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DEVELOPING AND CONDUCTING CASE STUDIES



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FOREWORD

This document provides information to DOE staff and contractors that can be used by training staffs (e.g., instructors, designers, developers and managers) and others for the development and conduct of case studies in the areas of facility operations, maintenance, and technical support. Users are not obligated to adopt any part of this document; rather, they can selectively use the information to establish or improve facility training programs as applicable. This document was based upon DOE Handbook Guide to Good Practices for Developing and Conducting Case Studies.

Beneficial comments (recommendations, additions, and deletions) and any pertinent data that may be of use in improving this document should be addressed in the Comments Section of this forum.

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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 document contains a method for learning from experience to prevent mistakes from occurring; that method is the case study. This document describes how to develop and present case studies. This document 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*, which is the basis of this document, was developed using 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 426.2, *Personnel Selection, Training, Qualification, and Certification Requirements for DOE Nuclear Facilities*, can use this document to assist them in meeting the applicable performance criteria contained in DOE Standard 1070, *Criteria 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 426.2 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 426.2 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 document 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 *Lessons Learned Programs*, available on this site.

Continuing Training, also available on this site, 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 *Developing Learning Objectives*, available on this site.

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 argue, debate,
	DEFENSE	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.

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.

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:

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

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:

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

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

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.

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	
<p>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</p>	<p>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.</p>

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:

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

- Make the narrative as concise as possible; use graphs and figures to help present the facts.
- Case studies can date very quickly; therefore, use periods of time (e.g., one year) rather than actual dates (e.g., September 1983).
- 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.
- Give factors that affected the severity of the event (i.e., what made the situation worse).
- 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.</p> <p>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 supply</p>	<p>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>
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<p>...operation and also the potential personnel hazards associated with fighting fires in electrical cabling with water.</p> <p>Effects on Plant Operation</p> <p>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</p>	<p>OR CORE SPRAY AUTOMATIC BLOWDOWN PERMISSIVE," " REACTOR WATER LEVEL LOW-AUTOMATIC BLOWDOWN," and "CORE COOLING SYSTEM/DIESEL INITIATE."</p> <p>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....</p>
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<p>...instructed to recheck all penetrations in their assigned areas.</p> <p>Fire in the Cable Spreading Room</p> <p>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...</p>	<p>...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....</p>
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<p>...instrumentation was lost. Unit 2 reactor was placed in shutdown cooling about 11 hours after the fire started.</p> <p>Lessons Learned</p> <p>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.</p> <p>Compounding this was the fire...</p>	<p>...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.</p> <p>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....</p>
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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	
- What steps are taken at your facility to ensure the ability to operate equipment and valves locally?	- What are the immediate individual responses to a fire at your facility of the...
- How are the operators at your facility made knowledgeable of alternate equipment power supplies and system cross-connect capabilities?	- Shift supervisor - Fire brigade leader - Fire brigade team member
- How is the quantity and location of breathing air packs at your facility determined?	- How are the following casualty response elements coordinated with the surrounding communities at your facility?
- What sources of emergency lighting and ventilation are available at your facility for use at the scene of a fire? Where are they located?	- 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.

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 *Criteria for Evaluation of Nuclear Facility Training Programs*.

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:

- 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.
- 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.
- The instructor should use a lesson plan. The lesson plan should include directions for size of work groups, class arrangement, etc.
- 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 document 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.

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.