

Table 1: Description of exercise on MORT (and ETBA)

<p>Description of Method(s) used for: Phase 1: Chronology Phase 2: Causality (Direct Causes) Phase 3: Underlying Causes</p>	<p>Phase 1. MORT Tree analysis is NOT used to establish a chronological chain of events.</p> <p>Phase 2. Energy Trace and Barrier Analysis (ETBA) is used to identify unwanted physical changes in the immediate timeline of the accident.</p> <p>Phase 3. MORT tree analysis prompts the analyst to challenge the implementation of the controls and barriers identified by ETBA, and the associated Safety Management System (including design).</p> <p>The MORT tree can also be used by reviewers to assess the completeness of the investigation report.</p> <p>MORT can also be used for safety audits, before incidents.</p>
<p>Accident(s) studied</p>	<p>BP Texas City refinery explosion and fire, March 23rd, 2005.</p>
<p>Expectation of outcomes <i>Simple statement about criteria for evaluating the usefulness of the methods applied.</i></p>	<p>See the SWOT analysis provided in the “Method Criteria Table”</p>

Table 2: Findings relevant to the accident and report information

<p>What was the result of this process? e.g., -findings -questions, gaps in information that you hope to resolve in the next steps -scope of the investigation -limitations imposed by information available -potential themes already emerging -gaps in information</p>	<p>How did each phase meet your expectations? <i>Please indicate your experience for Phase 1, 2 and 3 in regard to each of the categories below.</i></p>
	<p>ETBA and MORT were applied in a limited way to the BP Texas City accident, enough to demonstrate how these methods work. Only a full-scale application of the methods would test the comprehensiveness of the CSB report. However, our sample analysis did raise questions that we could not immediately answer; but further study of the report might answer some of these. We did not set out to challenge the completeness of the CSB report.</p>
	<p>2) Findings in the investigation report(s):</p> <p>The team’s emphasis was on trying MORT, not on reviewing the CSB report. MORT is very extensive, and the CSB report allowed us to answer most questions. Further study of the report may well answer all of the questions prompted by the sample of MORT analysis.</p>
	<p>3) Limitations of the report (generally):</p> <p>The team’s focus was on MORT, not on the CSB report.</p>
	<p>4) Gaps in information in the reports (specifically):</p> <p>See previous comment.</p>
	<p>Please indicate how each method contributed to findings in :</p> <p>Phase 1 (Chronology) Not performed because of the availability detailed chronologies of the last 24 hours’ startup operation and history of the last 50 years of key decisions.</p> <p>Phase 2 (Direct Causes) As described in the MORT user’s manual, MORT tree analysis begins with Energy Trace and Barrier Analysis. ETBA expresses the accident sequence as a progression of unwanted</p>

	<p>transfers of energy.</p> <p>The team performed the ETBA (see Appendix 1) in a Skype teleconference lasting two hours.</p> <p>ETBA characterizes accidents as unwanted transfers of energy, beginning with the first and ending in the last. In the BP Texas City case, the first was the oversupply of ‘raffinate’ into the splitting tower) and the last was the kinetic fragments/material of the trailers which caused the fatalities and injuries. A concept in ETBA is the ‘meticulous trace of energy’: all transfers of energy need to be accounted for, because the controls of each are then made visible for review by the accident analysts. The ETBA revealed a chain of 7 unwanted transfers, and 12 energy and controls and barriers. (A full MORT analysis is likely to deduce several missing controls and barriers, adding these the initial 12)</p> <p>Phase 3 (Root Causes)</p> <p>A complete MORT analysis would need to examine every barrier and control found by the team’s ETBA of all energy transfers. The team selected just one unwanted transfer of energy as the subject for the sample MORT analysis. If performed at full-scale, the analysts would iterate the MORT tree analysis for all controls. The analysis would accelerate, as each new iteration would repeat some of the data and questions.</p> <p>MORT tree analysis can be done as a paper and pencil exercise. However, recording the results of MORT analysis, especially of a complex case like BP Texas City, is cumbersome with paper and pencil—especially if there is the expectation of sharing the analysis electronically. For those reasons, the team put the MORT tree question set into “Mindjet Mindmanager” (mind-mapping) software. This allowed the MORT tree and questions to be projected onto a screen, and the results to be recorded in the Mindmanager file.</p> <p>A separate document is available, where the exercise is explained in more detail.</p>
<p>If you were an investigator or inspector, what questions would you ask</p>	<p>The sample MORT analysis was too limited to provide a representative list of questions that an inspector might ask about BP Texas City. However, even this limited application of MORT</p>

the site following this analysis?	raised questions about technical details, and about the design and operating philosophy (e.g. verification of operational readiness before start-up).
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Table 3: Findings relevant to the method

General impressions of experience working with each method	The MORT tree (and ETBA) is a highly structured method. It requires time to understand the principles of its application and to become familiar with its content. However it is easy to use after this minimum training.
Advantages	<p>The structure allows a common language to be adopted in the analysis.</p> <p>MORT can also be used at reduced scale and still yield relevant results. For example, sub-branches of the MORT Tree can be applied in isolation.</p> <p>ETBA can be used as a stand-alone method to quickly identify the essentials of direct causation in terms of unwanted energy transfers and the associated barriers and controls.</p>
Disadvantages	MORT is technical, informed by engineering and ergonomics, but not wider social science perspectives.
Advice for analysts/inspectors using this (these) method(s)	Be sure that you read and understand the manual before applying MORT to an accident. Then, apply MORT in order to better understand it.

Table 4: Reference materials - List of Links

Date	Title	Link	Comment
	CSB report		
