



**NOT MEASUREMENT
SENSITIVE**

DOE-HDBK-1116-98
January 1998

Superseding
DOE-STD-1058-93

DOE HANDBOOK

GUIDE TO GOOD PRACTICES FOR DEVELOPING AND CONDUCTING CASE STUDIES



U.S. Department of Energy
Washington, D.C. 20585

AREA TRNG

DISTRIBUTION STATEMENT A. Approved for public release; distribution is unlimited.

This document has been reproduced directly from the best available copy.

Available to DOE and DOE contractors from the Office of Scientific and Technical Information, P.O. Box 62, Oak Ridge, TN 37831; (423) 576-8401.

Available to the public from the U.S. Department of Commerce, Technology Administration, National Technical Information Service, Springfield, VA 22161; (703) 605-6000.

Order No. DE98001291

DOE-HDBK-1116-98

FOREWORD

1. This Department of Energy (DOE) Handbook is approved for use by all DOE Components and their contractors. The Handbook incorporates editorial changes to DOE-STD-1058-93, *Guide to Good Practices for Developing and Conducting Case Studies*, and supersedes DOE-STD-1058-93. Technical content of this Handbook has not changed from the original technical standard. Changes are primarily editorial improvements, redesignation of the standard to a Handbook, and format changes to conform with current Technical Standards Program procedures.

2. The purpose of this Department of Energy (DOE) *Guide to Good Practices for Developing and Conducting Case Studies* is to provide Department of Energy contractor organizations with information that can be used in the development and use of case studies as a method to incorporate operating experiences into the training program. Contractors are not obligated to adopt all parts of the document. Rather, they can use the information in this guide to develop programs that apply to their facility. This guide can be used as an aid in the design, development, and conduct of case studies for use in the training program. This guide can be used for both the initial and continuing training programs.

3. Beneficial comments (recommendations, additions, deletions) and any pertinent data that may improve this document should be sent to the Office of Nuclear Safety Policy and Standards (EH-31), U.S. Department of Energy, Washington, DC 20585, by letter or by using the self-addressed Document Improvement Proposal (DOE F 1300.3) appearing at the end of this document.

4. DOE technical standards, such as this Handbook, do not establish requirements. However, all or part of the provisions in a technical standard can become requirements under the following circumstances:

(1) they are explicitly stated to be requirements in a DOE requirements document; or

(2) the organization makes a commitment to meet a technical standard in a contract or in a plan or program required by a DOE requirements document.

DOE-HDBK-1116-98

INTENTIONALLY BLANK

DOE-HDBK-1116-98

CONTENTS

| | |
|--|------|
| FOREWORD | iii |
| 1. INTRODUCTION | 1 |
| 1.1 Purpose | 1 |
| 1.2 Background | 1 |
| 1.3 Application | 1 |
| 1.4 Discussion | 2 |
| 2. TYPES OF CASE STUDIES | 5 |
| 3. SOURCES OF INFORMATION FOR CASE STUDIES | 7 |
| 4. DEVELOPING CASE STUDIES | 9 |
| 4.1 The Case Study Focus | 9 |
| 4.2 The Case Study Situation | 10 |
| 4.3 The Case Study Symptoms | 10 |
| 4.4 Writing the Case Study | 11 |
| 4.5 Providing Case Study Questions | 13 |
| 4.6 Providing Information on Facility-Specific Actions | 13 |
| 4.7 Incorporating the Case Study Into the Lesson Plan | 14 |
| 4.8 Piloting the Case Study | 14 |
| 4.9 Review and Approval of the Case Study | 14 |
| 5. CONDUCTING CASE STUDIES | 15 |
| 5.1 Instructor Preparation | 15 |
| 5.2 Trainee Preparation | 15 |
| 5.3 Questioning Techniques | 16 |
| APPENDIX A | A-1 |
| TYPES OF CASE STUDIES | A-3 |
| APPENDIX B | B-1 |
| CASE STUDY EXAMPLES | B-3 |
| THE COMPREHENSIVE CASE STUDY | B-3 |
| THE BACKGROUND CASE STUDY | B-13 |

TABLE

| | |
|--|---|
| Table 1. Action verbs that lend themselves to case studies. | 3 |
|--|---|

DOE-HDBK-1116-98

INTENTIONALLY BLANK

DOE-HDBK-1116-98

1. INTRODUCTION

1.1 Purpose

“Experience keeps a dear school,” said Benjamin Franklin. “A fool can learn in no other.” Learning from experience is often very costly to a facility in terms of injured personnel, damaged equipment, and wasted time. Learning from the experience gained at the facility and from industry can prevent repeating costly mistakes. This guide contains a method for learning from experience to prevent mistakes from occurring; that method is the case study. This guide describes how to develop and present case studies. This guide provides the instructional developer insight on the best kind of case study to use and includes examples of the various types of case studies.

1.2 Background

The DOE *Guide to Good Practices for Developing and Conducting Case Studies* was developed on the basis of experience from the nuclear industry and incorporates information from various resources that include: reports prepared for the Nuclear Regulatory Commission (NRC) and the Department Of Energy; information gathered from training manuals and training handbooks; and methods successfully implemented by DOE and commercial nuclear facilities.

Case studies have been used for many years as an alternative to the lecture method. The first case studies were developed on the Harvard University campus. The Harvard Method has been used to report actual situations and analyze case reports since the 1880s. This nondirective way of helping students to think for themselves has won acceptance in law, medicine, business administration, and social work.

One of the lessons learned from the Three Mile Island (TMI) accident was that personnel in the nuclear industry did not have a means to share information learned from events at other plants. As training programs and methods have improved since the TMI accident, the nuclear industry has relied more and more on the case study to teach the lessons learned from industry events. By reviewing actual facility events in detail, trainees are challenged with analyzing actual situations and problems.

1.3 Application

Case studies can be used in training programs for managers and supervisors, control room teams, maintenance personnel, process operators, and other disciplines at DOE facilities. This method works well in initial and continuing training programs. Case studies can be developed for various issues that include technical problems, plant events, management concerns, or a combination of these. Commercial utilities and other organizations have developed case studies on a variety of subjects.

DOE facilities subject to DOE Order 5480.20A, “Personnel Selection, Qualification, and Training Requirements for DOE Nuclear Facilities,” can use this guide to assist them in meeting the

DOE-HDBK-1116-98

applicable performance criteria contained in DOE Standard 1070, *Guidelines for Evaluation of Nuclear Facility Training Programs*. Specifically, using case studies will help meet Criteria 4.2 and 5.4. Criteria 4.2 states in part "...and industry operating experience are referenced...to establish both initial and continuing training." Criteria 5.4 states in part "Continuing training content includes...training on...facility and industry events...."

DOE Order 5480.20A also contains requirements for incorporation of industry operating experience, training on identified performance problems, and other subjects that must be part of certain nuclear facility personnel training and qualification programs. DOE Order 5480.20A, Chapter I, Section 7.d.(1) states in part:

"...Continuing training shall include, at a minimum,...applicable industry operating experience...and other training as needed to correct identified performance problems."

In addition, facilities can use the methods and information presented in this guide to improve existing training programs and comply with DOE Order 232.1A "Occurrence Reporting and Processing of Operations Information" and its implementing Manual M 232.1-1A.

Section 4, Requirements, of DOE O 232.1A states in part:

"Lessons learned from the facility's respective occurrences and the operations information obtained from other similar DOE facilities shall be collected and disseminated."

Section 7, Utilization..., of DOE M 232.1-1A, states in part:

"Facility staff at each facility or group of facilities should collect and disseminate to their personnel information from occurrences related to their facilities and similar DOE facilities, including lessons to be learned from this information."

Another area where the case study method could be applied is in a lessons learned program, described in the DOE Handbook, *Implementing U.S. Department of Energy Lessons Learned Programs*.

The DOE *Guide to Good Practices for Continuing Training* can provide information and methods useful in the development and implementation of continuing training programs.

1.4 Discussion

In the DOE Training Program Handbook, *A Systematic Approach to Training*, the design phase begins with writing terminal objectives which clearly state the measurable performance the trainee will be able to demonstrate at the conclusion of the training, including conditions and standards of performance. Information on how to write learning objectives can be found in the DOE *Guide to Good Practices for Developing Learning Objectives*.

DOE-HDBK-1116-98

After the learning objectives have been written, the instructional developer should consider what instructional strategies (i.e., the settings and methods) should be used to teach the objectives. Whether designing lesson plans for initial or continuing training, or revising existing lesson plans, the instructional developer has many choices to make when considering the instructional strategy of a lesson. A case study is but one of those strategies that can be used.

When reviewing the objectives, an instructional developer should look for key words that indicate a higher-level objective that may be suitable for a case study. Higher-level learning objectives are those objectives that require a trainee to use problem-solving skills rather than simple recall or memorization. Table 1 contains examples of action verbs that lend themselves to using a case study.

Table 1. Action verbs that lend themselves to case studies.

| OBJECTIVE DOMAIN | HIGHER LEVEL CLASSIFICATIONS AND KEY WORDS |
|------------------|---|
| COGNITIVE | DIAGNOSIS analyze, classify, compare, detect, diagnose, examine, identify, recognize, troubleshoot DEVELOPMENT conclude, derive, design, develop, discuss, formulate, organize, plan, predict, relate, restate, solve, summarize, write EVALUATION assess, decide, choose, defend, determine, evaluate, rate, select |
| AFFECTIVE | PROMOTION advocate, model, support DEFENSE argue, debate, defend, prevent |

Before an instructional developer can develop and use case studies, an understanding of what they are and why they are useful is necessary.

1.4.1 What Are Case Studies, and Why Use Them?

A case study is a presentation of real or hypothetical situations used to stimulate analytical and problem solving approaches. The key words to note here are "...analytical and problem solving approaches." By design, a case study requires a trainee to analyze the situation and solve the problems using previous or newly acquired knowledge or skills.

An instructional developer can help motivate the trainees to learn by designing lessons that allow them to participate in the learning activity. Trainee interest is aroused and maintained by making them active rather than passive participants. The trainees examine situations that have actually occurred, could have occurred, or are occurring. The trainees are given specific facts about events and are then required to think through the case study to arrive at a conclusion.

DOE-HDBK-1116-98

Case studies can help the trainee develop judgment skills and the ability to think independently and maturely, which in turn prepares them for job experiences. Trainees can make comparisons and draw their own conclusions to arrive at a solution in an environment that is risk-free. They also learn how to listen better and improve their ability to convey ideas.

Often, the trainees work in a group to analyze a case study. This helps the trainee to establish a give and take attitude. Trainees see that people approach the same problem differently; that there is no “one correct way” to solve problems. Trainees develop a willingness to see problems from all points of view.

1.4.2 Adult Learners and the Case Study

Adult learners bring many characteristics to the learning environment. These characteristics, (e.g., rate of learning, experience, relevance of the training to the job, need for self-direction, differences in learning styles, and a need for problem-centered situations) are described in detail in many different textbooks on learning theory. These characteristics, and how they apply to case studies, are briefly summarized here.

The rate of learning of an adult can be affected by many events. For example, a “typical adult” has been out of the classroom environment for some time. They may have lost effective study habits, which in turn may inhibit their ability to study independently. Case studies may be able to overcome this problem by allowing the adult to work in a group; each person helping the other to learn.

Adult learners bring to the classroom an abundance of experiences: previous knowledge, habits, prejudices, and so on. When designing a case study, instructional developers should require discussion and input from the participants to allow for their experiences.

An instructional developer may expect a participant to retain and use the information presented in a case study if it is shown how the information is relevant to the job. When an adult understands and accepts the relevance of the information, they will be more open to learning the information and transfer the learning back to the job. Instructional developers should design a case study that incorporates plenty of examples of where, how, or when the information presented can be used after the participants leave the learning environment.

Adults want to be responsible for their own actions, and they want to be treated that way. Most adults feel that they have something to contribute to learning situations, and they want that feeling recognized. The instructional developer should consider this need for self-direction and design the case study to encourage it in learning situations.

Because of different learning styles, some adults may learn more effectively by reading. Others may learn by listening to a lecture. Still others may need to put their hands on an object to understand it. Instructional developers should design case studies that accommodate as many different learning styles as practical.

DOE-HDBK-1116-98

2. TYPES OF CASE STUDIES

There are many types of case studies that are used today. No one type can be singled out as the “best” because each type of case study has a different application. Often, more than one type of case study could be used for the same objective. The trainer will have to decide which type to use. Types of case studies include the following:

- C Background
- C Complex
- C Comprehensive
- C Critical Incident
- C Decision
- C Exercise
- C In-Tray
- C Live
- C Participant
- C Role Play
- C Sequential
- C Situation
- C Interactive Video.

Appendix A contains a list of the types of case studies, suggested objective classifications they could support, and a description of the case study. Appendix B provides some case study examples.

DOE-HDBK-1116-98

INTENTIONALLY BLANK

DOE-HDBK-1116-98

3. SOURCES OF INFORMATION FOR CASE STUDIES

Case studies present facts and situations. These situations are based on information from events that have actually occurred. To obtain this information, the instructional developer must have information resources such as:

- C In-house events (occurrence reports, near misses, etc.)
- C Occurrence Reporting and Processing System (ORPS)
- C DOE Office of Nuclear Safety's Operating Experience Weekly Summary
- C Supplier/vendor letters and bulletins
- C Nuclear Plant Reliability Data System (NPRDS) (available to production reactors only)
- C Personal experiences
- C Experiences of colleagues
- C Problems presented by lecturers at conferences, workshops, and training sessions
- C Articles in training, personnel, and management journals
- C Articles in newspapers and magazines
- C Organizational events
- C Nuclear Network operating experience entries (available only to production reactors)
- C DOE/NRC bulletins, information notices, and generic letters
- C Case books
- C National Transportation Safety Board Accident Reports.

The DOE Handbook, *Implementing U.S. Department of Energy Lessons Learned Programs*, describes how to gather and process information that may be useful for case studies.

DOE-HDBK-1116-98

INTENTIONALLY BLANK

DOE-HDBK-1116-98

4. DEVELOPING CASE STUDIES

The following steps and related examples illustrate the development of a comprehensive case study.¹ Where applicable, suggestions are made on how these steps relate to the development of other types of case studies.

4.1 The Case Study Focus

The focus of a case study will be determined by the learning objective(s). This step is the most critical one, because not meeting the learning objective equates to wasted time. For example, the following objectives may be found in a typical facility training program:

OPERATOR LEARNING OBJECTIVE: Given a situation involving a facility fire, assess the facility conditions and determine a course of action that will place the facility in a safe condition.

FIRE BRIGADE MEMBER LEARNING OBJECTIVE: Given a situation involving unusual maintenance activities in the facility, identify potential personnel and/or facility safety hazards and identify how these hazards could be prevented.

Based on these objectives, the focus of the case study can be written in the case study introduction and look like this:

A CABLE TRAY FIRE AT A COMMERCIAL NUCLEAR POWER PLANT

¶

This case study covers a cable tray fire at a commercial nuclear power plant. An event description of operator actions necessary to fight the fire and maintain control of the plant is included.

Successfully extinguishing a fire is difficult under ideal conditions; combining fire fighting efforts with a plant shutdown requires forethought and planning.

For other types of case studies, the focus can be noted in the instructor's lesson plan stating the purpose of the case study activity.

¹ The complete case study used to explain the development steps can be found in Appendix B of this guide.

DOE-HDBK-1116-98

4.2 The Case Study Situation

Establish a situation that illustrates the focus of the case study. This requires the instructional developer to draw upon actual events or their own experience to develop typical problems. The situation should provide an appreciation that the event occurred and has the potential to occur at the facility. The situation can be introduced in an overview of the case study like this:

OVERVIEW

The commercial nuclear power plant experienced a serious cable tray fire. The fire was started by an engineer who was using a candle to check for air leaks through a fire wall penetration seal. The fire spread and was fought on both sides of the reactor building and cable spreading room wall by plant and local community fire fighting personnel. Efforts to put out the fire were made difficult by several factors including: delay in notifying personnel of the exact location of the fire, physical location of the fire in the cable trays, and the high differential pressure between the cable spreading room and the reactor building that

resulted in high air flow rates through the wall.

The effects of the fire on the plant were almost immediate. All Unit 1 emergency core cooling systems were lost, as well as the capability to monitor core power. To remove decay heat, low pressure water from the condensate pumps and manual operation of primary relief valves were used until normal decay heat removal systems could be made operational. Control power to motor operators and pump controls was established using temporary jumpers to allow the plant to be brought to a stable shutdown condition. There was no release of radioactivity.

In other types of case studies, a “thumbnail sketch” of the situation can be provided to the instructor within the lesson plan to aid in lesson preparation.

4.3 The Case Study Symptoms

The symptoms are the basic building material of the case study. No matter what kind of case study the instructional developer chooses, the symptoms must be provided to the trainees. Instructional developers should provide evidence or clues that will give the symptoms to the trainee. Depending on the trainee's experience with using case studies, as well as the learning objective the case study supports, some clues may need to be more obvious than others. Looking at the example case study in this text, the clues and symptoms include:

- C An engineer who used a candle to check for air leaks.
- C Various plant personnel who delayed notifying the control room of the fire.
- C The location of the fire in an area difficult to access.
- C The use of flammable materials to seal wall penetrations.

DOE-HDBK-1116-98

- C The existence of high air flow rates through various wall penetrations.
- C Cables damaged by fire that prevented automatic equipment operation.

Depending on the type of case study, you will need to provide facts or statements from key characters that will lead the trainee toward the symptoms and training objective. To do this, the developer may need to create story characters. Make these characters real, with acceptable everyday names and ensure that they are human—not all bad or all good.

4.4 Writing the Case Study

The instructional developer should keep some specific points in mind when writing the body of the case study.

- C Make the narrative as concise as possible; use graphs and figures to help present the facts.
- C Case studies can date very quickly; therefore, use periods of time (e.g., one year) rather than actual dates (e.g., September 1983).
- C Provide the cause of the event either in the body of the case study, as the example shows, or in the lesson plan for other types of case studies.
- C Give factors that affected the severity of the event (i.e., what made the situation worse).
- C State the lessons learned from the event either by writing it into the case study, as in the example, or by providing it in the lesson plan for case study types.

Although the instructional developer should be concise, enough of a description is needed to make the case meaningful. All aspects of the case related to the objective must be included. In this example case study the specific points mentioned above are included in the following excerpts.

| | |
|--|--|
| <p><i>DESCRIPTION OF THE EVENT</i></p> <p>This commercial nuclear power plant is a three-unit boiling water reactor site. At the time of the event, Units 1 and 2 were in operation at 100% power. Unit 3 was under construction.</p> <p><i>Activities Preceding the Fire</i></p> <p>The plant is designed so the air movement from one plant area to another is controlled by</p> | <p>supply and exhaust fans and will always be toward the area of possible higher radiation. The reactor building and refueling floor is the area of lowest pressure. The standby gas-treatment system must exhaust air from the reactor building to maintain a negative pressure. In order not to exceed the capacity of this system, inleakage to the reactor building must be kept at a minimum.</p> <p>The refueling floor is common for all three reactor units. To maintain the proper pressure....</p> |
|--|--|

DOE-HDBK-1116-98

...operation and also the potential personnel hazards associated with fighting fires in electrical cabling with water.

Effects on Plant Operation

The first indication of the fire's effect on Unit 1 operation came 20 minutes after the fire started with the almost simultaneous annunciation of several alarms: "RESIDUAL HEAT REMOVAL

OR CORE SPRAY AUTOMATIC BLOWDOWN PERMISSIVE," "REACTOR WATER LEVEL LOW-AUTOMATIC BLOWDOWN," and "CORE COOLING SYSTEM/DIESEL INITIATE."

The control room operators observed that normal conditions of reactor water level, reactor steam pressure, and drywell atmosphere pressure existed, so they were confused by the alarms. Over the next 8 minutes, several events occurred, including the....

...instructed to recheck all penetrations in their assigned areas.

Fire in the Cable Spreading Room

Cable penetrations had been sealed after initial installation but additional cables were often added. To make an opening for additional cables, holes were punched through the wall...

...After inserting the resilient polyurethane foam into the leak, the inspector placed the candle about 1 inch from the foam to check the success of the repaired seal. The airflow through the leak pulled the candle flame into the resilient polyurethane foam, which sizzled and began to burn. The inspector and the electrician attempted unsuccessfully to put out the fire by breaking up....

...instrumentation was lost. Unit 2 reactor was placed in shutdown cooling about 11 hours after the fire started.

Lessons Learned

The inability to put out the fire was caused, in part, by the large air flow through the penetration that prevented the carbon dioxide and dry chemicals from smothering the fire. Compounding this were the fire...

...not already affected. Although the suggestion to use water was made repeatedly by the local community fire chief, plant personnel were concerned about the effects of grounds and shorts on plant operation and potential personnel hazards.

Community fire fighting personnel did not arrive at the scene until approximately 45 minutes after they were called. Part of the delay was the need to....

DOE-HDBK-1116-98

4.5 Providing Case Study Questions

The case study should include questions for the instructor to ask the trainees. These questions can be written within the case study, as the next example shows, or within the lesson plan for other types of case studies. These questions should be based on the learning objectives because they ask for the correct response to be observed. The instructional developer should provide the instructor with correct or acceptable answers in an answer key within the lesson plan.

QUESTIONS

- | | | |
|---|--|---|
| C | What steps are taken at your facility to ensure the ability to operate equipment and valves locally? | - Shift supervisor - Fire brigade leader - Fire brigade team member |
| C | How are the operators at your facility made knowledgeable of alternate equipment power supplies and system cross-connect capabilities? | C What sources of emergency lighting and ventilation are available at your facility for use at the scene of a fire? Where are they located? |
| C | How is the quantity and location of breathing air packs at your facility determined? | C How are the following casualty response elements coordinated with the surrounding communities at your facility? |
| C | What are the immediate individual responses to a fire at your facility of the... | - Knowledge of response capabilities - Compatibility of equipment - Provisions for rapid.... |

4.6 Providing Information on Facility-Specific Actions

Provide information on facility-specific design or procedures that would moderate the severity of a similar event should it occur at your facility. This information may consist of excerpts from procedures, DOE orders, Technical Safety Requirements, descriptions of engineered and other corrective solutions, and so on. The next example illustrates this point.

DOE-HDBK-1116-98

FACILITY ACTIONS

Maintain high standards of housekeeping and cleanliness.

Station fire watches during spark or flame producing activities.

Obtain the proper permits for cutting, welding, or flame producing operations.

Notify the control room of casualty conditions and location.

For other types of case studies, facility-specific actions can be provided to the instructor within the lesson plan.

4.7 Incorporating the Case Study Into the Lesson Plan

No matter which type of case study has been selected, the instructional developer should incorporate it into new or existing lesson plans. When incorporating the case study into the lesson plan, the instructional developer should write clear instructions to the instructor on how to administer the case study. The instructions should include guidance on what materials to hand out to the trainees, some questions the instructor could ask to “set the mood” for the case study, and a summary at the conclusion of the case study.

When developing a lesson plan that will use the case study method, the instructional developer will want to build in extra time to allow for the discussion the case study will generate.

4.8 Piloting the Case Study

Pilot (i.e., test) the case study! This is a very important step, because the pilot will check the case study for consistency, completeness, and acceptability. The pilot will ensure that the desired answers to the questions develop logically during the discussion of the case study and represent the terminal behavior required of the trainees. The pilot will also determine if the directions for administering the case study are adequate. It is best to use a sample of the trainee population for whom the case study was written. If this is not feasible, allow other instructors to read it and discuss their interpretation of the case study materials.

4.9 Review and Approval of the Case Study

After the case study has been developed, reviewed for technical and editorial accuracy, and piloted, it should undergo a final review and approval process by facility management. The training manager should provide the final review. Managers of other facility departments, especially those departments the case study will affect, should also review and approve (or concur with) the case study. This review and approval process is required by Criteria 5.3 of the DOE *Guidelines for Evaluation of Nuclear Facility Training Programs*.

DOE-HDBK-1116-98

5. CONDUCTING CASE STUDIES

After the case study has been prepared, reviewed, and approved, it is ready to be presented to the trainees. Both the instructor and the trainees must be properly prepared to maximize learning with the case study.

5.1 Instructor Preparation

The case study method requires a skilled instructor. If the case study is not presented properly, the instructor will lose many of the benefits of using the case study method. The instructor should consider the following items prior to using a case study:

- C The instructor must be completely knowledgeable about the case study to be presented. Read the case study several times and analyze it. Develop plausible solutions and make a list of them. Have another trainer read the case study and give possible solutions.
- C The instructor must have all of the necessary training aids and materials to facilitate learning from the case study. This includes trainee handouts, graphs, transparencies, video tapes, reference material, etc.
- C The instructor should use a lesson plan. The lesson plan should include directions for size of work groups, class arrangement, etc.
- C The instructor should review and understand the questions developed for the case study. In addition to the prepared questions, the instructor should think of questions to ask the trainee during the discussions of the case study. The instructor must be able to phrase questions to stimulate discussion. The instructor should not give his/her personal views on the case and must avoid giving the answer away—the learning must come from the trainees' own discoveries. Section 5.3 of this guide discusses questioning techniques that an instructor may use.

5.2 Trainee Preparation

The case study should be introduced to the trainees to ensure they understand how a case study is used and how the discussions are conducted. Trainees can be encouraged to examine each element of the case carefully by reflecting on the analysis process. This begins by examining their own statements and by listening to what others say. It includes withholding their judgment until all the facts are stated, questioning rather than making pronouncements, and reflecting on “the whys” as well as “the whats.”

Trainees should be encouraged to listen to other points of view. They should support creative approaches to solving problems. The trainees should ask the instructor, as well as each other, questions that probe for understanding of the situation.

DOE-HDBK-1116-98

5.3 Questioning Techniques

The instructor who asks questions during the course of instruction is using the adult learning concept of experience and self-direction. Questioning is an important element in the adult learning environment. The way an instructor phrases a question will affect the trainee response.

Good questioning techniques are especially important when using case studies. The question an instructor asks the trainees at the beginning of the case study usually sets the tone for the discussion that follows. The questions—What do you think? What should happen next?—are designed to create interest in the case and to get the trainee involved. From that time on, the instructor should act as a facilitator, monitoring and directing the group discussion. This ensures that the trainees remain focused. If the discussion starts to stray from the case being studied, the instructor should ask one or two questions to get the trainees back on track. This is not to say that the instructor forces the direction of the case study. Case study discussions should be somewhat freewheeling so as to allow the trainees to search for the conclusions.

At the end of the case study, the instructor should ask questions that probe the understanding of the underlying principle that is illustrated by the case study. Usually, this is started by inviting the trainees to state their own conclusions and, based on the response they give, the instructor should then ask questions that probe their depth of understanding. For example, the instructor may say, “That's a good response. How would you explain your answer to someone who feels otherwise?” An instructor needs to be sensitive at this point. As stated previously, often there is no one right answer, and the trainees may discover another unique and valid answer to the case study.

Regardless of the answer, an instructor should provide positive feedback. If a trainee has missed the point of the case study, don't criticize. Motivate by reinforcing the portions of the response that is correct (e.g., The first part of your answer is a partial solution of the problem. Can you take that idea one step farther?). If the trainee still cannot answer, use the part of the response that was correct and redirect the question to the rest of the group (e.g., S/he brought up an interesting point. Can someone add something to this?). Positive feedback to responses will signal the trainees that it is safe to present their thoughts, ideas, views, and solutions. This “safe feeling” will encourage more trainee participation and increased trainee learning.

DOE-HDBK-1116-98

APPENDIX A
TYPES OF CASE STUDIES

DOE-HDBK-1116-98
APPENDIX A

INTENTIONALLY BLANK

DOE-HDBK-1116-98
APPENDIX A

TYPES OF CASE STUDIES

Case studies have been recognized as an excellent method to involve the trainee in the learning process. One problem facing the instructional developer is selecting the right type of case study to deliver that learning. There have been many books and magazine articles written on what is the “best type” of case study. In reality, there is no one best type. The following list of case study types have been selected from the dozens that are available to the instructional developer. Along with each type of case study given, suggestions for use with objective classifications (i.e., higher order objectives) have been given, as well as a description and suggested use for the case study.

| | |
|---|--|
| Case Study Type: BACKGROUND | Objective Classifications: DEVELOPMENT |
| <p>Description and suggested uses:</p> <p>The primary purpose of the background case study is to impart information, to supply factual data, or to familiarize the trainee with the wider circumstances of a specific situation. It can be presented as a motivator to a lesson or within the body of a lesson to illustrate a point. The instructor provides a brief description of the case then asks the trainees questions. After the lesson presentation, a handout giving the facts of the case, the lessons learned, facility specific actions, and questions asked by the instructor can be distributed to reinforce the material.</p> <p>The advantage of doing this through the medium of a case study, rather than by means of reading, is that the trainee absorbs the data more easily. It relates to a real situation. It also has advantages for the older trainee, who needs to acquire the data but might not be prepared to admit their ignorance if it were presented more formally.</p> | |

| | |
|--|--|
| Case Study Type: COMPLEX | Objective Classifications: DIAGNOSIS, EVALUATION |
| <p>Description and suggested uses:</p> <p>The complex case study is a variation of the situation case study (described later), where the problem is to diagnose the underlying issues. These issues are not easy to distinguish because they are submerged in a mass of data, much of which is irrelevant, and because a number of more superficial issues are present as distractions (although the superficial and underlying issues are normally interdependent).</p> <p>The complex case study can be used within a single lesson plan or spread out through a series of lessons within a course. The complex case study is ideal when the trainee is required to sort out and interpret data in order to make a decision.</p> | |

DOE-HDBK-1116-98
APPENDIX A

| | |
|---|---|
| Case Study Type: COMPREHENSIVE | Objective Classifications: DIAGNOSIS, DEVELOPMENT, EVALUATION |
| <p>Description and suggested uses: The comprehensive case study is the most widely used case study. The information used is drawn from real situations and must be well-researched. The primary objective of the comprehensive case study is to help trainees learn for themselves by independent thinking. Comprehensive case studies are best suited for a single lesson plan. They can be written based upon a single situation, or a combination of situations based on the same theme.</p> | |

| | |
|--|--|
| Case Study Type: CRITICAL INCIDENT | Objective Classifications: DIAGNOSIS, EVALUATION |
| <p>Description and suggested uses: The critical incident case study is sometimes known as a jigsaw case study. Here, the trainee is presented with a small amount of information about a situation. Additional data is supplied by the instructor over time and may take the form of handouts or verbal descriptions. Once all of the data is received, the case situation can be understood, and once understood often leads to suggestions for action. This type of case provides an opportunity to develop the skills of "asking the right questions." This type of case study is appropriate for training facility operators. It would help them develop the diagnostic skills needed for unusual events or emergency situations. The critical incident case study can be presented in the form of an exercise within a lesson plan. A technique for this kind of exercise is to break the trainees into teams. Some of the teams are given the true facts of a situation and should reach similar conclusions. The other teams are given slightly distorted facts that, without careful consideration, can lead to conclusions different from the other teams. This difference will generate discussions that allow the trainees to contrast and compare their conclusions in order to arrive at a consensus.</p> | |

DOE-HDBK-1116-98
APPENDIX A

| | |
|--|--|
| Case Study Type: DECISION | Objective Classifications: DEVELOPMENT, EVALUATION, PROMOTION, DEFENSE |
| <p>Description and suggested uses:</p> <p>The decision case study can be used as an exercise within a lesson plan, or as an evaluation tool to measure whether the trainees have achieved the objective. This type of case study can be combined with a role play to enhance the learning experience. The decision case study requires the trainee to do more than to acquire and manipulate data or to provide an analysis of a situation. Here, the trainee has to exercise judgment and state what should be done in the circumstances described. This requires the formulation of an action plan.</p> <p>The decision case study is useful when the instructional developer wants to improve creative thinking, judgment, or attitudes. This is also an excellent method to gauge trainee performance under various situations. It provides a risk-free atmosphere for the trainees to test their actions.</p> | |

| | |
|--|---|
| Case Study Type: EXERCISE | Objective Classifications: DIAGNOSIS, DEVELOPMENT, EVALUATION |
| <p>Description and suggested uses:</p> <p>This type of case study relates to real-life situations. Similar to the background case study method, the practice of certain techniques, particularly those involving quantitative manipulations (e.g., chemistry dilution or concentration problems, startup rate problems, shielding problems, criticality problems) are made easier if the data is presented in case form. The trainee can see that the manipulation relates to a necessary job skill, rather than being purely an academic exercise. This is important especially when instructing adult learners. This type of case study is equally effective in classroom, laboratory, or on-the-job settings.</p> | |

DOE-HDBK-1116-98
APPENDIX A

| | |
|--|---|
| Case Study Type: IN-TRAY | Objective Classifications: DIAGNOSIS, DEVELOPMENT, EVALUATION, PROMOTION, DEFENSE |
| <p>Description and suggested uses:</p> <p>The in-tray case study is a variation of the decision-type case study and consists of a number of documents that managers or supervisors might find in their in-trays. Some background information is provided, and the trainees are allowed a limited time to determine and record their actions on each of the documents provided. This type of case study closely approximates a real-life supervisory function. The in-tray case study is very useful for improving analytical skills, promoting creative thinking, and practicing decision making. For example, it can be used to train on facility policies and for evaluating learning objectives in the affective domain. The in-tray case study can be used as an exercise within a single lesson plan or as a series of exercises throughout a course.</p> | |

| | |
|--|---|
| Case Study Type: LIVE | Objective Classifications: DIAGNOSIS |
| <p>Description and suggested uses:</p> <p>The live case study is one of the more unique types of case studies in use. The material for a live case study comes from events that are occurring at the present time. Often, nothing more than a newspaper article is used to provide the trainees with the case study information. The instructor provides questions for thought and to prompt a discussion. The answers are truly unknown when this case is presented. Only after a few days can the trainee's conclusions be compared with the actual decisions made. This is usually found in a follow-up newspaper article or industry publication. This type of case study can be used in classes that last several weeks (such as reactor operator qualifications), or for requalification programs.</p> <p>Because the information for a live case study is based on current events, it is difficult to plan for and write into a lesson plan.</p> <p>To use a live case study, give the trainees up-to-date factual information to start with. During the remainder of the class, provide an interim problem-solving exercise. Finally offer opportunities to compare and appraise a variety of solutions for the problem analyzed (i.e., comparing hypothetical solutions worked out in the study group against the actual solutions that have been applied).</p> | |

DOE-HDBK-1116-98
APPENDIX A

| | |
|--|--|
| Case Study Type: PARTICIPANT | Objective Classifications: DEVELOPMENT, PROMOTION, DEFENSE |
| <p>Description and suggested uses:</p> <p>The participant case study is a variation of the conventional case study. The idea is to have the trainees develop and present a case study to the group. The trainees can readily identify with this type of case since it is being conveyed (normally) by one of their peers. The advantages of this approach include greater trainee involvement and interest, cases which are complex and challenging, and increased responsibility by trainees to contribute materials for the learning experience, with a corresponding reduction in the dependency on the trainer who ordinarily “does it all.” A participant case study can promote interaction and teamwork since the cases brought in by the trainees often relate to problems in their work environment or area.</p> <p>This type of case study can be used as a final exercise within a course, where the information has been presented to the trainees over the entire course.</p> | |

| | |
|--|---|
| Case Study Type: ROLE PLAY | Objective Classifications: DIAGNOSIS, DEVELOPMENT, EVALUATION, PROMOTION, DEFENSE |
| <p>Description and suggested uses:</p> <p>With a role play case study, the trainees participating receive outlines of the roles that they have agreed to assume and are then free to develop the characterization of the roles as they see fit. The roles are written on the basis of actual incidents with the characters being the participants in the incident. A brief summary of the incident is presented by the instructor to “set the scene” before the trainees begin the role play. Role plays usually are not scripted; consequently, the outcome cannot be predetermined. When role playing is used, it generates a near-live case study for subsequent analysis and an opportunity for the players to experience the feelings of being themselves in the case situation, in which they can test the validity of their views. Role playing is an excellent way to teach and evaluate affective learning objectives.</p> <p>Simulator scenarios are a form of role play, because the simulator is set to provide a certain facility condition and the trainees are trained and evaluated on the required responses.</p> <p>Role plays can be combined with other types of case studies to enhance the learning. Role plays can be used anywhere within a lesson plan: as a motivator, as an internal transition, or for evaluation.</p> | |

DOE-HDBK-1116-98
APPENDIX A

| | |
|---|---|
| Case Study Type: SEQUENTIAL | Objective Classifications: DIAGNOSIS, DEVELOPMENT, EVALUATION |
| <p>Description and suggested uses:</p> <p>The technique in this type of case study is to “stop the action” at a critical point in the event so that the trainees can predict outcomes or suggest courses of action. The event is then continued, and an analysis made of the reasons for the differences between the predictions and what actually happened. This technique is an excellent way to improve the trainee's analytical thinking. It can be effectively employed at facilities using simulators. The sequential case study can be combined with other case studies such as an exercise case study or role play for enhanced learning.</p> | |

| | |
|--|---|
| Case Study Type: SITUATION | Objective Classifications: EVALUATION |
| <p>Description and suggested uses:</p> <p>This case study is similar to the comprehensive case study. This type of case describes events that may be seen either as a success or as a failure. While the issues are usually fairly clear, they are often not those stated by the characters in the case. For example, it could relate a situation where one participant inadvertently discriminates against another participant. This type of case study is excellent for improving analytical thinking. Trainees studying the case learn to critically examine such statements in the light of the other evidence presented. They can also be used as preventive training for negative events (i.e. If personnel are informed of adverse events and understand the causes, they might not make the same mistake themselves). A situation case study can be written anywhere within a lesson plan.</p> | |

| | |
|--|--|
| Case Study Type: INTERACTIVE VIDEO | Objective Classifications: DIAGNOSIS, EVALUATION |
| <p>Description and suggested uses:</p> <p>Technology has merged the computer with the videodisc to produce a powerful instructional tool. This technology allows the instructional developer to bring simulation into the classroom, providing realistic, hands on training for the trainee. Interactive video can simplify ideas and events so that the trainees “get the message” with relative ease (e.g., this is helpful to those trainees who have difficulty learning the information from reading). For this type of case study, the simulation can be that of a process, system, or component, set up so that events that have occurred in the past can be repeated for the trainees. The trainees interact with the system and respond to the situation presented. This type of case study helps to build diagnostic skills and analytical thinking.</p> | |

DOE-HDBK-1116-98

APPENDIX B
CASE STUDY EXAMPLES

DOE-HDBK-1116-98
APPENDIX B

INTENTIONALLY BLANK

DOE-HDBK-1116-98
APPENDIX B

CASE STUDY EXAMPLES
THE COMPREHENSIVE CASE STUDY

The example comprehensive case study that follows was used to train personnel in the commercial nuclear industry. Because of the length of the comprehensive case, trainees may need to spend considerable time (as much as two or three hours) in preparation for the case discussion session. The discussion is very nondirective, with the instructor's role being that of catalyst, encourager, climate-setter, devil's advocate, issue sharpener, referee, etc., rather than that of expert, lecturer, authority figure, and the like. The instructor's technique to start the discussion is often a simple question: "What seems to be going on here?"

The group typically will identify many issues in the case since it is so comprehensive and diverse. A major goal is for the trainees to see the "big picture," the relationships of events, the internal and external forces at work, the role of personality in decision making, and so forth. Learning takes place largely because of the different views of the group.

DOE-HDBK-1116-98
APPENDIX B

INTENTIONALLY BLANK

DOE-HDBK-1116-98
APPENDIX B**A CABLE TRAY FIRE
AT A COMMERCIAL NUCLEAR POWER PLANT**

This case study covers a cable tray fire at a commercial nuclear power plant. An event description of operator actions necessary to fight the fire and maintain control of the plant is included.

Successfully extinguishing a fire is difficult under ideal conditions; combining fire fighting efforts with a plant shutdown requires forethought and planning.

OVERVIEW

The commercial nuclear power plant experienced a serious inplant cable tray fire. The fire was started by an engineer who was using a candle to check for air leaks through a fire wall penetration seal. The fire spread and was fought on both sides of the reactor building and cable spreading room wall by plant and local community fire fighting personnel. Efforts to put out the fire were made difficult by several factors: delay in notifying personnel of the exact location of the fire, physical location of the fire in the cable trays, and the high differential pressure between the cable spreading room and the reactor building that resulted in high air flow rates through the wall.

The effects of the fire on the plant were almost immediate. All Unit 1 emergency core cooling systems were lost, as well as the capability to monitor core power. To remove decay heat, low pressure water from the condensate pumps and manual operation of primary relief valves were used until normal decay heat removal systems could be made operational. Control power to motor operators and pump controls was established using temporary jumpers

allowing the plant to be brought to a stable shutdown condition. There was no release of radioactivity.

DESCRIPTION OF THE EVENT

This commercial nuclear power plant is a three-unit boiling water reactor site. At the time of the event, Units 1 and 2 were in operation at 100% power. Unit 3 was under construction.

Activities Preceding the Fire

The plant is designed so the air movement from one plant area to another is controlled by supply and exhaust fans and will always be toward the area of possible higher radiation. The reactor building and refueling floor is the area of lowest pressure. The standby gas-treatment system must exhaust air from the reactor building to maintain a negative pressure. In order not to exceed the capacity of this system, inleakage to the reactor building must be kept at a minimum.

The refueling floor is common for all three reactor units. To maintain the proper pressure conditions, an airtight partition was constructed between operating Units 1 and 2, and Unit 3, while Unit 3 was under construction. It was necessary to determine that the standby gas-treatment system could handle the added inleakage from the Unit 3 reactor building before the partition between Units 2 and 3 could be removed. Leakage tests run on the Units 1 and 2 reactor buildings indicated that leakage had to be reduced to a maintaining inleakage within the requirements of the Units 1 and 2 technical specifications when the partition was removed.

DOE-HDBK-1116-98
APPENDIX B

The program undertaken to reduce leakage required that all leaks be identified and listed, that leaks be sealed, and that work be verified and signed off by an engineer. The method for detecting air leaks was left to the discretion of the engineer in charge. Several methods had been employed including smoke devices, soap solutions, and candles. The movement or flickering of a candle flame was an especially effective method for locating leaks in dimly lighted areas and became the method most used. As the number of leaks was reduced, the differential pressure across the walls increased and penetrations that originally did not leak began to permit leakage. Therefore, the inspectors, accompanied by electricians who sealed leaking penetrations as they were discovered, were instructed to recheck all penetrations in their assigned areas.

Fire in the Cable Spreading Room _____

Cable penetrations had been sealed after initial installation but additional cables were often added. To make an opening for additional cables, holes were punched through the wall penetration sealing materials and fire stop with a wooden stick. This process resulted in pieces of polyurethane and flameastic (fire retardant material) being knocked onto the cables on both sides of the penetration.

In the early afternoon, an inspector and an electrician were checking cable penetrations through the wall between the cable spreading room and the Unit 1 reactor building. The inspector was using a candle flame to detect air leaks. The inspector detected a strong air leak in the penetration for the second tray from the bottom on the west row. The electrician experienced difficulty reaching the penetration to seal it

because it was recessed into the wall farther than he could reach. The inspector volunteered to seal the leak for the electrician. The electrician handed him pieces of resilient polyurethane foam sealing material that the inspector inserted into the hole. After inserting the resilient polyurethane foam into the leak, the inspector placed the candle about 1 inch from the resilient polyurethane foam to check the success of the repaired seal. The airflow through the leak pulled the candle flame into the resilient polyurethane foam, which sizzled and began to burn. The inspector and the electrician attempted unsuccessfully to put out the fire by breaking up and smothering the burning material. Realizing the fire was progressing beyond their ability to control, the electrician called for fire extinguishers. The fire burned for about 1 minute before the first carbon dioxide fire extinguisher arrived. The entire contents of three carbon dioxide extinguishers, two of which were only partially filled, were emptied on the fire without effect because of the air flow across the penetration.

The inspector realized that the fire had spread to the reactor building side of the wall, and two construction workers who were in the area left the spreading room for the reactor building to fight that fire. On their way to the reactor building they informed a public safety officer of the fire in progress in the Unit 1 reactor building. The public safety officer called the control room and reported the fire, 15 minutes after it had started.

As the engineer prepared to discharge a fourth extinguisher, the spreading room carbon dioxide system alarm was sounded and all workers evacuated the spreading room. Twenty minutes after the fire started and after ensuring that no workers were in

DOE-HDBK-1116-98
APPENDIX B

the spreading room, an assistant shift engineer attempted to initiate the cable spreading room's total flooding carbon dioxide system from outside the cable spreading room, but was unable to do so because it had been deenergized while workmen were in the spreading room. The assistant shift engineer restored the electrical power and initiated the carbon dioxide system. After the carbon dioxide system had been operated, the assistant shift engineer checked the spreading room and found that the fire was still burning because the ventilation system had not been secured.

Organized fire fighting efforts were delayed because the control room did not know the exact location of the fire. An assistant shift engineer located the construction workers fighting the fire in the reactor building and called the control room, while another assistant shift engineer in the reactor building reported the cable spreading room fire to the control room.

Fifty minutes after the start of the fire, fire fighting efforts were underway on both sides of the wall but met with little success in stopping the spread of the fire. The assistant shift engineer in charge in the reactor building called for the assistance of a nearby community fire department. These fire fighting personnel arrived on the scene after the fire had burned for almost an hour and a half. Fire fighting continued in the cable spreading room using portable carbon dioxide and dry chemical extinguishers for almost three hours when a near continuous application of dry chemical and carbon dioxide agents extinguished the cable spreading room fire.

Fire in the Reactor Building _____

When the two construction workers arrived at the penetration in the reactor building, they discovered the fire had spread into the cable tray system about 20feet above the floor. Their attempts at extinguishing the fire were unsuccessful. When the assistant shift engineer arrived at the scene, he took charge of the fire-fighting efforts and evacuated all construction workers from the reactor building. Heavy smoke reduced area visibility and made the use of breathing apparatus necessary. An hour and ten minutes after the fire started, all ac lighting in the reactor building was lost. Soon after lighting was lost in the reactor building, the decision was made to concentrate on fighting the fire in the cable spreading room. This was necessary because the cable spreading room fire was beginning to affect the operability of plant systems and because the control room was located directly above the cable spreading room.

Consequently, limited fire fighting took place in the reactor building. When the fire in the cable spreading room was extinguished four hours after the start of the fire, the assistant shift engineer, who had been directing activities in the cable spreading room, took charge of fire fighting in the reactor building. Because of limited visibility, wires and ropes were used as guides by fire fighting personnel. Eventually, temporary DC lighting was installed. Teams of two to three people were relayed into the fire area to discharge fire extinguishers and then return. Water was not used as an extinguishing agent until later that evening, seven hours after the fire started. After water was continuously applied for 10 minutes, the fire in the reactor building was extinguished. Water was initially not used to fight the fires because plant personnel were concerned

DOE-HDBK-1116-98
APPENDIX B

about the effects of grounds and shorts on plant operation and also the potential personnel hazards associated with fighting fire in electrical cabling with water.

Effects on Plant Operation _____

The first indication of the fire's effect on Unit 1 operation came 20 minutes after the fire started with the almost simultaneous annunciation of several alarms:

“RESIDUAL HEAT REMOVAL OR CORE SPRAY AUTOMATIC BLOWDOWN PERMISSIVE,” “REACTOR WATER LEVEL LOW-AUTOMATIC BLOWDOWN,” and “CORE COOLING SYSTEM/DIESEL INITIATE.”

The control room operators observed that normal conditions of reactor water level, reactor steam pressure, and drywell atmosphere pressure existed, so they were confused by the alarms. Over the next 8 minutes, several events occurred, including the automatic starting of residual heat removal and core spray pumps, the high-pressure coolant-injection pump, and the reactor core isolation coolant pump. In addition, control board indicating lights were randomly glowing brightly, dimming, and going out; numerous alarms occurred; and smoke came from beneath Panel 9-3, which is the control panel for emergency core cooling systems. The operators shut down equipment that was not needed, such as the residual heat removal and core spray pumps, only to have them restart again automatically.

When reactor power was affected by an unexplained runback of the reactor recirculating pumps, the shift engineer instructed the operator to reduce recirculating pump loading and scram the

reactor. While this was being done, the recirculating pumps tripped off. The reactor was scrambled by the operator 30 minutes after the fire started.

Operators confirmed that the reactor control rods were fully inserted. Thirty-five minutes after the fire started the turbine-generator was manually tripped. One minute later, all capability to monitor core power was lost as the vital power supply electrical boards were lost. In addition, all emergency core cooling systems were lost because their motor-operated valves lost power and could not be operated remotely. All of the outboard main steam isolation valves shut, isolating one main condenser as a heat sink. Because reactor pressure increased rapidly to 1100 psig, the control room operators took manual control of the main steam relief valves to reduce pressure by cycling pressure between 850 and 1080 psig.

Owing to the almost constant blowdown of reactor pressure that added heat to the suppression pool, suppression pool cooling became essential 40 minutes after the fire started, but the residual heat removal system, which is normally used, was unavailable because of the electrical board losses.

The next 30 minutes were spent trying to get the shutdown buses powered either by the running diesel generators or from Unit 2. During this period, the reactor water level dropped from its normal 201 inches to 48 inches above the top of the active fuel. To recover water level, water was added to the reactor through the feedwater bypass valve from the condensate booster pump. Water level went too high because control of the bypass valve had been lost, so an auxiliary unit operator was sent to manually throttle the valve.

DOE-HDBK-1116-98
APPENDIX B

Nearly four hours after the fire started, four auxiliary unit operators working in pairs were successful in isolating faulted residual heat removal circuits to get the residual heat removal system aligned. The residual heat removal system was not started until early the next morning, 13 hours after the fire started, because it could not be confirmed that the system was filled with water.

Sixteen hours after the fire started, shutdown cooling had been established, suppression pool cooling continued, and essential plant instrumentation had been restored. Nearly all of these activities were accomplished as a result of operator actions locally.

Temporary power supplies, manual valve operation, and use of temporary procedures were typical conditions because of the fire damage. The effects on Unit 2 were less severe; however, the reactor depressurized because of a suspected stuck-open relief valve and some vessel level instrumentation was lost. Unit 2 reactor was placed in shutdown cooling about 11 hours after the fire started.

DOE-HDBK-1116-98
APPENDIX B**Lessons Learned** _____

The inability to put out the fire was caused, in part, by the large air flow through the penetration that prevented the carbon dioxide and dry chemicals from smothering the fire. Compounding this were the fire fighters' difficulty in seeing exactly what was burning and working in the confined spaces, which made access to the affected areas difficult.

The use of water at an early stage would have extinguished this fire and prevented the loss of circuits not already affected. Although the suggestion to use water was made repeatedly by the local community fire chief, plant personnel were concerned about the effects of grounds and shorts on plant operation and potential personnel hazards.

Community fire fighting personnel did not arrive at the scene until approximately 45 minutes after they were called. Part of the delay was the need to process temporary radiation monitoring badges.

The community fire department special water hose nozzle for electrical fires was not compatible with the plant's hose.

A fire watch, who normally has no other duties but to watch for potential fires, had not been assigned.

QUESTIONS _____

- C What steps are taken at your facility to ensure the ability to operate equipment and valves locally?
- C How are the operators at your facility made knowledgeable of alternate equipment power supplies and system cross-connect capabilities?
- C How are the quantity and location of breathing air packs at your facility determined?
- C What are the immediate individual responses to a fire for the following personnel?
- Person discovering the casualty
 - Shift supervisor
 - Reactor operator
 - Shift technical advisor
 - Fire brigade leader
 - Fire brigade team member.
- C What sources of emergency lighting and ventilation are available for use at the scene of a fire? Where are they located?
- C How are the following casualty response elements coordinated with the surrounding communities?
- Knowledge of response capabilities
 - Compatibility of equipment
 - Provisions for rapid facility access
 - Definition of roles and responsibilities

DOE-HDBK-1116-98
APPENDIX B

- C What additional steps need to be taken at your facility to enhance the operator's ability to deal with this or a similar casualty?

FACILITY ACTIONS _____

Maintain high standards of housekeeping and cleanliness.

Obtain the proper permits for cutting, welding, or flame producing operations.

Stationing fire watches during spark or flame producing activities.

Promptly notify the control room of casualty conditions and location.

DOE-HDBK-1116-98
APPENDIX B

INTENTIONALLY BLANK

DOE-HDBK-1116-98
APPENDIX B

THE BACKGROUND CASE STUDY

The background case study is ideal for use within a lesson plan as a motivator, as an introduction to a new objective or lesson topic, or as a means for measuring trainee comprehension of the lesson material. The case study is presented to the trainees by the instructor and then discussed. After the discussion, a handout similar to the one beginning on page B-15 can be distributed to the trainees as reinforcement of the case studies lessons learned.

DOE-HDBK-1116-98
APPENDIX B

INTENTIONALLY BLANK

DOE-HDBK-1116-98
APPENDIX B**A CABLE TRAY FIRE AT A COMMERCIAL NUCLEAR POWER PLANT**

A commercial nuclear power plant experienced a serious inplant cable tray fire. The fire was started by an engineer who was using a candle to check for air leaks through a fire wall penetration seal. The fire spread and was fought on both sides of the reactor building and cable spreading room wall by plant and local community fire fighting personnel. Efforts to put out the fire were made difficult by several factors: delay in notifying personnel of the exact location of the fire, physical location of the fire in the cable trays, and the high differential pressure between the cable spreading room and the reactor building that resulted in high air flow rates through the wall.

The effects of the fire on the plant were almost immediate. All Unit 1 emergency core cooling systems were lost, as well as the capability to monitor core power. To remove decay heat, low pressure water from the condensate pumps and manual operation of primary relief valves were used until normal decay heat removal systems could be made operational. Control power to motor operators and pump controls was established using temporary jumpers allowing the plant to be brought to a stable shutdown condition. There was no release of radioactivity.

A. Lessons Learned

- C The inability to put out the fire was caused, in part, by the large air flow through the penetration that prevented the carbon dioxide and dry chemicals from smothering the fire. Compounding this were the fire fighters' difficulty in seeing exactly what was burning and working in the confined spaces, which made access to the affected areas difficult.
- C The use of water at an early stage would have extinguished this fire and prevented the loss of circuits not already affected. Although the suggestion to use water was made repeatedly by the local community fire chief, plant personnel were concerned about the effects of grounds and shorts on plant operation and potential personnel hazards.
- C Community fire fighting personnel did not arrive at the scene until approximately 45 minutes after they were called. Part of the delay was the need to process temporary radiation monitoring badges.
- C The community fire department special water hose nozzle for electrical fires was not compatible with the plant's hose.
- C A fire watch, who normally has no other duties but to watch for potential fires, had not been assigned.

DOE-HDBK-1116-98
APPENDIX B

B. Questions and answers

1. What are the immediate individual responses to a fire for the following personnel?

Person discovering the casualty. *Report it to the Control Room at _____.*

Shift Supervisor. *Notify all facility personnel, the fire department, and security.*

Reactor Operator. *If necessary, scram the reactor. Carry out the directions of the control room supervisor.*

Shift Technical Advisor. *Monitor the situation and advise the control room supervisor as necessary.*

Fire Brigade Leader. *Report to the equipment locker and assemble fire party. Coordinate fire fighting efforts. Keep the control room informed.*

Fire Brigade Team Member. *Report to the equipment locker and proceed as directed by the fire brigade leader.*

2. How are the following casualty response elements coordinated with the surrounding communities?

Knowledge of response capabilities. *Contained in the Fire and Safety Manual.*

Compatibility of equipment. *Contained in the Fire and Safety Manual.*

Provisions for rapid facility access. *Contained in the Facility Security Manual.*

Definition of roles and responsibilities. *Contained in the Fire and Safety Manual and stated in the letter of agreement with the State Department of Public Safety.*

3. What additional steps need to be taken at your facility to enhance the operators' ability to deal with this or a similar casualty? (List your ideas.)

DOE-HDBK-1116-98
APPENDIX B

C. Actions to take to minimize the effects of this kind of event at the facility

1. Maintain high standards of housekeeping and cleanliness
2. Obtain the proper permits for cutting, welding, or flame producing operations
3. Stationing fire watches during spark or flame producing activities
4. Promptly notify the control room of casualty conditions and location.

DOE-HDBK-1116-98

INTENTIONALLY BLANK

DOE-HDBK-1116-98

CONCLUDING MATERIAL

Review Activity:

DOE

HR

DP

EH

EM

ER

NN

RW

Field Offices

AL

CH

ID

NV

OR

RL

SR

OAK

RFFO

Preparing Activity:

DOE-EH-31

Project Number:

TRNG-0006

National Laboratories Contractor Organizations

ANL-W

BNL

LLNL

LANL

INEL

ORNL

EG&G MOUND

ORAU

ReeCO

WHC

WEMCO

WRSC

DOE-HDBK-1116-98

INTENTIONALLY BLANK

| U.S. Department of Energy | | OMB Control No. | |
|--|--|--|--|
| DOE F 1300.3 (01-94) | DOCUMENT IMPROVEMENT PROPOSAL <i>(Instructions on Reverse)</i> | | 1910-0900 OMB Burden Disclosure Statement on Reverse |
| 1. Document Number | 2. Document Title | | |
| 3a. Name of Submitting Organization | | 4. Type of Organization (<i>Mark one</i>) <input type="checkbox"/> Vendor <input type="checkbox"/> User <input type="checkbox"/> Manufacturer <input type="checkbox"/> Other (Specify: _____) | |
| 3b. Address (<i>Street, City, Zip Code</i>) | | | |
| 5. Problem Areas (Attach extra sheets as needed.) | | | |
| a. Paragraph Number and Wording | | | |
| b. Recommended Wording | | | |
| c. Reason/Rationale for Recommendation | | | |
| 6. Remarks | | | |
| 7a. Name of Submitter (<i>Last, First, MI</i>) | | 7b. Work Telephone Number (Include Area Code) | |
| 7c. Mailing Address (<i>Street, City, State, Zip Code</i>) | | 8. Date of Submission | |

INSTRUCTIONS: In a continuing effort to improve the U.S. Department of Energy (DOE) Technical Standards, this form is provided for use in submitting comments and suggestions for improvements. All users of DOE Technical Standards are invited to provide suggestions. This form may be detached, folded along the lines indicated, taped along the loose edge (DO NOT STAPLE) mailed to the address indicated or faxed to (423) 574-0382.

1. The submitter of this form must complete blocks 1 through 8.
2. The Technical Standards Program Office (TSPO) will forward this form to the Preparing Activity. The Preparing Activity will reply to the submitter within 30 calendar days of receipt from the TSPO.

NOTE: This form may not be used to request copies of documents, nor to request waivers, deviations, or clarification of specification requirements on current contractors. Comments submitted on this form do not constitute or imply authorization to waive any portion of the referenced document(s) or to amend contractual requirements.

OMB Burden Disclosure Statement

Public reporting burden for this collection of information is estimated to average 30 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, Records Management Division, HR-422 - GTN, Paperwork Reduction Project (1910-0900), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget (OMB), Paperwork Reduction Project (1910-0900), Washington, DC 20503.



**U.S. Department of Energy Technical Standards Program Office
c/o Performance Assurance Project Office
P.O. Box 2009, Bldg. 9201-3
Oak Ridge, Tennessee 37831-8065**