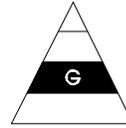


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NOT MEASUREMENT
SENSITIVE

IMPLEMENTATION GUIDE
for Use with
DOE O 225.1,
ACCIDENT INVESTIGATIONS



**ASSISTANT SECRETARY FOR
ENVIRONMENT, SAFETY AND HEALTH**

FINAL GUIDE - FOR UNLIMITED USE AND DISTRIBUTION

IMPLEMENTATION GUIDE FOR USE WITH DOE O 225.1, ACCIDENT INVESTIGATIONS

This Department of Energy (DOE) guide for implementation of DOE O 225.1 has been approved by the Assistant Secretary for Environment, Safety and Health and is available for use by all Departmental elements and their contractors.

DOE used the work of individuals within the Department and its contractor community, as well as private industry, to develop its accident investigation program. Portions of their work and ideas are incorporated herein.

Beneficial comments (recommendations, additions, deletions, consolidations, and any pertinent data that may improve this document) should be sent to the Office of Security Evaluations, Office of the Deputy Assistant Secretary for Oversight, Assistant Secretary for Environment, Safety and Health.

BY ORDER OF THE SECRETARY OF ENERGY:



ARCHER L. DURHAM
Assistant Secretary for
Human Resources and Administration

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IMPLEMENTATION GUIDE
FOR USE WITH DOE ORDER 225.1,
ACCIDENT INVESTIGATIONS

I. INTRODUCTION

DOE Order 225.1, *Accident Investigations*, prescribes requirements and responsibilities related to the Department's accident investigation program. The purpose of the Guide is to explain the requirements addressed in the Order and provide guidance regarding acceptable methods for implementing those requirements. The approach to investigations described in the Guide is similar to and consistent with methods used by other government agencies and private industry. It provides an organized and proven approach for effectively and efficiently conducting Type A and Type B accident investigations.

Primary users of this Guide will be DOE accident investigation board appointing officials, DOE accident investigation boards (including board chairpersons, board members, and board consultants, advisors, and administrative support staff). Headquarters and field points of contact for the accident investigation program, DOE and DOE contractor managers, and site readiness teams will find the Guide useful in understanding DOE's accident investigation approach and their associated responsibilities.

The Guide contains general guidelines for categorizing accidents, establishing accident investigation boards, and conducting and reporting Type A and Type B accident investigations, including causal factor analysis, investigation closure, and post-investigative activities. Roles and responsibilities for appointing officials, board chairpersons, board members, and field points of contact are also addressed.

The concepts for accident investigations, reflected in this Guide and DOE Order 225.1, involve streamlining and simplifying the process. The investigative process and the resulting report development are more timely and efficient and focus on what happened, why it happened,

and how similar accidents can be prevented. More emphasis is placed on the possible contributory roles of management systems as root causes of accidents, where appropriate, and on the application of or failure to apply the guiding principles of safety management.¹

Reports are designed to concisely convey key information in an easily understandable format, providing useful information and insight that can help prevent future accidents. In addition, training to support the process is streamlined. The *Workbook for Conducting Accident Investigations* that is referenced in this Guide provides more details on the accident investigation process. The Workbook, which should be considered as training material, will be prepared under separate cover and distributed throughout DOE. This Guide and the Workbook replace all previously distributed manuals and guidance on accident investigations.

Appendix 1 to this Guide provides a list of acronyms used; Appendix 2 provides definitions of key terms.

II. APPLICATION

This Guide applies to DOE for the conduct, support, and followup of Type A and Type B accident investigations. To the extent the requirements of DOE Order 225.1 are incorporated into appropriate contractual documents, DOE contractors and subcontractors will also find it useful in meeting support requirements for accident investigations. Its most widespread application is for use by appointing officials, accident investigation board chairpersons, board members, and designated points of contact who must implement the requirements of DOE Order 225.1 in conducting or supporting Type A or B

¹The guiding principles of safety management referred to in this Guide are those identified by the Secretary of Energy in an October 1994 letter to the Defense Nuclear Facilities Safety Board, and subsequently to Congress. The five guiding principles identified in the Secretary's letter are: line management responsibility for safety, comprehensive requirements, competence commensurate with responsibilities, independent oversight, and enforcement. The first three are applicable to management systems related to accident investigations. The Secretary's letter included a comprehensive description of the functions that the Department deems necessary to fulfill its mandate under enabling legislation to provide "reasonable assurance that the safety and health risk of operating personnel and the public be minimized."

accident investigations. It is also useful to DOE contractors and subcontractors who support accident investigations and DOE line management who must develop corrective action plans for followup to investigations.

The Guide discusses information on the Department's expectations in meeting DOE Order 225.1; the Guide does not introduce nor impose any new requirements. Users of this Guide have the latitude to choose whether and how to apply the procedures, methodologies, and techniques discussed in the Guide. Alternative approaches and methods that implement the requirements of DOE Order 225.1 are acceptable. However, this Guide provides a method for successfully conducting and reporting effective, comprehensive investigations.

While the Guide deals solely with Type A and B accident investigations, much of the guidance can also be effectively applied to investigations of accidents and occurrences resulting in lesser losses not requiring Type A or B investigations; these occurrences make up the majority of accidents in DOE. Well-planned and executed investigations of these events (including formerly designated Type C accident investigations) can result in more effective reporting, discovery of contributing and root causes, and identification and resolution of systemic problems, the correction of which might prevent more serious occurrences.

III. GENERAL INFORMATION

Objectives of the Accident Investigation Program. The objectives of the accident investigation program are to: (1) contribute to improved environmental protection and enhanced safety and health of DOE employees, contractors, and the public; (2) prevent the recurrence of accidents; and (3) reduce accident fatality rates and promote a downward trend in the number and severity of accidents. Preventing accidents and reducing lost time and fatalities due to accidents are line management's responsibility. However, the accident investigation program provides useful, timely, and needed information to managers in the DOE complex in an efficient manner so they can use the information to improve their programs.

To accomplish these objectives, the accident investigation process must respond with speed, accuracy, focus, and brevity. The results of accident investigations can help managers eliminate underlying causes and prevent similar accidents across the complex. However, to achieve maximum benefit, accident investigations need to be convened rapidly, staffed and supported adequately, focused on pertinent and essential facts and causation, conducted accurately and thoroughly, concluded quickly, and reported clearly and concisely. Analytical techniques used to draw conclusions and to establish causes must be valid, appropriate, and easy to use. Finally, sound judgments of need promote better safety practices, address systemic problems, and, when implemented, help prevent future occurrences.

Overall Management of the Program. The DOE Accident Investigation Program Manager (referred to throughout the Guide as "Program Manager"), appointed by the Director, Office of Security Evaluations (EH-21) within the Office of Oversight (EH-2), is responsible for administering the program on behalf of the Assistant Secretary for Environment, Safety and Health (EH-1). These responsibilities can be grouped into two categories: (1) general Department-wide program responsibilities for Type A and Type B investigations; and (2) responsibilities associated with Type A investigations conducted by boards appointed by the Assistant Secretary for Environment,

Safety and Health. The former includes developing Departmental policy; maintaining program guidance; coordinating the program with Headquarters and field element points of contact; maintaining program-related resource databases; providing or identifying acceptable program-related training; analyzing and trending data from past accidents; verifying corrective actions; and assisting in disseminating lessons learned to the Department. The latter includes assisting in the selection, appointment, support, training and qualification, and other activities of EH-1-appointed Type A accident investigation boards.

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Roles and Responsibilities. DOE Order 225.1 establishes requirements and responsibilities for the Assistant Secretary for Environment, Safety and Health, Secretarial Officers, heads of field elements, accident investigation boards, and DOE contractors, who must collectively implement the DOE accident investigation program.

One of the most important responsibilities of appointing officials is to ensure that the authority of the board is clear in investigating potential causes of a given accident. This authority includes reviewing management systems, policy, and line management oversight processes up to and beyond the level of the appointing official as possible root causes. This emphasis should be included in the briefing given to the board before they begin the investigation.

Significant responsibilities of field element managers include acting as the appointing official for Type B accident investigations; maintaining a cadre of qualified accident investigation board chairpersons and accident investigators; ensuring that DOE and contractor organizations under their purview are prepared to effectively carry out initial investigative actions such as preserving the accident scene and other evidence, taking initial investigative actions, and assisting accident investigation boards; and developing and implementing corrective action plans to address judgments of need identified by accident investigation boards.

The accident investigation board should ensure that its activities include, in addition to gathering appropriate factual information, sufficient data gathering on the impact of policy, organizational structure, management systems, and line management oversight processes on the accident as possible root or contributing causes. Data analysis should also address these considerations. The board chairperson has responsibility for ensuring the investigation is objective and is broad enough to identify and report on root causes.

The Accident Investigation Cycle. The concept for Type A accident investigations calls for a nominal 30-day investigation cycle from date of board appointment to

submission of the accident investigation report to the Assistant Secretary for Environment, Safety and Health. While the nature and complexity of the circumstances surrounding an accident will ultimately dictate the length of the investigative process (some will require less time, some more), the typical accident investigation should be no more than four weeks. Week one (on site) will be spent collecting data about the accident with priority to conducting interviews. Any testing requirements (engineering, physical, chemical, metallurgical, toxicological, destructive, nondestructive) will be identified and conducted as needed. Some analysis of collected information will occur, as will some preliminary writing. Week two (on site) will also be primarily devoted to data collection, with additional emphasis and time devoted to information analysis and preliminary writing. Week three (on site) will be devoted primarily to data analysis and writing a final draft report. Followup data collection will be conducted as necessary. This week's activity will include a factual accuracy review of the factual portion of the draft report by site DOE and contractor line management personnel. In addition, during this week the Office of Oversight will review the report and provide comments to the board chairperson on behalf of the Assistant Secretary for Environment, Safety and Health. After this review and resolution of comments, all board members will sign the report. By the end of the week, the board will brief the responsible managers on the findings and conclusions of the investigation. Week four (at Headquarters, with selected personnel only) will be devoted to final report editing and formatting. After the report is prepared, it will be submitted for acceptance to the Assistant Secretary for Environment, Safety and Health.

It is expected that similar processes will be used for Type B investigations, but modified to meet the needs of the field appointing official. The nominal 30-day life cycle is still appropriate. The Office of Oversight will also review and comment on these reports as the designee of the Assistant Secretary for Environment, Safety and Health as prescribed by DOE Order 225.1, 5. a. (5).

Effects of Cancellation of DOE Order 5484.1 and the Elimination of Type C Accident Investigations. DOE Order 225.1 eliminates the requirement for Type C investigations (unless they are specified in contractual documents) currently defined in DOE Order 5484.1, *Environmental Protection, Safety, and Health Protection Information Reporting Requirements*, Change 7. Therefore, Type C investigations will not be mandatory in the future, except as requirements from DOE Order 5484.1 remain in existing contracts. Under DOE Order 225.1, it is anticipated that contracts will be modified to meet the new Order. After the contracts have been modified, the accepted approach is as follows: if an incident does not meet the criteria for Type A or Type B investigations but would have formerly led to a Type C investigation, it is to be reported and investigated in accordance with the Occurrence Reporting and Processing System (ORPS) or the Computerized Accident and Incident Reporting System (CAIRS), as appropriate, in accordance with DOE Order 232.1, *Occurrence Reporting and Processing of Operations Information*.

Using the Order's Algorithm to Determine Investigation Type. Attachment 2 to DOE Order 225.1, "Accident Investigation Categorization Algorithm", contains the criteria for determining if an accident investigation should be categorized as Type A or Type B. These criteria are summarized in Table 1. For estimating the monetary loss in the category of Property Effects, standard cost estimating guides and escalation factors should be used. The heads of DOE field elements are responsible for reporting and categorizing all accidents to determine whether a Type A or Type B investigation is required.

TABLE 1. INVESTIGATION CATEGORIZATION ALGORITHM SUMMARY

Categorization Criteria	Human Effects	Environmental Effects	Property Effects	Other Effects
Type of Investigation				
Type A	Any fatal or likely to be fatal <ul style="list-style-type: none"> • injury • chemical exposure • biological exposure 	Any release greater than five times the reportable limits in 40 CFR Part 302 of a hazardous substance, material, waste, or radioactive resulting in serious environmental damage	Loss or damage of \geq \$2.5 million in property including costs for <ul style="list-style-type: none"> • cleaning • decontaminating • renovating • replacing or • rehabilitating structures, equipment, or property 	Any accident or series of accidents deemed appropriate by the Secretary or Assistant Secretary for Environment, Safety and Health
	Any one accident <ul style="list-style-type: none"> • requiring hospitalization of three or more individuals or • has high probability of permanent total disability 		Apparent loss, explosion, or theft involving radioactive or hazardous material in quantities or circumstances likely to constitute a hazard to health, safety, or property	

Categori zati on Cri teria	Human Effects	Envi ronmental Effects	Property Effects	Other Effects
Type of Investi gati o n				
	<p>One i ndi vi dual radiati on exposure of</p> <ul style="list-style-type: none"> • 25 rem or more total • 75 rem or more to the eye • 250 rem or more to skin or extremity (shallow dose) • 250 rem or more for external exposure (deep dose) or to organ or tissue (committed dose) for other than lens of the eye • 2.5 rem or more dose to embryo or fetus of pregnant woman 	<p>Any rel ease greater than five times the reportable limits in 40 CFR Part 302 of a hazardous substance, material, waste, or radi onucl ide resul ting in seri ous envi ronmental damage</p>	<p>Any unpl anned nucl ear cri ti cal ity</p>	<p>Any acci dent or series of acci - dents deemed appropri ate by the Secretary or Assi stant Secretary for Envi ronment, Safety and Heal th</p>

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Categori zati on Cri teri a	Human Effects	Envi ronmental Effects	Property Effects	Other Effects
Type of Investigati o n				
Type B	Any one or series of <ul style="list-style-type: none"> • injuri es • chemi cal exposures • biologi cal exposures resulti ng i n hospi tali zati on of one or more persons for more than fi ve conti nuous days or result s i n permanent partial disabili ty of one or more persons	Any release over two times but less than fi ve times the reportabl e li mi ts i n 40 CFR 302 of hazardous sub-stance, materi al, waste, radi o-nucli de resulti ng i n seri ous envi ronmental damage	Loss or damage of over \$1 milli on but less than \$2.5 milli on i n property i ncl udi ng costs for <ul style="list-style-type: none"> • cleani ng • decontami nati ng • renovati ng • replaci ng or • rehabili tati ng structures, equi p-ment, or property	Any acci dent or series of acci dents deemed appropri ate by the <ul style="list-style-type: none"> • Secretary • Assi stant Secretary for Envi ronment, Safety and Heal th • Associ ate Deputy Secre-tary for Fi eld Management • Cogni zant Secretari al Offi cer or • Heads of Fi eld El ements
	Any one acci dent or series of acci dents wi thi n one year resulti ng i n fi ve or more lost workday cases or i nvol vi ng fi ve or more persons, wi th one or more lost workday cases		The operati on of a nuclear faci lity beyond i ts authori zed li mi ts	

Categori zati on Cri teri a	Human Effects	Envi ronmental Effects	Property Effects	Other Effects
Type of Investi gati o n				
	<p>A single radiation exposure to an individual that results in:</p> <ul style="list-style-type: none"> • 10 rem but <25 rem total dose • 30 rem but <75 rem dose to the lens of the eye • 100 rem but <250 rem shallow dose to skin or an extremity • 100 rem but <250 rem sum of deep dose and dose to organ or tissue (other than lens of the eye) • 1 to <2.5 rem dose to embryo or fetus of pregnant woman 	<p>Any release over two times but less than five times the reportable limits in 40 CFR 302 of hazardous substance, material, waste, radio-nuclide resulting in serious environmental damage</p>	<p>The operation of a nuclear facility beyond its authorized limits</p>	<p>Any accident or series of accidents deemed appropriate by the</p> <ul style="list-style-type: none"> • Secretary • Assistant Secretary for Environment, Safety and Health • Associate Deputy Secretary for Field Management • Cognizant Secretarial Officer or • Heads of Field Elements

Not categorizing an accident investigation properly can result in wasted resources (over-categorization) or more serious accidents because of unresolved or unidentified causes (under-categorization). Therefore, it is important for heads of field elements to make an accurate categorization. It is often difficult to categorize accidents since there may be varying interpretations of terminology. The use of best judgment in applying categorization is acceptable, provided the rationale is documented. Uncertainty as to proper categorization should be mutually resolved by the heads of field elements and the Program Manager. As a general rule, this categorization and subsequent initiation of a Type A or Type B investigation should occur as soon as possible after the accident occurs.

Board Staffing, Qualifications, and Training. Federal employees acting as board chairpersons or members may be subject to the Department's Technical Qualification Program (see DOE Order 360.1, *Training*). It is a local decision whether Federal staff at Headquarters or in the field, who may be board chairpersons or members, fall under this program. If so, the necessary competencies should be determined and added to the pertinent qualification standard in the employees' organizations; and board chairpersons or members should demonstrate acceptable experience, education, and skills to meet qualification standards in accordance with local procedures, as applicable.

The board must be familiar with accident investigation techniques, and must have sufficient skills and knowledge, either through board members or advisors and consultants, to evaluate: (1) the effectiveness of management systems, as defined in the guiding principles of safety management [there should be requisite knowledge on the board of the safety management template (see Appendix 3)]; (2) the adequacy of DOE policy and policy implementation; and (3) how line management oversight responsibilities are executed, all as related to the accident.

Board chairpersons must:

- C Be senior DOE managers
- C Have demonstrated managerial competence and preferably

be a member of the Senior Executive Service

- C Be knowledgeable of DOE accident investigation techniques and experienced in conducting accident investigations through participation in at least one Type A or Type B investigation.

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Board members must:

- C Be DOE employees
- C Be subject matter experts in areas related to the accident.

At least one board member must be an accident investigator and must have participated in at least one Type A or Type B accident investigation; at least one board member or consultant/advisor must be knowledgeable in evaluating management systems (i.e., have demonstrated understanding and experience in applying and evaluating the criteria in the safety management template in Appendix 3). These skills may reside in a single member on the board. At least one board member should understand and have had training in the analytical techniques used to determine accident causation. In addition, each board should have (either through board membership or advisory staff) expertise in DOE requirements applicable to the investigation, DOE policies, and how management oversight responsibilities are executed in line organizations. Consultants and advisors may support the board in analyzing facts and identifying causal factors and judgments of need for corrective actions. At least two board members or consultant/advisors are recommended for this knowledge base.

The term "DOE accident investigator," as used in DOE Order 225.1 and this Guide, means an individual who understands DOE accident investigation techniques and has experience in conducting investigations through participation in at least one Type A or Type B investigation. This individual's knowledge may be demonstrated through experience, training, education, or qualification.

The Program Manager will keep the field and Headquarters apprised of appropriate training to support the accident investigation program. To implement the program, training will be necessary in the following areas:

- C Basic accident investigation techniques

- C Board chairperson training
- C Analytical techniques training
- C Site responder (readiness team) training.

The Program Manager, in coordination with field and program office points of contact, may schedule and offer training courses or distribute training materials as required, or identify courses available from universities, commercial sources, or other government agencies that meet the Department's needs. Therefore, points of

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contact should coordinate their program-related training needs with the Program Manager and provide feedback and recommendations to the Program Manager on training from these various sources.

The Role of Points of Contact. Points of contact have important roles in supporting accident investigations. There should be at least one point of contact for each field element and for sites and facilities that report directly to a cognizant secretarial officer or Headquarters element. The principal responsibilities of the points of contact are to assure that all of the requirements of the Order are understood by the operations office or other organizations for which they work and can be carried out by DOE or contractor staff. They act as liaison with the Program Manager on matters pertaining to the DOE accident investigation program. In addition, they ensure that DOE and contractor personnel are trained in accident investigations and readiness in sufficient numbers to meet site needs for responding to, or assisting with, Type A and Type B investigations; that appropriate equipment to support investigations is procured and available for use; and that DOE and contractor staff are trained to operate it. They maintain a current list of DOE and contractor personnel trained in accident investigations and readiness.

It is anticipated that points of contact will assist heads of field elements in implementing DOE Order 225.1, as well as assisting accident investigation boards. This includes responsibilities such as:

- C Maintaining a state of readiness to conduct accident investigations throughout the field element, their operational facilities, and in their readiness teams.
- C Overseeing accident response activities of the site readiness teams by:
 - Taking initial witness statements in writing as soon as possible after an accident occurs.
 - Preserving the accident scene until it is examined and released by the board.

- Creating a photographic and videotape record of the accident scene as soon as possible after the accident occurs.
 - Identifying, collecting, inventorying, and protecting pertinent physical evidence until it is turned over to the board.
 - Establishing and maintaining a chain of custody for photographs, videotapes, and physical and documentary evidence until it is turned over to the board.
 - Providing a briefing for the board on the day of their arrival at the accident site. This briefing should include, as a minimum, a description of the accident, emergency response actions taken, the status of evidence and the accident scene, and the DOE and contractor organizations having line management and oversight responsibilities related to the accident.
 - Determining the medical condition and fitness for duty status of accident victims and others who are directly involved in the accident as soon as possible after the accident, including requesting an autopsy, if appropriate.
 - Making sure all documentation pertinent to the accident, including medical records, in the possession of contractors and subcontractors is available to the board immediately upon the board's arrival at the site and as directed by the board chairperson thereafter.
- C** Assisting response teams in coordinating investigation activities and accident mitigation.
- C** Communicating and transferring information to the board chairperson prior to and subsequent to his/her arrival on site.
- C** Coordinating corrective action planning and followup with the head of the field element and coordinating

comment resolution by reviewing parties.

- C Assisting heads of field elements in tracking implementation of corrective action plans.
- C Facilitating distribution of Lessons Learned.

A significant part of these responsibilities is to assure that contractors are aware of and trained in the requirements for supporting accident investigations and that they are prepared to support the process by assisting in the functions discussed above.

Documentation and the Accident Investigation File.
Permanent records must be maintained for Type A and Type B accident investigations, in accordance with DOE record retention requirements. Accident investigation reports do not contain all of the records and backup data associated with the investigation. Therefore, the records that form the basis for the facts in the report should be kept in an investigation file for future reference. Examples of the type of records that should be retained in the file include: stenographic transcripts of interviews, interview statements, videotapes, photographs, analytical test results, policies and procedures

pertinent to the investigation or referenced in the report, daily logs, training records, job or work records, and checklists. Investigation records are retained for ten years following the date of the final report.

IV. GUIDELINES

1.0 SITE READINESS AND INITIAL INVESTIGATIVE ACTIONS

This section addresses how field readiness for accident investigations and initial actions after an accident can meet the intent of DOE Order 225.1.

1.1 READINESS TO CONDUCT ACCIDENT INVESTIGATIONS

Readiness to conduct accident investigations means preparing in advance for an initial response to accidents in order to achieve the following:

- C Preserve the integrity of various types of evidence-- physical, human (given through witness statements or interviews), and documentary (including photographic media)
- C Restore operations if necessary
- C Conduct accident investigations
- C Provide other DOE sites with DOE accident investigation board chairpersons and investigators on request.

Readiness teams should be established consisting of individuals who respond to accidents at the site. Their composition, location, equipment, and other characteristics are determined by field elements and their contractors. These teams should be able to mitigate immediate consequences and restore operations, if appropriate; assist in collecting, controlling, and preserving evidence; and assist with conducting investigations. Readiness teams should coordinate their actions with or be integrated with emergency management personnel, and the performance and equipment for the team

should be documented in procedures and periodically tested.

When an accident occurs, immediate actions include taking charge of the accident scene quickly, initiating any required emergency response, assisting injured parties, ameliorating the accident conditions, restoring operations if there is no danger to workers or the public, and preserving and protecting evidence and the accident scene for later investigation. Each field element should maintain readiness capability to respond to accidents in this manner. To ensure the capability for the rapid response necessary, heads of field elements and designated points of contact should ensure that sufficient numbers of initial responders and prospective accident investigation board personnel are trained and available, adequate procedures for initial response have been established, equipment is available and functional, and the necessary infrastructure can be quickly assembled to respond to the accident and support the accident investigation.

When determining the number and qualifications of potential accident investigation board members, consideration should be given to the need for supporting other Departmental elements by providing chairpersons and board members. DOE and contractor managers should ensure that accident responders and readiness teams can complete the immediate and near-term steps that will enable an accident investigation board to do its job. These include:

- C Reporting and categorizing events (in accordance with DOE Order 225.1 and ORPS)
- C Photographing or videotaping the accident scene
- C Collecting, controlling, and securing evidence
- C Mitigating the consequences of the accident
- C Transferring responsibility for the accident scene, evidence, and documentation to the board when it arrives at the scene

C Assisting with the investigation.

Managers, through points of contact, should evaluate the need for site- or organization-specific training to ensure that sufficient numbers of staff are available to perform these functions. Contracts that address accident readiness by contractors should be modified to include these provisions under DOE Order 225.1, if they are not adequately addressed in existing contracts. The benefits of incorporating initial investigative or investigative support actions into emergency preparedness plans and drills should also be considered.

A well-trained readiness team that participates in the initial response to an accident can greatly assist in securing, preserving, and documenting the accident scene, collecting and controlling evidence, identifying witnesses, and taking initial statements. In addition, they can provide valuable assistance to the accident investigation board when it assembles on-site.

1.2 PRESERVING THE ACCIDENT SCENE

Preserving an accident scene and evidence is important to the ensuing investigation. Important evidence must be collected quickly, or it may be lost or lose its value to the investigation. Site procedures should specify the DOE or contractor official who will control the scene and access to it. Generally, an accident scene should be isolated as soon as possible and preserved as intact as possible until it is turned over to the accident investigation board. This prevents the scene from being disturbed or altered, prevents evidence from being removed from or relocated at the scene, and protects people from hazards that may remain after an accident. An accident scene can be protected in a number of ways, including: cordoning the area with rope, tape, or barricades; locking doors and gates; posting warning signs; using a log to identify who enters the area and why; and posting guards to control access. Special controls and coordination with local security operations are necessary if the accident scene or evidence contain classified or unclassified controlled nuclear information material. The accident investigation board may require

that the same or different preservation and control procedures be kept in place until it has concluded the examination and documentation of the scene.

There may be circumstances where an accident scene must be preserved for investigation by an agency other than DOE. This could include the National Transportation Safety Board (e.g., for aircraft or railway accidents), the Occupational Safety and Health Administration, law enforcement agencies, or other agencies that may exercise jurisdiction to conduct investigations. In the event that an accident scene must be preserved to satisfy the investigative needs of these agencies, the scene should be cordoned, access to it controlled, and otherwise secured, as indicated above, until the agency having jurisdiction arrives and takes control of the scene.

1.3 COLLECTING AND CONTROLLING EVIDENCE

The collection and control of physical evidence is an important element of preserving the accident scene and an important role of readiness teams. Some physical evidence can safely be left intact at a protected accident scene. However, other evidence may be located remotely from the scene, may have been removed during emergency response or casualty evacuation activities, or may be too perishable to safely remain at the scene. Such evidence should be protected from damage or contamination and safely stored for delivery and transfer to the board. A strict chain of custody (documentation showing physical custody) should be maintained on all evidence. Further, if evidence is removed from the accident scene, its exact location and orientation at the scene should first be recorded, using measurements, photography, and video. It may not be apparent if some items are evidence--that is, if they are significant to the investigation. When in doubt, the best response is to be conservative in treating items as evidence--it is easy to discard items later that are not needed, but difficult or impossible to recover needed items that were not preserved.

Physical and documentary evidence should be preserved and secured as it is collected. These steps are necessary to prevent alteration and to establish the accuracy and validity of collected evidence. Evidence should be stored in a secured area and access to the evidence controlled. Access to evidence should be limited to those who have a need to examine and use it during the accident investigation. Release of any evidence should not be made without authorization of the board chairperson.

Additional information concerning the handling of evidence is contained in Sections IV.3.2 and IV.3.3 of this Guide.

1.4 OBTAINING INITIAL WITNESS STATEMENTS

Statements from witnesses should be taken as soon as possible, preferably before they leave the accident scene. Quickly identifying witnesses (e.g., victims, eyewitnesses, and other participants) and taking witness statements are important, since the first statements of witnesses are more accurate and have greater credibility than those made later. Other persons, such as emergency response personnel, persons who arrived at the scene shortly after the accident, and anyone else who would be expected to provide material information about the accident should be identified, located, and asked to provide statements.

While the board will conduct more formal interviews later, initial statements help to preserve early impressions and observations and help the board focus its efforts in the most productive directions. A standardized witness statement form should be used to obtain initial statements. Use of a form provides necessary information about the witnesses and where they can be contacted later, ensures a consistent set of questions is provided to all witnesses, and provides an opportunity for persons who have just witnessed or been associated with an accident to record what they know in a structured manner. More information concerning witness interviewing is provided in Section IV.3.4 of this Guide.

1.5 DOCUMENTING THE ACCIDENT

Documenting the accident means making a record of the accident scene and collecting records of conditions before, during, and after the accident. Since the accident investigation board may not arrive at the accident site until two or three days after the accident, it is important for readiness or other personnel to document thoroughly the condition and status of the accident scene just after the accident (see also Section IV.3.2.1).

The best way to record the accident scene is usually with photographs, videotapes, and sketches. It is important to record the location, orientation, and subject matter for each photograph. Photographic coverage should be detailed, complete, and, if necessary, should include standard references to help establish distance, perspective, color, and date. Videotapes should cover the overall accident scene as well as focus on specific locations or items of significance. A thorough videotape may relieve the board from making repeated visits to the accident scene; this may be important if the scene is difficult to access or it presents hazards of any kind. If evidence must be moved, its exact location and orientation at the scene should be first recorded in detail, perhaps using sketches with measured distances and directions from reference objects that will remain at the scene. The original location of evidence can also be marked (using paint, tape, chalk, etc.) before it is removed.

1.6 RESTORING OPERATIONS AND OTHER CONSIDERATIONS

Accident investigation needs, particularly such immediate needs as preservation of evidence, will always be overridden by life and property-saving considerations and sometimes by risk reduction and programmatic considerations, such as restoration of operations. Casualties are treated and removed, fires extinguished, roads cleared, and services and operations may be restored or resumed. All of these activities may result in alteration of the accident scene. However, care must be taken by readiness teams so their activities do not

interfere with emergency response actions. Initial investigations by readiness teams normally do not commence until the accident scene and affected personnel have been released by the emergency response organization.

Even given the secondary nature of preserving evidence when compared with taking emergency actions, much can be done concurrently, or soon after emergency actions are taken, to preserve the accident scene and relevant evidence and records. Training emergency response and readiness team personnel in the need for and methods of evidence preservation, and prior planning and coordination facilitates the ability of both groups to conduct their activities in a way that will enhance, rather than degrade, preservation of important evidence and the accident scene.

Evidence of suspected criminal behavior, fraud, waste, and abuse should be handled in the manner indicated in Section IV.2.2.1, and reported to the head of the field element and appointing official.

Line management has the authority and responsibility for making decisions on restoring operations following an accident. This decision is made after considering such factors as operational needs, mission objectives, and risk to workers, the public, and the environment, balanced against the need to preserve evidence. This decision is coordinated in advance by the board chairperson and the head of the field element involved or his/her designee.

2.0 THE ACCIDENT INVESTIGATION BOARD

2.1 THE ROLE OF THE APPOINTING OFFICIAL

2.1.1 Establishing the Board's Authority

Authority to appoint accident investigation boards and to assign individuals to conduct accident investigations resides with the appointing official. Each Type A and Type B accident investigation board must be established in writing by the appointing official. The written authorization includes the scope of the investigation, the names of the individual board members being appointed, a specified completion date for the final report, and any special provisions deemed appropriate. The scope of the investigation must include gathering facts; analyzing the facts and evidence; developing conclusions regarding the direct, contributing, and root causes; and identifying judgments of need for DOE and contractor organizations and management systems that could have or should have prevented the accident. The scope of the investigation includes reviewing all levels of the organization up to and beyond the level of the appointing official. An example of an appointment memorandum is provided in Appendix 3.

DOE heads of field elements are responsible for determining if an accident meets the criteria for a Type A or Type B investigation. This determination must be made using the Accident Investigation Categorization Algorithm contained in Attachment 2 to DOE Order 225.1 (See also Section III of this Guide). The appointing official for Type A accident investigations is the Assistant Secretary for Environment, Safety and Health. The head of the field element with cognizance over the site or facility responsible for the accident is the appointing official for Type B investigations.

2.1.2 Selecting Board Members

Appointing officials select DOE accident investigation boards which consist of a chairperson and three to six members who meet the qualifications and criteria indicated in Sections III and IV.2.1.4 of this Guide.

The Program Manager maintains a list of trained and experienced chairpersons, members, and consultants, including particular areas of expertise for each. The Program Manager may be contacted by appointing officials for assistance in identifying candidate chairpersons or members. It is recommended that appointing officials select DOE accident investigators to fill as many board member positions as possible.

CANCELED

2.1.3 Briefing the Board

The appointing official should conduct a briefing for all board members as soon as possible after their appointment (preferably prior to their departure for the accident site) in order to ensure they clearly understand their roles and responsibilities. This briefing may be done in person or via videoconference or teleconference. However, if it is impractical to brief the board, the board chairperson will receive the briefing. The chairperson then should convey the contents of the briefing to the other board members prior to commencing the investigation. The briefing should include the following subjects:

- C Scope of the investigation
- C Emphasis that the board is empowered to examine DOE and contractor organizations and management systems as possible root causes of the accident, that the board is required by DOE Order 225.1 to do so, and that they are to fully report the findings
- C Confirmation that the board has the authority to investigate up to and beyond the level of the appointing official when reviewing specific management systems and organizations
- C Avoiding conflicts of interest for board members
- C Skills and qualifications of board members
- C Application of the safety management template to the investigative process (See Appendix 4)
- C Special concerns of the appointing official based on site accident patterns or other considerations.

2.1.4 Avoiding Undue Influence and Conflict of Interest

Board chairpersons and members report only to the appointing official during the investigation. During the investigation, board members and advisors are relieved of their normal duties. The responsibility for avoiding

undue influence and conflict of interest rests with the appointing official in the selection of board chairpersons and members. Care must be taken in selecting board members who are not in the direct line management chain responsible for day-to-day operations or for line management oversight of the facility, area, or activity involved in the accident. In addition, the board must not include both a supervisor and any of his/her subordinate(s).

CANCELED

2.2 ACCIDENT INVESTIGATION BOARD ROLES AND RESPONSIBILITIES

The accident investigation board has several major functions:

- C Conducting a comprehensive investigation within the defined scope, collecting all pertinent information and determining the facts relevant to the accident
- C Analyzing the facts and determining causative factors that contributed to the accident, with particular emphasis on determining the root causes of the accident
- C Identifying judgments of need that must be addressed to prevent recurrence of the accident
- C Reporting the essential facts and results of the investigation in a concise and understandable manner
- C Maintaining appropriate communications with interested organizations throughout the investigation
- C Ensuring the quality and accuracy of all its activities
- C Assisting the appointing official in closing the investigation, if requested.

2.2.1 Board Chairperson

The board chairperson manages board activities and is responsible to the appointing official for all aspects of the investigation. The chairperson maintains control of the accident scene until it is no longer needed for the investigation. The chairperson will not normally conduct investigative activities, but rather will direct the overall effort, keeping it focused and on schedule, and will maintain communications and coordination with interested managers and organizations that are legitimate stakeholders, such as unions or the surrounding community. The chairperson represents the Department in all matters pertaining to the investigation. If there is suspected unlawful activity revealed during the

investigation, the chairperson has the responsibility to notify appropriate DOE, other federal, state, or local investigative or law enforcement authorities (e.g., Federal Bureau of Investigation), or in the case of fraud, waste, and abuse, the DOE Office of the Inspector General.

2.2.2 Board Members

Board members are primarily responsible for collecting and analyzing information, reaching conclusions regarding causal factors, identifying judgments of need, and writing the report. Board members apply investigative and analytical techniques to make these determinations.

2.2.3 Advisors and Consultants

The board chairperson may require the assistance of advisors and consultants during the conduct of the investigation. Advisors and consultants may be DOE employees, DOE contractors or subcontractors, or outside personnel. They may include persons from the accident site. Advisors and consultants are normally used to provide the board with specialized expertise not otherwise available to the board. They may be site personnel with knowledge of site processes or activities, or of the accident itself, and may possess expertise in accident investigation and analytical techniques, law, medicine, metallurgy, chemistry, electricity, transportation, conduct of operations, or other specialized disciplines. Advisors and consultants may be used to facilitate investigative activities or conduct specific tasks (e.g., to review medical or contractual aspects of the accident). Alternatively, they may be integrated into a broader spectrum of the board's activities, participating throughout the investigation. The need for consultants and advisors will be dictated by the nature of the accident and the direction of the investigation.

Labor union representatives should be permitted to observe and advise the board. They may be present at interviews of bargaining unit employees, unless an employee requests otherwise, and at open meetings of the

board.

2.2.4 Support Functions

Appointing officials should assure that a board has sufficient administrative support personnel to expedite the investigative and report writing processes, freeing members from administrative burdens and allowing them to concentrate on data collection and analytical tasks. The following support positions are recommended:

- C Administrative Coordinator. An individual familiar with the administrative and logistical needs and processes for an accident investigation should provide daily coordination of those matters. Other functions to be performed include tracking and controlling documentation, tracking appointments, assigning administrative tasks and priorities, and coordinating report production.
- C Technical Writer/Editor. Use of a technical writer or editor can facilitate the report writing process. While board members have primary writing responsibilities, use of a dedicated writer focuses responsibility for assembling the report, facilitates report preparation, and results in a more cohesive and readable report.

- C Typist/Text Processor. A board usually needs at least one typist to perform general secretarial and administrative tasks, such as filing, typing or text processing, and answering telephones. Often these personnel can be provided by the facility where the investigation is being conducted.
- C Court Reporters. Using a court reporting service enhances the interview process by increasing the timeliness and accuracy of interview transcripts. The use of court reporters provides all members of the board the opportunity to review interviews in which they did not participate, and provides a transcript that can be used to reconstruct or develop the chronology of events preceding the accident. When an investigation requires numerous interviews, use of court reporters is essential, and can help prevent the investigation from getting behind schedule in its early stages, when most of the interviewing takes place and when the information elicited during interviews is needed. This service is generally available commercially in most areas.

2.2.5 Managing the Accident Investigation

The accident investigation is managed as a project--a complex project that must remain focused while confronted with a significant workload, finite time constraints, sensitive issues, and a dependence on the cooperation of others. Consequently, the investigation (and the board) process needs to be well-managed and closely controlled in order to be successful and efficient.

2.2.5.1 Role of the Chairperson

The board chairperson manages all aspects of the investigation. Some of the chairperson's first decisions and actions will greatly influence the tone, tempo, and degree of difficulty associated with the entire investigative process. A day planner format or similar tool should be used to indicate the detailed list of actions that the chairperson should complete during the first few days of and throughout an investigation. The Program Manager has copies of this tool for use by board

chairpersons.

An investigation is complex, so it requires management of several very different, interrelated activities. First, the investigative process itself needs to be managed. Information must be collected, processed, and integrated; facts must be analyzed; conclusions related to causal factors must be drawn; causal factors and judgments of need must be identified; and a report must be prepared. To manage this aspect of the investigation, the chairperson organizes work assignments for the board, establishes deadlines, requires feedback, remains continuously informed of progress and status, and makes adjustments as necessary. The chairperson keeps the board focused on essential activities and ensures that all efforts are directed appropriately and not wasted on irrelevant or inconsequential pursuits. While the chairperson's responsibilities may preclude him/her from participating in the detailed investigative tasks, he/she should remain fully informed of those activities and be the driving force behind all decisions concerning the investigation.

Concurrently, the chairperson manages the administrative, logistical, and budgetary activities of the board. Support of various kinds is obtained and coordinated when needed. If administrative and logistical support functions are not well managed, the productivity, efficiency, and accomplishments of the board can be degraded.

No less important is the chairperson's need to manage relationships among the board members and between the board and organizations external to the board. In the stressful situation created by the board's intense deliberations, it is essential that the board chairperson understand group dynamics to manage the individual personalities of the board members. Care must be taken to ensure that strong-willed personalities do not dominate and influence the objectivity of the investigation and that all viewpoints are heard and analyzed.

There will be a number of organizations that the board

may call upon for support of various kinds, whether it be administrative or logistical, technical, or merely cooperation in facilitating the investigation. One of the chairperson's important functions is to skillfully manage the board's relationship with these parties. Interested parties may include the appointing official, site contractor organizations, DOE field staff, employees and their organizations, unions, local community groups, and the media. Dealing with injured parties and their families (except on matters directly related to the investigation such as conducting interviews or taking witness statements) is the responsibility of the head of the field element or contractor management, not the board chairperson.

2.2.5.2 Investigation Schedule

The length of each particular investigation is dictated in part by the nature and complexity of the circumstances surrounding the accident. Most accident investigations, however, can be completed in a 30-day period, organized generally as indicated in Table 2.

TABLE 2. TYPICAL INVESTIGATION SCHEDULE

Timeframe	Activities
Week 1 (on site)	Board arrives; data collection and interviews; identification and initiation of physical testing requirements; initial data analysis; preliminary writing.
Week 2 (on site)	Continued data collection; additional emphasis on data analysis; initial report preparation begins.
Week 3 (on site)	Primarily devoted to data analysis and report preparation; follow-up data collection; factual accuracy review of draft report by site DOE and contractor managers; complete final draft report; brief local DOE and contractor managers; depart site.
Week 4	Selected personnel only; final report editing and formatting; submit report to appointing official.

Plans for managing the investigative process should be based on this 30-day schedule. As circumstances require, the chairperson and appointing official can establish a different timeframe, and the schedule can be modified accordingly. Keeping the length of the investigation (including submission of the final report) to a minimum consistent with thoroughness and accuracy is an important consideration.

2.2.5.3 Control Measures

As with any project, an accident investigation requires the use of management controls to ensure that necessary activities are completed properly and on time. Although not unique to accident investigations, the following common control methods are typically used by the

chairperson:

- C Task assignments and due dates--each specific task should be assigned to an individual or team so that responsibility is clearly understood. Due dates, including intermediate milestones if appropriate, should be assigned.
- C Daily meetings--the board should meet at least once daily to exchange necessary information and keep the chairperson fully informed of progress and status.
- C Progress reports--at the daily meetings, or whenever appropriate, individuals and teams should provide the chairperson with verbal or written progress reports, identifying potential problems and their solution.
- C Accountability controls--logbooks or some other method should be used to maintain control and accountability of items of physical evidence, documents, photographs, and other material pertinent to the investigation.
- C Correspondence control--appropriate measures should be employed to track incoming and outgoing correspondence.
- C Information release--the chairperson establishes and strictly enforces a specific policy regarding what information can be released, and by whom, to persons or organizations outside the board. The chairperson coordinates approved press releases with the local field and contractor public relations representatives to assure consistency and that releases are only made after review and concurrence by the board chairperson.

2.2.5.4 Administration and Logistics

Administrative and logistical arrangements and decisions should be made quickly and executed immediately so that start-up time is held to a minimum once the board arrives on-site. Inadequate or slowly developing administrative and logistical support can severely hinder an investigation. The chairperson, assisted by the administrative coordinator and others as appropriate,

should make necessary decisions and arrange for all support. Normal support requirements include:

- C Office/work space
- C Site specific security, safety, and health training, as required
- C A dedicated conference room suitable for board meetings and briefings
- C Telephones, including speaker phones as required (may include a publicized "hotline" number) and FAX machines
- C Computers/printers and software for word processing, graphics, and analytical programs
- C Copy machine (preferably dedicated)
- C Document shredder
- C Hotel selection and reservations
- C Rental car allotments
- C Security badges and passes
- C Property permits for cameras, recorders, other equipment
- C Office supplies and consumables
- C After-hours access to site and work space
- C Administrative and logistical support personnel
- C Court reporters.

2.2.5.5 Quality Assurance

Formal quality control measures are necessary because of the gravity and sensitivity of the work done by accident investigation boards, and the need for accuracy, thoroughness, and perspective. While the chairperson may

implement any quality assurance measures deemed necessary or helpful (see Section IV. 6.3 for more specific guidance on quality assurance), the following procedures are typically used:

- C When analytical results are being developed into conclusions, a thorough effort is made to ensure that all verified facts, the results of the analysis of those facts, and the resulting conclusions are both consistent and logical.
- C When essential portions of the draft report are complete, the board conducts a verification analysis of the report to ensure that facts in the report are consistent with the best information available, that each section of the report is consistent with other sections, and that the analyses, conclusions, and judgments of need in the report accurately reflect the products and consensus of the board.
- C The facts section of the draft report is provided to the affected DOE and contractor managers for factual accuracy review and validation, as indicated in Section IV. 6. 4.
- C The Office of Oversight (EH-2), on behalf of the Assistant Secretary for Environment, Safety and Health, conducts a review of the report (see Section IV. 6. 5). This review provides a quality check by staff not associated with the accident or the investigation and provides unbiased insight into the validity of the board's conclusions.

2. 2. 5. 6 Minority Opinions

The final accident investigation report is a consensus document that must be signed by the board chairperson and each board member. If all board members cannot agree on the report, the dissenting member(s) are still required to sign the report but may, at their discretion, prepare a minority report which will become an official part of the final report. The board chairperson should make a concerted effort to understand the logic underlying the differing opinions and to consider what changes might

resolve the conflict. If the conflict cannot be resolved, it is the board member's right to prepare a minority opinion, and the board chairperson's responsibility to accept the opinion and include it in the final report. The minority opinion addresses issues in conflict and is limited to this scope.

2.2.5.7 Freedom of Information and Privacy Acts

The Freedom of Information Act (FOIA) and Privacy Act place responsibilities on the board, which is acting on behalf of DOE, for disclosing information that the public has a "right to know." Disclosures may be made, while at the same time protecting individual rights against invasion of personal privacy. During investigations, the board will be accessing and generating information that falls under these two acts. The chairperson should obtain guidance from the FOIA/Privacy Act contact person at the site where the investigation is being conducted, field office, or Headquarters. They will assist the board in answering any disclosure questions.

The FOIA provides access to all Federal agency records except those which are protected from release by exemptions, in the case of DOE, for national security. The FOIA can be used by anyone, regardless of citizenship, to request access to government records. In order to comply with the Act, the board must assure that the information obtained is accurate, relevant, complete, and up-to-date before disclosing it to others, and must allow individuals access to records of their interviews so they can be reviewed for accuracy. That is why court reporters are used to record interviews, and why interviewees are allowed to review and correct transcripts. However, the board should inform the witnesses that confidentiality cannot be guaranteed, because the information may be disclosed under the FOIA.

The Privacy Act establishes safeguards for the protection of records the government collects and maintains on citizens and lawfully admitted permanent residents. The Act has some mandates applicable to investigations. Specifically, the board:

- C Informs people, at the time it is collecting information about them, why this information is being collected and how it will be used.
- C Prevents disclosure of information subject to the Privacy Act unless consent of the individuals is given. There are exceptions under certain conditions. Information that usually may be disclosed is name, present and past positions, grades, annual salaries, duty station, and position description. The Board should not request this information unless it is relevant to the investigation. Generally, there is no expectation of privacy regarding information about decedents, so records pertaining to decedents are not subject to the provisions of the Privacy Act. However, decedents' medical records that are not directly related to the accident are withheld from public disclosure.

3.0 GATHERING INFORMATION/FACTS

3.1 REVIEWING STANDARDS AND REQUIREMENTS

The board should identify DOE orders and standards, Federal and state regulations, other external regulatory requirements, and site-specific policies, requirements, or guidelines applicable to the accident. This is necessary in order to establish the requirements governing work at the site where the accident occurred, determine what role they played in the accident, and ensure that policy issues are adequately addressed during the investigation. Review of applicable safety analysis reports, standards requirements identification documents, and other requirements documents may be helpful in identifying this information.

3.2 GATHERING PHYSICAL EVIDENCE

Physical evidence should be gathered and a record made of all facts from all sources, including the witness interview transcripts, as soon as they become available. A good method for displaying the facts is to list them on removable notes with adhesive and put them on a wall, so they can be used to develop the events and causal factors

chart.

3.2.1 Recording the Accident Scene

Photographs, videotapes, and sketches should be used for recording the accident scene. The readiness team should document the accident scene initially, but the board may wish to record the scene as well. Photographs (digitized photographs are preferred) should be taken of obstructions, equipment, parts, material, debris, spill and stains, and anything else that may contribute to or affect the accident scene.

Still video pictures may be taken to document the accident scene and facilitate subsequent review by the board. A documented chain of custody (see Section IV.3.2.3) on still video camera disks and prints should be maintained.

Color film pictures are preferred. These pictures should be carefully logged on an accepted form with information recorded as to exact time, location, direction, and other pertinent data. Photographic aids that record the date and time on the negative should be avoided, because these images may obscure important details in the photo or video.

Reference aids such as rulers, grids, and color charts should be included in the photographs when there is any chance for distorted interpretation; size, color, or exact location are critical. Videotapes are of particular value at accident scenes where progression of events is critical, such as fires. Other specialized photographic methods may be desirable in certain circumstances. Some special techniques available are aerial, micrographic, ultraviolet, infrared, false color, motion pictures, stereo, x-rays, and thermal scanners. These special techniques are used to identify foliage changes, internal conditions, and other effects not visible to normal sight.

3.2.2 Handling and Preserving Physical Evidence

Physical evidence should be gathered and assigned to

categories, and a record made of all facts from all sources, including the witness interview transcripts, as soon as they become available. Care should be taken in the event pathogenic contamination of physical evidence occurs (e.g., in the case of blood). Such material may require autoclaving or other sterilization. Physical evidence is fragile: physical objects can be taken, broken, lost, misplaced, cleaned up, destroyed, distorted, or overlooked. When physical evidence is identified, it is collected and secured or the area in which it is located is secured to preserve integrity of the evidence. Materials can be bottled, bagged, or boxed, and their locations recorded or photographed. The accident scene can be roped or taped off, doors locked, and guards posted, or it can be preserved by other means.

3.2.3 Preserving the Chain of Custody

Security and custody of evidence are necessary to prevent alteration and to establish the accuracy and validity of the physical material, photographs, and documents collected.

In order to establish a chain of custody for evidence:

- C The evidence should be photographed/videotaped in its original location as it was found immediately after the accident.
- C The photographs\videotapes should be time and date stamped and inventoried and treated as other physical evidence using the chain of custody principles described below.
- C A decision should be made about what evidence is to be removed from the scene.
- C The person collecting the evidence should prepare an inventory of the items and sign a chain of custody document stating at least the following:
 - What items were removed from the scene
 - When the items were removed from the scene

- Who removed the items from the scene
 - Location of the items at the time of inventory.
- C Evidence should be controlled by signature transfer (signatures of the recipient and the person relinquishing custody), and made available to those who have need to examine and use the evidence during the accident investigation.
- C Secure storage and access control to evidence must be maintained throughout the investigation.
- C The accident investigation board chairman should determine the disposition of evidence at the conclusion of the investigation.

3.2.4 Testing Physical Evidence

Testing and analysis of physical evidence may be an important tool in identifying contributing and root causes of an accident. Testing is generally divided into nondestructive and destructive testing and must be properly sequenced to assure that all nondestructive testing and analysis is performed prior to the start of destructive testing. A simple test and analysis plan may help to avoid problems. Testing need not be performed by an independent off-site laboratory if the tests are straightforward and are witnessed by a board member. Decisions on performing testing and analysis need to be made early in the investigation so that the results are available in time to meet the board's schedule.

3.3 GATHERING DOCUMENTARY AND ELECTRONIC SYSTEMS EVIDENCE

Preserving documentary evidence, data, and information is an important consideration. This evidence might be on paper, videotape, magnetic tape, or computer media, either at the site or related to the accident and in files at other locations. Such evidence may include items such as permits, reports, analyses, logbooks, work process documentation, instrument charts, as-built drawings, entry control records, maintenance tags, and process records. Documents or paper evidence can be

overlooked, misplaced, or taken. Documents can be altered, disfigured, misinterpreted, or electronically sanitized. Computer software and disks can be erased by exposure to magnetic fields. Documentary evidence that could be altered in any way should be collected, catalogued, and secured (in locked containers if necessary).

3.4 CONDUCTING INTERVIEWS

Human evidence can be extremely delicate. Eyewitnesses can forget, overlook, or fail to record evidence of critical value to the investigation. Individuals naturally begin to rationalize the circumstances of traumatic accidents after the event. Therefore, to preserve accuracy, the preferred approach is to obtain and record initial eyewitness statements before the participants and witnesses leave the accident site. This step should be taken as part of the initial response efforts discussed in Section IV.1.4.

After the board arrives, a witness interviewing schedule should be established, and interviewing should begin as soon as practical. A neutral location free from distractions (i.e., phones, noise, etc.) should be reserved for these interviews. Each board member is responsible for assuring that the interviews are effective and productive. Court reporters should be used to document key interviews to ensure accuracy and expeditious availability of transcripts to the board. In some cases, those being interviewed may request the presence of an attorney during the interview. Unless directed to do otherwise by DOE legal counsel, this request should be honored. The transcript should then be reviewed for accuracy by the board and the witness, and discrepancies resolved. The transcript should be read by all board members and placed in the investigation files.

3.4.1 Who to Interview

The board should develop a strategy and the sequence of interviews prior to scheduling interviews with the following types of individuals:

- C Witnesses to a specific event
- C Co-workers
- C Supervisors
- C Managers
- C Injured parties
- C Emergency response personnel
- C Individuals first on the scene
- C Medical personnel /physicians
- C Other organizational personnel.

3.4.2 Interview Techniques

Care needs to be exercised in interviewing witnesses in order to minimize hearsay and collaboration. It also may be necessary to conduct followup interviews of witnesses for clarifying and corroborating information. A board member should be present at key interviews and control the interviews. Good interviewing techniques that will aid in this effort include the following:

- C Ask open-ended questions (i.e., those that do not have "yes" or "no" answers).
- C Establish rapport before the interview starts--create an environment in which the witness will be more comfortable; do not treat the interview like an interrogation.
- C Provide a standard opening statement to ensure consistency.

- C Ask for narrative of the interviewee's first-hand knowledge without interruption, prior to asking questions.
- C Be unbiased and nonjudgmental --do not ask leading questions or questions that suggest a certain point of view; the witness may feel that a decision has already been made and any contrary information will not be taken seriously.
- C Plan the interview--plan strategy ahead of time on what information is needed and what questions to ask.
- C Schedule effectively--schedule time between interviews to reflect on the information obtained and to decide if any new information has affected the questions planned for the next witness.

3.5 EXAMINING ORGANIZATIONAL CONCERNS, MANAGEMENT SYSTEMS, AND OVERSIGHT

Accident investigations and reports must thoroughly examine organizational concerns, management systems, and line management oversight processes to determine whether deficiencies in these areas contributed to root causes of the accident. This examination focuses on management systems, not on individuals. To find out why management systems were not effective in preventing the conditions leading to the accident, investigators should apply the safety management template (see Appendix 4).

Review of management issues should focus initially on the following criteria and how they may have contributed to the accident. However, the review should not be limited to these criteria alone and should be expanded by board members as appropriate. Consideration of issues such as maintenance, work planning and controls, etc. may also be appropriate.

- C Are there clear safety policies and goals established?
- C Are safety responsibilities and authorities adequately defined, understood, and communicated?
- C Are hazards analyzed and understood, and appropriate mitigation actions identified and in place?
- C Are safety-related matters reviewed, monitored, and audited on a regular basis, and conclusions from these activities resolved?
- C Are requirements in place to ensure adequate protection of worker safety and health, the public, and the environment? And are the requirements disseminated?
- C Are programs implemented in compliance with defined requirements?
- C Are assessment programs established and implemented to evaluate adherence to applicable Departmental requirements and industry standards?
- C Are managers, supervisors, staff, and subcontractors adequately qualified, technically competent, and knowledgeable of the hazards associated with site operations at all levels of the organization?
- C Do workers and managers have authority to take appropriate action in dealing with hazards?
- C Are incentives in place to promote safety-consciousness and worker participation and involvement in safety management?

- C Are training programs established and implemented to effectively measure and improve performance?

4.0 DETERMINING FACTS AND ANALYZING INFORMATION

4.1 DETERMINING FACTS

The first elements of information required in an accident investigation are determining facts or **what happened**. Identifying all the relevant facts through the investigative process enables the board to satisfy this requirement. As facts are gathered and reviewed, first impressions should not guide the investigation, rather the board should review all facts in the totality of the accident's circumstances to ensure that only truly factual information is considered in determining what actually occurred. Facts are constantly reviewed for relevance and accuracy, and validated. Not all information can be established as factual with complete certainty. Therefore, the board should identify areas of uncertainty in the report.

The investigation determines facts in a logical manner by:

- C Establishing a clear chronological description of the accident (what happened and how)
- C Stressing those aspects of the accident that may have a bearing on causal considerations
- C Establishing accurate, complete, and substantive information that can be used to support the analysis and conclusions of the investigation
- C Stressing aspects of the investigation that suggest the basis for corrective measures
- C Resolving matters of speculation and disputed facts through analysis, testing, and board discussions.

Care must be taken to ensure relevant facts are not overlooked and are considered. Investigators' preconceived notions, press accounts, and other

publicized information may bias the investigation. Investigators should examine evidence critically and establish an objective and independent account of the accident. Examples of information to include in the determination of facts are:

- C Pertinent background information on the site or facility (e.g., facility description and its mission, location, and history)
- C Description of the injury, exposure, property damage, or costs
- C Physical evidence, including meteorological conditions at the time of the accident (if relevant)
- C Chronology of pertinent events/causal sequence
- C Physical hazards and safety controls present or absent at the time of the accident
- C Technical data on operations or processes impacting the accident
- C Related events that are not part of the causal sequence but that provide revealing information about how or why the accident occurred
- C Description of organizational, procedural, policy, or safety management processes relating to the accident, such as quality assurance procedures, safety practices, work procedures, and hazards analyses.

One procedure that has been used in the past with success in organizing factual material is to place removable notes with adhesive on a wall in a large room to form an events and causal factors chart. The analytical tools used later in the investigation will validate and analyze the facts on this events and causal factors chart. This procedure also aids in developing a logical flow and chronological timeline of the accident, which all board members can review at any time. The events and causal factors chart is constantly updated so board members can keep current with new information. The chart is also

helpful in report preparation and the associated analyses.

4.2 ANALYZING FACTS

Analyzing facts provides another key element of information for the investigation--**how the accident happened**. Analysis focuses on the facts connected to the accident and the conditions leading up to the accident, and identifies the causal factors that allowed the accident to occur. The board thoroughly documents the methodology it uses to arrive at its understanding of the facts, conditions, and circumstances. It also identifies inferences developed to support conclusions based on causal factors and judgments of need. Analytical tools are used to chart events; analyze the relationships of causes to events; assist investigators in reaching conclusions about the direct, contributing, and root causes; and aid in developing judgments of need. Proper investigation and analysis should be performed in a cost effective manner, but not at the expense of rigorous and comprehensive investigation and review of management or other system failures.

Most analyses are performed using tools such as change analysis, barrier analysis, events and causal factors analysis, and root cause analysis. Further descriptions of these techniques are provided below in Section IV.4.4. The results of applying each technique should be identified in the report. If the board arrives at different conclusions from each type of analysis, the report should explain how they fit together.

A root cause analysis should be conducted for each accident investigation. The methodology used is not as important as the results. In accident investigations, it is important to look beyond the errors and failures that immediately precipitated them. The investigator must identify system deficiencies at the work and management levels to determine the underlying oversights, omissions, performance errors, and accepted risks which are the root causes. These causes may lie in the organizational structure, safety management systems, or line management oversight processes related to the accident.

4.3 DETERMINING CAUSAL FACTORS

A key element of the investigation is determining the causal factors--**why the accident happened**. The causal factors of an accident are events and conditions which are necessary and sufficient to produce or contribute to the unwanted result. The types of causal factors are direct causes, contributing causes, and root causes. The direct cause is the immediate event or condition that caused the accident. Contributing causes are conditions or events that collectively increase the likelihood of an accident but which individually did not cause the accident. Root causes are conditions or events that, if corrected or eliminated, would prevent the recurrence of the accident. All three types of causal factors need to be identified. They generally consist of a series of relatively simple and explicit statements that summarize the causes and their contributing factors, including any systemic factors. If the accident investigation board is unable to identify the root causes of the accident, a statement to that effect is included in the report.

4.4 DESCRIPTION OF ANALYTICAL TECHNIQUES

A suite of analytical techniques available to support the accident investigation process is listed in Table 3. Change analysis, barrier analysis, root cause analysis, and events and causal factors analysis and charting are all easy to learn and use, are efficient, and meet the needs of DOE's accident investigation program. They are considered core analytical techniques for accident investigations. While many techniques could be used on most accidents, those used must be suitable for the type and complexity of the accident. For example, causation for a complex accident could not be determined through the use of only one technique, such as barrier analysis. Automated and manual techniques for root cause analysis are both acceptable. Computer-based root cause analysis programs available from commercial sources may be used to automate the analysis by determining causal factors and arriving at judgments of need. Manual tools are also acceptable; however, a computerized analysis aids in the consistency of root cause determinations.

For complex accidents, more rigorous techniques, such as those that employ complicated analytical trees, may be necessary to assure that accident causation is identified. Two examples which are acceptable for use are: (1) Management Oversight and Risk Tree (MORT), and (2) Project Evaluation Tree (PET).

Other analytical techniques could be used, if needed for specific situations such as scientific modeling (e.g., for incidents involving criticality and atmospheric dispersion), material and structural analysis, software hazards analysis, common cause failure analysis, or sneak circuit analysis. In certain situations, an integrated accident event matrix may be developed to determine the actions of personnel around the time of the accident. The application of the techniques for a given accident is determined by the board chairperson, in consultation with board members and advisors/consultants who have expertise in analytical techniques.

TABLE 3. ACCIDENT ANALYTICAL TECHNIQUES

Core Analytical Techniques
<p>For the basic accident with few system failures, these analytical techniques may be used:</p> <ul style="list-style-type: none"> Barrier Analysis Change Analysis Root Cause Analysis (manual or automated) Events and Causal Factors Analysis and Charting
Complex Analytical Techniques
<p>For complex accidents with multiple system failures, the analytical technique may include fault or analytic tree analysis, as well as the core analytical techniques listed above.</p>
Specific Analytical Techniques

Core Analytical Techniques

This pool of analytical techniques should be used to select techniques for specific investigations (depending on the nature and complexity of the accident) as determined by subject matter experts and the board chairperson.

Human Factors Analysis
Integrated Accident Event Matrix
Failure Modes and Effects Analysis
Software Hazards Analysis
Common Cause Failure Analysis
Sneak Circuit Analysis
72-Hour Profile
Materials and Structural Analysis
Scientific Modeling (e.g., for incidents involving
criticality and atmospheric dispersion)

Following is a brief discussion of techniques that are used in most accidents. Further details are available in the *Workbook for Conducting Accident Investigations*.

Barrier Analysis--The basic premise of barrier analysis is that there is energy flow associated with all accidents. This energy may be kinetic, potential, electromagnetic, thermal, steam or other pressurized system, or a myriad of other energy sources. It is the isolation, shielding, and control (barriers) of this energy (hazard) from people or valuable objects (targets) that prevent accidents. Barriers generally fall in the following categories: equipment, administrative (procedures and work processes), supervisory/management, warning devices, knowledge and skills, and physical. Therefore, by identifying the energy sources and the failed or deficient barriers and controls in an accident investigation, a structure is formed for identifying the causal factors of the accident.

If barriers were installed, and one fails partially or totally, an investigator examines the secondary safety

systems, if any, that were in place to mitigate the failure. The investigator also determines what events led up to and through the failure sequence and pays particular attention to changes made in the system. To accomplish this, the entire sequence of events is broken down into a logical flow from the beginning to the end of an accident. Questions are asked about the practicality of the barriers and controls selected, why they failed, or why none were selected for use.

The principal benefits of barrier analysis are that it identifies safety system elements that failed, and the results can be succinctly presented. Another benefit of barrier analysis is that the results can easily be graphically presented. A graphical flowchart (diagram) can clearly and concisely portray the energy flows and failed or unused barriers that led to the accident. Thus, barrier analysis is valuable in understanding the accident and the sequence of events that led to it.

Change Analysis--Change analysis is a systematic approach to problem-solving that can aid in identifying accident causes. Change analysis is a simple, straightforward process that is relatively quick and easy to learn and apply. Change is a necessary ingredient for progress; however, change to systems also contributes to errors, loss of control, and accidents. Changes and their impact usually contribute to accidents. The purpose of change analysis is to list and examine all changes systematically and determine the significance or impact of the changes. The use of this technique in accident investigation is particularly well suited for finding quick answers and identifying obscure direct causes.

It has been demonstrated that for any functional system that has been operating satisfactorily (i.e., up to some standard), when problems do arise, changes and differences associated with personnel, plant and hardware, or procedures and managerial controls have proven to be actual *causal factors* in the creation of these problems. Change can be thought of as stress on a system that was previously in a state of dynamic equilibrium. Change can also be viewed as anything that disturbs the planned or normal functioning of a system.

Accident investigators need to carefully evaluate all the changes identified during the investigation. Did the change really cause the result, or did the change merely bring an existing system deficiency to light? The investigation must focus on the systemic deficiencies that allowed the accident to happen and not just accept the changes identified as being the sole cause of the accident. Often change analysis will lead to further insight into areas that must be explored by other analytical techniques.

Events and Causal Factors Analysis--Events and causal factors analysis is an effective means of integrating other analytical techniques into a concise and complete investigative summary. Events and causal factors analysis depicts, in logical sequence, the necessary and sufficient events and conditions for accident occurrence. It provides a systematic accident analysis tool to aid in collecting, organizing, and depicting accident information; validating information from other analytical techniques; writing and illustrating the accident report; and briefing management. The events and causal factors charts are graphic representations that basically produce a picture of the accident: both the sequence of events that led to the accident and the conditions that were causal factors.

It is essential that accident investigators probe deeply into the events and the causal factors that create accident situations, and also into the managerial control systems that may have allowed them to develop, so that the accident's systemic causal factors can be identified. Identifying systemic causal factors requires understanding the sequence of events that occurs over time and the interaction of those events and their causal factors. This sequence proceeds from an initiating event through the final loss-producing occurrence. A meticulous tracing of unwanted energy transfers and their relationships to each other and to the people, plant, procedures, and controls involved in an accident will usually reveal a definable sequence for an accident.

Two basic principles are helpful in defining and understanding these sequences of events, causal factors,

and energy transfers:

- C Accidents are the results of a set of successive events that produce unintentional harm (i.e., personal injury, property damage).
- C The accident sequence occurs during the conduct of some work activity (i.e., a series of events directed toward some anticipated or intended outcome other than injury or damage).

The events and causal factors sequence charting technique is an integral and important part of the DOE accident investigation process. It is used in conjunction with other key tools--such as root cause analysis, change analysis, and barrier analysis--to achieve optimum results in accident investigation.

Root Cause Analysis--DOE Order 225.1 requires that root causes of the accident be identified. Root cause analysis is used in accident investigations to identify those deficiencies, including management systems factors that, if corrected, would prevent recurrence of the accident (i.e., the root cause(s) of an accident.)

Root causes of an accident can be determined using numerous automated and manual techniques. A manual version of root cause analysis or substitute techniques--such as compliance/noncompliance or tier diagrams--is acceptable. Commercially available automated techniques are widely used in the DOE complex. For example, one software package is a computer-based root cause analysis program which prompts the user for input to answer questions. These inputs about the accident structure the analytic tree. The package is easy to learn and apply, and comes with its own self-instructional training program.

Whatever technique is used, investigators should assure that actual root causes are determined and not just contributing causes. The contributing causes are important; however, the need to find concise and justified root causes should be the main intent of these analytical techniques.

The core analytical techniques that have been discussed have been used successfully in the past to perform acceptable analyses, and they are considered acceptable for most Type A and Type B investigations. Other techniques can be used if they yield the same results.

Analytical Trees--An analytical tree is a graphical representation of an accident using a deductive approach (general to specific). The tree starts with the event (accident) and branches out as specific details are developed. The bottom branches of the tree identify the causal factors. There are many acceptable equivalent methods of using analytical trees, such as fault trees (computerized and manual versions), of which MORT and PET are two examples.

Management Oversight and Risk Tree--The purpose of MORT analysis is to provide a systematic aid to planning, organizing, and conducting an in-depth, comprehensive accident investigation. This technique helps in identifying factors involved in complex accidents and the events leading up to the accidents. Mini-MORT is a progeny of MORT and was developed to serve as a tool for performing MORT analysis on a reduced scale in minor or less complex accidents. Investigators may find mini-MORT appropriate for analyzing accidents that do not require the comprehensive scope and complexity of MORT.

MORT is a comprehensive tool that can be used in analyzing complex accidents involving multiple system failures (e.g., nuclear safety systems). Users of MORT need extensive training in order to perform the in-depth causation analysis required for complex accidents. The use of MORT may be inappropriate for relatively simple, straightforward accidents.

Project Evaluation Tree Analysis--PET analysis is a relatively new technique, which was developed in response to the complexity of MORT analysis. This tool uses a MORT-type approach, but is quicker and simpler to learn and use.

PET is an analytical tree used primarily as a graphic check in basically the same manner as MORT. The PET

chart is divided into three branches: procedures, personnel, and plant and hardware. For a simple accident involving only a few procedures, personnel, and/or facilities/hardware, PET can be applied to the relevant items relatively quickly. For a complex accident involving many procedures, personnel, and/or facilities/hardware, many iterations of the PET chart are required to produce an in-depth analysis. If accident investigators are not familiar with MORT, PET would be easier to learn and apply.

5.0 DETERMINING CONCLUSIONS AND JUDGMENTS OF NEED

5.1 ARRIVING AT CONCLUSIONS

Conclusions are significant deductions derived from the investigation's analytical results. Conclusions are derived from and supported by the facts plus the results of testing and the various analyses conducted. They are statements that answer two questions the accident investigation addresses: what happened and why did it happen? Conclusions may include concise recapitulations of the causal factors (direct, contributing, and root causes) of the accident determined by analysis of the facts. An example of a conclusion is, *"XYZ contractor failed to adequately implement a medical surveillance program, thereby allowing an individual with medical restrictions to work in violation of those restrictions. This was a contributing factor to the accident."* They also may be statements that alleviate potential confusion or issues that may have originally been suspected causes (e.g., *"Welds did not fail during the steam line rupture."*). Conclusions may also address significant concerns arising out of the accident or address unsubstantiated concerns or inconclusive results (e.g., *"Blood tests on the injured worker did not conclusively establish his blood alcohol content at the time of the accident."*). Where appropriate, conclusions may be used to highlight positive aspects of performance revealed during the investigation (e.g., *"The implementation of comprehensive response procedures in place prevented the fire from spreading to areas containing dispersible radioactive materials, averting a significant escalation in the consequences of the fire."*).

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When developing conclusions, the investigator should:

- C Organize conclusions sequentially, preferably in chronological order, or in logical sets (e.g., hardware, procedures, people, organizations).
- C Base conclusions on the facts and the subsequent analysis of the facts.
- C Include only substantive conclusions that bear directly on the accident, and which reiterate significant facts and pertinent analytical results that lead to the accident's causes.
- C Keep conclusions as short as possible and, to the extent possible, limit reference citations (if used) to one per conclusion.

5.2 STATING JUDGMENTS OF NEED

The judgments of need are the board's judgment as to the managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence. This is the only reason for judgments of need. Judgments of need should be stated in clear, concise, and direct language; should be based on the weight of the substantive evidence; and should provide the basis for subsequent corrective actions. Judgments of need should not include process issues (e.g., evidence control, preservation of the accident scene, readiness, etc.) unless they have a direct impact on the accident. These concerns should be noted in a separate memorandum to the appointing official, with a copy to site management and the Assistant Secretary for Environment, Safety and Health.

Judgments of need should be constructed so they clearly identify the organization that is to implement corrective actions to prevent recurrence of the accident. The board should avoid generic statements and focus on processes and systems, not individuals. Judgments of need should focus on causal factors. Being specific and concise is essential; vague, generalized, broad-brush, sweeping solutions introduced by "should" statements should be

avoided. Sentences listing judgments of need may start, "A need exists . . ." or, "There is a need to . . ." As an example, a judgment of need might be worded, "There is a need for XYZ corporation to ensure that an adequate hazards analysis is performed prior to changes in work tasks that affect the safety and health of personnel." A judgment of need does not tell management how to do something, but simply identifies the need.

Corrective action plans are prepared to address the judgments of need. The resulting corrective actions are the responsibility of line management and are not indicated or directed by the board. If

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the board finds the need to make specific recommendations, they should be listed in a separate communication, not in the body of the report or transmittal letter to the appointing official.

6.0 REPORTING

The purpose of Type A and Type B investigation reports is to clearly and concisely convey the results of the investigation in a manner that will help the reader understand what happened, why it happened, and what can be done to prevent a recurrence. Investigation results shall be reported without attributing individual fault or proposing punitive measures. The investigation report constitutes an accurate and objective record of the accident and provides complete and accurate details and explicit statements of the board's investigation process, facts pertaining to the accident, analytical results, causes of the accident, conclusions reached, and judgments of need to correct deficiencies that should have, or could have, prevented the accident.

6.1 PREPARING THE REPORT

The body of the report should include facts; analysis of those facts; the root, contributing, and direct causes of the accident, including DOE and contractor management systems that could have prevented the accident; conclusions; and judgments of need. Other information, such as the investigation board appointment letter and supporting analytical results, should be included in appendices rather than in the body of the report. Figures, graphs, charts, and diagrams should be designed to promote quick and easy comprehension.

Each report has a disclaimer, worded as indicated below, on the back of the inside cover.

This report is an independent product of the (*nature of accident*) accident investigation board appointed by (*appointing authority*).

The board was appointed to perform a (*nature of accident*) investigation of this accident and to prepare an investigation report in accordance with DOE Order 225.1, *Accident Investigations*.

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

This report neither determines nor implies liability.

6.2 FORMAT AND CONTENT

The investigation report should consist of the following:

Appointing Official's Report Acceptance

The appointing official should sign a statement that the investigation has been completed in accordance with procedures specified in DOE Order 225.1 and that the final report has been accepted from the accident investigation board. An example of wording for an acceptance statement is provided below.

On (Date), I established a Type (A or B) Accident Investigation Board to investigate the (Type/Title of Accident) Accident at (Location of Accident) that resulted in (describe result, e.g., injury, death, exposure, property damage). The Board's responsibilities have been completed with respect to this investigation. The analysis process; identification of direct, contributing, and root causes; and development of judgments of need during the investigation were done in accordance with DOE Order 225.1, *Accident Investigations*. I accept the findings of the Board and authorize the release of this report for general distribution.

(Signature)
Signature Block of Appointing

Official

Table of Contents

Self-explanatory

Acronyms and Initialisms

This is self-explanatory. If necessary, a glossary of technical terms should follow this section.

Prologue - Interpretation of Significance

This is a one page discussion of the key management concerns and the primary lessons learned from the accident.

Executive Summary

The executive summary should include a brief account of the essential facts surrounding the occurrence and major consequences (what happened), the conclusions and root causes based on factors such as the organizational, management system, and line management oversight deficiencies that allowed the accident to happen (why it happened), and judgments of need for

preventing recurrence of the accident (what must be done to correct the problem and prevent it from recurring). It should be written for the executive or general reader, who may be relatively unfamiliar with the subject matter. It should not contain information not discussed elsewhere in the report.

1.0 Introduction

This section normally contains three major subsections: (1) a brief description of the accident and its results, and a statement regarding the authority to conduct the investigation; (2) brief descriptive data concerning the facility, area, or site and the major organizations involved to help the reader understand the context of the accident and the information that follows; and (3) descriptions of the scope of the investigation, its purpose, and the methodology employed in conducting the investigation.

2.0 Facts and Analysis

This section states the facts related to the accident and the analysis of those facts. It focuses on events connected to the accident and the causal factors that allowed those events to occur. This section should logically lead the reader to the conclusions and judgments of need. It includes subsections dealing with: (1) accident description and chronology, including a description of the responses to the accident; (2) facts and analysis regarding pertinent physical hazards, controls, and other related factors; a separate subsection on management systems is included; (3) brief descriptions and results of various analyses that were conducted (e.g., events and causal factors analysis, barrier analysis, change analysis, root cause analysis); and (4) causal factors, including the direct cause, contributing causes, and root causes.

Care should be taken in writing the report to clearly distinguish facts from analysis, which may contain opinions. Photos and diagrams, which may provide perspectives that written narrative cannot capture,

may be included, as determined by the board.

3.0 Conclusions and Judgments of Need

This section includes conclusions in the form of: (1) statements of what was found (through interviews, analysis, deduction, etc.) by the accident investigation board; and (2) judgments of need, which are identified needs (actions) required to prevent future accidents.

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Minority Report

If required, this section contains any board member opinions that differ from the rest of the board. It should address only those sections of the report in which there is a minority opinion; should follow the same format as the overall report, addressing only the points of variance; and should not be a complete rewrite of the report.

Board Signatures

The accident investigation board chairperson and members shall sign and date the report, even if they have a minority opinion. The signature page indicates the name and position of each board member and the accident investigation board chairperson, and indicates whether the signatory is a DOE accident investigator.

Board Members, Advisors, Consultants, and Staff

This section contains the names of the board members, advisors, and staff indicating their employers, job titles, and positions.

Appendices

Appendices are added as required to provide supporting information, such as the accident investigation board's appointment letter and the results of detailed analyses conducted during the investigation.

As a general rule, the amount of documentation in the appendices should be limited. The appendices should not be more comprehensive than the report itself. If there is any doubt about whether there is benefit for including material as an appendix, it should be summarized or omitted. All appendices should be referenced in the report.

6.3 QUALITY REVIEW AND VALIDATION OF CONCLUSIONS

The board reviews the report to ensure its technical accuracy, completeness, and internal consistency, and to ensure that analysis of organizational concerns, safety management systems, and line management oversight processes that may have contributed to the accident are properly considered. Following are further considerations for quality review of the report.

Structure and Format--The report is reviewed to ensure it follows the format and contains the information outlined in Section 6.2 to meet the intent of Section 4. b. (3) of DOE Order 225.1. Variation in the format is acceptable, as long as it does not affect the report's quality and the requirements of the Order.

Technical and Policy Issue--Technical requirements applicable to the investigation are reviewed by appropriate subject matter experts to assure their accuracy. Likewise, a knowledgeable board member or advisor reviews whether policy, requirements, and procedures were followed prior to the accident. Whether or not these requirements were adequate should also be reviewed by a board member or advisor knowledgeable in such policy and requirements.

Requirements Verification Analysis--Requirements verification analysis is conducted after all the analytical techniques are completed and a draft of the report has been prepared. The analysis ensures that all portions of the report are accurate and consistent, and verifies that the conclusions are consistent with the facts and judgments of need. The verification analysis determines whether the flow from facts to analysis, conclusions, and judgments of need is logical. The conclusions and judgments of need are traced back to locate the facts that support the conclusions. The goal is to eliminate conclusions that are not based on facts. One approach is to compare the facts, analysis, conclusions, causes, and judgments of need on a wall chart; and validate the continuity of facts through the analysis and conclusions to the judgments of need. This method also identifies any misplaced facts, insufficient

analyses, and unsupported conclusions or judgments of need.

Classification Review--A classification review should be completed by a classification officer prior to dissemination of the report for factual accuracy review.

6.4 FACTUAL ACCURACY REVIEW

When the accident investigation report has been drafted in its final form, but before it is sent to the appointing authority for acceptance, the facts section of the report should be reviewed by DOE and contractor line management affected by the investigation to validate the factual accuracy of the contents of the report. Additional portions of the report may also be provided, at the discretion of the chairperson. The review is important for ensuring an accurate report and establishing the mutuality of positions for all affected parties. This is consistent with identifying system's deficiencies so corrective action can be taken, rather than fixing blame. It also supports openness in the oversight process, which is DOE policy.

6.5 REVIEW BY THE ASSISTANT SECRETARY FOR ENVIRONMENT, SAFETY AND HEALTH

DOE Order 225.1, 5. a(5) requires review of Type A and Type B accident investigation reports by the Assistant Secretary. This function has been delegated to the Deputy Assistant Secretary for Oversight. Coordination for these reviews are made through the Program Manager. After the reviews are conducted, comments are provided to the appointing official and board chairperson, as appropriate. Time for this review must be scheduled prior to submission of the draft report to the appointing official.

6.6 REPORT SUBMISSION

When the report is completed and all comments are resolved, the board chairperson provides the final report to the appointing official for acceptance and distribution.

7.0 CLOSING THE INVESTIGATION

When the report is accepted by the appointing official, the onsite portion of the investigation is complete. However, the chairperson and the board are often requested to assist in meeting additional responsibilities, such as participating in corrective action reviews, conducting briefings, and finalizing the report to include any late developments.

7.1 BRIEFINGS

A briefing on the investigation's outcome to DOE Headquarters and field line management with cognizance over the site of the accident is required by DOE Order 225.1. This briefing is conducted by the board chairperson and the senior manager of the site at which the accident occurred. Accident investigation participants (chairperson, board members, and any consultants and advisers deemed appropriate by the chairperson) may attend the briefing. The briefing covers:

- What happened
- Why it happened
- What needs to be corrected to prevent recurrence
- Organizations that should be responsible for correcting problems.

Other briefings may be provided by the board chairperson and board members, as appropriate or if requested. These include briefing DOE and contractor line management at the site of the accident following factual accuracy validation of the report, and briefing the appointing official.

7.2 APPOINTING OFFICIAL'S REPORT ACCEPTANCE

The onsite phase of the investigation is considered complete when the appointing official accepts the report. Acceptance does not mean that the report is complete and

final; rather, it means that the formal investigative phase of the investigation is complete. The chairperson is responsible for final editing and production of the

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report, with assistance from administrative support staff. The appointing official indicates formal acceptance by completing an acceptance certification in the format indicated in Section IV.6.2.

8.0 POST-INVESTIGATION ACTIVITIES

8.1 CORRECTIVE ACTION PLANS

The final report is submitted by the appointing official to senior managers of organizations identified in the judgments of need in the report, with a request for the organizations to prepare corrective actions. These plans address judgments of need identified in the report and include milestones for completing the actions. Corrective actions fall into four categories:

- Immediate corrective actions that are taken by the organization managing the site where the accident occurred to prevent a second or related accident.
- Board-identified corrective actions, stated as judgments of need, that are designed to prevent recurrence and correct system problems. These are transmitted by the appointing official.
- Corrective actions determined by the appointing official to be appropriate for DOE-wide application. The appointing official makes these recommended corrective actions known when the report is distributed.
- DOE Headquarters corrective actions that result from discussions with senior management. These actions usually address DOE policy.

Heads of field elements are responsible for developing corrective action plans, submitting them for approval and concurrence, and implementing and tracking action plans to completion, in order to satisfy judgments of need identified in the investigation report. These plans are submitted to the cognizant secretarial officer for approval and to the Assistant Secretary for Environment, Safety and Health for concurrence and comments. Approval

responsibility of the secretarial officer may be delegated to the field at the discretion of the secretarial officer. A copy of the plan should also be forwarded to the Program Manager. These actions and responsibilities apply to both Type A and Type B investigations.

8.2 TRACKING AND VERIFYING CORRECTIVE ACTIONS

Corrective action plans submitted to the Assistant Secretary for Environment, Safety and Health for concurrence or comment are reviewed by the Office of Oversight on behalf of the Assistant Secretary. This review is done to determine:

- The adequacy of proposed corrective actions in meeting the deficiencies stated in the judgments of need
- The feasibility of the proposed corrective actions
- The timeliness of the proposed corrective actions
- The necessity for any interim actions to prevent further accidents, pending permanent corrective actions.

After review of the corrective action plan, the Office of Oversight determines whether the plan proposes acceptable means of meeting the concerns in the judgments of need and prepares an appropriate response or indicates concurrence.

The heads of field elements whose site, facility, operation, or area was involved in the accident have responsibility for implementing applicable corrective actions. However, other DOE Headquarters and field elements may have responsibility for completing actions resulting from the investigation. In these cases, the organization(s) indicated in the corrective action plan as having responsibility for implementation are accountable for completing the requisite actions. The Assistant Secretary for Environment, Safety and Health, through the Office of Oversight, verifies completion of approved corrective actions and satisfaction of judgments

of need. The Office of EH Residents and safety management evaluations by the Office of ES&H Evaluations execute this responsibility for the Assistant Secretary.

When corrective action plans have been implemented, those Headquarters and field elements having responsibilities for corrective actions notify the appointing official, who closes the investigation. Copies of the notification to and closure by the appointing official are sent to the Program Manager.

8.3 LESSONS LEARNED

The purpose of conducting accident investigations is to determine the system deficiencies that allowed the accident to occur, so that those deficiencies can be corrected and similar accidents can be prevented. Summaries of deficiencies and the recommended corrective actions are identified as "Lessons Learned." In the interest of preventing recurrence of accidents, Lessons Learned are disseminated DOE-wide to ensure that the results of investigations have the greatest effect for continuous improvement in environment, safety, and health performance. DOE Lessons Learned Programs (DOE Standard 7501-95, *Development of DOE Lessons Learned Programs*, May 1995, and DOE Handbook 7502-95, *Implementing U. S. Department of Energy Lessons Learned Programs*, August 1995) describe methods for disseminating this information. Lessons Learned are also disseminated through reports, workshops, and newsletters.

APPENDIX 1

ACRONYMS

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APPENDIX 1

ACRONYMS

EH-1	Assistant Secretary for Environment, Safety and Health
EH-2	Office of Oversight
EH-21	Office of Security Evaluations
FOIA	Freedom of Information Act
MORT	Management Oversight and Risk Tree
ORPS	Occurrence Reporting and Processing System
PET	Project Evaluation Tree

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APPENDIX 2

DEFINITIONS

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DEFINITIONS

Accident: An unwanted transfer of energy or an environmental condition which, due to the absence or failure of barriers or controls, produces injury to persons, damage to property, or reduction in process output.

Analysis: The use of methods and techniques of arranging data to: a) assist in determining what additional data are required; b) establish consistency, validity, and logic; c) establish necessary and sufficient events for causes; and d) guide and support inferences and judgments.¹

Analytical tree: Graphical representation of an accident in a deductive approach (general to specific). The structure resembles a tree--that is, narrow at the top with a single event (accident) and then branching out as the tree is developed, and identifying root causes at the bottom branches.

Barrier: Anything used to control, prevent, or impede energy flows. Common types of barriers include equipment, administrative procedures and processes, supervision/management, warning devices, knowledge and skills, and physical. Barriers may be control or safety barriers or act as both.

Barrier analysis: An analytical technique used to identify the energy sources and the failed or deficient barriers and controls that contributed to an accident.

Causal factors: All events or conditions in the accident sequence necessary and sufficient to produce or contribute to the unwanted result. Some types of causal factors are:

- **Direct cause:** The immediate events or conditions that caused the accident.
- **Contributing causes:** Events or conditions which increase the likelihood of an accident but which individually did not cause the accident.
- **Root causes:** Conditions or events which, if eliminated or modified, will prevent recurrence of the accident or similar accidents.

Cause: Anything which contributes to an accident or incident. In an investigation, the use of the word "cause" as a singular term should be avoided. It is preferable to use a multiple term such as "causal factors," rather than identifying "*the cause.*"

Chain of custody: The process of documenting, controlling, securing, and accounting for physical possession of evidence from initial collection through final disposition.

¹Ferry, Ted S., *Modern Accident Investigation and Analysis*, 2nd Edition, John Wiley & Sons, New York, New York, 1988.

Change: Stress on a system that was previously in a state of equilibrium, or anything that disturbs the planned or normal functioning of a system.

Change analysis: An analytical technique used for accident investigations, wherein accident-free reference bases are established, and then changes relative to accident causes and situations are systematically identified. In change analysis, all changes are considered including those initially considered trivial or obscure.

Conclusions: Significant deductions derived from analytical results. Conclusions are derived from and must be supported by the facts plus the results of testing and analyses conducted. Conclusions are statements that answer two questions the accident investigation addresses: what happened and why did it happen? Conclusions include concise recapitulations of the causal factors (direct, contributing, and root causes) of the accident determined by analysis of facts.

Controls: Those barriers used to control wanted energy flows, such as the insulation on an electrical cord, a stop sign, a procedure, or a safe work permit.

Energy: The capacity to do work and overcome resistance. Energy exists in many forms, including acoustic, potential, electrical, kinetic, thermal, biological, chemical, and radiation (both ionizing and non-ionizing).

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Energy flow: The transfer of energy from its source to some other point. There are two types of energy flows: wanted (controlled--able to do work) and unwanted (uncontrolled--able to do harm).

Event: An occurrence. Something significant and real-time that happens. An accident involves a sequence of events occurring in the course of work activity and culminating in unintentional injury or damage.

Events and causal factors chart: Graphical depiction of a logical series of events and related conditions that precede the accident.

Field element: A general term for all DOE sites (excluding individual duty stations) located outside the Washington, D. C. metropolitan area.

Hazard: The potential for an energy flow(s) to result in an accident or otherwise adverse consequence.

Judgments of need: Managerial controls and safety measures necessary to prevent or minimize the probability or severity of a recurrence of an accident.

Occurrence: An event or condition that adversely affects, or may adversely affect, DOE or contractor personnel, the public, property, the environment, or DOE mission.

Occurrence Reporting and Processing System (ORPS): The reporting system established and maintained for reporting occurrences related to the operation of DOE facilities.

(Accident Investigation) Program Manager: The individual within the Office of Security Evaluations responsible for administering the DOE accident investigation on behalf of the Assistant Secretary for Environment, Safety and Health.

Readiness team: Trained personnel at each site that are available to perform initial response activities immediately following an accident and to begin the investigation process as quickly as possible. They are responsible for initiating the

accident investigation, maintaining the integrity of evidence before the accident investigation board arrives, and supporting the board after its arrival.

Requirements verification analysis: A validation technique that determines whether the logical flow of data from analysis to conclusions and judgments of need is based on facts. This technique is conducted after all the analyses are completed.

Root cause analysis: Any methodology that identifies the causal factors that, if corrected, would prevent recurrence of the accident.

Target: A person, object, or animal upon which an unwanted energy flow may act to cause damage, injury, or death.

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APPENDIX 3

SAMPLE CONTENT--
MEMORANDUM ESTABLISHING
AN ACCIDENT INVESTIGATION BOARD

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SAMPLE CONTENT-- MEMORANDUM ESTABLISHING AN ACCIDENT INVESTIGATION BOARD

I hereby establish a (Type A or Type B) Accident Investigation Board to investigate the accident which occurred at the (*site*) on (*date*). I have determined it meets the requirements established for a (Type A or Type B) accident investigation in DOE Order 225.1, Accident Investigations, dated April 26, 1996.

I appoint (*name*) as the accident board chairperson. The board members will be (*three to six names*). The board will be assisted by advisors and consultants, and other support personnel as determined by the chairperson.

The scope of the board's investigation will include, but is not limited to, identifying all relevant facts, analyzing the facts to determine the direct, contributing, and root causes of the accident, developing conclusions, and determining the judgments of need that, when implemented, should prevent the recurrence of the accident. The investigation will be conducted in accordance with DOE Order 225.1 and will specifically address the role of DOE and contractor organizations and management systems as they may have contributed to the accident. The scope will also include (specific disciplines related to the accident) and the application of lessons learned from similar accidents within the Department.

The board will provide my office with periodic reports on the status of the investigation but will not include any conclusions until an analysis of all of the causal factors has been completed. Draft copies of the factual portion of the investigation report will be submitted to (DOE and contractor organizations at the accident site) for a factual accuracy review prior to report finalization.

The report should be provided to me for acceptance within (*nominally 30 days or specify date*) from the date of this memorandum. Discussions of the investigation and copies of the draft report will be controlled until I authorize release of the final report.

(Signature)
Signature Block of Appointing Official

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APPENDIX 4

SAFETY MANAGEMENT TEMPLATE

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SAFETY MANAGEMENT TEMPLATE

The three applicable fundamental principles for an effective safety management program are discussed below.

<i>Principle #1 - Line managers are responsible and accountable for safety.</i>
Criterion 1-1: Clear Safety Policies and Goals
Line management implements effective safety policy and goals that reflect Departmental policies and industry standards and assures a safety culture that permeates every level of the organization.
Criterion 1-2: Defined Responsibilities and Authorities
Line managers are responsible and accountable for ensuring that DOE facility operations and work practices are performed in a manner that provides adequate protection to worker safety and health, the public, and the environment. Accordingly, line managers must ensure that: <ul style="list-style-type: none">■ A clear division of responsibilities is established and communicated.■ Line managers have the authority to make and implement decisions regarding ES&H that are commensurate with their responsibilities.■ There are clear mechanisms throughout the line organizations for adjudicating disputes among line managers where discrepancies are believed to exist between work goals and ES&H management needs.
Criterion 1-3: Project and Resource Management Systems
Decision makers at appropriate levels of the organization must be capable of understanding and synthesizing program goals and ES&H risks in order to effectively deploy resources adequate to address both. Line managers must manage safety and its attainment by establishing management information systems to ensure that: <ul style="list-style-type: none">■ Hazards are analyzed and understood.■ Appropriate hazard mitigation actions are identified and are in place.
Criterion 1-4: Line Management Accountability for Performance

Line managers are accountable for ES&H performance. Performance should be explicitly tracked and measured, and inadequate performance should have visible and meaningful consequences. Line managers must execute actions to attain and continuously improve the safety of their operations by ensuring that:

- Safety-related matters are reviewed, monitored, and audited on a regular basis.
- Findings resulting from these reviews, monitoring activities, and audits are resolved in a timely manner.

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<p><i>Principle #2 - Comprehensive requirements exist, are appropriate, and are executed.</i></p>
<p>Criterion 2-1: Requirements Management</p>
<p>Processes must be in place to ensure that requirements are identified, transmitted, and implemented, and that they provide adequate protection to worker safety and health, the public, and the environment.</p>
<p>Criterion 2-2: Hazards Analysis</p>
<p>Hazards generally change as a facility cycles through the phases of design, construction, operation and maintenance, decommissioning and decontamination, and environmental restoration. It is thus important to continually analyze and assess hazards in order to identify the relative significance and application of Department requirements. To effectively mitigate hazards, line managers must ensure that:</p> <ul style="list-style-type: none">■ Requirements are established that are commensurate with hazards throughout the life cycle of the facility.■ Internal requirements are based on hazards analyses and, when implemented, are sufficient to ensure safety.■ Site-specific implementation plans and associated operating procedures define standards that will be used to comply with applicable safety requirements.■ The site is in compliance with applicable Federal and state statutes and Departmental policy and requirements.
<p>Criterion 2-3: Implementation of Requirements</p>
<p>Line managers are responsible for ensuring that programs are implemented in compliance with defined requirements.</p>
<p>Criterion 2-4: Assessment Programs</p>
<p>Line management must establish and implement effective methodologies to monitor, review, and evaluate adherence to all applicable Departmental requirements and industry standards for safety and to achieve timely correction where warranted.</p>

Principle #3 - Competence is commensurate with responsibilities.

Criterion 3-1: Staffing and Qualifications

The organization supports effective safety management by assuring appropriate levels of staffing and competence at every level. The organization has in place the means to:

- Determine the appropriate levels of staffing, experience, and training for each function, including consideration of responsibilities, activities, hazards, and schedules.
- Assure that subcontractors employed on site are adequately trained and qualified on job tasks, hazards, and DOE and contractor safety policies and requirements.
- Clearly identify vertical and horizontal lines of interface, communication, and support.
- Provide managers and supervisors with sufficient authority, staffing, and support to implement assigned responsibilities, analyses, and decisions.
- Develop and implement strategies for recruitment and retention of competent personnel.

Criterion 3-2: Technical Competence and Knowledge of Hazards

Workers and managers are technically competent to perform their jobs and are appropriately educated and knowledgeable of the hazards associated with site operations. Line managers must ensure that:

- Workers have the technical capability to recognize and respond appropriately to workplace hazards.
- Management, technical staff, and workers have the necessary levels of education, training, and experience.

Criterion 3-3: Worker Participation and Empowerment

Line managers recognize that active participation by workers is essential in maintaining and improving protection to worker safety and health, the public, and the environment. Therefore, line managers must ensure that:

- Workers and managers are empowered to take appropriate action in the face of hazards encountered during normal and emergency conditions, including the right to refuse unsafe work assignments.
- Processes for raising safety issues are established.
- Incentives are in place to promote a safety-conscious culture and worker participation and involvement in safety management.

Criterion 3-4: Training Programs

Line managers must establish and implement processes to ensure that training programs effectively measure and improve performance, and identify additional training needs.

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