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TITLE: Discussion of Nuclear Explosive Operation Process Changes Generated by a Preliminary Hazard Assessment

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AUTHOR(S): David A. O'Brien
Stewart R. Fischer

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Los Alamos
Los Alamos National Laboratory
Los Alamos, New Mexico 87545

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Discussion of Nuclear Explosive Operation Process Changes Generated by a Preliminary Hazard Assessment

David O'Brien and Stewart R. Fischer
Probabilistic Risk and Hazard Analysis Group
Los Alamos National Laboratory

Abstract

Hazard assessments (HAs) are being used to support the US Department of Energy (DOE) Integrated Safety Process (SS-21), Nuclear Explosive Safety Study Group (NESSG), and Environmental Safety and Health (ES&H) initiatives. The HAs are used to identify hazards associated with nuclear explosive operations involving tooling and procedural processes.

In general, a HA is a formal, systematic, in-depth method for evaluating a set of possible accident scenarios associated with a process. Two assessments of a nuclear explosive surveillance process have been performed or are in progress: (1) a preliminary HA of current operations to focus efforts on maximizing safety improvements during subsequent process redesign and track overall improvement following process redesign (completed) and (2) a rolling assessment of hazards present in conceptual solutions and solutions to improve safety (in progress).

The preliminary HA was used to focus the process design teams on problem areas. The rolling assessment is evaluating how well problem areas were eliminated or mitigated. This paper will summarize the preliminary HA, how it focused the design teams on problem areas found by the assessment, and the rolling assessment of solutions generated by the process design team.

Introduction

The Department of Energy SS-21 program, which integrates environment, safety, and health (ES&H) and nuclear explosive safety requirements under a single program, uses hazard assessments (HAs) to identify accidents that have the potential for worker injury, public health impact, or environmental impact. The SS-21 program requires the HA to generate information to support the following requirements: evaluate the likelihood of accident sequences that have the potential for worker or public injury or environmental damage; identify safety-critical tooling and procedural steps; identify operational safety controls; identify safety-class/significant systems, structures, and components; identify dominant accident sequences; demonstrate that the facility Safety Analysis Report design-basis accident encompasses process-specific accidents; and produce a Hazard Analysis Report (HAR) that can be used to support future change control activities.

The SS-21 process is based on the principle that the real benefit of a HA is in facilitating risk reduction during process design and development. Tooling and process designers implement design and procedure changes or initiate positive measures to minimize or eliminate the likelihood of the important base events from occurring. This iterative risk reduction process is the basis for SS-21

The overall philosophy in the SS-21 process is to reduce the risk of nuclear explosive operations to an acceptable level and to provide defense in depth against potential accident scenarios. The goal of this process is to produce safe, efficient, and effective operations that design in safety features to reduce the likelihood of accident scenarios; that is, are driven by design not by review.

This paper summarizes the results to date of a preliminary HA on a nuclear explosive operation and its effect on process redesign now in progress.

Los Alamos Hazard Assessment Process

To address this multitude of requirements being imposed on the process HA, Los Alamos National Laboratory has developed a hazard analysis (HA) methodology for nuclear explosive operations. This methodology evolved from HA efforts conducted at the Los Alamos Plutonium Facility and has now been used to conduct several HAs for the B61 and W69 dismantlement efforts (Bott, 1995; Fischer, 1995) and for the W76 surveillance program.

The Los Alamos HA approach integrates traditional probabilistic safety assessment tools (fault trees, event trees, uncertainty analysis, importance measures, etc.) with qualitative HA methods to develop an effective HA methodology for nuclear explosive operations. The Los Alamos HA methodology provides a systematic approach to identifying hazards associated with nuclear explosive assembly/disassembly activities and for assessing the risk associated with those hazards qualitatively. Figure 1 outlines the integrated HA process developed at Los Alamos to support the SS-21 activities.

Conduct of the Preliminary Hazard Assessment

For the preliminary HA (the second block of Fig.1), only the existing process was analyzed. In addition, to date, the accident sequence identification has only

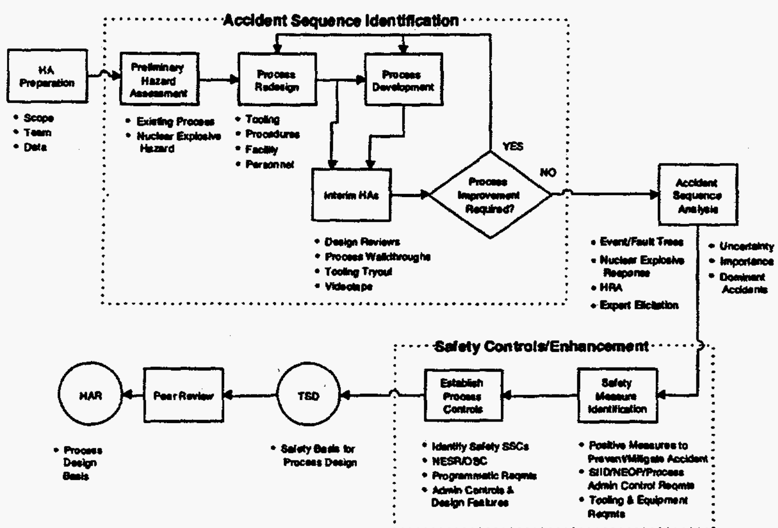

Figure 1. Integrated Hazard Assessment Process.

identified potential accidents and their worst possible consequences. The intent is to refine the analysis to provide more detailed understanding. However, the analysis to date has provided insight into which portions of the process could be changed to provide the most risk reduction by reducing the largest number of potential accidents in the nuclear explosive's most vulnerable configuration.

Before the HA is conducted, an extensive data-gathering effort was undertaken to evaluate nuclear explosive response in the disassembly accident environments and to obtain information on past operating incidents. After viewing a videotape of the disassembly/assembly process and reviewing the procedure steps, the HA team members used guide words (similar to those used in the HAZOP process [Center for Chemical Process Safety, 1992]) and comparable historical events and drew from their experience and training to develop "what if" questions. These were recorded by the team member serving as scribe and examined by the team under the leadership of the HA Team Leader. In cases where the events postulated in response to the "what if" questions could pose a hazard, the events were developed into a postulated accident sequence by the HA team and then documented.

The developed accident scenarios, along with the scenario consequence, were discussed in detail by the HA team. To facilitate future evaluation of the identified accident sequences, each sequence was assigned a keyword—industrial accident, radiation dose, explosion, and equipment or facility damage. The HA team determined the consequence severity for each of the two risk attributes—Worker Safety and Facility Damage—using Table 1. The HA team noted those parts of the process where the nuclear explosive became more vulnerable to drops, impact, and electrostatic discharge. This would facilitate estimating, based on numbers of potential accidents and vulnerability of the nuclear explosive, where efforts at process redesign should occur.

Results of the Preliminary Hazard Assessment

The results to date of the preliminary HA are shown in Figs. 2 and 3 for the disassembly and assembly processes. Figures 2 and 3 show a common area of the highest number of potential accidents to be in portions of the process where the nuclear explosive is more vulnerable to drops, impact, and electrostatic discharge. It should be noted that those potential accidents that could cause a Facility Category A or B consequence also would cause a Worker Category A or B consequence. However, at present, these are not counted in the total for Worker Category A or B consequences.

Based on the number of potential accidents and nuclear explosive vulnerability, the HA team recommended that the process redesign teams concentrate on those portions of the process where the team felt there were the highest number of potential accidents. The major initiators in these areas are drops, impacts, and electrostatic discharge. By reducing the potential for drops, impacts, and electrostatic discharge by redesigning tooling and procedures, the process risk would be reduced. In addition, several studies were initiated on the response of nuclear explosives to some of the insults identified by the preliminary HA. The intent of these studies is to eliminate potential accidents by demonstrating that the insults identified do not result in adverse nuclear explosive response.

Table 1. Consequence Severity Categories

Category	Definition (Bounding Consequences)	
	Worker	Facility
A Catastrophic	**Loss of Life** as a result of chemical, physical (e.g., explosion), or nuclear-related hazard. • Lethal chemical >> ERPG-3	**Significant Facility Damage** or contamination resulting in loss of facility for future use.
B High	**Severe Injury/Permanent Disability** • Exceed lifetime occupational radiation limits • Physical injury resulting in permanent disability • Chemical exposure > ERPG-3	**Moderate to Significant Facility Contamination and Damage** • Repair and cleanup possible but quite expensive
C Moderate	**Lost Time Accident but No Disability** • Chemical exposure < ERPG-3 • Exceed annual/quarterly worker radiation dose limits • OSHA reportable injury	**Facility Contamination Minor Facility Damage** • Repair and cleanup possible at moderate expense
D Low	**No Significant Impact: Minor or No Injury** • Minor recordable injury • Chemical exposure < ERPG-1	**Minor or No Facility Contamination** • Minor facility damage
E No Hazard	**No Impact to Worker**	**No Facility Damage**

Based on these recommendations, the process redesign teams changed the tooling for those portions of the process where the team felt there were the highest number of potential accidents. The HA team then re-evaluated those portions and found a significant drop in potential accidents (Fig. 4). In addition, many potential accidents had their likelihood reduced, either by improving the handling of the nuclear explosive or by reducing the magnitude of the insult to the nuclear explosive. Thus, safety was designed into the process rather than "reviewed in."

Future Work

The HA team will be completing the final HA on the process while providing continuous feedback to the process design teams on any additional problem areas discovered. The final HA will provide a risk ranking of potential accidents using Table 2 and estimates of the likelihood and consequences of the identified potential accidents. In addition, HA team members are participants on the various process design teams. This will allow the process design teams to be kept abreast of information from the final HA as well as getting feedback on concepts developed by the teams.

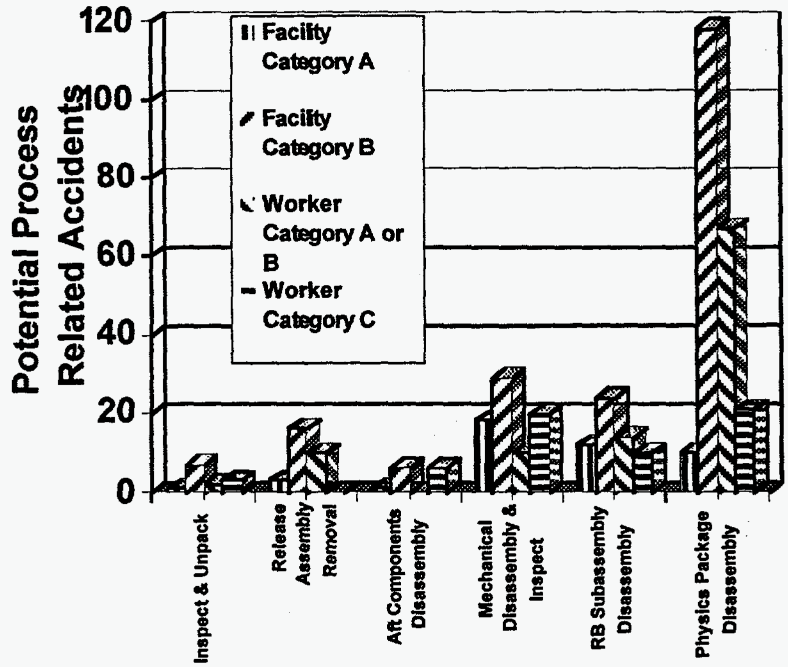

Figure 2. Potential Process-Related Accidents for Disassembly Operations.

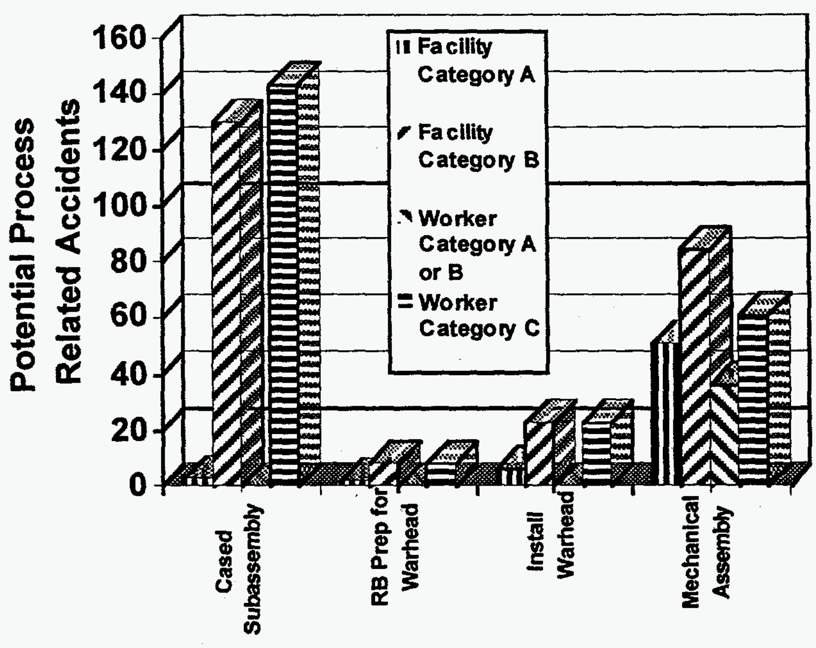

Figure 3. Potential Process-Related Accidents for Assembly Operations.

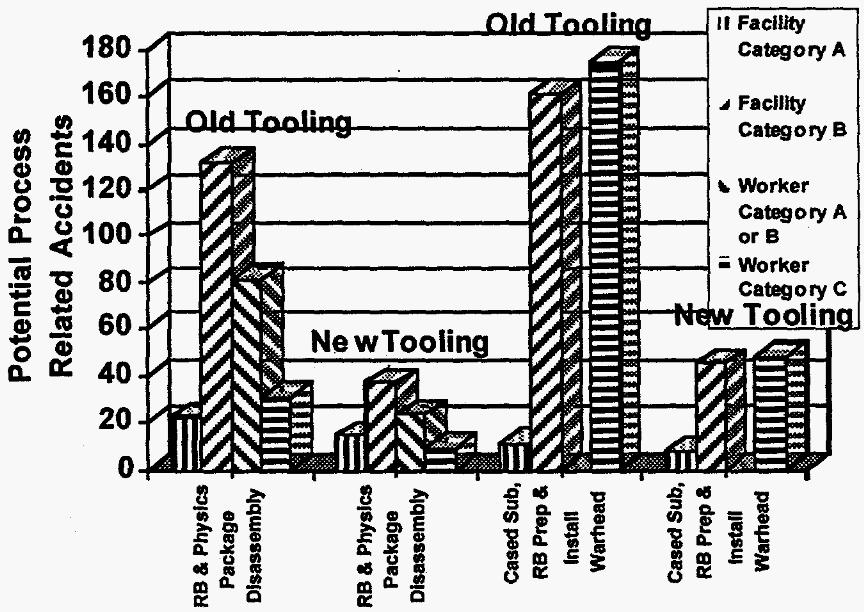

Figure 4. Comparison of Potential Accidents for Old and New Tooling.

Table 2. Risk Matrix

Severity of Consequence	Likelihood of Postulated Accident				
	I	II	III	IV	V
A	1	1	2	3	3
B	1	2	3	3	4
C	2	3	3	4	4
D	3	4	4	4	4
E	NH	NH	NH	NH	NH

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