
**Type A Accident
Investigation Board Report
on the February 13, 1997,
Welding/Cutting Fatality
at the
K-33 Building, K-25 Site
Oak Ridge, Tennessee**



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April 1997

**Office of Oversight
Environment, Safety and Health
U.S. Department of Energy**

This report is an independent product of the Type A Accident Investigation Board appointed by Tara O'Toole, M.D., M.P.H., Assistant Secretary for Environment, Safety and Health (EH-1).

The Board was appointed to perform a Type A investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.1, *Accident Investigations*.

The discussion of facts, as determined by the Board, and the views expressed in the report do not assume and are not intended to establish the existence of any duty at law on the part of the U.S. Government, its employees or agents, contractors, their employees or agents, or subcontractors at any tier, or any other party.

This report neither determines nor implies liability.

On February 14, 1997, I established a Type A Accident Investigation Board to investigate the February 13, 1997, Welding/Cutting Fatality at the K-33 Building, K-25 Site, Oak Ridge, Tennessee. The Board's responsibilities have been completed with respect to this investigation. The analysis, identification of contributing and root causes, and judgments of need reached during the investigation were performed in accordance with DOE Order 225.1, *Accident Investigations*.

I accept the findings of the Board and authorize the release of this report for general distribution.

Tara O'Toole, M.D., M.P.H.
Assistant Secretary
Environment, Safety and Health

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ACRONYMS AND INITIALISMS

| | |
|------------------|---|
| ANSI | American National Standards Institute |
| CFR | Code of Federal Regulations |
| D&D | Decontamination and Decommissioning |
| DNFSB | Defense Nuclear Facilities Safety Board |
| DOE | U.S. Department of Energy |
| EH | DOE Office of Environment, Safety and Health |
| EM | DOE Office of Environmental Management |
| ES&H | Environment, Safety and Health |
| HEPA | High-Efficiency Particulate Air |
| LMES | Lockheed Martin Energy Systems, Inc. |
| LMUS | Lockheed Martin Utility Systems, Inc. |
| M&O | Management and Operating |
| OR | Oak Ridge Operations Office |
| OSHA | Occupational Safety and Health Administration |
| SWP | Safety Work Permit |
| SSMRP | Small-Scale Metal Recycle Project |
| U ²³⁵ | Uranium-235 isotope |
| UF ₆ | Uranium hexafluoride |
| USEC | U.S. Enrichment Corporation |

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EXECUTIVE SUMMARY

INTRODUCTION

On February 13, 1997, a welder suffered fatal burns when his clothing caught fire while he was using a cutting torch at the K-33 Building, Oak Ridge K-25 Site, Oak Ridge Reservation. On February 14, 1997, Tara O'Toole, M.D., M.P.H., Assistant Secretary for Environment, Safety and Health, U.S. Department of Energy (DOE), appointed a Type A Accident Investigation Board to investigate the accident in accordance with DOE Order 225.1, *Accident Investigations*. The Board commenced its investigation on February 17, 1997, completed the investigation on March 14, 1997, and submitted its findings to the Assistant Secretary for Environment, Safety and Health on March 19, 1997.

ACCIDENT DESCRIPTION

Under contract to the Oak Ridge Operations Office, Lockheed Martin Energy Systems, Inc. (LMES) is decontaminating and decommissioning the K-25 site. By agreement among the Department of Energy, the United States Enrichment Corporation, LMES, and Lockheed Martin Utility Systems, Inc., spare process equipment needed for the Portsmouth and Paducah facilities is available from K-25. Beginning on February 8, 1997, LMES began to remove selected process equipment from the K-33 Gaseous Diffusion Building, the largest of the K-25 gaseous diffusion process facilities, for use by United States Enrichment Corporation. The work was similar in many ways to work performed in another K-25 building in 1996 and to the extensive equipment replacement activities necessary to support operations prior to 1985. Because of these similarities, LMES classified the work as routine maintenance, thereby eliminating the requirement for a task-specific work plan.

The accident occurred at approximately 11:10 a.m. on Thursday, February 13, 1997, at the K-33 Building. The work involved the removal of six converters from Cell 7. These cells were scheduled to be shipped to Portsmouth and/or Paducah as spare parts. Although the roof of the cell was removed, the cell's lighting was very poor, and temporary lighting was installed. The physical layout of the equipment in the cell created a constricted work space with very difficult ingress and egress. Converters 2 and 3 had already been removed, and the welder was performing a cutting operation on Converter 4. During this cutting operation, a spark or a piece of hot metal ignited his anti-contamination coveralls at, or somewhat below, his left knee. At the time of the accident, the welder was wearing multiple layers of clothing and radiological protective equipment that limited his ability to detect and extinguish the flames quickly. Since the welder was working alone, the flames spread undetected until they were beyond his ability to extinguish them without assistance. By the time a co-worker responded to the emergency and extinguished the fire with a dry chemical fire extinguisher, flames had totally engulfed the welder's body. At approximately 11:46 a.m., he was transported by ambulance to Methodist Medical Center in Oak Ridge, arriving at noon. The welder had suffered third-degree burns over 95 percent of his body. He died at 10:41 a.m. on February 14, 1997, after being transferred to Erlanger Burn Center in Chattanooga.

ROOT AND CONTRIBUTING CAUSES

The Board identified two root causes¹ for the accident, either of which would have prevented a fatality or serious injury:

- Failure to use flame-retardant anti-contamination clothing
- Failure to identify a fire watch with appropriate personal safety responsibilities.

In addition, five contributing causes² were identified:

- LMES failed to adequately plan the work, provide adequate procedures, or ensure that existing procedures were implemented.
- Line management responsibility and accountability for safety were not adequately defined for the Oak Ridge Operations Office or LMES, as evidenced by their failure to ensure that workers and supervisors were properly qualified and trained to perform assigned tasks.
- Neither the Oak Ridge Operations Office nor LMES performed sufficient oversight to maintain an awareness of site job hazards, as evidenced by their failure to observe and react to numerous clothing fires prior to the fatal accident.
- LMES management did not foster an atmosphere that encouraged reporting of incidents; therefore, workers did not report the previous incidents of clothing fires to management.
- Equipment used to protect workers from radiological hazards created an additional fire hazard by limiting the welder's ability to see, smell, or feel the ignition of his clothing and by interfering with his ability to call for help.

Section 3.0 of this report provides major conclusions derived from this investigation and the judgments of need that address them.

RESULTS OF THE INVESTIGATION

Personal Protection

A Radiological Work Permit issued for the converter removal required the use of anti-contamination clothing and a respirator. The Board found that neither DOE nor LMES policies require the use of flame-retardant anti-contamination clothing for welding, cutting, or hotwork operations. Because of the cutting operation, the welder was also wearing a welder's mask. The Board found that the welder's senses of sight and smell would have been severely limited by the welder's mask and the respirator. In addition, the multiple layers of protective clothing would

¹ The fundamental causes that, if eliminated or modified, would prevent recurrence of this and similar accidents.

² Causal factors that significantly increased the likelihood of the accident without individually causing the accident.

allow a fire to burn for some time before the ensuing heat could be felt. Testing conducted by the Board indicated that there would have been a 65- to 80-second delay before the welder could detect that his clothing had ignited. After 90 seconds, the flame could not have been extinguished by the welder alone. The Board found no evidence that consideration was given to the K-25 *Radiological Control Program Manual* criterion that determination of personal protective equipment should be based on the anticipated work activity, worker health considerations, and regard for the non-radiological hazards that may be present. As a result, concern regarding a possible contamination hazard may have caused the use of a level of protective equipment that impeded worker response to the actual, but unidentified, hazard of clothing ignition.

Although LMES procedures require a fire watch to be present for welding or cutting operations outside an approved shop area, a fire watch was not designated on the work permits for work performed on the day of the accident. A fire watch is a designated individual trained in fire-watch duties, who is dedicated to monitoring the work site for possible fires during welding/cutting activities and for thirty minutes after the work has stopped. Of three previous work permits for work in the cell that were made available for review, two did not require that a fire watch be identified. The Board also found that neither DOE nor LMES policies emphasize personnel safety as a responsibility for a fire watch. For example, these procedures do not indicate the need for the fire watch to (1) maintain a line of sight with the welders, (2) be at a distance that would enable a timely and effective response, or (3) be trained in personal emergency response techniques and first aid.

The Board concluded that the designation of a fire watch with clear personnel safety responsibilities and/or the welder's use of flame-retardant anti-contamination clothing would have prevented this fatality. However, as noted below, the Board determined that to prevent recurrence of a similar accident, significant deficiencies must be corrected in management identification of accident precursors and in the LMES work planning and control program.

Accident Precursors

Interviews revealed that anti-contamination clothing had caught fire during similar work performed at another facility (K-31) in 1996. Also, anti-contamination clothing had caught fire more recently at K-33 when hot molten metal (slag) dropped/splashed on the clothing. For example, several days before the accident, a welder's bootie caught fire. Further, the day before the accident, the clothing of the welder fatally burned in this accident caught fire, burning both sets of anti-contamination clothing and scorching his general-purpose coveralls. These and many similar incidents were not reported to LMES management or to DOE as "near misses" through the occurrence reporting system.

LMES management considered the work being performed at the time of the accident to be similar to that previously performed at K-31 in 1996. Because it had been several years since major removal of equipment had been performed, the K-31 work was fully planned and documented to enable application of lessons learned to future similar work. A project report, prepared at the end of the K-31 work, documented completion of the project and included lessons learned. These lessons learned included the need for developing and using a work plan for similar work in the future; developing specialized cutting tools; assigning fire watches; and reducing anti-

contamination coverall requirements to one rather than two pairs during burning/cutting operations. There was no evidence that personnel involved in the K-33 work used either the project report or the lessons learned from the K-31 project.

Work Planning

LMES procedures require a Job Hazards Analysis and describe the process for conducting the analysis, as well as the conditions under which a new analysis should be performed. They also assign responsibility for performing the analysis to the “supervisor.” The process includes assembling a multidisciplinary team of workers and safety professionals, documenting individual work steps for the job, identifying the hazards for each step, and specifying the controls for each hazard. However, the procedures do not clearly identify the individual responsible for ensuring that a Job Hazards Analysis is performed; consequently, no analysis was performed for the K-33 converter removal. Further, during similar work at K-25 in 1996, industrial safety/industrial hygiene personnel were permanently assigned to the job and monitored the actual cutting operations at the work site to evaluate the hazards and controls. No similar assignment of safety/industrial hygiene personnel was made for the K-33 work during which the accident occurred.

A task-specific work plan was not prepared for K-33 converter removal work. LMES classified the work as “routine maintenance” within the “skill of the craft.” LMES procedures do not require a detailed work plan for such efforts.

The work permits proposed for the K-33 converter removal work did not specify alternative cutting methods, engineered controls, or the use of personal protective equipment to protect the workers from sparks or hot slag generated during cutting operations. They also did not contain any provisions to ensure adequate ingress and emergency egress for personnel or equipment. The Board observed that human entry/egress was restricted by the confined space and the equipment configuration.

Signatures found on work permits indicate that some approving authorities did not visually inspect the work area in Cell 7 prior to signing the work permits, and they were not present to observe whether work was being performed within the scope of the controls identified to mitigate identified hazards. The Board found that the Industrial Hygiene Department was not notified prior to commencing cutting operations; consequently, industrial hygiene surveys—required by the work permits—were not conducted.

The Board could find no evidence that a pre-job safety meeting of the Service Supervisor, all the craft disciplines, and appropriate safety personnel assigned to monitor the work had been conducted as required.

CONCLUSIONS

There are some urgent policy issues with respect to flame-retardant clothing and fire watch responsibilities that must be addressed as a result of this accident. However, the overarching concern stemming from this investigation is the failure to conduct adequate work planning and hazards analyses. Part of this failure may be because classifications assigned to many work activities, for example, “routine maintenance,” are interpreted by some as obviating the need for sound work planning/control or because of complacency expressed by line management who believe structured work planning is not necessary because “this is a job we have performed thousands of times before.” Another contributor to poor work planning may be the assumption that such activities require very elaborate analysis of the hazards and preparation of a thick report. None of these reasons are accurate, nor do they reflect the policy or guidance the Department has promulgated to date.

The increasing emphasis on decontamination and decommissioning activities within the Department and the lessons learned from this accident underline the pressing need to implement the commitments made in the Department’s response to DNFSB 95-2 and the DOE Enhanced Work Planning Program. Both of these initiatives emphasize a shift in focus from “paper requirements” to a disciplined, analytical, and collaborative approach to work planning, hazards analysis, and hazards control. If we are to minimize worker injuries and fatalities in the Department’s changing mission, then emphasis must be placed on a multidisciplinary approach to pre-job planning where each step of the work to be done is reviewed for the hazards expected and appropriate controls are put in place.