associations, professional and industrial bodies, other organisations, other sites.</i></p> | |
| <p>d9. External Network Definition LTA?</p> <p>How well had the organisation identified external sources of knowledge relevant to the work/process?</p> <p>How well was the organisation connected to any relevant external sources of knowledge?</p> | |
| <p>d10. External Network Operation LTA</p> <p>Was information obtained from these external sources in an effective way?</p> | <p><i>The use and maintenance of information networks is considered in MA3 of the Management branch.</i></p> |
| <p>a2. Data collection</p> <p>This branch considers how the organisation captures data about its own operating experience.</p> <p><i>The purpose of collecting this data is to provide feedback to improve the work/process.</i></p> <p><i>The focus here is not only data current to the problem under consideration but also the collection of relevant data before this incident to detect problems at an early stage.</i></p> | |
| <p>b3. Was there an adequate plan for monitoring the work and conditions?</p> | <p><i>Who puts the plan into practice? (There may be a number of people including the supervisors of the work/process in question.)</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>b4. Did an independent organisation/person review the work/process to identify high potential hazards? Was the review done adequately?</p> <p>If no review, should one have been undertaken?</p> | |
| <p>b5. Was information about relevant problems from earlier incidents/accidents used adequately?</p> <p>Where there are relevant instances:</p> <ul style="list-style-type: none"> <input type="checkbox"/> had the work/process been improved in the light of findings and recommendations; <input type="checkbox"/> were improvements documented; and, <input type="checkbox"/> had relevant information been made available to people employed within the work/process. | <p><i>In practice, you will need to consult the organisation's records to determine whether or not there are previous, relevant accidents.</i></p> |
| <p>b6. Learning from employee/contractor experience LTA</p> <p>Was there an adequate method for gaining insights into operating experience of the work/process?</p> <p>Might it have provided information to identify the problem in question?</p> <p>Was there a plan for undertaking research to identify insights? Was it adequate?</p> <p>Was there an adequate system for collecting and using employee suggestions?</p> | <p><i>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.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>b7. Were there routine inspections of the work/process?</p> <p>Did they adequately consider safety, health and protection of the environment?</p> | |
| <p>b8. "Upstream" process audits LTA</p> <p>Was an adequate system in place to assure the quality of the planning and design of the work/process?</p> | <p><i>Upstream work flow processes include design, construction, selection and training, etc.</i></p> <p><i>Audits of planning and design these processes need to include examination of the three basic work ingredients - hardware, procedures, and people.</i></p> |
| <p>b9. Was the monitoring of the general health of operational personnel in the work/process adequate?</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>a3. Data analysis</p> <p>This branch considers whether data relevant to the work/process had been adequately analysed.</p> <p><i>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.</i></p> <p><i>Analyses should provide decision-makers with adequate information and interpretation to make appropriate decisions about risk.</i></p> <p><i>Analysis is a continuous process that should aim to provide the best understanding based on the most current and relevant information.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>b10. Priority problem list LTA?</p> <p>Is the problem in the work/process included on the priority problem list?</p> <p>Should it have been?</p> <p>Is the absence of the problem in question from the list, an indication that the list is not up-to-date?</p> | <p><i>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.</i></p> <p><i>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.</i></p> <p>Your own examples may help to illustrate this.</p> |
| <p>b11. Statistics and Risk projection LTA?</p> <p>Were the available status, predictive statistics and projections adequate? Would they have alerted management to the problem in the work/process?</p> | <p><i>These include:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Diagnostic statistics (concerned with current performance) <input type="checkbox"/> Predictive statistics <input type="checkbox"/> Risk projection analysis (statistics concerned with future performance) <p>Your own examples may help to illustrate these.</p> <p><i>Diagnostic statistics and risk projection methods are useful to determine whether the data available are important and require attention.</i></p> |
| <p>b12. Status Display LTA</p> <p>Was there an adequate single information display point for managers to help them keep abreast of current problems, analyses, and results?</p> | <p><i>Examples include an “incident room” or intra/internet information page.</i></p> |
| <p>a4. Triggers to hazard analysis LTA</p> <p>This branch considers whether problems in the work/process should have triggered the hazard analysis process before the incident in question.</p> <p><i>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 hazard analysis. Unplanned change needs to be detected by monitoring and analysis, these in turn need to be designed to trigger hazard analysis where appropriate. Hazard analysis should then initiate appropriate action to reduce risk. .</i></p> | |
| <p>b13. Sensitivity LTA</p> <p>Was the technical information system sensitive enough to trigger hazard analysis for the individual problem (within the work/process in question)?</p> | <p>Your own examples may help to illustrate this</p> |
| <p>b14. Priority Problem Fixes LTA:</p> <p>Did the technical information system trigger the inclusion of the risk/problem on the HAP Priority Problem Lists?</p> <p>Does the absence of the problem from the list indicate less than adequate trigger arrangements?</p> | <p><i>HAP – Hazard Analysis Process</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>b15. Planned Change Controls LTA</p> <p>If there had been a planned change in the work/process, did the people involved in making that change adequately recognise the need for hazard analysis?</p> <p>Were the pre-set triggers to initiate hazard analysis adequate?</p> <p>Was the fact that the HAP was not used, evidence of inadequacies in the change control process?</p> | <p><i>Planned changes covers changes to both plant and procedures.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>b16. Unplanned Change Controls LTA</p> <p>If there has been unplanned change in the work/process, were the people involved in making that change adequately aware of the need for HAP?</p> <p>Were there adequate pre-set triggers to initiate hazard analysis?</p> <p>Was the fact that the HAP was not used, evidence of problems in the change control process?</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>b17. New Information Use LTA</p> <p>Were HAP triggers from research, new standards, etc. , adequately recognised and used?</p> | <p><i>A retrospective test is whether a literature search would reveal that new information relevant to the work/process was published, but had not been recognised or acted on.</i></p> |
| <p>a5. Independent Audit and Appraisal LTA:</p> <p>Was the technical information system subject to adequate review?</p> | <p><i>Audit and appraisal should include usability criteria as well as measures of functional adequacy.</i></p> |
| <p><u>SD2. Operational Readiness LTA</u></p> <p>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 not have been adequate.</p> <p><i>When evaluating readiness of the work/process, consider readiness in terms of:</i></p> <ul style="list-style-type: none"> • <i>plant/hardware;</i> • <i>procedures/management controls;</i> • <i>personnel.</i> <p><i>This branch deals with “Here & Now Readiness”. The purpose of “Here & Now Readiness” is to ensure that the requirements specified by planners and designers are met when the work/process or equipment is actually used.</i></p> <p><i>Examples – isolation certificates, hand-over certificates, work permits and inspection of the worksite.</i></p> <p><i>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.</i></p> | |
| <p>a1. Verification of operational readiness LTA</p> <p>This branch considers whether verification of the operational readiness of the facility and/or work process was adequate.</p> <p><i>Example – worksite inspection before hand-over of area or start of work.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>b1. Was an operational readiness check specified for this work/process?</p> <p>Would an adequate operational readiness check have identified the problem in question?</p> | |
| <p>b2. Were the criteria used in the check to determine operational readiness, adequately specified?</p> <p>Does the problem in question indicate inadequacies in the criteria?</p> | |
| <p>b3. Was the required procedure for determining operational readiness adequate? Was it followed adequately?</p> | |
| <p>b4. Were the personnel who made the decision on operational readiness adequately skilled, competent and experienced?</p> | |
| <p>b5. Were actions (identified through operational readiness checks) adequately followed up?</p> <p>Were all outstanding actions resolved before start-up of the work/process?</p> | |
| <p>a2. Technical Support LTA:</p> <p>Was adequate technical support provided to assuring the readiness of the work/process,</p> <p>Was the failure to assure readiness due to inadequate technical support?</p> | <p><i>The technical support (e.g. by scientific and engineering personnel) at the work site is particularly important to ensure readiness.</i></p> |
| <p>a3. Interface between Operations and Maintenance or Testing Activities LTA:</p> <p>Was the interface between operations personnel and testing or maintenance personnel adequate?</p> <p>Could procedures have prevented misunderstandings about the state of readiness?</p> | <p><i>This event considers whether changes in activities, such as those mentioned in the question, caused or allowed misunderstanding of the status of the work/process or equipment?</i></p> <p><i>Consider shift change when evaluating the adequacy of interfaces.</i></p> <p><i>Example – change of use procedures, shift hand-over procedures/hand-over certificates</i></p> |
| <p>a4. Configuration LTA:</p> <p>Was the actual physical arrangement or configuration of the work/process identical with that required by latest specifications and procedures?</p> <p>Consider whether the configuration and documentation of changes to the facility or process are adequately controlled.</p> | <p><i>Your own examples may help to illustrate this</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p><u>SD3. Inspection LTA</u></p> <p>Questions are the same as Maintenance LTA (SD4)</p> <p>Inspections are done to determine the state of equipment, processes, utilities, operations, etc. This may be carried out by the organisation directly or by agents (e.g. contractors) acting on its behalf.</p> | |
| <p><u>SD4. Maintenance LTA</u></p> <p>This branch considers the contribution of maintenance (or inspection) of equipment, processes, utilities, operations, etc relating to the problem in question.</p> | |
| <p>a1. Planning LTA: This branch considers whether the scope of the (inspection or) maintenance plan adequately considered all the areas relevant to the problem in question.</p> <p>Was management aware of those areas relevant to the problem in question not included in the plan?</p> <p><i>In MORT a plan is based on what is currently known with the expectation that it will need to be updated in the light of new information. Hence the emphasis is on planning a process, rather than plans as finished products.</i></p> | |
| <p>b1. Did not Specify: This branch considers whether the problem in question is related to how the maintenance (or inspection) plan was specified.</p> | |
| <p>c1. Maintainability (Inspectability) LTA: Is the problem in question a result of inadequate maintainability (inspectability)?</p> <p>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)?</p> | |
| <p>c2. Schedule LTA: Did the plan schedule maintenance (inspections) frequently enough to prevent or detect undesired changes?</p> <p>Was the schedule readily available to the maintenance (inspection) personnel?</p> <p>Was the schedule co-ordinated with operations to minimise conflicts?</p> | <p><i>This event looks at whether the problem in question is a result of how maintenance (inspections) has been scheduled.</i></p> <p><i>For example a “deferred maintenance schedule” may lead to failures in practice.</i></p> |
| <p>c3. Competence LTA: Was personnel competence adequately specified/developed for the maintenance tasks (inspection tasks) in question?</p> | |
| <p>b2. Did not Identify Cause of Failure: Have previous relevant failures been subject to adequate analysis for cause?</p> <p>Were such analyses adequately specified by the plan?</p> <p>Did an appropriate individual or group adequately act upon the results of such analysis?</p> | <p><i>Previous near-miss or incident investigations may also have highlighted the need for maintenance (or inspection) plans to be modified.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>a2. Execution LTA: This branch looks at whether the problem in question is a result of how the maintenance (or inspection) plan was executed.</p> | |
| <p>b3. Did not Maintain "Point-of-Operation" Log: Is the problem in question connected to whether a log of maintenance (inspections) was available at the point-of-operation of the piece of equipment, process, or activity?</p> | <p><i>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.</i></p> <p>Your own examples may help to illustrate this</p> |
| <p>b4. Failure caused by maintenance (inspection) activity: Was the problem in question the result of a failure introduced by maintenance (inspection) of the work/process?</p> | |
| <p>b5. Time LTA: Was the time specified in the plan's schedule sufficient to adequately perform each task? Was the time allocated for personnel adequate to fulfil the schedule? Was the time actually made available?</p> | |
| <p>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-b3).</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>SD5. Supervision and Staff Performance LTA</p> <p>This branch is about the role of staff performance and supervision in the control of work/process in question.</p> <p><i>The purpose of supervision is to ensure that an activity or process is working, or will work, smoothly.</i></p> <p><i>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:</i></p> <ul style="list-style-type: none"> • <i>Hierarchical levels</i> • <i>Boundaries and interfaces of supervision</i> • <i>Duties and motivations</i> • <i>For any one supervisor, the prevailing circumstances at the time in question.</i> | |
| <p>a1. Help and Training LTA:</p> <p>Is the problem in question connected to the on-going help and assistance given to supervisors to enable them to fulfil their roles?</p> <p>Was the feedback to the supervisor about his/her performance adequate?</p> <p>Had the supervisor been given adequate training in general supervision?</p> <p>Had the supervisor been given adequate training in safety and risk management?</p> | |
| <p>a2. Time LTA:</p> <p>Did the supervisor have sufficient time to thoroughly examine the work/process?</p> | <p><i>You may need to explore the workload of the supervisor around the time in question.</i></p> |
| <p>a3. Continuity of Supervision LTA:</p> <p>Were there any gaps or confusions in the transfer or hand-over of supervisory tasks related to the problem in question?</p> <p>If the supervisor was recently transferred to the job, was there procedure for reliable transfer of risk information from the old to the new supervisor?</p> | <p><i>Hand-over includes shift changes, new employees and hand-over of responsibility for a location.</i></p> <p><i>Examples – 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</i></p> |
| <p>a4. Did not Detect/Correct Hazards:</p> <p>This branch considers whether the supervisor's efforts in detection and correction of hazards were systematic and adequate.</p> | |
| <p>b1. Did not Detect Hazards:</p> <p>This branch considers whether the problem in question was related to pre-existing hazardous conditions which went undetected by the supervisor.</p> | |
| <p>c1. Knowledge (Checklists) LTA:</p> <p>Did the absence of a checklist of hazards specific to the work/process contribute to the problem in question?</p> <p>If there was a checklist, was it used correctly?</p> | |
| <p>c2. Detection Plan LTA:</p> <p>This branch considers whether there was a systematic approach to uncovering hazardous conditions in the work/process.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>d1. Posting of Warnings, Emergency Procedures LTA: Was the point-of-operation posting of warnings, emergency procedures, etc., provided for in a general detection plan?</p> <p>Were maintenance and inspection logs available at the equipment concerned adequate?</p> <p>Were work diagrams adequate?</p> <p>Was the use of labels/tags to signify changed equipment or settings adequate?</p> | <p><i>“Point-of-operation” meaning the equipment, workstation or area in question.</i></p> <p><i>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.</i></p> <p>Your own examples may help to illustrate this</p> |
| <p>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)?</p> | <p><i>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.</i></p> |
| <p>d3. Did not Review Changes: Were any changes involved in the work/process, whether planned or unplanned, known to the supervisor? Was his response adequate?</p> <p>Was the supervisor's method of detecting and reviewing change adequate?</p> | |
| <p>d4. Did not Relate to Prior Errors: If there were problems in the work/process before the incident, did the supervisor consider the impact these might have on quality and safety?</p> <p>Was the supervisor aware of other signs or warnings that the work/process was moving out of control?</p> | <p><i>For example, a machine that continuously blocks will provoke users to clear the blockage without turning off the machine.</i></p> |
| <p>c3. Time: If the problem in question was not identified before the incident, had the supervisor adequate time to detect the hazards?</p> | <p><i>Consider the supervisor’s workload, especially if this is spread over a number of locations.</i></p> <p><i>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.</i></p> |
| <p>c4 Workforce Input LTA If the workforce already knew about the problem in question, was this information passed on to the supervisor?</p> | <p><i>Knowledge of hazards is often available from the work force. The supervisor must be receptive and accessible and must act on suggestions in a constructive way.</i></p> |
| <p>b2. Did not Correct Hazards: This branch considers whether the problem in question was related to detected hazards which went uncorrected by the supervisor.</p> | |
| <p>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?</p> | <p><i>Interdepartmental co-ordination is a key responsibility supervision and line management. It should not be left to work level personnel.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>c6 Postpone</p> <p>Was the supervisor's decision to accept the risk associated with postponing the correction adequately reached?</p> <p>Note that the event is flagged with R5 assumed risk symbol.</p> | <p><i>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.</i></p> <p><i>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.</i></p> |
| <p>c7. Failed to Act:</p> <p>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.</p> | |
| <p>d5. Was the supervisor's decision to delay hazard correction made on the basis of limited authority to stop the work/process?</p> | |
| <p>d6. Was the supervisor's decision to delay made because of budget considerations?</p> | |
| <p>d7. Was the supervisor's decision to delay made because of time considerations?</p> | |
| <p>c8. Housekeeping LTA:</p> <p>Would adequate housekeeping have prevented the problem in question?</p> <p>Was the storage plan for unused equipment adequate?</p> | |
| <p>C9. Supervisory Judgement:</p> <p>Was the judgement exercised by the supervisor (not to correct the detected hazard) adequate considering the level of risk involved?</p> <p>Has a precedent been established that the supervisor does not act in such circumstances?</p> | <p><i>Review the supervisor's decision not to act on the hazard. Reasons include perceived ownership, authority to act on hazard, risk perception (underestimating risk, over-estimating cost of correction).</i></p> |
| <p>a5. Performance Errors:</p> <p>This branch considers how errors made by frontline personnel contributed to the problem in question.</p> <p>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:</p> <ul style="list-style-type: none"> <input type="checkbox"/> hazard analysis; <input type="checkbox"/> management or supervisory detection; and <input type="checkbox"/> review of procedures for safe systems of work; <input type="checkbox"/> Human factors review of task/equipment. | |
| <p>b3. Task Performance Errors:</p> <p>When using this branch, you need to have in mind <u>specific</u> errors that contributed to the problem in the work/process.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>c8. Task Assignment LTA:</p> <p>Was the problem in question a result of how the task was assigned by the supervisor to the member of staff?</p> <p>Was the assigned task properly scoped with steps and objectives clearly defined?</p> <p>Was the task one an employee should undertake without specific instructions from the supervisor?</p> | |
| <p>c9. Task Specific Risk Assessment Not Performed:</p> <p>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.</p> <p><i>The MORT diagram analysis proceeds on the premise that a task specific risk assessment should <u>always</u> 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.</i></p> | |
| <p>d8. High Potential was not Identified:</p> <p>This branch assumes that a high potential for harm or damage arising from the work/process in question has <u>not</u> been identified (at the time of the incident).</p> <p>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.</p> | |
| <p>e1. Pre-Job-Analysis Not Required:</p> <p>Did the work/process management require a pre-job-analysis to be performed for the work/process in question?</p> | <p><i>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.</i></p> |
| <p>e2. Pre-Job-Analysis LTA</p> <p>If required, was the pre-job-analysis adequate for the work/process in question?</p> | |
| <p>e3. Pre-Job-Analysis not Made:</p> <p>This branch considers the failure to do a pre-job-analysis that was required for the work/process in question.</p> | |
| <p>f1. Was the pre-job analysis not carried out because of lack of authority or because the duty had not been assigned for the work/process in question?</p> | |
| <p>f2. Was it because of budget reasons?</p> | |
| <p>f3. Was it because of time constraints?</p> | |
| <p>f4. Was the pre-job analysis not carried out for the work/process in question because of an inappropriate decision by the supervisor?</p> | <p><i>You will need to consider supervision, in terms of:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> Who was in a position to undertake this; and <input type="checkbox"/> When they could have done it. |

| 1. Questions | 2. Pointers & Examples |
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| <p>d9. Low Potential: Was the work/process in question assessed as one involving low risk potential? Was this a reasonable assessment?</p> <p>Was the supervisor delegated to decide whether to perform a task safety analysis the right person to make this decision?</p> <p>Was this act of delegation itself appropriate?</p> <p>Note the event is flagged with R6 assumed risk symbol.</p> | <p><i>If the criteria for risk identification and assessment were properly met, this event transfers to the Assumed Risk branch.</i></p> <p><i>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.</i></p> |
| <p>c10. Pre-Task Briefing LTA: Was the workforce given an adequate pre-task briefing (prior to performing the task)?</p> | <p><i>For example, did the briefing include new hazards, the effect of recent changes, such as changes arising through maintenance, new equipment, etc.?</i></p> |
| <p>c11. Task Specific Risk Assessment LTA:</p> <p>This branch considers whether the task specific risk assessment for the work/process in question was adequate and scaled properly for the hazards involved.</p> <p>An example of a task specific risk assessment is job safety analysis (JSA).</p> <p><i>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.</i></p> | |
| <p>d10. Development LTA: This branch considers whether the preparation and content of the task specific risk assessment contributed to the problem in question.</p> | |
| <p>e4. Knowledge LTA: This branch considers whether there was adequate knowledge available to the task specific risk assessment in question?</p> | |
| <p>f5. Use of Employee Suggestions and Inputs LTA: Did a lack of employee involvement compromise the knowledge available to the task specific risk assessment?</p> | <p><i>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.</i></p> |
| <p>f6. Technical Information LTA:</p> <p>This branch considers whether the task specific risk assessment was adequately supported by technical information.</p> <p>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. Analysis of the possible reasons for this is shown under SD1-a1. Your evaluation of SD1-a1 should be from the perspective of developing a risk assessment.</p> | |
| <p>e5. Execution LTA This branch considers reasons why the quality of the task specific risk assessment may have been LTA.</p> | |
| <p>f7. Time LTA: Was there sufficient time to an adequately develop the task specific risk assessment for the work/process in question?</p> | <p><i>This needs to be considered in the context of the workload of the individuals in question.</i></p> |
| <p>f8. Budget LTA: Was there a sufficient budget?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| f9. Scope LTA: Were the scope and detail of the task specific risk assessment sufficient to cover all hazards related to the work/process in question? | |
| f10. Professional 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 assessment. | |
| g1. Were the criteria used to identify hazards for later analysis adequate? | |
| g2. Were the methods used in prioritising the identified hazards adequate? | |
| d11. Recommended Controls LTA: This branch considers whether the problem in question was related to the adequacy of controls recommended by the task specific risk assessment. 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? | <i>Was the directive explicit and not subject to possible misunderstanding?</i> |
| e10. Availability LTA: Was the recommended control in question available for use by personnel involved in the work/process? | |
| e11. Adaptability LTA: Were the recommended controls designed in a way that allowed them to be adequately adapted to varying situations? | |
| c12. Did not Use Recommended Controls: This branch considers any failure to use recommended controls relevant to the problem in question. | |

| 1. Questions | 2. Pointers & Examples |
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| <p>d12. Use Not Mandatory: Was use of the recommended controls mandatory?</p> <p>Note that the event 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.</p> | <p><i>The event cannot be closed until justification for assuming risk has been evaluated.</i></p> <p><i>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. See page 46 and section 2.4 in the introduction.</i></p> |
| <p>d13. Failed to Use: If use of the recommended controls was mandatory, was their use adequately enforced?</p> | <p><i>If use was mandatory, you need to consider what could reasonably be expected of a supervisor and take into account the constraints on him.</i></p> |
| <p>c13. Task Procedure did not fit with Functional Situation:</p> <p>Did the procedure, whether oral or written instruction, fit with the actual requirements or circumstances of the work/process at the time in question?</p> | <p><i>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.</i></p> |
| <p>c14. Personnel Performance Discrepancy:</p> <p>This branch considers whether the failure of individuals to perform their individual task assignments contributed to the problem in question.</p> <p>Possible causes of performance discrepancy should be considered for each individual whose performance was judged to vary from correct practice.</p> | |
| <p>d14. Personnel Selection LTA:</p> <p>This branch considers the contribution of how personnel were selected to the problem in question.</p> | |
| <p>e12. 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?</p> | |
| <p>e13. Testing LTA: Was an adequate (i.e. valid and reliable) method used to test the candidates against the criteria established for the job.</p> <p>Had the assigned individual been recently re-examined to the requirements established for the task?</p> | |
| <p>d15. Training LTA: This branch considers whether the training of the individual contributed to the performance error.</p> | |
| <p>e14. None: Was the individual trained for the task he or she performed?</p> | |
| <p>e15. Criteria LTA: Was the individual unable to perform the task in question correctly because of inadequate definition of his or her training needs?</p> | |
| <p>e16. Methods LTA: Did the methods used in training adequately prepare the individual to meet the requirements established for the task?</p> | <p><i>Consider methods such as realistic simulation, programmed self-instruction, and other special training in addition to basic initiation, plant familiarisation, etc.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| e17. Professional Skills LTA: Did inadequacies in the professional skills of the trainers compromise the performance of the task in question? | |
| e18. Verification LTA: Was the verification of the person's current competence adequate? Did the verification process include initial testing and later assurance of task performance to ensure that the standards established for the task were met? Were re-training and re-qualification requirements of the task adequately defined and enforced? | |
| d16. Consideration of Deviations LTA: This branch considers whether the <u>supervisor</u> was adequately alert to personnel performance and variability. | |
| e19. Normal Variability: Was the individual's performance within the range of normal variability? | <i>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.</i> |
| e20. Changes: Was the individual's performance in the task in question significantly different from the performance standard needed for the task? Was the supervisor given guidance on detection of individual personnel problems, such as alcoholism, drug use, personal problems? | <i>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 outside the normal range of variability. MORT assumes that the supervisor will be alert to changes of this type.</i> |
| e21. Supervisor did not Observe: Did the supervisor observe the individual performing incorrectly (i.e. extreme variability or significant change on the part of individual)? | |
| e22. Supervisor did not Correct: This branch is concerned with whether the supervisor's actions to correct the individual's performance were adequate. | |
| f13. Did not Re-instruct: Did the supervisor re-instruct the person as to the correct performance? | |
| f14. Did not Enforce: Did the supervisor enforce established correct rules and procedures? Were disciplinary measures ordinarily taken against personnel who wilfully and habitually disregarded rules and procedures? | <i>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.</i> |

| 1. Questions | 2. Pointers & Examples |
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| <p>d17. Employee Motivation LTA:</p> <p>This branch considers whether employee motivation contributed to the incorrect performance of the task in question.</p> <p><i>We can 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.</i></p> | |
| <p>e23. Leadership and Example LTA:</p> <p>Was the individual poorly led?</p> <p>Leadership and example are difficult to measure but you will need to consider their adequacy, particularly within the line organisation.</p> | <p><i>Aspects of leadership relevant to the task performance issue might include:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> the consistency through different levels of management; <input type="checkbox"/> whether managers 'walk the talk'; <input type="checkbox"/> the visibility of management concern to the individual whose task performance we are considering; and <input type="checkbox"/> the vigour with which management expresses its concern. |
| <p>e24. Time Pressure:</p> <p>Did time pressure, as perceived by the individual, provoke the performance error?</p> <p>Was enough done to limit time pressure and workload to an acceptable level?</p> | |
| <p>e25. Correct Performance is Punished:</p> <p>In the past, was the employee "punished" for performing the task in question correctly?</p> <p>Was the supervisor sufficiently alert to this factor?</p> | <p><i>From the viewpoint of the employee, sometimes there is an undesirable consequence to the person doing a good job.</i></p> <p><i>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.</i></p> |
| <p>e26. Incorrect Performance is Rewarded:</p> <p>Did the employee find the consequence of doing the task in question incorrectly more favourable than doing it correctly?</p> <p>Was the supervisor sufficiently alert to this factor?</p> | |
| <p>e27. Job Interest Building LTA:</p> <p>Does performing the task well really matter to the individual performing it?</p> <p>Did management adequately balance giving the individual discretion with the need for uniform performance?</p> | <p><i>Uniform performance may be required for tasks that are essential e.g. safety critical tasks.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>e28. Group Norms Conflict:</p> <p>Did management make adequate efforts to actively engage the individual in activities likely to promote agreement about what is important (i.e. policy issues and goals of task performance)?</p> <p>Activities might include participation in implementation of new equipment and working practices, training, projects and investigations.</p> | <p><i>This concerns the significance of differences between the norms of different groups within the organisation and how this may have contributed to the performance error in question.</i></p> <p><i>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 requirements and those interpreting them.</i></p> |
| <p>e29. Obstacles Prevent Performance:</p> <p>Were there obstacles that prevented the individual from performing the task to an acceptable level?</p> | <p><i>Obstacles need to be considered from the individual's perspective. They might be physical or situational in nature.</i></p> |
| <p>e30. Personal Conflict:</p> <p>This branch considers the contribution of individual personal conflicts to the performance error in question.</p> <p><i>You will need to explore the work relationships between the individual concerned and co-workers and supervisors.</i></p> | |
| <p>f15. [Conflict] with Supervisor:</p> <p>Was the relationship between the individual and the supervisor conducive to adequate performance of the task in question?</p> | <p><i>You will need to consider that there may be a range of people providing supervision to this individual.</i></p> |
| <p>f16. [Conflict] with Others:</p> <p>Was the relationship between the individual and other workers in the work environment conducive to adequate performance of the task in question?</p> | |
| <p>f17. Deviant:</p> <p>Were the psychological traits exhibited by the individual judged acceptable when considered in the context of the task requirements and related risks?</p> <p>Note the event is flagged with R8 assumed risk symbol.</p> | <p><i>Individuals exhibiting abnormally high levels of social maladjustment, emotional instability, and conflict with authority may be more unpredictable and unreliable than others. Therefore the assignment of such individuals to a task needs to be informed by a risk assessment.</i></p> <p><i>The event cannot be closed until justification for assuming the risk has been evaluated.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> |
| <p>e31. General Motivation Programme LTA:</p> <p>Was there adequate use of motivational programmes to develop desired behavioural change in individuals?</p> <p>In the light of the previous questions, have motivational programmes been effective in achieving behavioural change?</p> | |
| <p>b4. Non-Task Performance Errors:</p> <p>This branch considers whether the control of the work/process in question was compromised by activities that are not directly part of the task.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>c15. Allowed activities: Did an allowed activity, unrelated to the work/process in question, contribute to a problem in the control of the work/process?</p> | <p><i>“Allowed” meaning that the activity was not in conflict with the rules. Examples are going to or from the work area, authorised work break, going to lunch, etc.</i></p> |
| <p>c16. Prohibited: Did a prohibited activity, unrelated to the work/process in question, contribute to a problem in the control of the work/process?</p> | <p><i>A prohibited activity is one in violation of rules, such as horseplay.</i></p> <p><i>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.</i></p> |
| <p>b5. Emergency Shutoff Errors:</p> <p>Use this branch <u>if an incident was in progress</u> at the time in question. It considers the contribution of errors made during emergency shutdown resulting in:</p> <ul style="list-style-type: none"> • 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). | |
| <p>c17. Task Performance Errors:</p> <p>Did the incorrect execution of a planned shutdown sequence contribute to the control failure?</p> <p>If the emergency shutdown was not error-free, what were the performance errors?</p> <p>Consider these errors using SD5-b3 (Task Performance Errors).</p> | <p><i>Emergency situations usually are a time of rapid change and high stress, subsequent analysis of errors should take account of this.</i></p> |
| <p>c18. Non-Task Performance Errors:</p> <p>Did a non-task activity compromise the execution of a planned shutdown sequence?</p> | <p><i>In this context, a “Non-Task” is an activity that is unrelated to executing emergency shutdown.</i></p> |
| <p><u>SD6. Support of Supervision LTA</u></p> <p>This branch considers whether upper level management supported and guided their organisation adequately, allowing the achievement of satisfactory control of the work/process.</p> <p>Consider the following questions in the light of any supervisory problems identified through earlier stages of your analysis.</p> | |
| <p>a1. Research and Fact-Finding LTA:</p> <p>If not readily available, was information necessary to controlling the work/process researched and provided for the supervisor?</p> | |
| <p>a2. Information Exchange LTA:</p> <p>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?</p> <p>Was communication always verified through feedback?</p> <p>Is there a history of shared responsibility (between the supervisor and people providing support) for resolving problems?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>a3. Standards and Directives LTA:</p> <p>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?</p> | |
| <p>a4. Resources LTA:</p> <p>This branch considers whether resourcing of the support services to the supervisor contributed to the problems in the control of the work/process in question.</p> | |
| <p>b1. Training LTA:</p> <p>Was there sufficient training to update and improve needed supervisory skills?</p> | |
| <p>b2. Access to Expertise</p> <p>Did supervisors have their own technical staff or access to individuals with technical expertise?</p> <p>Was technical support adequate for their needs?</p> | |
| <p>b3. Access to Equipment & Materials LTA:</p> <p>Did individuals have sufficient access to relevant equipment, materials and other services?</p> | <p><i>Examples include useful tools for analysis, training materials, audio-visuals, meeting time and rooms, technical information, etc.?</i></p> |
| <p>b4. Co-ordination of Resources LTA:</p> <p>Were resources adequately managed to avoid conflicts between different users and duplication of effort?</p> | |
| <p>a5. Deployment of Resources LTA:</p> <p>Did ineffective use of the available resources contribute to the problems in the control of the work/process in question?</p> <p>Was the means of prioritising the use of resources adequate?</p> | |
| <p>a6. Referred Risk Response LTA:</p> <p>Was management adequately responsive to problems referred from lower levels?</p> <p>Should the issue in question have been dealt with as a matter of urgency?</p> <p>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?</p> | <p><i>Note b21 of MBI.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>SC2. Barriers LTA</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>An ETBA (barrier analysis) will facilitate the identification of barriers that you will consider in this branch.</p> | |
| <p>a1. On Energy Source</p> <p>This branch considers the adequacy of barriers <u>on</u> the energy source?</p> <p><i>Note all lower tier development under this event also transfers to events a2, a3, and a4.</i></p> <p><i>Barriers of this type are protective devices/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 target in question.</i></p> <p><i>Examples – isolations, insulation, fall protection. Your own examples may help to illustrate this.</i></p> | |
| <p>b1. None Possible: Was such a barrier impossible?</p> <p>Note that the event is flagged with R2 assumed risk symbol.</p> | <p><i>Appropriate management must assume risk for designing work/processes where no barriers were possible.</i></p> <p><i>The event cannot be closed until justification for assuming risk has been evaluated.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> |
| <p>b2. Barrier Failed: Did the barrier function as intended?</p> | <p><i>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 MBI).</i></p> |
| <p>b3. Did not Use: The branch applies to barriers that were possible but not used.</p> | |
| <p>c1. Did not Provide: Were barriers provided where possible?</p> <p>Note the event is flagged with R3 assumed risk symbol.</p> | <p><i>Appropriate management must assume risk for designing or sanctioning work/processes where barriers are not provided.</i></p> <p><i>The event cannot be closed until justification for assuming risk has been evaluated.</i></p> <p><i>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 section 2.4 in the introduction.</i></p> |
| <p>c2. Task Performance Errors: The branch considers errors associated with using provided barriers.</p> <p><i>Note that all the lower tier development under event SD5-b3 transfers to this event also.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p><u>a2. Between</u></p> <p>This branch considers the adequacy of barriers <u>between</u> the energy and the target.</p> <p>The events associated with this branch transfer from a1.</p> <p><i>Barriers of this type are protective devices/systems that have been or 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 target in question.</i></p> <p><i>Examples – handrail, fire wall, machinery guards. Your own examples may help to illustrate this</i></p> | |
| <p><u>a3. On persons or objects</u></p> <p>This branch considers the adequacy of barriers <u>on</u> persons and/or objects.</p> <p>The events associated with this branch transfer from a1.</p> <p><i>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 target in question.</i></p> <p><i>Examples – PPE, piping restraints, paint. Your own examples may help to illustrate this</i></p> | |
| <p><u>a4. Separate time and space</u></p> <p>This branch considers the adequacy of “time and space” barriers.</p> <p>The events associated with this branch transfer from a1.</p> <p><i>Barriers of this type work by ensuring the separation of energy and targets in time or space. A written procedure or some other type of administrative control may accomplish separation by time or space. The adequacy of the barrier depends upon the nature of the energy and target in question.</i></p> <p><i>Examples – clearing area for pressure testing, evacuation. Your own examples may help to illustrate this</i></p> | |
| <p><i>SB4. Events and Energy Flows Leading to Accident-Incident</i></p> <p>In MORT analysis there are usually several energy/target interactions to analyse. 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 section 3.1 (page xv) for help on this subject.</p> | |
| <p><u>SC3. Barriers and Controls LTA</u></p> <p>Were barriers and controls on energy transfers and other events (leading to conversion of a hazard to an actual accident) less than adequate?</p> <p>Refer to SC4 for a description of these events and to SB2 for further development relating to barriers and controls on preceding events.</p> | |
| <p><u>SC4. Events and Energy Flows</u></p> <p>What were the precursor events and energy flows that resulted in the conversion of a hazard to an actual accident?</p> <p>Refer to SB1 for further development relating to these preceding events.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <u>SA2. Stabilisation and Restoration LTA</u> | |
| <p>This branch is intended to evaluate events following a serious accident.</p> <p>After an accident, efforts should be directed to limiting the consequences of what has immediately occurred and to reducing the sensitivity of those consequences whenever possible.</p> <p>In general when evaluating this branch, consider whether actions were pre-planned as opposed to occurring fortuitously at the time of a particular accident.</p> | |
| <p>a1. Prevention of Second Accident LTA:</p> <p>This branch considers why the first accident contributed to a second.</p> <p><i>For example, a chain reaction, a follow-up accident, propagation of fire, a second person entering an enclosed place to rescue a first.</i></p> | |
| <p>b1. Plan LTA:</p> <p>Was the plan for stabilisation and restoration adequate?</p> | |
| <p>b2. Execution LTA:</p> <p>This branch considers whether the plan was executed as intended.</p> | |
| <p>c1. Training & Experience LTA:</p> <p>Was there adequate training and experience of the various assignments required by plan?</p> <p>Was it realistic?</p> | |
| <p>c2. Personnel and/or Equipment Changes:</p> <p>Was the performance of people and equipment significantly different from the performance standard assumed by the plan?</p> <p>Had adequate counter-changes been considered and introduced to balance any changes in personnel or equipment?</p> | <p><i>Some degree of change is normally expected to occur. MORT assumes that managers and supervisor will be alert to relevant changes outside the norm.</i></p> |
| <p>c3. Task Performance Errors:</p> <p>This Branch considers errors in the performance of the plan.</p> <p><i>The events associated with this branch transfer from b3-SD5.</i></p> | |
| <p>a2. Emergency Action (Fire-fighting, Etc.) LTA:</p> <p>This branch considers whether the emergency response to the <u>first</u> incident was prompt and adequate.</p> <p>The events associated with this branch transfer from a1.</p> <p><i>You need to consider the range of (internal and external) emergency response teams required and the notification and response of each.</i></p> <p><i>The adequacy of detection and alarm systems may also be relevant here.</i></p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>a3. Rescue and Salvage LTA:</p> <p>This branch primarily considers whether victims were satisfactorily removed to a safe area.</p> <p>You should also consider:</p> <ul style="list-style-type: none"> <input type="checkbox"/> the salvage of objects and policy of resolving conflict between rescuing people vs. objects and associated insurance concerns. <input type="checkbox"/> how rescuers balanced the risk of a second accident against the ability to lessen the severity of injuries to victims, before entering a hazardous area <input type="checkbox"/> the evacuation of employees or the public from potentially hazardous areas <p><i>The events associated with this branch transfer from a1.</i></p> | |
| <p>a4. Medical Services LTA:</p> <p>This branch considers the adequacy of medical assistance and the harm suffered by victims of the accident.</p> <p>Medical services include: near-by hospitals, on-site first aid, ambulance services, or general practitioners.</p> | |
| <p>b3. First Aid LTA:</p> <p>Was adequate first aid immediately available at the scene?</p> <p>Was it used correctly to prevent immediate injuries from becoming more severe?</p> | |
| <p>b4. Logistics LTA:</p> <p>The branch considers how the availability of transport for medical personnel, equipment and services to and from the accident scene (and injured people to medical facilities) may have contributed to the harm suffered by victims of the accident.</p> <p>You need to consider whether logistics, including the provision of catering and hygiene facilities, was handled adequately.</p> | |
| <p>c4. Plan:</p> <p>Was there a medical services plan?</p> <p>Was the design of the plan adequate?</p> <p>Was it distributed to appropriate personnel?</p> | |
| <p>c5. Notification LTA (Trigger):</p> <p>Was notification made to medical services correctly and without delay?</p> <p>Were employees instructed on how to notify medical services?</p> <p>Was there an alternative means of notification and was this pre-planned and trained for?</p> | <p><i>Consider whether the notification process was easy to do, especially during the stress of an emergency.</i></p> |
| <p>c6. Personnel and Equipment:</p> <p>Did medical and transport personnel use the equipment correctly?</p> <p>Did the equipment function properly?</p> <p>Did the personnel have all the necessary equipment?</p> <p>Were the personnel adequately trained?</p> | <p><i>Consider whether equipment could be operated easily during the stress of an emergency.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>c7. Response delay:</p> <p>Was the response time adequate?</p> <p>Note the event is flagged with R I I assumed risk.</p> | <p><i>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.</i></p> <p><i>The event cannot be closed until justification for assuming the risk has been evaluated.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> |
| <p>b5. Medical Treatment LTA:</p> <p>Was there adequate medical treatment en route and at the medical facilities?</p> | |
| <p>a5. Dissemination of information LTA:</p> <p>This branch considers the contribution made by the organisation’s attempts to disseminate information about the accident to all interested parties in an adequate manner.</p> | |
| <p>b6. Plan:</p> <p>Was there a plan covering the dissemination of information about the accident to all interested parties?</p> <p>Was it adequately integrated with other aspects of contingency planning?</p> | |
| <p>b7. Relatives & Employees:</p> <p>Were the relatives of those injured adequately informed about the accident first-hand by an appropriate individual representing the organisation?</p> <p>Were the employees in the organisation adequately notified first-hand about the accident?</p> | <p><i>Also consider issues such as the management of emotional trauma and provision of other support services to relatives and employees.</i></p> |
| <p>b8. Officials:</p> <p>Were the facts about the accident given adequately to the correct officials?</p> | <p><i>The category “Official” might include representatives of:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>the organisation;</i> <input type="checkbox"/> <i>the local authority;</i> <input type="checkbox"/> <i>governmental agencies;</i> <input type="checkbox"/> <i>customers, suppliers and other stakeholders; and</i> <input type="checkbox"/> <i>others as appropriate</i> |
| <p>b9. Public and Media:</p> <p>Were the news media (and thereby the public) given adequate information?</p> <p>Was a specific point of contact representing the organisation provided as the source of additional information?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <u>M. Management System Factors LTA</u> | |
| <p>This branch considers the design, planning or policy formulation processes that may have contributed to the incident or accident and its consequences.</p> <p>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.</p> <p>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 MORT "M" branch is the responsibility of a person who is not thought of as a manager,</p> <p>The analyst uses the M-branch in two ways.</p> <p>First, during S-branch analyses the analyst uses the M-Branch to explain specific problems and issues as they are encountered.</p> <p>Secondly, when the analyst has completed the S-Branch referrals, the M-branch is used to perform an 'overview analysis', including a final check that M-branch events coded "irrelevant" are truly not applicable. The 'overview' analysis of the organisation uses the M-branch to identify weaknesses at a more general level than the specifics of the incident under consideration.</p> | |
| <i>MA1. Policy LTA</i> | |
| <p>"Policy" refers to a specific policy issue identified during previous analysis. You will need to bear this context in mind when considering the questions below.</p> <p>Concerning a specific policy:</p> <ul style="list-style-type: none"> <input type="checkbox"/> was the policy clearly stated; <input type="checkbox"/> was the policy up to date; <input type="checkbox"/> was policy formulation adequate; <input type="checkbox"/> was the policy of sufficient scope to address the major issues and problems likely to be encountered; <input type="checkbox"/> was this policy integrated with other policies. | <p><i>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.</i></p> <p><i>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).</i></p> |
| <i>MA2. Implementation of Policy LTA</i> | |
| <p>Well-articulated policies may still fail to realise the intended improvements in practice.</p> <p>This branch considers the contribution of policy implementation to the problems revealed through the analysis so far. The policy in question is that identified as relevant by previous analysis.</p> <p>MORT assumes that implementation is a continuous process rather than a one-off event.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>a1. Methods, Criteria, Analyses LTA:</p> <p>Were adequate methods used to manage implementation?</p> <p>Was there an adequate set of criteria used for assessing the short and long-term impact* of the implementing the policy?</p> <p>Did management require adequate analyses to assess the impact of the new policy and alternative countermeasures for minimising problems?</p> | <p><i>*Impact upon safety, health, quality, protection of environment and the goals of other policies.</i></p> <p><i>Examples (of criteria) – risk assessment, human factors assessment, impact on safety-critical systems.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>a2. Definition of Line Responsibility LTA:</p> <p>Was there a clear, written statement of duties, derived from the policy, for each person in the line organisation to whom it applied?</p> <p>Did each person concerned adequately understand and accept their responsibility for implementing the policy?</p> <p>Was this verified in an adequate fashion?</p> | <p><i>The assignment of duties should form an unbroken chain from the most senior person through the first line supervisor(s) to the individual employee(s) concerned.</i></p> <p><i>Acknowledgement of responsibility needs to be explicit if implementation is to succeed. There are various channels that might be used: discussion based on job description, induction training, appraisal interviews etc.</i></p> |
| <p>a3. Staff Responsibility LTA:</p> <p>If the implementation of policy relied upon more than one department, was adequate provision made to assign specific duties to the various departments concerned?</p> | <p><i>Specific departments may lead policies such as those for environmental protection, safety, quality, equal opportunities. However, implementation requires other departments to make appropriate arrangements.</i></p> |
| <p>a4. Information Flow LTA:</p> <p>Did management adequately specify the types of information it needed to implement the policy?</p> <p>Did management establish adequate communication arrangements to transmit this information through the organisation?</p> <p>Did management support implementation with adequate response to requests for information by lower organisational levels?</p> <p>Were problems encountered implementing the policy, adequately relayed back to the people who made the policy?</p> | <p><i>Communication is seen as minimally a two-way process.</i></p> <p><i>Policy makers may become cocooned from “bad news”. To help avoid this it is necessary for the organisation to establish and maintain channels of communication. These channels need to be designed to impose the minimum of bureaucratic burden on those wishing to send messages. Similarly, even “bad-news” needs to be met with a constructive response if channels of communication are to remain open and trusted.</i></p> |
| <p>a5. Guidance and Directives LTA:</p> <p>Did guidance and directives aimed at communicating the policy adequately emphasise risk management approaches (such as risk analysis, monitoring, review)?</p> <p>Were these directives published in a style conducive to understanding?</p> <p>Were the directives constructed to ensure continuity across interfaces between departments and processes?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>a6. Management Services LTA:</p> <p>This branch considers whether management supported lower organisation levels by providing adequate services and guidance.</p> <p><i>The events associated with this branch follow the same logic as SD6.</i></p> | |
| <p>a7. Budgets LTA:</p> <p>Was the budget adequate to support the implementation of the policy by the lead department “owning the policy”?</p> <p>Were the budgets of other departments and groups adequate to support the implementation of the specific aspects of the policy for which they had responsibility?</p> | <p><i>For example, a policy to protect the environment from a new effluent process would require expenditure by the group managing environmental issues within the organisation concerned. However, all other parts of the organisation associated with the new process may well need to expend resources to fully implement the policy.</i></p> |
| <p>a8. Delays:</p> <p>Were solutions to problems introduced early in the life cycle of projects?</p> <p>If not, was the delay made known to someone who was able to expedite a solution and assume the risk of continued delay?</p> <p><i>Note the event is flagged with an R_{12} assumed risk symbol</i></p> | <p><i>If delay was justified on practical grounds, the delay should be evaluated as an assumed risk.</i></p> <p><i>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 46 and section 2.4 in the introduction.</i></p> |
| <p>a9. Accountability LTA:</p> <p>Was line management subject to adequate measures of accountability for the issue in question?</p> | <p><i>Adequate accountability would include:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>measures that are adequately valid and reliable indicators of the performance required;</i> <input type="checkbox"/> <i>agreement about the measures by the people concerned (with any disagreements subject to amicable resolution);</i> <input type="checkbox"/> <i>integration of the accountability measure into the appraisal or other review processes that applied to the individual(s) in question.</i> |
| <p>a10. Leadership and Example LTA:</p> <p>Did senior individuals provide adequate leadership and set an example that reflected the importance of the issue in question?</p> | <p><i>Adequacy here could include:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>consistency about the issue between different managers and levels of management;</i> <input type="checkbox"/> <i>the vigour with which management expresses its concern;</i> <input type="checkbox"/> <i>whether manager's words are reflected in their actions;</i> <input type="checkbox"/> <i>the visibility of senior management concern to line management and to employees.</i> |
| <p>MA3. Risk Assessment and Control System LTA</p> | |
| <p>This branch considers the adequacy of planning/design processes and the hazard analysis that supports them.</p> | |
| <p>MB1. Hazard Analysis Process LTA</p> <p>This branch considers hazard analysis and the design and development of specific work activities and processes.</p> | |
| <p>a1. Concepts and Requirements LTA:</p> <p>This branch considers the adequacy of the hazard analysis process and its definition by the organisation.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>b1. Technical Information System LTA</p> <p>This branch considers how the technical information system may have failed to provide adequate support to hazard analysis. Refer to the SDI branch asking the questions from this perspective.</p> | |
| <p>b2. Definition of Goals and Tolerable Risks LTA:</p> <p>This branch considers the definition of goals and tolerable risks within the organisation</p> | |
| <p>c1. ES&H Goals and Risks not Defined:</p> <p>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?</p> | <p><i>ES&H: Environment, Safety and health.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c2. Performance Goals and Risks Not Defined:</p> <p>Have goals been set for performance efficiency and productivity? Have tolerable risks for lost efficiency and productivity been identified and actual risks quantified?</p> | <p><i>Examples – part of the business plan includes business risk and contractual arrangements with partners. Your own examples may help to illustrate this</i></p> |
| <p>b3. Risk Analysis Criteria LTA:</p> <p>This branch considers the specification of risk analysis.</p> | |
| <p>c3. Plan LTA:</p> <p>Was the plan that describes "who does what and when" in risk analysis, study, and development, adequate?</p> | |
| <p>c4. Change Analysis LTA:</p> <p>Was there an adequate method for analysing the effects of planned change? Was it adequately applied?</p> | <p><i>Whatever method(s) is used, it should:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>include the impact of the change upon people, procedures and plant/equipment;</i> <input type="checkbox"/> <i>be scoped to review arrangements until no change is demonstrated (i.e. the full ramifications should be identified).</i> |
| <p>c5. Other Analytical Methods LTA:</p> <p>Was adequate use made of appropriate analytical techniques?</p> <p>If not, does this reflect inadequacies in the skills available to the organisation (internally or externally)?</p> | <p><i>You need to be clear about what would have been appropriate to the matter in question.</i></p> |
| <p>c6. Scaling Mechanism LTA:</p> <p>Was a reasonably clear-cut mechanism established to measure the seriousness/severity of different events?</p> <p>Did this mechanism adequately support the evaluation of the work/process in question?</p> | <p><i>There are several types of scaling mechanisms, for example:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>Severity x frequency matrices</i> <input type="checkbox"/> <i>Ranking by hazard potential</i> <input type="checkbox"/> <i>Ranking by amount of energy</i> <p><i>Your own examples may help to illustrate this</i></p> <p><i>Providing review by experienced people and applying actuarial data may also be relevant here.</i></p> |
| <p>c7. Required Alternatives LTA:</p> <p>Did management insist on presentation of alternative solutions in its bases for choices and decisions?</p> | <p><i>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.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| <p>c8. Solution Precedence Sequence LTA: Was the selection of solutions prioritised by: (1) Design, (2) Protective Devices, (3) Warning Devices, (4) Human Factors Review, (5) Procedures, (6) Personnel, and (7) Acceptance of Residual Risks (after considering the preceding six items)?</p> | <p><i>This sequence is in order of <u>effectiveness</u> and <u>reliability</u>. Design can wholly remove a problem, whereas other options attempt to control the effects.</i></p> <p><i>The sequence also reflects the lifecycle and hence cost effectiveness: early solutions are typically less costly and more effective.</i></p> |
| <p>b4. Procedures Criteria LTA: Were criteria for writing procedures specified adequately and communicated to staff involved in producing them?</p> <p>Were criteria for reviewing new and revised procedures adequately specified and applied?</p> | <p><i>These criteria should remind engineers and designers of the limitations and issues relevant to writing procedures for operating personnel.</i></p> |
| <p>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. Refer to the a1-SDI sub-branch asking the questions from this perspective.</p> | |
| <p>c9. Stakeholder/customer requirements.</p> | <p><i>This includes partners, workforce, customers, government agencies, etc.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c10. Statutory codes and regulations</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c11. Other National and International codes and standards</p> | <p><i>Example – ISOs, EN codes and standards.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c12. Local Codes and Bylaws applicable to the geographical area where the work was performed.</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c13. Internal Standards developed within the organisation to cover situations not addressed by outside requirements.</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>b6. Information Search LTA: This branch considers the adequacy of the information search undertaken in support of hazard analysis. This issue is explored using the lower tier events shown under SDI-a1.</p> | |
| <p>b7. Life Cycle Analysis LTA: Did risk analysis ensure adequate consideration of all phases of lifecycle?</p> | <p><i>The lifecycle can be conceived as starting with planning and continuing through design, purchasing, fabrication, construction, operation, maintenance, and disposal.</i></p> |
| <p>c14. Scope LTA: Did the scope include not only the work/process equipment and systems, but also ancillary equipment and systems?</p> <p>Did the analysis adequately include the personnel and procedural components of primary and ancillary systems?</p> | <p><i>Examples of ancillary systems include ventilation, waste heat recovery, testing, maintenance, cleaning, etc.</i></p> <p><i>Your own examples may help to illustrate this</i></p> |
| <p>c15. Analysis of Environmental Impact LTA: Did the life cycle analysis adequately address environmental impact?</p> | <p><i>An adequate analysis would minimally include all relevant statutes, industry codes and customer requirements.</i></p> |

| 1. Questions | 2. Pointers & Examples |
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| 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 Procedures 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. <i>According to this principle, the ideal approach is to limit energy to the minimum needed to accomplish the work/process.</i> | |
| c18. Did not Substitute Safer Energy: Did the design use the safest form of energy that will perform the desired function? | |
| c19. Did not Limit Energy: 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? | <i>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.</i> |
| 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? | <i>Examples – electrical earth, pressure relief valve.</i> <i>Your own examples may help to illustrate this</i> |
| c24. Barriers and Controls LTA: Were adequate barriers included as part of the design, plan, or procedure? | <i>Note other lower tier events included by transfer from SB2.</i> |
| b9. Human Factors (Ergonomics) Review LTA: This branch considers the adequacy of human factors review of the work/process in question. <i>Human Factors here is defined as the application of psychology and physiology to the analysis and improvement of human work performance.</i> | |

| 1. Questions | 2. Pointers & Examples |
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| c25. Professional 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? | |
| c27. Allocation Human-Machine Tasks LTA: Did the review adequately ensure the optimum allocation of work/process tasks to people and machines? | <i>For example, machines excel at tasks requiring high levels of accuracy, strength and repetition. People excel at creative and variable tasks.</i> |
| c28. Did not Establish Human-Task Requirements: Did the review determine special characteristics or capabilities required of people and machines? | <i>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.</i> |
| 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? | <i>Defining users and their characteristics allows the design to accommodate diversity in the workforce or user population.</i> |
| d2. Displays LTA: Were the work/process displays designed to allow rapid interpretation with high reliability? Did the HF review ensure that display stereotypes were used and not violated? | <i>“Stereotypes” refer to 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.</i> |
| d3. Mediation (Transduction) LTA: Was there adequate review of the likely effects of delays and unreliable interpretation of displays and control actions? | <i>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.</i> |
| d4. Controls LTA: Were the work/process controls designed to allow rapid use with high reliability? Did the HF review ensure that control stereotypes were used and not disregarded? | <i>“Stereotypes” refer to 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.</i> |

| 1. Questions | 2. Pointers & Examples |
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| <p>c29. Did not Predict Errors: Was the design process informed by adequate human error prediction and analysis?</p> <p>Examples of general human error types are:</p> <ul style="list-style-type: none"> <input type="checkbox"/> incorrect act <input type="checkbox"/> act out of Sequence <input type="checkbox"/> failed to act <input type="checkbox"/> act not required <p>Did the review adequately assess the scope for deliberate errors and other acts of malevolence?</p> | <p><i>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.</i></p> |
| <p>b10. Inspection Plan LTA: This branch considers the development of an inspection plan for the operation/facility. Note other lower tier events included by transfer from SD3-a1.</p> <p><i>At this point you need to consider the following issues should be considered:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>How inspectability requirements were specified in the design or procurement documents for the operation, facility or equipment in question;</i> <input type="checkbox"/> <i>The adequacy with which inspection activities were specified in operational plans;</i> <input type="checkbox"/> <i>How minimum requirements for inspection equipment and staffing were arrived at and committed.</i> | |
| <p>b11. Maintenance Plan LTA: This branch considers the development of a maintenance plan for the operation/facility. Note other lower tier events included by transfer from SD4-a1.</p> <p><i>At this point you need to consider the following issues should be considered:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>How maintainability requirements were specified in the design or procurement documents for the operation, facility or equipment in question;</i> <input type="checkbox"/> <i>The adequacy with which maintenance activities were specified in operational plans;</i> <input type="checkbox"/> <i>How minimum requirements for maintenance equipment and staffing were arrived at and committed.</i> | |
| <p>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.?</p> | |
| <p>b13. Environment LTA: Did the design adequately minimise physical stresses upon people and objects?</p> | <p><i>This might include stresses caused by;</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>the physical conditions of the facility,</i> <input type="checkbox"/> <i>conditions generated by the operation, or</i> <input type="checkbox"/> <i>interactions of one operation with another?</i> |

| 1. Questions | 2. Pointers & Examples |
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| <p>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 SB2 dealt with the verification of operational readiness, this branch deals with the <i>definition</i> of operational readiness for the work/process in question.</p> <p>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.</p> | |
| <p>c30. Test and Qualification LTA: Were new/modified work/processes subject to adequate testing and adjustment before full implementation?</p> <p>Did this incorporate plant, people, and procedural aspects of operation and the interfaces between these?</p> | <p><i>Example – part of the hand-over certificate, including service test, testing under operational conditions, formal review of procedures.</i></p> <p><i>Your own examples may help to illustrate this.</i></p> |
| <p>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?</p> <p>Were there adequate guidelines for the supervisory support of JSA and other risk assessment activities associated with the work or process?</p> | |
| <p>c32. Task Procedures did not meet Criteria: This branch considers the criteria for work/process procedures.</p> | |
| <p>d5. Did not Fit with Hardware Change: Were procedures revised, if necessary, to correspond with changes in plant or equipment?</p> | |
| <p>d6. Match to Users LTA: Were procedures adequately matched to the minimum reading ability and technical competence of the staff who actually used them?</p> | <p><i>Involving a representative group of users in a structured review of draft procedures can help this.</i></p> |
| <p>d7. Match to task/equipment LTA: Were procedures adequately checked against applicable criteria and tested under dry run operating conditions?</p> | |
| <p>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?</p> | |
| <p>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?</p> | <p><i>Example – advisory/warning signs for non-stereotypical valves or controls.</i></p> <p><i>Your own examples may help to illustrate this.</i></p> |
| <p>d10. Task Sequence LTA: Did the procedures describe task steps in sequential order where possible?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>d11. Lockouts LTA: Were lockouts required where hazardous situations could be encountered or created by the application of the procedure in question?</p> | <p><i>Lockouts – physically preventing the use of equipment or access to areas.</i></p> |
| <p>d12. Communication Interfaces LTA: Where procedures called for communication between users and other individuals, were these interfaces made clear?</p> | <p><i>Your own examples may help to illustrate this</i></p> |
| <p>d13. Did not Specify Personnel Environment: 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?</p> | |
| <p>c33. Personnel Selection LTA: Were selection methods and criteria for the people undertaking the work/process adequately developed and specified?</p> | <p><i>Note – consider this and associated checking/verification for directly employed staff, and contractors and sub-contractors.</i></p> <p><i>Examples – competency standards and assessment, matching the individual to the task in terms of the competence required.</i></p> |
| <p>c34. Personnel Training and Qualification LTA: Were training methods, qualification criteria and verification process for the people undertaking work/process adequately developed and specified?</p> <p>Personnel training and qualification factors are considered in detail under SD5-d15.</p> | <p><i>Examples – National vocational qualifications, passport systems, verified in-company systems for core staff.</i></p> |
| <p>c35. Personnel Motivation LTA: Was motivation adequately considered in the design of the work/process?</p> <p>Personnel motivation factors are considered in detail under SD5-d17</p> | <p><i>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.</i></p> |
| <p>c36. Monitor Points LTA: Did written procedures contain adequate prompts to allow monitoring of key steps of the work/process?</p> | |
| <p>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?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <p>b16 Contingency Planning LTA</p> <p>Were all of the emergency functions pre-planned (rather than left to improvisation)?</p> <p>Did these plans adequately consider the types and severity of accidents to which they applied?</p> <p>Were adequate resources allocated to properly execute the plan?</p> <p>Was management aware of any residual risk beyond the scope of the plan? If so, you may need to evaluate whether this represents an oversight or a correctly assumed risk.</p> <p>Were any consumable resources subject to an adequate schedule of periodic checks and planned replenishment?</p> | |
| <p>b17. Disposal Plan LTA:</p> <p>Did the design adequately minimise disposal problems and hazards associated with the disposal of the plant?</p> | <p><i>Note that lifecycle analysis is considered at b7-MBI.</i></p> |
| <p>b18. Independent Review Method and Content LTA:</p> <p>Was there adequate provision of thorough and independent ES&H review at pre-established points in the life cycle?</p> <p>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?</p> | |
| <p>b19. Configuration Control LTA:</p> <p>Was there an adequate programme to assure configuration control throughout the entire life cycle of the facility?</p> | <p><i>The aim of configuration control is to ensure the synchronisation of plant, people and procedural subsystems with each other and to specifications.</i></p> |
| <p>b20. Documentation LTA:</p> <p>Was the document design process adequate?</p> <p>Were all types of documentation (whether paper or electronic) complete, up-to-date, and accessible to users?</p> | |
| <p>b21. Fast Action Expedient Cycle LTA:</p> <p>Was there an adequate method of bypassing the usual delays to get an immediate correction of a work/process problem?</p> <p>Would it have corrected the work/process problem in question?</p> | <p><i>Fast action cycles should be reserved for high hazard or other problems with significant consequences.</i></p> <p><i>Poorly defined triggers or “gatekeepers” that block access may compromise a fast action cycle.</i></p> |
| <p>b22. Design Acceptance & Change Control Process LTA:</p> <p>This branch considers the adequacy of acceptance and control-of-change procedures.</p> | |
| <p>c37. Code Compliance Procedures LTA:</p> <p>Was there adequate verification that all codes and standards noted as relevant at the conceptual stage were incorporated into the design?</p> | |

| 1. Questions | 2. Pointers & Examples |
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| 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: Did change review cover form, fit, and function up the part–component–subsystem chain to a point where no change was demonstrated? Were there change annotations/warnings on drawings and at points-of-operation? | |
| 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? | <i>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.</i> |
| MB2. Programme Review LTA | |
| This branch considers the adequacy of review processes aimed at assuring the management of environmental protection, safety and health. | |
| a1. Definition of Aims and Policy LTA: Were there adequate ES&H policy statements and were the aims of the ES&H programmes articulated? Did these summarise what management should know (and require) of ES&H assurance processes? Did the aims provide a benchmark against which to measure the programme and the improvement projects (including the work/process in question)? | |

| 1. Questions | 2. Pointers & Examples |
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| <p>a2. Description and Schematics LTA: Were ES&H assurance processes documented adequately?</p> <p>Were operating data (from work activities or processes) available and evaluated adequately?</p> | |
| <p>a3. Monitoring, Audit, and Comparison LTA: Was there a formal measurement system that compared actual (i. e. field) performance with ES&H programme aims and objectives?</p> | |
| <p>a4. ES&H Programme Organisation LTA: This branch considers the organisation of Environment, Safety & Health (ES&H) assurance programmes.</p> | |
| <p>b1. Professional Staff LTA: Did ES&H personnel perform well by both ES&H <u>and</u> management criteria?</p> <p>Were they effective in both technical and behavioural aspects?</p> <p>Did they have high status in the organisation and were they qualified, experienced, and “promotable”?</p> | |
| <p>b2. Management Peer Committees LTA: Were special-purpose and ongoing committees and boards used to improve ES&H understanding and attitudes within operational, support, scientific and engineering groups?</p> <p>Were these ongoing groups positive and action orientated toward real-life problems?</p> | |
| <p>b3. Scope LTA: Did the ES&H programme scope address all forms of hazards, including anticipated hazards associated with advanced technological development and research?</p> | |
| <p>b4. Integration LTA: Was the staff support for ES&H integrated in one major unit rather than scattered in several places?</p> | |
| <p>b5. Organisation for Improvement LTA: Was the ES&H programme adequately designed and managed to produce the desired pace of ES&H improvement?</p> | <p><i>Although ownership of problems in the line organisation is crucial, achievement of significant ES&H improvement also requires clear goal definition and effective organisation efforts, particularly by ES&H staff.</i></p> |
| <p>a5. ES&H Programme Services LTA: This branch considers the provision of services and guidance needed to support the ES&H programme review at lower organisational levels.</p> <p>Note the transfer in of all lower tier events from SD6. Evaluate this branch from the perspective of the organisation as a provider of ES&H services to all levels. Note that your evaluation of service provision may need to extend beyond that provided by ES&H staff.</p> | |

| 1. Questions | 2. Pointers & Examples |
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| <u>R. Assumed Risk</u> | |
| 1. Questions | 2. Pointers & Examples |
| <p>What were the assumed risks?</p> <p>Were they specific, named events?</p> <p>Were they analysed and, where possible, calculated (quantified)?</p> <p>Was there a specific decision to assume each risk?</p> <p>Was the decision made by a person who had [management delegated] authority to assume the risk?</p> | <p><i>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.</i></p> <p><i>To reach your judgement of whether a risk was properly assumed, you will need to consider:</i></p> <ul style="list-style-type: none"> <input type="checkbox"/> <i>The adequacy with which costs were weighed against benefits of risk reduction;</i> <input type="checkbox"/> <i>Uncertainty about the risks themselves</i> <input type="checkbox"/> <i>Tolerability of risk;</i> <input type="checkbox"/> <i>Adequacy of information and interpretation provided to the person making the decision;</i> <input type="checkbox"/> <i>Whether the decision to assume the risk was made by an appropriate person.</i> |

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NRI Document Improvement Proposal

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