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Title: **Prototype Information Base for Quantifying Detonator Reliability**

Author(s): Richard J. Yactor
Mary A. Meyer
Marie Davidson
Thomas R. Bement
Dale Talbot t

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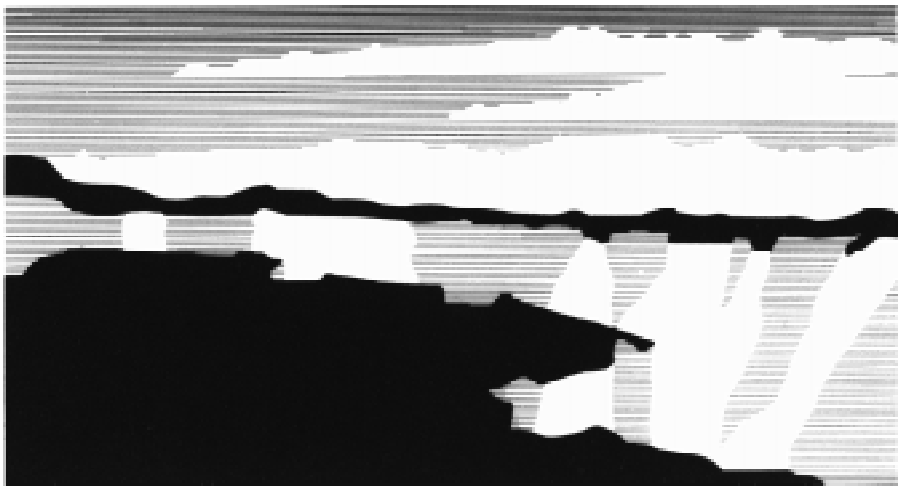

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PROTOTYPE INFORMATION BASE FOR QUANTIFYING DETONATOR RELIABILITY

Richard J. Yactor
DX-1, Detonation Science and Technology, MS P950
Los Alamos National Laboratory

Mary A. Meyer, Marie Davidson, Thomas R. Bement
TSA-1, Statistics Group, MS F600

Dale Talbott
TSA-11, Probabilistic Risk and Hazard Analysis, MS K557

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ABSTRACT

This paper illustrates a prototype information base for quantifying detonator reliability. The information base is structured around a reliability model of the detonator's parts and the events associated with its functioning. A Graphical Users Interface depicts an image map of the reliability model and allows the user to easily access the information underlying the reliability estimates (e.g., test data, calculations, surveillance reports, and expert judgment). To date, the reliability of the detonator has been assessed and the information base underlying the reliability assessments continues to be updated as new information becomes available. This detonator information base is being developed as part of the Enhanced Reliability Methodology Pilot Program (LA-ESP96-23).

1 INTRODUCTION

In this paper, we describe a prototype information base for quantifying detonator reliability. This information base captures knowledge related to assessing the reliability of a warhead component and organizes it in context. The information base allows users to trace the estimates of reliability and uncertainty to their source whether it be test data, surveillance findings, calculations, expert judgment, or some combination of these. Thus, the users can decide for themselves whether they agree with the assigned estimate. The information base provides an archive for conducting research, writing reports, or for transferring knowledge to novices. We anticipate that this archive will become more valuable in the future, if some problem arises with detonator reliability. Future researchers will be able to refer to the archive to answer such questions as: had this problem been anticipated and tested for; what was done in the design to address the problem; and how serious does the problem appear to be?

The detonator information base is part of Enhanced Reliability Assessment Methodology Pilot Program (LA-ESP96-23). The objective of this larger program is to provide a structured, quantitative approach to modeling the reliability of the weapon system nuclear package. Reliability is defined as the probability that a nuclear package will produce a yield within the certified range. The pilot program is being applied to the W76 system.

2 METHOD FOR CREATING THE INFORMATION BASE

The information base is structured around a logic model of the sequence of events required for the detonator to function. The logic model was developed in two stages. First, technical managers created a strawman model of the overall nuclear package, allotting a node to the detonator. [i]Second, the detonator node was further elaborated by someone whom the managers designated as knowledgeable. This specialist, namely Richard Yactor, was asked to define the detonator and to roughly follow Probabilistic Risk Assessment (PRA) concepts in creating a logic model of the detonator. The detonator was broken into sequential events beginning with the "cable transmits the signal" and ending with the "initiation of the boosters". These possible outcomes of these events were further disaggregated into bins, such as, the "cable could properly transmit", "partially transmit", or "fail to transmit".

At a finer level of detail, the specialist described potential causes of the unsuccessful events. For example, the cable might fail to transmit or only partially transmit, if the cable were broken or open. At this level in the model, data, such as concerning the condition of the stockpile, can be plugged in. If sufficient data exists to calculate the frequency of occurrence of a particular condition, it is entered here; otherwise, the specialists estimate a likelihood of occurrence based on whatever information is available.

When the detailed logic model was largely completed, a Graphical Users Interface (GUI) was designed to link the parts of the model to their underlying information. This was done by depicting the logic model as an image map whereby the parts of the model, the reliability blocks and the branches of the trees, were linked to an electronic document library. The document library contains the documents, namely the texts and images, that support the reliability estimates. These documents may be transcripts of the interviews with the specialists, reference documents, drawing diagrams, or the results from peer reviews of the information base. . The GUI allows users to point and click on a portion of the model or text, browse through the relevant information, and evaluate for themselves the assigned probabilities. The GUI is facilitated via a standard browser, such as Netscape or Internet Explorer.

The unique advantage to this configuration of the logic model, documents library, and GUI is that it captures and preserves knowledge in its context. Preserving knowledge in its context is beneficial because it mirrors the way that we, as humans, think.[ii] As a result, users intuitively know how and where to browse for underlying information and specialists can trace through their previous thinking when updating their estimates to reflect new knowledge.

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[i] Meyer, Bement, Davidson, Hayden, Krajcik, Mortensen, Parkinson, and Smith, "Prototype Method for Quantifying Nuclear Package Reliability Using Expert Judgment," (LACP-95-82), Defense Research Review, vol. 7, no. 3, July 1996, pp. 57-79.

[ii] Meyer, "The Nuclear Community and the Public: Cognitive and Cultural Influences on Thinking About Nuclear Risk," (LAUR-94-3768), Nuclear Safety, vol. 37, no. 2, p. 97-108.

3 CURRENT STATUS AND FUTURE DIRECTIONS

The reliability assessment for the detonator used in the W76 system has been completed, although specialists continue to add to and review the information base.

Future directions for the detonator information base are as follows:

- update the reliability assessment as new information becomes available;
- simplify and automate the process of having specialists add and update the information;
- facilitate the process of peer review and annotation; and
- add full-text search capabilities, as appropriate.

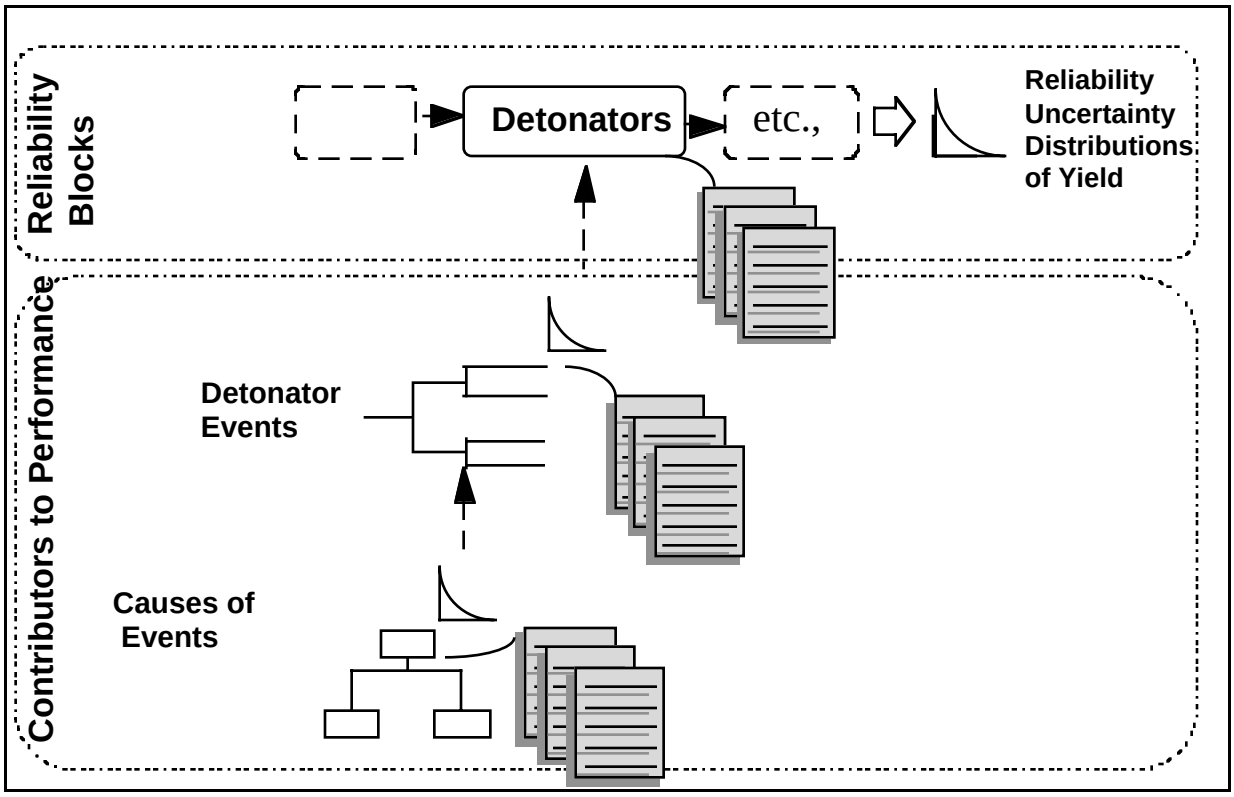

Figure 1: Illustration of the Detonator Information Base for the Enhanced Reliability Methodology Pilot Program.