DEFENSE NUCLEAR FACILITIES SAFETY BOARD

625 Indiana Avenue, NW, Suite 700, Washington, D.C. 20004-2901
(202) 208-6400

April 26, 1999

The Honorable Bill Richardson
Secretary of Energy
1000 Independence Avenue, SW
Washington, DC 20585-1000

Dear Secretary Richardson:

Over the past 9 years since its inception, the Defense Nuclear Facilities Safety Board (Board) has maintained an active interest in emergency management at defense nuclear facilities throughout the complex and has expressed its continuing interest in this matter through numerous communications with the Department of Energy (DOE). As you also have emphasized in your policy statements on this subject, the integration of safety management, including planning for possible accidents—a crucial portion of an acceptable Integrated Safety Management System—is indispensable for the protection of workers, the public, and the environment. Events in the last 2 years have reconfirmed the importance of some of the emergency management issues the Board has previously brought to DOE's attention.

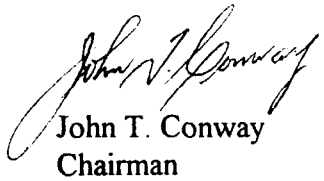
Specifically, insights and information gained as a result of the chemical explosion in the Plutonium Reclamation Facility at the Hanford Site and the asphyxiation fatality at the Idaho National Environmental Engineering Laboratory highlighted weaknesses the DOE's own oversight organizations have emphasized in the follow-up activities to both these unfortunate events.

The Board's staff has recently completed a report on the status of DOE's emergency management program throughout the defense nuclear complex. The report, enclosed for your information, reaches many of the same conclusions as your own staff regarding weaknesses, in DOE's emergency management program.

The Board and its staff have also carefully reviewed the information included in the emergency management evaluations recently completed by DOE's internal oversight organizations. The most significant of these evaluations were completed in response to Secretary Peña's two memoranda dated August 27, 1997, "Lessons Learned from the Emergency Response to the May 14, 1997, Explosion at Hanford's Plutonium Reclamation Facility," and "Timely Notification of Emergencies and Significant Events." Subsequent internal DOE memoranda from the Deputy Secretary and reports prepared by the Office of Nonproliferation and National Security and the Office of Environment, Safety and Health in November 1997 and July 1998 respectively, discussed emergency preparedness weaknesses throughout the complex, and identified a number of necessary corrective actions. Many of the weaknesses are common across the complex.

Line management's response to the findings of the Office of Environment, Safety and Health has generally been slow and inadequate. The Board considers the emergency management issue to be a clear example of the feedback and improvement deficiencies addressed in Recommendation 98-1 and to be an issue that warrants specific attention. The Board sees DOE's response to the emergency management issues as a case in point to test the effectiveness of the improvements emerging from the implementation plan for Board Recommendation 98-1. If you have any questions on this matter, please do not hesitate to contact me.

Sincerely,



John T. Conway
Chairman

c: Mr. Mark B. Whitaker, Jr.

Enclosure

DNFSB/TECH- 21

Status of Emergency Management
at
Defense Nuclear Facilities
of the
Department of Energy

Defense Nuclear Facilities Safety Board

Technical Report

March 1999

STATUS OF EMERGENCY MANAGEMENT
AT
DEFENSE NUCLEAR FACILITIES
OF THE
DEPARTMENT OF ENERGY

This technical report was prepared for the Defense Nuclear Facilities Safety Board by the following staff members:

John E. Deplitch
Dudley Thompson

with assistance from:

Farid Bamdad
Ronald W. Barton
Raphael S. Daniels
Joyce P. Davis
Steven L. Krahn
James J. McConnell

EXECUTIVE SUMMARY

This report is an assessment of the overall status of emergency management throughout the Department of Energy's (DOE) defense nuclear complex. It summarizes the results of evaluations of emergency management programs at various defense nuclear facilities conducted by the staff of the Defense Nuclear Facilities Safety Board (Board), including the Savannah River Site, the Hanford Site, the Nevada Test Site, the Rocky Flats Environmental Technology Site, the Los Alamos and Sandia National Laboratories, the Pantex Plant, the Y-12 Plant at Oak Ridge, and the Idaho National Environmental and Engineering Laboratory. These evaluations, all of which were conducted during the past 9 years, encompassed observations of emergency response exercises, as well as reviews of emergency plans and procedures, DOE exercise evaluation reports, and site/facility corrective actions and lessons learned. Members of the Board's staff also observed activities of the DOE Headquarters Emergency Response Organization, including the Emergency Management Team and the Technical Operations Cadre and other responders in the Headquarters Emergency Operations Center. Certain emergency management elements were reviewed in some detail at one or two sites, other elements were reviewed broadly, while others received only limited review.

Fortunately, there have been no catastrophic accidents at defense nuclear facilities—that is, no accidents having dire off-site consequences. However, most defense nuclear facilities are showing serious signs of aging, including many facilities where large quantities of radiological and nonradiological hazardous waste have accumulated. Much of this material is stored in uncertain and unstabilized forms. In addition, significant changes in mission and operational modes have occurred at many sites. Waste is being processed and stabilized, and facilities are being decontaminated and decommissioned. Many members of the experienced workforce that has manned the defense nuclear complex during the past five decades have retired or are departing, and a less-experienced workforce is left to operate well-worn facilities and to manage a large legacy of hazardous materials. A number of unusual and off-normal occurrences and near-misses have occurred. In the face of these circumstances, reliable emergency preparedness is especially critical, since it is the final defense-in-depth link in an Integrated Safety Management System that provides protection of the health and safety of workers and the public, as well as of the environment.

The reviews documented in this report were based on objective evaluation guidance promulgated by both DOE and the Federal Emergency Management Agency (FEMA). Yet any assessment based on observations at several facilities with widely diverse missions and operating characteristics is at least partially subjective, and the facts can be interpreted differently by different reviewers. This is particularly true when the observations were made over an extended time period, as was the case here. Nevertheless, in this instance, there were a number of observations that recurred, and the fact that all the organizations involved are subject to the same set of requirements and guidance provides a normalizing function. The general conclusions drawn

herein by the Board's staff are also supported by the reports on reviews of individual facilities that are cited in the appendix.

The Board's staff offers the following general conclusions regarding the status of emergency management in a DOE-wide context:

- Top-level requirements and guidance for DOE and contractor organizations involved in emergency management functions are well founded and clearly set forth in appropriate documents.

- Applicable requirements and guidance are applied selectively. In some cases, noncompliance is condoned on the basis of a faulty conclusion—either that a requirement "doesn't apply here," or that a particular guidance element "isn't mandatory."

- A potentially serious problem exists at the DOE level, involving apparent misperceptions and questionable interpretations regarding the division of responsibility for: (1) development and promulgation of emergency management requirements and guidance; (2) establishment, conduct, and supervision of emergency management programs; and (3) oversight and evaluation of performance. Responsibilities are set forth clearly enough in DOE Order 151.1, *Comprehensive Emergency Management System* (dated September 25, 1995), but implementation could be made more effective with better cooperation among senior and mid level managers in programmatic and staff offices involved with emergency management matters. These conflicts, which also exist between DOE Headquarters and field elements, have been observed in other DOE contexts as well. All the involved organizations bear some degree of responsibility for these problems. This matter merits attention at the highest levels of DOE management.

- Deficiencies exist in emergency hazard analyses in one or more of the following areas:

  – Thoroughness of hazard assessments performed as elements of emergency planning at defense nuclear facilities, particularly in addressing all nuclear and non-nuclear hazards with potential impact on ongoing nuclear operations.

  – Verification and independent review processes used to ensure the completeness and accuracy of the parameters and analytical tools employed in hazard and consequence analyses and identification of Emergency Classifications, Emergency Planning Zones, and Protective Action Recommendations.

  – Integration of emergency hazard assessments with related authorization basis activities for identification and implementation of the controls necessary for effective accident response.

- In general, consequence assessment is weak all across the DOE complex. Observations have included use of inapplicable computational models and/or software that is limited with regard to the hazards and accident scenarios that can be simulated. There are too few qualified responders assigned to execute sophisticated computer modeling programs for downwind plots of likely radiation levels and/or contamination; at some sites this responsibility is vested in a single individual.

- At some sites and facilities, Emergency Action Levels are insufficiently developed and poorly implemented. Response procedures occasionally fail to address reasonably postulated incidents that could lead to an operational emergency, sometimes because hazard assessments were not sufficiently comprehensive or penetrating. In some cases, initiating conditions have not been recognized in sufficient detail to permit timely initiation of the appropriate emergency action.

- Responders are slow to classify emergencies and to disseminate appropriate Protective Action Recommendations, both in drills and exercises and in actual events. In some cases, recommended actions have been inconsistent with the prevailing conditions; in others, communication of the recommendations has been confused and unclear, leading either to failure to implement suitable protective measures or to implementation of unnecessary measures.

- Members of emergency response organizations whose emergency response duties are in addition to their routine day-to-day responsibilities are generally provided only minimal training regarding the infrastructure, equipment, and procedures involved in emergency response. Most of the training they do receive is imparted on the job during periodic drills and exercises; little formal classroom training or one-on-one tutoring is conducted for this group of responders.

- Tracking of the resolution of weaknesses disclosed during drills and exercises, as well as those experienced during actual emergencies, is poor. Closure of these issues is, at best, informal, with almost no attention from senior DOE managers. As a result, many weaknesses do not get satisfactorily resolved, and repetition tends to ingrain them groundlessly as inevitable characteristics of emergency response that cannot be corrected.

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1. INTRODUCTION

The U.S. Department of Energy (DOE) and its predecessor agencies have never been called upon to cope with a catastrophic nuclear accident at a defense nuclear facility involving serious off-site consequences. However, accidents that have occurred within the defense nuclear complex serve as sobering reminders of the inherent dangers of the day-to-day work associated with defense nuclear materials and processes. A small number of these accidents, some involving inadvertent nuclear criticality, have had very serious, even fatal, results for small numbers of on-site workers. These accidents have been extensively documented elsewhere,[1] and they are not recapitulated here.

In the past, responsible DOE and contractor managers have taken considerable comfort from the large distances between most defense nuclear activities and the nearest site boundary where members of the public might be subjected to unacceptable personnel exposure to radiation, intolerable levels of radioactive contamination of property, or other hazardous or life-threatening conditions in the event of a major accident. Yet experience in the international nuclear community as a whole has been less than reassuring with regard to potentially catastrophic accidents. Widespread media coverage of nuclear-related events—such as the graphite fire in the Windscale reactor in the United Kingdom; the SL-1 reactor accident in Idaho; dropped nuclear weapons near Palomares, Spain; the explosion at the Tomsk fuel processing plant in the former Soviet Union; the extensive fuel melting during the Three Mile Island accident near Harrisburg, Pennsylvania; and the Chernobyl reactor explosion near the Ukrainian city of Kiev—have contributed not only to heightened public awareness, but also to increased sensitivity within the nuclear community regarding the need for thorough contingency planning.

Emergency preparedness has also taken on increased importance as a result of new challenges imposed by:

- The effects of aging equipment and facilities in the defense nuclear complex;
- Accumulations of very large quantities of highly radioactive and toxic waste;
- Questions regarding the stability of residues remaining from decades of high-priority production of nuclear weapons materials;

[1] For example, a summary description of one of the lesser-publicized fatal accidents, as well as a transcript of a face-to-face group interview of a number of individuals involved in other accidental exposures to plutonium, is contained in *Los Alamos Science*, Number 23, 1995 (and at ***http://lib-www.lanl.gov/la-pubs/00326025.pdf*** on the World Wide Web). Additional information on this same 1958 accident is contained in: T. L. Shipman, C. C. Lushbaugh, D. F. Petersen, W. H. Langham, P. S. Harris, and J. N. P. Lawrence. 1961. Acute radiation death resulting from an accidental critical excursion. *Journal of Occupational Medicine: Special Supplement*. (March 1961): 145-192.

- The loss of experienced personnel; and

- The undertaking of new and previously uncharted activities associated with environmental restoration activities, including decontamination and decommissioning of facilities no longer considered necessary for national security.

At the same time, improved knowledge regarding the long-term effects of radiation exposure, together with progressively more restrictive standards for radiation exposure, has led to recognition of the need for better protection of on-site workers. This is particularly the case for on-site workers largely dependent upon emergency management actions to avoid undue exposure to hazardous materials in the event of accidental releases.

1.1 PURPOSE

This report assesses the overall status of emergency management throughout DOE's defense nuclear complex. It summarizes the results of evaluations of emergency management at various defense nuclear facilities conducted by the staff of the Defense Nuclear Facilities Safety Board (Board), including the Savannah River Site, the Hanford Site, the Nevada Test Site, the Rocky Flats Environmental Technology Site, the Los Alamos and Sandia National Laboratories, the Pantex Plant, the Y-12 Plant at Oak Ridge, and the Idaho National Environmental and Engineering Laboratory. These evaluations, all of which were conducted during the past 9 years, encompassed observations of emergency response exercises, as well as reviews of emergency plans and procedures, DOE exercise evaluation reports, and site/facility corrective actions and lessons learned. Members of the Board's staff also observed activities of the DOE Headquarters Emergency Response Organization, including the Emergency Management Team and the Technical Operations Cadre and responders in the Headquarters Emergency Operations Center. Certain emergency management elements were reviewed in some detail at one or two sites, other elements were reviewed broadly, while others received only limited review.

1.2 BACKGROUND

DOE and its predecessor agencies, the Atomic Energy Commission and the Energy Research and Development Administration, established emergency management requirements for internal organizational elements and for DOE's management and operating contractors. These requirements later evolved into the present-day series of applicable Federal Regulations, DOE Orders, and accompanying guidance documents.

During the early 1980s, in the aftermath of the Three Mile Island accident, significant changes were made in approaches to emergency management throughout the nuclear industry. A vigorous interagency cooperative effort within the federal government led to improved guidance on the subject. Specifically, substantial revisions were made to Parts 350–352 of Title 44 of the

Code of Federal Regulations, as well as to several Parts of Title 10, involving the Federal Emergency Management Agency (FEMA) and the Nuclear Regulatory Commission (NRC), respectively. A seminal guidance document, NUREG 0654/FEMA-REP-1, Rev. 1, *Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants*, was issued jointly by FEMA and NRC in November 1980.

DOE was also a party to the development of this revised guidance, but because NUREG 0654/FEMA-REP-1 was specifically associated with off-site preparations to support commercial nuclear power plants, DOE chose to adopt the gist of the requirements by incorporation in its own directives program, largely paralleling the guidance issued by the other agencies involved. Current DOE guidance to its own staff and to its contractors remains consistent with that promulgated by the other agencies.

DOE initiated an in-depth, wholesale revision of its entire directives program during the summer of 1995. The effort generally resulted in fewer requirements and more guidance, driven by contract reform and initiatives for reduction in requirements. This revision was monitored closely by the Board and its staff. In the emergency management arena, early agreement regarding the content of the revised Order and Guide was reached between the Board's staff and DOE staff members from the Office of Emergency Management (NN-60). That DOE office is responsible for preparation and promulgation of requirements and guidance associated with emergency management. It is the DOE organizational element that drafted both the previous 5500 series of Orders addressing emergency management and the new emergency management Order, DOE Order 151.1, and its associated guidance.

DOE's requirements for emergency management are well documented in DOE Order 151.1, *Comprehensive Emergency Management System*, dated September 25, 1995 (with Changes 1 and 2 dated October 26, 1995, and August 2, 1996, respectively). DOE Order 151.1 establishes policy and assigns and describes roles and responsibilities for DOE's emergency management program, providing the framework for development, coordination, control, and direction of all emergency operations.

DOE Order 151.1 applies to all DOE organizational elements and contractors, with the exception of those facilities and activities under the authority of other federal regulatory agencies, such as the NRC and the U.S. Navy. The Order requires that all Headquarters, Operations, and Field Offices and DOE transportation activities, as well as all sites and facilities ". . . develop and participate in an integrated and comprehensive Emergency Management System . . . ."

Although DOE Order 151.1 does provide an effective top-level framework, DOE relies heavily on implementing Guides and procedures for additional guidance. DOE Guide 151.1-1, the *Emergency Management Guide* (EMG), dated July 1997, provides guidance for implementation of DOE Order 151.1. The EMG comprises 11 volumes, each addressing a specific element of

emergency management.[2] The guidance is generic, intended to be applied across the DOE complex.

In the summer of 1997, following an accident involving a chemical explosion in a tank at the Plutonium Finishing Plant at the Hanford Site, the Secretary of Energy directed that the status of emergency management throughout DOE be independently reassessed.[3] The results of that appraisal effort are presented in two reports. The first, prepared by the Office of Emergency Management, was published in November 1997.[4] It was followed by a memorandum from the Deputy Secretary[5] directing that specified follow-on actions be taken immediately. The second report, which was prepared by a special task force under the direction of the Office of Environment, Safety and Health (ES&H), was published in July 1998.[6] Both groups reached conclusions similar to those of the Board's staff as presented here.

In July 1998, a fatal accident occurred at the Idaho National Environmental and Engineering Laboratory, involving the discharge of a carbon dioxide fire protection system into an electrical switchgear building occupied by 13 maintenance workers. Although the facility involved was not a defense nuclear facility, the report of the post-accident investigation[7] by DOE's internal oversight group disclosed many generic deficiencies that are equally applicable to defense nuclear facilities under the jurisdiction of the Board. That accident is currently receiving much attention in DOE, as is appropriate.

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[2] The subjects of the 11 volumes are: Vol. I, *Introduction to the Emergency Management Guide*; Vol. II, *Hazards Surveys and Hazards Assessments*; Vol. III, *Program Elements (1)*; Vol. IV, *Program Elements (2)*; Vol. V, *Administration and Training*; Vol. VI, *Evaluations*; Vol. VII, *Exercises*; Vol. VIII, *Response Assets*; Vol. IX, *Transportation Emergency Management System*; Vol. X, *Hazardous Waste Operations Emergency Response*; and Vol. XI, *Glossary of Emergency Management Terms*.

[3] Memorandum dated August 27, 1997, from Secretary Peña to Secretarial Officers and Heads of Field Elements, Subject: Lessons Learned from the Emergency Response to the May 14, 1997, Explosion at Hanford's Plutonium Reclamation Facility.

[4] Memorandum dated November 7, 1997, from Kenneth Baker, Acting Director, Office of Nonproliferation and National Security, to Elizabeth Moler, Deputy Secretary, Information Report: Summary of Field Findings and Actions Regarding Notification and Reporting Requirements.

[5] Memorandum dated December 16, 1997, from Elizabeth A. Moler, Deputy Secretary of Energy, to Heads of All Departmental Elements, Follow-on Actions to Improve Emergency Event Recognition, Classification and Notification.

[6] *Independent Oversight Evaluation of Emergency Management Programs Across the DOE Complex*, Vol 1, *DOE-Wide Perspective*; and Vol 2, *Summary Assessments of DOE Site Emergency Management Programs*. July 1998.

[7] *Type A Accident Investigation Board Report of the July 28, 1998, Fatality and Multiple Injuries Resulting from Release of Carbon Dioxide at Building 648, Test Reactor Area, Idaho National Engineering and Environmental Laboratory*, Office of Oversight, Environment, Safety and Health, U. S. Department of Energy, September 1998.

1.3 SCOPE

An emergency management program is only one link in an Integrated Safety Management System[8] designed to protect the public and workers. Many tiers of redundant and overlapping protection precede any actions entailed in emergency response. Because emergency management, by its very nature, involves a contingent response to events expected to occur only rarely, it is not likely to be tested very often in real life.

Emergency management comprises all those activities involved in preparing for and executing effective responses to potentially hazardous conditions arising from accidents. In its broadest context, it involves a wide range of contingency planning and execution activities. These may include activities as simple as providing flashlights and first aid kits at preplanned locations. They may, and often do, include activities as complex as evaluating downwind plumes to determine the boundaries of control zones configured to limit radiation exposures and prevent the spread of contamination. Others may involve rescue and recovery operations requiring highly sophisticated protective equipment and procedures.

Regardless of how elaborate emergency management programs are, they all involve five major phases: planning, preparedness, response, recovery, and readiness assurance. For an emergency management program to be successful, each of these phases must be developed individually, but all five must be seamlessly and thoroughly interconnected into one coherent package. The present assessment can be considered part of the fifth phase. In addition, the Board's staff has examined DOE's own program for verifying the adequacy of emergency management programs throughout the defense nuclear complex. Each of the major phases is discussed in detail in the following sections; as appropriate, the staff's observations are provided regarding the effectiveness of implementation of each phase at defense nuclear facilities and sites.

It should be noted that, in addition to responsibility for response to emergencies at its own facilities, DOE is designated as the federal agency responsible for a variety of specialized national assets designed to be mobilized in the event of accidents involving nuclear weapons or nuclear threat devices anywhere in the world. DOE is also a major provider of support under the Federal Radiological Emergency Response Plan. The additional assets for which DOE is responsible include the following:

- A large number of highly skilled and carefully trained individuals comprising a national Accident Response Group;

- Nuclear Emergency Search Teams, which are prepared to respond to events involving lost or stolen nuclear explosives;

[8] See Board Recommendation 98-1, *Integrated Safety Management*, dated September 28, 1998.

- An Aerial Measuring System mounted in aircraft capable of rapid deployment to accident sites to perform airborne surveys of downwind plumes of radioactivity;

- A sophisticated Atmospheric Release Advisory Capability, which is closely linked to the National Oceanic and Atmospheric Administration's National Weather Service, and uses real-time local meteorological data and sophisticated computer models to predict downwind airborne and deposition patterns in a post-accident situation;

- Federal Radiological Monitoring and Assessment Centers, which remain on 24-hour standby alert for dispatch to an accident scene to provide skilled teams of field surveyors and analysts that can assist state, tribal, and local governments in responding effectively to radiological emergencies;

- Trained and equipped radiological technicians and senior health physicists at each major DOE site, who are prepared to respond promptly to off-site emergencies in their general geographic area as part of an Interagency Radiological Assistance Program; and

- The Radiation Emergency Assistance Center/Training Site, which also provides skilled personnel who respond to an accident site with a wide range of survey and monitoring equipment.

The present assessment does not include explicit appraisal of the above assets. However, members of the Board's staff have had opportunities to observe deployment of these assets during some exercises. The prodigious technical capabilities represented in these assets are truly awesome.

1.4 APPROACH

During the past 9 years, the Board's staff completed numerous reviews of emergency management activities at defense nuclear facilities. The results of many of these reviews have been documented in written reports to the Board, most of which have been previously furnished to DOE either as enclosures to formal correspondence or as courtesy copies of publicly available reports. Most reviews focused on scheduled drills and exercises, but they have also included assessments of the adequacy of emergency plans and implementation procedures. In the reviews on which this report is largely based, the Board's staff routinely used evaluation criteria set forth in FEMA-REP-15, *Radiological Emergency Preparedness Exercise Evaluation Methodology*, dated January 1991, and DOE's own guidance regarding evaluation of emergency response exercises. These criteria are accepted by most federal agencies as definitive for evaluation of exercises involving both the threat of radiological effects on off-site members of the public and responses to simulated radiological emergencies involving only on-site personnel.

1.5 ORGANIZATION OF THIS REPORT

Sections 2 through 6 describe in turn the five major phases of emergency management—planning, preparedness, response, recovery, and readiness assurance—and summarize the findings of the Board's staff relative to the current status of implementation for each phase. Section 7 presents general conclusions based on the staff's review of emergency management at DOE defense nuclear facilities.

2. PLANNING PHASE

Emergency planning includes the identification of hazards and threats; preparations for their mitigation; development and dissemination of emergency plans and procedures; and designation of facilities, resources, and personnel needed for effective response. All hazards that are significant enough to warrant consideration in a facility's operational emergency management program are identified and analyzed by means of a Hazard Assessment (HA). HAs provide the technical bases for emergency management programs in sufficient depth to determine the scope and extent of needed program elements. Each DOE site/facility with significant quantities of hazardous materials (radiological or nonradiological) is required by DOE Order 151.1 to be covered by appropriate quantitative HAs. An adequate HA considers a broad range of potential emergency events and includes the designation of an Emergency Planning Zone (EPZ), usually identified in cooperation with responsible state, local, and tribal authorities and other on-site tenant facilities. The EPZ is an area within which both government and facility planners agree that special planning and preparedness efforts are warranted.

The consequences of postulated accidents, which are set forth in emergency HA reports, are used during the planning phase to establish EPZs, to define Emergency Classifications and Emergency Action Levels (EALs), and to develop Protective Action Recommendations (PARs). These are critical elements for prompt decision making during the initial phase of emergency response, when actions are taken to understand the nature and extent of the emergency, often on the basis of very limited information.

DOE Guide 151.1-1 defines the scenarios that should be considered for evaluation in the HA. It provides guidance on the preparation of HAs and states that the results of HAs should be used in determining the EPZ, Emergency Classifications, and EALs. It also states that "to the maximum extent possible, the Hazard Assessment should make use of facility description and accident scenarios from Safety Analysis Reports [SARs]." The consequences of hazardous material releases are to be estimated using the models and calculational methods most appropriate to the material released, the physical characteristics of the site, and its atmospheric dispersion conditions. And "generally, the consequence assessment models used for emergency planning and response purposes and for SAR evaluation guide comparison at the facility should be used to conduct this Hazard Assessment."

Current Status of Implementation

Reviews of HAs for a variety of defense nuclear facilities revealed a wide range of completeness and technical depth.[9, 10, 11, 12, 13, 14] Staffs at some facilities identify each hazard and quantify its potential consequences, then categorize and associate those hazards with potential effects. In other cases, only those hazards with obvious potential off-site airborne consequences are analyzed. The comprehensiveness of most HAs lies between these two extremes.

In general, facility staffs adequately analyze and document those hazards and accidents whose consequences extend outside the facility (leading to Site Area or General Emergencies), although there are wide variations in the quality and comprehensiveness of these analyses. In contrast, hazards and accidents having only localized consequences and affecting only the workers at the facility involved (leading to Alerts) are generally not as well analyzed or documented, and at some facilities are not addressed at all. Moreover, HAs are not routinely reviewed annually and updated prior to significant changes to the site/facility or hazardous material inventories, as required.

Contrary to the guidance in DOE Guide 151.1-1, Safety Analysis Reports are generally not used as bases for event scenarios used in emergency HAs.[15] Some of these event scenarios are similar to, or the same as, those for the bounding analysis of the authorization basis, yet some of the assumptions, parameters, and analytical tools, such as computer programs, are different for the two assessment efforts. These differences have resulted in inconsistencies in the consequence

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[9] Memorandum for G. W. Cunningham, Technical Director, December 17, 1993, Subject: Pantex Site, DNFSB Staff Trip Report, Emergency Preparedness Exercise Review, R. Zavadoski.

[10] Memorandum for G. W. Cunningham, Technical Director, February 7, 1994, Subject: Savannah River Site (SRS) Replacement Tritium Facility (RTF) Emergency Preparedness and Radiation Protection Follow-up Review, J. Troan.

[11] Memorandum for G. W. Cunningham, Technical Director, November 30, 1995, Subject: Report on the Savannah River Site (SRS) Emergency Preparedness (EP) Defense Waste Processing Facility (DWPF) Site Exercise, J. Deplitch.

[12] Memorandum for G. W. Cunningham, Technical Director, September 19, 1996, Subject: Observe W79 WPRR for Rocket Motor Removal and Review W79 Dissolution Work Station, 10-12 Sep 96, J. Deplitch.

[13] Memorandum for G. W. Cunningham, Technical Director, July 28, 1997, Subject: Review of Device Assembly Facility (DAF) Emergency Preparedness Drill, July 21, 1997, J. Deplitch.

[14] Memorandum for G. W. Cunningham, Technical Director, September 8, 1997, Subject: Emergency Response at the Nevada Test Site U1a Complex, W. White, J. Deplitch, and J. Preston.

[15] Memorandum for G. W. Cunningham, Technical Director, May 29, 1998, Subject: Exercise Ready 98 at Rocky Flats Environmental Technology Site, D. Thompson.

analyses in the two sets of documents.[16] Resolution of these inconsistencies could affect the emergency planning and accident response at some facilities. For example, at the Rocky Flats Environmental Technology Site (RFETS), a number of emergency classifications were upgraded recently as a result of review by the Board's staff and discussions with DOE and contractor personnel.[17]

The concept of predesignating EPZs based on HAs generally is not well implemented within the defense nuclear complex.[18, 19] This is probably a legacy of the remote locations and large site areas involved for most of the facilities. Instead of designating EPZs in advance on the basis of formal hazard analyses, many of the sites rely on ad hoc, informed judgment by qualified technical managers at the time an accident occurs with regard to what protective measures should be instituted in which off-site sectors. This approach provides considerable flexibility, but it forces crucial decisions to be made at times when stress is high, rather than allowing careful consideration of possible alternatives under calmer conditions. On balance, the more deliberate approach of predesignating EPZs for reasonably anticipated hazards is more desirable, and is consistent with DOE's own requirements and guidance. Of course, for some potential emergencies (e.g., off-site transportation accidents), the location and configuration of EPZs cannot be predesignated. In these situations, ad hoc determinations are obviously unavoidable.

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[16] Memorandum for G.W. Cunningham, Technical Director, August 3, 1998, Subject: Review of Analytical Methodologies Used for Emergency Preparedness and Response at Defense Nuclear Facilities, F. Bamdad

[17] Memorandum for G. W. Cunningham, Technical Director, June 4, 1998, Subject: Review of Analytical Methodologies Used for Emergency Response at Rocky Flats Environmental Technology Site, F. Bamdad.

[18] November 30, 1995, J. Deplitch, op. cit.

[19] Memorandum for G. W. Cunningham, Technical Director, August 19, 1997, Subject: Review of Pantex Plant Emergency Preparedness Exercise, EMEX 97-2, August 13, 1997, J. Deplitch.

3. PREPAREDNESS PHASE

If HAs indicate the potential for an operational emergency, the analytical results are used to determine necessary resources for an effective emergency management program. Such a program must include provisions for an Emergency Response Organization (ERO), off-site response interfaces, facilities and equipment, notifications and continuing communications, medical support, EALs and PARs, consequence assessment, and training and qualification.

3.1 EMERGENCY RESPONSE ORGANIZATION

As mandated by DOE Order 151.1, an ERO is required for each site—and most facilities—where there are hazards and potential accidents that could conceivably lead to an operational emergency, as part of an overall DOE Emergency Management System (EMS). The fundamental DOE EMS has three tiers: (1) the facility- or site-specific ERO; (2) the DOE Field/Operations Office ERO; and (3) the DOE Headquarters ERO, including the senior DOE Emergency Management Team (EMT).

Effective emergency response demands an in-place, site- or facility-specific ERO that can take action promptly to mitigate an emergency and initiate actions to protect workers, the public, and the environment. This ERO is responsible for effective control at the incident scene and for mobilization of local agencies and organizations that provide on-site and, as necessary, off-site response services. Clearly defined authorities and responsibilities are assigned to individuals, groups, agencies, and organizations comprising an effective ERO. Almost without exception at DOE defense nuclear facilities, these response activities are conducted by contractor employees.

The DOE Field/Operations Office ERO is responsible for event categorization, Emergency Classifications, notifications, PARs, management and decision making, control of on-site emergency activities, consequence assessment, protective actions, medical support, public information, activation and coordination of on-site response resources, security, communications, administrative support, and coordination and liaison with off-site support and response organizations. In many cases, these responsibilities are shared with the site- or facility-specific ERO. The contractor organization is often heavily involved in these second-tier EROs, especially when the ERO representatives of the DOE management office exercising direct management authority over the contractor (e.g., most of the Area Offices) are collocated with the contractor's organization during emergency responses. In many of these cases, most, and sometimes all, emergency management responsibility is delegated to the contractor, with the DOE representatives serving in essentially observer roles.

DOE Field/Operations Office EROs that are geographically distant from the site, and DOE Headquarters EROs, typically operate in oversight and assistance roles for the facilities/sites within their purview, monitoring the mitigative actions of the lower-tier EROs and coordinating

the activation of additional internal and external capabilities within their respective jurisdictions. The Field/Operations Office ERO also coordinates with regional federal agencies, as well as with state, tribal, and local authorities. If located at a site, Field/Operations Office EROs often operate jointly with the major contractor(s) for that site and are integrated into the EMT.

The DOE Headquarters ERO is considered an EMT because of its overall direction and coordination role. The Headquarters EMT consists of two elements: an Executive Team and a Technical Operations Cadre (TOC). The Headquarters EMT is composed of senior managers at the Assistant Secretary/Office Director level and is normally chaired by the Under Secretary, with the Principal Deputy of the primary affected Program Office as Deputy Chairman. The TOC comprises personnel from the cognizant Program Office, the Office of Emergency Management, and specialized Headquarters offices. The Executive Team provides strategic direction for the response and evaluates the broad impacts of the emergency on the DOE complex. The TOC provides oversight of and coordinates national-level assistance to field elements while providing information to and responding to questions from the White House, federal agencies, Congress, and the public.

Current Status of Implementation

Designation of individuals as members of an ERO is inconsistent across the defense nuclear complex.[20, 21] In some cases, personnel for various positions are not designated by name. In general, duty assignments change too frequently for ERO members, other than professional emergency responders (such as fire and rescue, medical, and full-time emergency management personnel) to maintain a high level of proficiency in their emergency management responsibilities. Many sites rely on voluntary participation. Although volunteerism connotes an eagerness to participate, it sometimes conflicts with normal chains of authority and responsibility. Furthermore, voluntary participation does not necessarily foster maintenance of qualifications at a high level, which demands frequent diversion from normal, day-to-day operational duties for sufficient emergency management training and participation in drills and exercises.

[20] February 7, 1994, J. Troan, op. cit.

[21] Memorandum for G. W. Cunningham, Technical Director, August 21, 1995, Subject: Report on Hanford Emergency Response Exercise "Oz," J. Deplitch.

DOE field elements generally rely heavily on major site contractors for coordination and decision making, and often act in a support role to the contractors, rather than take command.[22, 23, 24] Field element organizations tend to be somewhat irresolute in a crisis, and are generally less tenacious than the contractors in pursuing their emergency management responsibilities.

In general, Headquarters ERO performance is heavily dominated by the urgent need for up-to-date information, frequently resulting in interrogation of the field elements at inopportune moments.[25] Too often, the inevitable time lag between the occurrence of key actions or events at the scene and communication of information about those actions or events through the chain of command to the DOE Headquarters elements becomes a source of considerable friction. However, recent exercises have demonstrated significant improvement in this regard. Most of the Field/Operations Office EMTs now assign an experienced senior staff member to serve as a full-time communicator between the field command center or Emergency Operations Center (EOC) and its DOE Headquarters counterpart. This step, in conjunction with ongoing improvements in electronic communications among the on-scene responders and the Field/Operations Office and DOE Headquarters EOCs, augur well for future continued improvement in this regard.

The DOE Headquarters TOCs (whose membership varies, depending on the most affected programmatic office involved) generally comprise relatively senior, well-qualified personnel. Despite this characteristic, or perhaps because of it, the TOCs often become too heavily involved with detailed response actions better left in the hands of field elements. This is partially because the routine DOE Headquarters functions of day-to-day program management and oversight normally performed by members of the TOC are inherently activities involving critique of field activities, and making the switch to being supportive and proactive is difficult. This is a continuing problem in any emergency response situation, and DOE managers are well aware of the dilemma.[26]

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[22] Memorandum for G .W. Cunningham, Technical Director, October 15, 1993, Subject: Report on Hanford Emergency Response Exercise “Fremont,” D. Thompson.

[23] Memorandum for G. W. Cunningham, Technical Director, April 5, 1995, Subject: Report on Rocky Flats Emergency Response Exercise “Ready 94,” D. Thompson.

[24] Memorandum for G. W. Cunningham, Technical Director, March 3, 1998, Subject: Nevada Test Site U1a Facility Emergency Drill, February 25, 1998, D. Thompson.

[25] October 15, 1993, D. Thompson, op. cit.

[26] Memorandum for G. W. Cunningham, Technical Director, July 31, 1995, Subject: Report on Sandia National Laboratories-New Mexico (SNL-NM), Emergency Response Exercise “Rubble Glow,” J. Deplitch.

3.2 OFF-SITE RESPONSE INTERFACES

Interface with off-site agencies and organizations is an integral part of facility and site emergency management programs. DOE guidance calls for completion of preparations for interface and coordination with appropriate federal, state, tribal, and local agencies and organizations responsible for off-site emergency response (such as agencies responding to 911 calls) to ensure that these response entities are familiar with potential accidents, hazards, and consequences they might encounter and are adequately trained in appropriate protective measures. Interrelationships with federal, state, tribal, and local agencies and organizations are to be prearranged and documented in formal plans, agreements, understandings, and/or other prearrangements for mutual assistance that detail the emergency measures to be provided by non-DOE entities.

Current Status of Implementation

Except for sites with meager emergency response assets—sites that normally depend heavily on off-site response assets—most sites have only limited routine interfaces with off-site response agencies and organizations regarding preparedness activities. There is generally enough interface and coordination to reach broad agreements for support and responsibilities, but limited opportunities for mutual training and practice often dilute the effectiveness of off-site emergency response coordination.[27] There are exceptions, in particular where the professional responders (e.g., firefighters and emergency medical technicians) have developed mutual support agreements that call for providing contingent backup capability to one another independent of the requirements of DOE Order 151.1. Most off-site support groups appear to be eager participants when their involvement is solicited. This is not surprising, since many of these organizations are in small communities with limited government funding and only rudimentary training resources. Participation in drills and exercises with the DOE sites generally provides excellent training opportunities for these organizations.[28, 29]

3.3 FACILITIES AND EQUIPMENT

Adequate facilities and equipment must be established and maintained to provide an integrated response for operational emergencies. Facilities and equipment support the functions and responsibilities of the ERO. Emergency facilities are established to provide a location from which the ERO can perform its functions, using available equipment for implementing any response action. Specific capabilities for emergency facilities and equipment at field element

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[27] December 17, 1993, R. Zavadoski, op. cit.

[28] July 31, 1995, J. Deplitch, op. cit.

[29] Memorandum for G. W. Cunningham, Technical Director, May 8, 1996, Subject: Report on the Rocky Flats Environmental Technology Site Annual Emergency Preparedness Exercise, Ready-96, J. Deplitch.

locations should be derived from the facility/site-specific HAs; they should include the capability to mitigate the consequences of an emergency and to facilitate protective actions for employees.

Current Status of Implementation

Resources dispatched to the scene from central facilities (e.g., firefighting and emergency medical personnel and equipment) are among the most important elements of the site ERO. For nearly all sites, adequate resources are available from full-time, professional organizations on site, provided as part of the site infrastructure, although some sites have seen these resources reduced to marginally adequate levels in recent years.

With regard to emergency response, the most important fixed physical facility at the field element level is the EOC.[30, 31] From the EOC, the ERO assesses, evaluates, coordinates, and directs emergency response activities and communicates internally, as well as through the DOE chain of command and with other federal, state, tribal, and local response organizations. Other emergency facilities generally include provisions for technical support, security, personnel assembly, decontamination, medical services, process control, and hazard consequence analysis.

Many defense nuclear sites integrate most ERO activities (except for on-scene responses) in a single EOC, often located at or near the DOE Field/Operations Office, with varying effectiveness. Most field elements have recently modernized their EOCs to improve organizational interfaces and facility habitability during an emergency. At several sites, there has been insufficient familiarization and training to facilitate use of new automated data processing, communications, and video display equipment called for by DOE Headquarters direction. The pace of installation of this new equipment has been disappointing; it is apparently often delayed by budgetary limitations. In addition, little opportunity for suitable training of responders is generally available, except for scheduled drills and exercises, also apparently because of limited resources.

3.4 NOTIFICATIONS AND CONTINUING COMMUNICATIONS

Provisions must be in place for prompt initial notification of workers, emergency response personnel, and response organizations, including appropriate DOE elements and other federal, state, tribal, and local organizations, and for continuing effective communication throughout an emergency. The content and format of initial notification and recurring follow-up messages should be prearranged and standardized in the emergency plan.

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[30] December 17, 1993, R. Zavadoski, op. cit.

[31] Memorandum for G. W. Cunningham, Technical Director, December 2, 1993, Subject: Report on Rocky Flats Emergency Response Exercise "Ready 93," D. Thompson.

Emergency planning must include means of communicating accurate, candid, and timely information to the public and potentially affected workers during an operational emergency. In addition to facilitating press coverage through establishment of centralized sources of information for reporters, it is desirable to organize a rumor control effort promptly to avoid speculation. It is crucial that EROs establish the credibility of the responding organizations through timely availability of confirmed information and complete candor in dealing with the public, either directly or through the media.

EOCs are generally set up with many telephones—usually one for each functional ERO element of response—as well as computers, copiers, facsimile machines, and other office equipment. Communications among the numerous elements of the EOC, the incident command, and the accident scene responders are usually via portable radios.

Current Status of Implementation

In its exercise critiques and after action reports following actual events, DOE routinely calls attention to persistent problems concerning the timeliness of initial notifications[32] of actual or simulated accidents. It appears to the Board's staff that this recurring problem area is attributable to a combination of unrealistically stringent administrative time requirements for these notifications[33, 34] and a desire on the part of communicators to make their messages as comprehensive as possible, often at the expense of timely initial notifications. In addition, there is often understandable reluctance to alarm the off-site public when conditions are insufficiently known to establish unequivocally that an emergency actually exists.[35, 36] These notifications rarely meet the literal timeliness requirements, but usually occur within 15 minutes of their due times.

Joint Information Centers (JICs) have been established in a timely fashion in most of the exercises observed by the Board's staff, and they have generally been competently staffed with professional communicators. Some problems are inevitably encountered with interactions between technical spokespersons and members of the press.[37] Cautiousness and a desire for precision and accuracy on the part of technical spokespersons, and/or communication time lags

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[32] Ibid

[33] DOE Order 151.1 requires that site/facility managers notify Headquarters/Field EOCs and state and local agencies within 15 minutes of declaration of an Alert or a Site Area or General Emergency, and all other agencies within 30 minutes.

[34] Memorandum for G. W. Cunningham, Technical Director, October 16, 1995, Subject: Report on INEL Emergency Response Exercise "Varmint," J. Deplitch.

[35] April 5, 1995, D. Thompson, op. cit.

[36] August 21, 1995, J. Deplitch, op. cit.

[37] April 5, 1995, D. Thompson, op. cit.

that lead press representatives to probe for information not yet available, are contributing factors.[38, 39] In general, however, these problems have not been very significant or particularly damaging, even though they are sometimes embarrassing to the technical spokespersons involved.

Most sites establish a bank of telephones within the JIC to respond to direct inquiries from the public at large. In general, this approach has been effective in controlling rumors and allaying concerns of neighboring citizens when the telephone numbers have been made widely available early on through local radio and television stations. However, communicators manning the telephone banks often are not fully informed and/or adequately trained for the information exchange process.

Technical aspects of communications within the EROs are a common problem. Portable radios have hardware and environmental limitations that often interfere with clear and effective communications. Batteries fail routinely from heavy usage and temperature sensitivity. There are usually insufficient frequencies for the number of nets, and net managers are not used effectively. Topography, weather, and protective clothing often inhibit transmission and reception. Radio communication is typically difficult and often becomes ineffective.

Ambient noise in some of the EOCs is difficult to control, with multiple concurrent telephone and radio conversations occurring in acoustically poor conditions. This is a frequent cause of complaint by exercise participants. Facility upgrades at a number of the EOCs have greatly improved this situation, but in other cases, much in the way of redesign and improved utilization of available acoustic technology needs to be done. In addition, noise control could be improved in all of the EOCs.

3.5 MEDICAL SUPPORT

Skilled medical care, in terms of both first aid at the scene and medical facilities to which victims are subsequently evacuated, is clearly an essential element for the survival of casualties among workers (or others) involved in an accident or during an emergency. It is necessary for sites to have on-site first aid and emergency medical treatment capability, and the ability to transport injured personnel to on-site and off-site medical facilities. On-site and off-site medical facilities must have documented arrangements for accepting and treating contaminated and injured personnel. Medical treatment facilities must plan for handling mass-casualty situations. To the extent on-site facilities are sufficient to cope with several injured workers, they may be adequate. For large numbers of patients, however, or for injuries beyond the treatment capability of on-site

[38] October 15, 1993, D. Thompson, op. cit.

[39] Memorandum for G. W. Cunningham, Technical Director, May 4, 1994, Subject: Report on Los Alamos National Laboratory Emergency Response Exercise “Porcupine,” D. Thompson.

medical staff, arrangements must be in place for timely evacuation of casualties to off-site facilities that can provide suitable medical support.

Current Status of Implementation

Medical support is recognized as an integral element of emergency response, although demonstrations indicate that protocols for its effective integration into the ERO could be improved. Sites typically have adequate on-site medical emergency response support resources, as well as agreements for off-site emergency medical response and treatment facility support. Medical personnel involved in emergency response support appear to be proficient in the professional skills they exercise on a daily basis, but lack practice and discipline in contamination control. On- and off-site medical support units train and practice regularly, but to varying degrees.

Medical support, including emergency medical technicians responding to the scene of an accident, is usually provided promptly. In some exercises, however, medical emergency responders have been unable to gain timely access to casualties because of indecisive on-scene leadership and poor integration of medical response into efforts to cope with hazardous or potentially hazardous conditions.[40] During some emergency response exercises, simulated casualties have been left unattended for hours (See also Section 4 below).[41, 42] Reviews by the Board's staff have disclosed instances in which unaccounted-for personnel have been presumed dead, with little or no priority given to prompt search and rescue operations.

3.6 EMERGENCY ACTION LEVELS AND PROTECTIVE ACTION RECOMMENDATIONS

Legal authority to take actions (such as mandatory evacuation) to protect citizens living in communities in the vicinity of DOE sites rests with local and/or state governments. In order for those protective actions to be effective, the responsible local agencies must be informed of conditions requiring their initiation. For this reason, timely and authoritative recommendations for appropriate protective actions in the event of an operational emergency are paramount. Specific criteria for recognizing and categorizing events must be developed for the spectrum of potential operational emergencies identified by the HA. These EALs form the basis for recommending to responsible organizations what and when protective actions are warranted. Observable and recognizable initiating conditions (e.g., individual instrument readings, equipment

[40] March 3, 1998, D. Thompson, op. cit.

[41] July 31, 1995, J. Deplitch, op. cit.

[42] Memorandum for G. W. Cunningham, Technical Director, September 23, 1994, Subject: Pantex Plant - Trip Report on Staff Review of the Pantex Emergency Preparedness Exercise, PXCOM-94, H. Waugh.

status, valve positions, parameter values, on-site and off-site monitor readings) need to be specified in procedures and must be determined in a timely manner.

PARs must be preplanned for specific, predetermined actions to be executed in response to emergency conditions to protect both on-site personnel and the off-site public. These recommendations are based on Protective Action Guides (PAGs) for radiological hazards and on Emergency Response Protective Guidelines for nonradiological hazards.[43] Effective PARs are dependent upon comprehensive HAs and thorough EAL procedures.

Current Status of Implementation

At some sites and facilities, EALs are insufficiently developed and poorly implemented. Response procedures occasionally fail to address reasonably postulated incidents that could lead to an operational emergency, sometimes because HAs were not sufficiently comprehensive.[44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55] In some cases, initiating conditions have not been recognized in sufficient detail to permit timely initiation of the appropriate emergency action. Some EROs have been slow to classify emergencies and to disseminate appropriate PARs. PARs have sometimes been

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[43] PAGs for radiological releases are those specified by the Environmental Protection Agency in its *Manual of Protective Action Guides and Protective Actions for Nuclear Incidents* (EPA-400). Emergency Response Planning Guidelines for nonradiological releases are those specified by the American Industrial Hygiene Association.

[44] December 17, 1993, R. Zavadoski, op. cit.

[45] October 15, 1993, D. Thompson, op. cit.

[46] May 4, 1994, D. Thompson, op. cit.

[47] Memorandum for G. W. Cunningham, Technical Director, June 23, 1994, Subject: Report on Hanford Emergency Response Exercise "Fraser," D. Thompson.

[48] September 23, 1994, H. Waugh, op. cit.

[49] February 7, 1994, J. Troan, op. cit.

[50] October 16, 1995, J. Deplitch, op. cit.

[51] November 30, 1995, J. Deplitch, op. cit.

[52] May 8, 1996, J. Deplitch, op. cit.

[53] Memorandum for G. W. Cunningham, Technical Director, May 29, 1997, Subject: Exercise Digit Pace II, J. Deplitch.

[54] July 28, 1997, J. Deplitch, op. cit.

[55] August 19, 1997, J. Deplitch, op. cit.

inconsistent with the prevailing conditions; in other cases, communication of the recommendations has been confused and unclear, leading either to failure to implement suitable protective measures or to implementation of unnecessary measures.

3.7 CONSEQUENCE ASSESSMENT

Provisions must be in place for assessing the actual or potential on-site and off-site consequences of an emergency promptly and adequately. The results of the consequence assessment can be used to refine the categorization of an emergency and to develop sound PARs. EROs at all levels rely heavily on sophisticated computerized tools for consequence assessment.

Current Status of Implementation

In general, consequence assessment is weak all across the DOE complex.[56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67] Observations have included use of inapplicable computational models and/or software that is limited with regard to the hazards and accident scenarios that can be simulated. In some cases, source terms could not be effectively quantified from available reference plans and procedures. Some staff members assigned responsibility for performing real-time consequence assessments during drills or exercises appear to be inadequately trained, particularly in use of the computational tools employed in emergency response. Consequence assessments have been inaccurate or untimely, or both. As a result, PARs have been ineffective too often.

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[56] December 17, 1993, R. Zavadoski, op. cit.

[57] December 2, 1993, D. Thompson, op. cit.

[58] May 4, 1994, D. Thompson, op. cit.

[59] June 23, 1994, D. Thompson, op. cit.

[60] September 23, 1994, H. Waugh, op. cit.

[61] April 5, 1995, D. Thompson, op. cit.

[62] Memorandum for G. W. Cunningham, Technical Director, July 12, 1995, Subject: Supplementary Report on Rocky Flats Emergency Response Exercise "Ready 94" Corrective Action Drill, J. Deplitch.

[63] October 16, 1995, J. Deplitch, op. cit.

[64] May 8, 1996, J. Deplitch, op. cit.

[65] May 29, 1997, J. Deplitch, op. cit.

[66] July 28, 1997, J. Deplitch, op. cit.

[67] August 19, 1997, J. Deplitch, op. cit.

3.8 TRAINING AND QUALIFICATION

Based on satisfactory completion of the planning phase of emergency management, an organization must proceed to obtain the needed resources and assign competent staff, conduct appropriate training, and maintain a state of readiness to cope with potential emergencies through frequent, realistic drills and exercises. These aspects of emergency management are considered preparedness steps, as distinguished from ongoing training derived from responding to and recovering from drills and exercises or actual emergency conditions.

Current Status of Implementation

The status of training and qualification of EROs throughout the defense nuclear complex varies widely, even within a given ERO.[68, 69] In general, the elements of EROs comprising professionals assigned full-time to response activities, such as fire and rescue units, security forces, and medical facility staff, maintain very high standards of individual and team qualification and performance. High standards are also generally demonstrated by DOE and contractor organizational elements assigned full-time responsibility for emergency planning and preparedness activities—those staff elements that develop scenarios for drills and exercises, control and monitor the conduct of drills and exercises, and serve as full-time cadres manning EOCs and central communications facilities.

Individuals assigned to EROs as "in addition to" duties are usually well qualified in those elements of emergency response that involve extensions of their normal, day-to-day activities. But many of these individuals display less than desirable understanding of some of the broader aspects of emergency response, such as the way their speciality fits into overall emergency response. Unique skills associated with the ERO (e.g., use of emergency procedures and manipulation of computer and communications equipment)[70, 71, 72, 73] are also lacking in many cases. This situation is understandable where limited opportunities are available for integrated training of EROs as operational units.

The effects of stress in an accident environment are frequently evident, particularly in situations such as on-scene responses that are both psychologically and physically demanding.

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[68] December 2, 1993, D. Thompson, op. cit.

[69] May 4, 1994, D. Thompson, op. cit.

[70] December 17, 1993, R. Zavadoski, op. cit.

[71] December 2, 1993, D. Thompson, op. cit.

[72] May 4, 1994, D. Thompson, op. cit.

[73] February 7, 1994, J. Troan, op. cit.

Errors in what should be routine functions for responders, such as contamination control, use of survey instruments, and general radiation safety practices, occur more frequently than is desirable, even among presumably experienced and knowledgeable workers. This is an indication either that drills and exercises are not held often enough, or that basic qualification programs for such specialized skill areas are inadequate.

At sites where there is a strong commitment to frequent, realistic drills and exercises, a higher level of performance by ERO members is readily discernible, both in the field and in the EOC. Similarly, at sites with stable ERO membership, the level of performance is consistently higher than among those EROs where turnover is higher.

4. RESPONSE PHASE

The response phase includes the immediate post-accident period during which actions are taken to care for victims, initiate protective actions for the public and neighboring workers, stabilize facility conditions, and assess actual downwind consequences utilizing all available field monitoring capabilities. This acute stage is, of course, a period of high stress, in which decisions with potentially very serious consequences must be made with limited information. For that reason, this aspect of emergency management receives a great deal of attention, and properly gets the most emphasis during drills and exercises. It is in this phase that errors and weaknesses are most likely to be manifested. Ex post facto critiques of drills and exercises often focus on response deficiencies, rather than flaws in planning and preparedness that are frequently the root causes of those errors or weaknesses.

Nearly all sites maintain a well-trained 24-hour supervisory presence to serve as on-scene Incident Commander in the event of an operational emergency. These are generally senior first- or second-tier supervisors with extensive experience and corporate memory concerning the site. They are provided adequate reference material, good installed and mobile communications gear, and dedicated transportation. They are also usually well supported by the central site communications unit, most often being collocated with first-response emergency forces.

An equally important command and control element involves the leadership of the EMT, especially the senior manager present in the EOC, most often designated the Crisis Manager. This individual may be the senior DOE manager or the senior manager from the contractor organization responsible for the facility or activity involved in the incident, as specified in advance in the Site Emergency Preparedness Plan. The Crisis Manager, supported by representatives of key functional elements of both DOE and contractor organizations (see Section 3.1 above), is the top decision maker in the ERO. Close cooperation between the Crisis Manager (who controls essentially all supplemental response assets) and the on-scene Incident Commander (who directs the immediate response assets at the scene of the incident) is essential to effective emergency management.

Current Status of Implementation

Ineffective transfer of command from facility staff members, who are the initial on-scene responders (usually including the Facility Manager as the Incident Commander) to site-wide supervisors or commanders of professional emergency response elements has been a recurrent problem at several sites.[74, 75] However, recent exercises have demonstrated improvements in this regard, with most site plans calling for mutual involvement of these two individuals in the on-

[74] July, 12, 1995, J. Deplitch, op. cit.

[75] August 21, 1995, J. Deplitch, op. cit.

scene command structure, one being formally identified as deputy to the other. This is an important relationship. The facility staff is a crucial element of the on-scene ERO, because it is likely to have the most detailed knowledge of facility layout and system characteristics, as well as the most intimate awareness of potentially hazardous conditions that could result from upset system conditions. At the same time, the professional firefighters and other responding units, such as emergency medical technicians, supplemental radiological protection technicians and industrial hygienists, are usually more knowledgeable regarding site-wide resources available for coping with the emergency. The relationship between the senior supervisors of both these staff elements is a crucial one for effective early response to an emergency.

Deficiencies observed most often on scene,[76, 77, 78, 79, 80] where contact with the consequences of real or simulated accidents is most intimate, appear to be associated with responders' understandable compulsion to act. These deficiencies include the following:

- Impetuous, ad hoc decisions, without adequate consideration of the potential hazards involved or of the resources required versus those available, or—at the other extreme—inaction or failure to act in a timely fashion, even when the situation is sufficiently clear to warrant action;

- Failure to adequately inform response teams regarding anticipated hazards, equipment conditions, personnel accountability, controls on approach routes and work times, and other limits;

- Inadequate follow-up on initiated activities to ensure their completion;

- Poor communications, both downward to direct activities effectively and keep on-scene responders informed of the developing situation, and upward to provide requested information and timely updates to the Crisis Manager and the EMT; and

- Inadequate after-action debriefing of on-scene responders and lack of appropriate after-action follow-up regarding lessons learned.

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[76] April 5, 1995, D. Thompson, op. cit.

[77] Memorandum for G. W. Cunningham, Technical Director, April 2, 1997, Subject: Report on the Oak Ridge Y-12 Plant Integrated Emergency Response Exercise, VOLUNTEER RESPONSE '97, March 19, 1997, J. Deplitch.

[78] May 29, 1997, J. Deplitch, op. cit.

[79] July 28, 1997, J. Deplitch, op. cit.

[80] May 29, 1998, D. Thompson, op. cit.

Command and control issues involving Crisis Managers have arisen only rarely in exercises observed by the Board's staff. Individuals from either DOE or contractor organizations assigned as Crisis Managers are most commonly senior managers with many years of experience, often involving direct experience in responding to actual emergencies. They are almost always decisive leaders who are comfortable in this command role and effective managers of the EMTs under their charge. The most common lapses in these positions involve a lack of clarity in communications, either within the EOC or between the Crisis Manager and the on-scene Incident Commander. Occasionally, Crisis Managers have become too involved with details of the immediate response, resulting in insufficient attention to more appropriate "big picture" issues.

5. RECOVERY PHASE

Recovery from an accident at a defense nuclear facility may be very complex, extending over many months or even years if significant contamination is involved. In some cases, once the post-accident situation has been stabilized and immediate threats to public health and safety have been reasonably mitigated, the emergency is formally terminated, and recovery is dealt with as an ongoing, albeit special, operation. This is often the wise approach, since it restores emergency response units to a state of readiness to respond to new demands that may arise, while recovery forces are marshaled from other available operational and support resources.

It is important, however, to address the recovery phase as an integral part of emergency management, since potential accidents at defense nuclear facilities can result in post-accident conditions that can be seriously exacerbated by ill-considered or hasty attempts at restoration. Furthermore, transition from the response phase to the recovery phase is generally a seamless change. That is, recovery operations—those that include reentry to the accident scene to remove casualties, mitigate the consequences of the accident, restore equipment to safe status, or clarify status and conditions—are often initiated during the response phase. Despite such potential overlaps, emergency management guidance prepared by DOE explicitly notes the need for careful recovery planning.

Current Status of Implementation

Nearly all scenarios for emergency response drills and exercises call for preparation of a reentry and recovery plan, and real accidents always involve recovery activities. Very rarely are any recovery actions associated with drills and exercises actually performed by the responders, although occasionally reentry actions are actually taken or simulated prior to termination of a drill or exercise.

There are valid reasons for not performing recovery actions as part of drills or exercises, including their cost in both time and resources. Their similarity to the routine, day-to-day activities of operations and support staffs also tends to lessen the importance of practice during drills or exercises. On the other hand, post-accident recovery actions are far more likely to involve complications associated with unanticipated hazards and widespread contamination. A less convincing argument for eliminating recovery activities, but one that is frequently the basis for cessation, is that the time allocated for the drill or exercise has been used for earlier elements of the response, and that pressures for early termination have escalated.

Most recovery plans generated as part of drills or exercises are superficial; often they are little more than outlines with essentially no detailed development. Recent exercises have devoted more attention to recovery planning, though only rarely are recovery activities actually carried out or even simulated. In some cases, recovery activities have been scheduled for follow-on tabletop exercises conducted separately from the originating event. However, these follow-on exercises are frequently postponed indefinitely or canceled outright when conflicting priorities occur.

6. READINESS ASSURANCE

Readiness assurance involves processes for the following:

- Building and maintaining the requisite infrastructure to facilitate emergency operations and intrasite and external communications;

- Developing and maintaining appropriate skill banks needed to respond effectively to emergencies;

- Maintaining an effective program for independent verification of readiness status through competent evaluation and assessment of performance; and

- Applying lessons learned from drills and exercises, as well as from real-life accidents and emergencies, in an ongoing feedback and improvement program.

These processes are closely related to the preparedness phase, discussed in detail in Section 3. However, certain aspects of readiness assurance—the design and control of drills and exercises and the application of a feedback and improvement program for emergency management—merit additional attention.

6.1 DESIGN AND CONTROL OF DRILLS AND EXERCISES

Drills are usually conducted as hands-on instruction and application sessions for individuals or teams, whereas exercises are formal, evaluated demonstrations of the integrated capabilities of emergency response resources. Both drills and exercises involve extensive preparation and control of activities during their conduct. Both include after-action evaluations, but drills are often interrupted for instructional purposes, whereas exercises are generally allowed to continue from start to finish without interruption. In addition, exercises generally are conducted somewhat more formally than are drills, with more detailed after-action reports being generated by the evaluators.

Current Status of Implementation

For the most part, drills and exercises observed by the Board's staff have been well prepared, carefully and competently controlled, and candidly evaluated by the full-time emergency management professionals in DOE Headquarters and field elements. The fidelity of scenarios has been generally high, although some of the exercises have been based on scenarios that were

insufficiently challenging.[81, 82] Simulation of on-scene accident conditions has been imaginative and realistic; moulage has been used effectively for accident "victims;" and a wide variety of conventional training aids, such as flash/bang simulators, smoke generators, and dummy equipment, have been routinely employed to increase realism at the accident scene.

Members of the complex-wide community of emergency management professionals know one another well and work effectively together, providing resources for the development and maintenance of guidance and for mutual support and relative independence in controlling and evaluating drills and exercises. Unfortunately, after-action reports by evaluators from off-site supporting organizations have sometimes been couched in overly tactful terms, diminishing their impact, possibly out of misplaced consideration for fellow professionals.

Despite the above generally positive elements, control of exercises and drills is often weak,[83, 84, 85, 86] with only limited training provided to staff members recruited or assigned as part-time controllers. It is apparent that many individuals recruited to serve as part-time controllers and evaluators have little understanding of their roles. In some cases, local personnel augmenting controller-evaluator teams have been observed prompting players during drills and exercises, thus compromising the integrity of the process.

6.2 FEEDBACK AND IMPROVEMENT

DOE Order 151.1 (Chapter X) provides for a program and requirements for evaluation and readiness assurance of emergency management programs. The Order also explicitly requires (Chapter XI, Section 5) that the emergency management program include a system for tracking and verifying correction of findings or lessons learned from training, drills, exercises, and actual responses. In this regard, emergency management programs share the need for an effective feedback and improvement program with other operational activities.

Such a program requires, first, comparison of the level of performance against established performance measures. As deviations from expected levels of performance are identified, both positive and negative, some form of causal analysis is needed. Once the causes for any

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[81] July 12, 1995, J. Deplitch, op. cit.

[82] November 30, 1995, J. Deplitch, op. cit.

[83] December 17, 1993, R. Zavadoski, op. cit.

[84] May 4, 1994, D. Thompson, op. cit.

[85] April 5, 1995, D. Thompson, op. cit.

[86] May 29, 1998, D. Thompson, op. cit.

deficiencies have been identified, corrective action that will tend to prevent their recurrence must be developed.

Key elements of continuous improvement include planning appropriate corrective actions; incorporating them into a corrective action tracking system, with assigned dates for completion and identification of responsible individuals; establishing the priorities for specified corrective actions; and monitoring to ensure their complete and effective execution. It is also important that lessons learned and best practices be provided to other similar activities, both locally and throughout the defense nuclear complex.

Current Status of Implementation

Across the board, feedback and improvement in the area of emergency management have been weak, receiving little more than lip service. Ex post facto critiques of drills and exercises have often focused on response deficiencies, rather than flaws in planning and preparedness that are frequently the root causes of those errors or weaknesses. There appears to be acceptance of the idea that certain deficiencies, such as communication weaknesses and tardy notifications, are inevitable, and their recurrence in exercise after exercise is accepted as routine. Other weaknesses frequently showing little improvement from one exercise to the next have included inadequate hazard identification and analysis, tardy and incomplete consequence assessment, and poor radiation survey and contamination control practices.

Such feedback and improvement mechanisms as do exist have lacked provisions regarding the definitive assignment of individual responsibility for the identification of suitable corrective action for deficiencies and timely completion of those actions, as well as follow-up on instances of failure or inadequate closure. There is little evidence that senior department managers review, or even consider, the effectiveness of feedback and improvement provisions in the emergency management arena.[87, 88, 89]

The DOE Office of Emergency Management has performed many thorough evaluations of site emergency management programs and emergency response; however, the findings of such evaluations seldom result in any improvements. Corrective action plans and root-cause analysis are often not completed, and corrective actions are frequently not implemented. Appraisals and assessments of site emergency management programs, required under DOE Order 151.1 to be performed by DOE Program and Operations/Field Offices, are too often either not performed or performed ineffectively.

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[87] DNFSB Letter from John T. Conway to T. Grumbly, April 17, 1995.

[88] DNFSB Letter from John T. Conway to T. Grumbly, October 6, 1995.

[89] DOE Letter from T. Grumbly to John T. Conway, October 11, 1995.

As a result of the Hanford Plutonium Finishing Plant accident in May 1997, Secretary Peña directed assessments of several elements of emergency planning and preparedness by the Office of Emergency Management, the Environment, Safety and Health Office of Oversight, and the Operations/Field Offices. The Operations/Field Office assessments revealed few deficiencies and findings. Assessments by the Offices of Emergency Management and Oversight revealed several noteworthy deficiencies and findings, although implementation of associated corrective actions has not been forthcoming.

DOE has established a number of Training Resources and Data Exchange (TRADE) Special Interest Groups, including one for emergency management, to provide a means for promulgating information across programmatic and site boundaries. This effort is less effective than it should be because the information does not go beyond the participating personnel of the various site emergency management offices, and because of what appears to be widespread antipathy for anything "not invented here."

7. CONCLUSIONS

The review documented in this report was based on objective evaluation guidance promulgated by both DOE and FEMA. Yet any assessment based on observations at several facilities with widely diverse missions and operating characteristics, as was this review, is at least partially subjective, and the facts can be interpreted differently by different reviewers. This is particularly true when the observations were made over an extended time period, as was the case here. Nevertheless, in this instance there were a number of observations that recurred, and the fact that all the organizations involved are subject to the same set of requirements and guidance provides a normalizing function. The general conclusions drawn herein by the Board's staff are also supported by the reports covering reviews of individual facilities that are cited in the appendix.

The Board's staff offers the following general conclusions regarding the status of emergency management in a DOE-wide context:

- Top-level requirements and guidance for DOE and contractor organizations involved in emergency management functions are well founded and clearly set forth in appropriate documents.

- Applicable requirements and guidance are applied selectively. In some cases, noncompliance is condoned on the basis of a faulty conclusion—either that a requirement "doesn't apply here," or that a particular guidance element "isn't mandatory."

- A potentially serious problem exists at the DOE level, involving apparent misperceptions and questionable interpretations regarding the division of responsibility for: (1) development and promulgation of emergency management requirements and guidance; (2) establishment, conduct, and supervision of emergency management programs; and (3) oversight and evaluation of performance. Responsibilities are set forth clearly enough in DOE Order 151.1, *Comprehensive Emergency Management System* (dated September 25, 1995), but implementation could be made more effective with better cooperation among senior and mid level managers in programmatic and staff offices involved with emergency management matters. These conflicts, which also exist between DOE Headquarters and field elements, have been observed in other DOE contexts as well. All the involved organizations bear some degree of responsibility for these problems. This matter merits attention at the highest levels of DOE management.

- Deficiencies exist in emergency hazard analyses in one or more of the following areas:

  – Thoroughness of hazard assessments performed as elements of emergency planning at defense nuclear facilities, particularly in addressing all nuclear and non-nuclear hazards with potential impact on ongoing nuclear operations.

  – Verification and independent review process used to ensure the completeness and accuracy of the parameters and analytical tools employed in hazard and consequence analyses and identification of Emergency Classifications, Emergency Planning Zones, and Protective Action Recommendations.

  – Integration of emergency hazard assessments with related authorization basis activities for identification and implementation of the controls necessary for effective accident response.

- In general, consequence assessment is weak all across the DOE complex. Observations have included use of inapplicable computational models and/or software that is limited with regard to the hazards and accident scenarios that can be simulated. There are too few qualified responders assigned to execute sophisticated computer modeling programs for downwind plots of likely radiation levels and/or contamination; at some sites this responsibility is vested in a single individual.

- At some sites and facilities, Emergency Action Levels are insufficiently developed and poorly implemented. Response procedures occasionally fail to address reasonably postulated incidents that could lead to an operational emergency, sometimes because HAs were not sufficiently comprehensive or penetrating. In some cases, initiating conditions have not been recognized in sufficient detail to permit timely initiation of the appropriate emergency action.

- Responders are slow to classify emergencies and to disseminate appropriate Protective Action Recommendations, both in drills and exercises and in actual events. In some cases, recommended actions have been inconsistent with the prevailing conditions; in others, communication of the recommendations has been confused and unclear, leading either to failure to implement suitable protective measures or to implementation of unnecessary measures.

- Members of emergency response organizations whose emergency response duties are in addition to their routine day-to-day responsibilities are generally provided only minimal training regarding the infrastructure, equipment, and procedures involved in emergency response. Most of the training they do receive is imparted on the job during periodic drills and exercises; little formal classroom training or one-on-one tutoring is conducted for this group of responders.

- Tracking of the resolution of weaknesses disclosed during drills and exercises, as well as those experienced during actual emergencies, is poor. Closure of these issues is, at best, informal, with almost no attention from senior DOE managers. As a result, many weaknesses do not get satisfactorily resolved, and repetition tends to ingrain them groundlessly as inevitable characteristics of emergency response that cannot be corrected.

APPENDIX

Board Staff Reports by Site

DOE-Wide or Multi-Site:

DNFSB Letter from John T. Conway to T. Grumbly, April 17, 1995.

DNFSB Letter from John T. Conway to T. Grumbly, October 6, 1995.

DOE Letter from T. Grumbly to John T. Conway, October 11, 1995.

Memorandum for G. W. Cunningham, Technical Director, May 29, 1997, Subject: Exercise Digit Pace II, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, August 3, 1998, Subject: Review of Analytical Methodologies Used for Emergency Preparedness and Response at Defense Nuclear Facilities, F. Bamdad

Hanford Site:

Memorandum for G. W. Cunningham, Technical Director, October 15, 1993, Subject: Report on Hanford Emergency Response Exercise "Fremont," D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, June 23, 1994, Subject: Report on Hanford Emergency Response Exercise "Fraser," D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, September 14, 1994, Subject: Supplementary Report on Hanford Emergency Exercise "Fraser," D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, August 21, 1995, Subject: Report on Hanford Emergency Response Exercise "Oz," J. Deplitch.

INEEL:

Memorandum for G. W. Cunningham, Technical Director, October 16, 1995, Subject: Report on INEL Emergency Response Exercise "Varmint," J. Deplitch.

LANL:

Memorandum for G. W. Cunningham, Technical Director, May 4, 1994, Subject: Report on Los Alamos National Laboratory Emergency Response Exercise "Porcupine," D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, May 19, 1994, Subject: Supplementary Report on LANL Emergency Response Exercise "Porcupine," D. Thompson.

NTS:

Memorandum for G. W. Cunningham, Technical Director, January 19, 1994, Subject: Trip Report on Scoping Reviews of the Nevada Test Site (NTS) Waste Management Program, Emergency Preparedness Program, and Radiation Protection Program, J. Preston.

Memorandum for G. W. Cunningham, Technical Director, March 11, 1997, Subject: Nevada Test Site: Status of Device Assembly Facility (DAF), C. Keilers.

Memorandum for G. W. Cunningham, Technical Director, July 28, 1997, Subject: Review of Device Assembly Facility (DAF) Emergency Preparedness Drill, July 21, 1997, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, November 21, 1997, Subject: Device Assembly Facility Emergency Preparedness Tabletop Exercise and Drill for DOE ORR Demonstration, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, September 8, 1997, Subject: Emergency Response at the Nevada Test Site U1a Complex, W. White, J. Deplitch, and J. Preston.

Memorandum for G. W. Cunningham, Technical Director, March 3, 1998, Subject: Nevada Test Site U1a Facility Emergency Drill, February 25, 1998, D. Thompson.

Y-12 Plant:

Memorandum for G. W. Cunningham, Technical Director, April 2, 1997, Subject: Report on the Oak Ridge Y-12 Plant Integrated Emergency Response Exercise, VOLUNTEER RESPONSE ‘97, March 19, 1997, J. Deplitch.

Pantex Plant:

Memorandum for G. W. Cunningham, Technical Director, December 17, 1993, Subject: Pantex Site - DNFSB Staff Trip Report - Emergency Preparedness Exercise Review, R. Zavadoski.

Memorandum for G. W. Cunningham, Technical Director, September 23, 1994, Subject: Pantex Plant - Trip Report on Staff Review of the Pantex Emergency Preparedness Exercise PXCOM-94, H. Waugh.

Memorandum for G. W. Cunningham, Technical Director, September 19, 1996, Subject: Observe W79 WPRR for Rocket Motor Removal and Review W79 Dissolution Workstation, September 10–12, 1996, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, August 19, 1997, Subject: Review of Pantex Plant Emergency Preparedness Exercise, EMEX 97-2, August 13, 1997, J. Deplitch.

RFETS:

Memorandum for G. W. Cunningham, Technical Director, December 2, 1993, Subject: Report on Rocky Flats Emergency Response Exercise "Ready 93," D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, April 5, 1995, Subject: Report on Rocky Flats Emergency Response Exercise "Ready 94," D. Thompson, with John T. Conway letter to T. P. Grumbly dated April 17, 1995.

Memorandum for G. W. Cunningham, Technical Director, July 12, 1995, Subject: Supplementary Report on Rocky Flats Emergency Response Exercise "Ready 94" Corrective Action Drill, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, May 8, 1996, Subject: Report on the Rocky Flats Environmental Technology Site Annual Emergency Preparedness Exercise, READY - 96, J. Deplitch.

Memorandum for G. W. Cunningham, Technical Director, May 29, 1998, Subject: Exercise Ready 98 at Rocky Flats Environmental Technology Site , D. Thompson.

Memorandum for G. W. Cunningham, Technical Director, June 4, 1998, Subject: Review of Analytical Methodologies Used for Emergency Response at Rocky Flats Environmental Technology Site, F. Bamdad.

SNL:

Memorandum for G. W. Cunningham, Technical Director, July 31, 1995, Subject: Report on Sandia National Laboratories-New Mexico (SNL-NM), Emergency Response Exercise "Rubble Glow," J. Deplitch.

SRS:

Memorandum for G. W. Cunningham, Technical Director, February 7, 1994, Subject: Savannah River Site (SRS) Replacement Tritium Facility (RTF) Emergency Preparedness and Radiation Protection Follow-up Review, J. Troan.

Memorandum for G. W. Cunningham, Technical Director, November 30, 1995, Subject: Report on the Savannah River Site (SRS) Emergency Preparedness (EP) Defense Waste Processing Facility (DWPF) Site Exercise, J. Deplitch.

GLOSSARY OF ACRONYMS

Abbreviation	Definition
Board	Defense Nuclear Facilities Safety Board
DOE	Department of Energy
EAL	Emergency Action Level
EMG	Emergency Management Guide
EMS	Emergency Management System
EMT	Emergency Management Team
EOC	Emergency Operations Center
EPZ	Emergency Planning Zone
ERO	Emergency Response Organization
ES&H	(Office of) Environment, Safety and Health
FEMA	Federal Emergency Management Agency
HA	Hazard Assessment
JIC	Joint Information Center
NN-60	Office of Emergency Management
NRC	Nuclear Regulatory Commission
PAG	Protective Action Guide
PAR	Protective Action Recommendation
RFETS	Rocky Flats Environmental Technology Site
SAR	Safety Analysis Report

TOC	Technical Operations Cadre
TRADE	Training Resources and Data Exchange