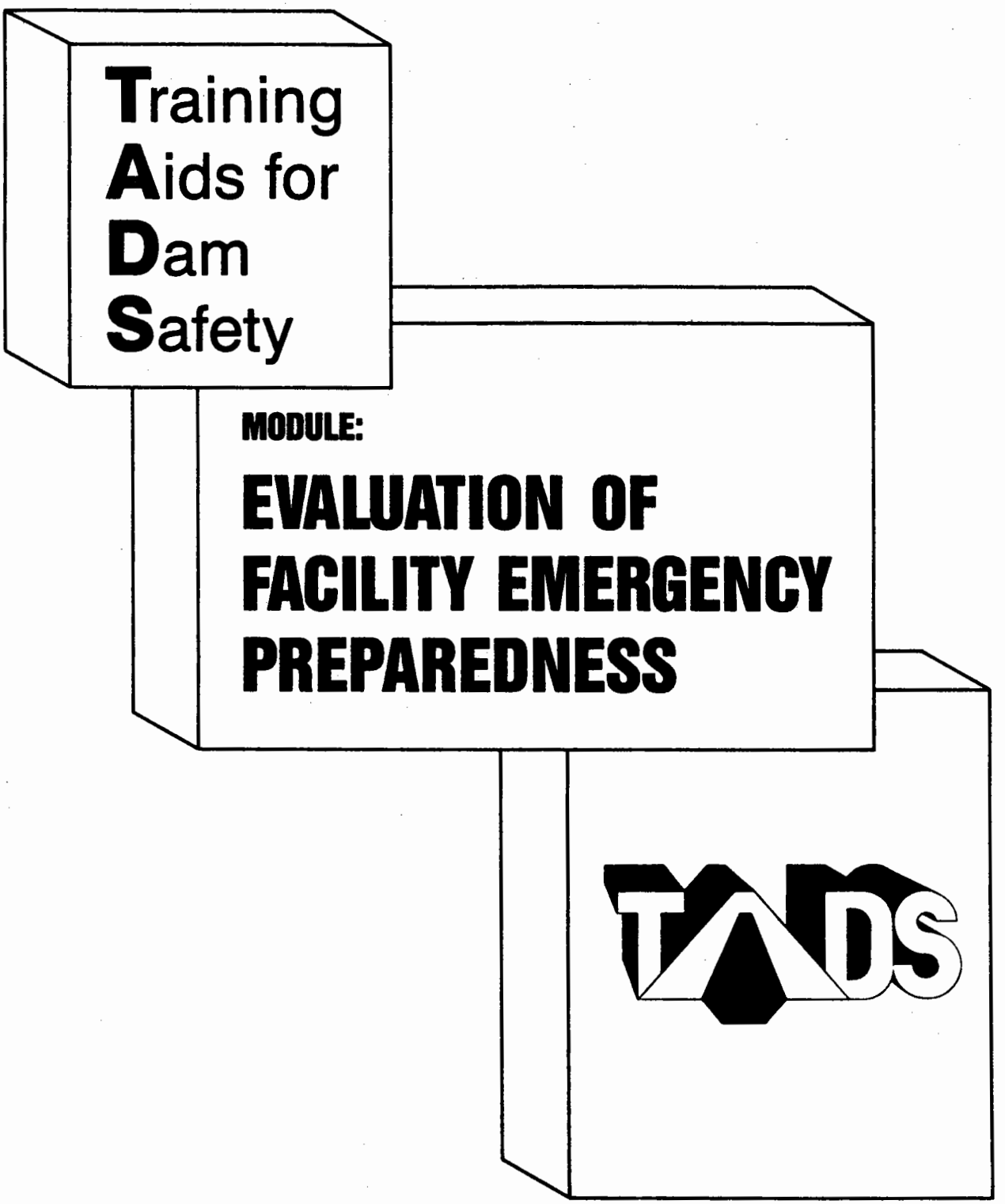
Training
Aids for
Dam
Safety

MODULE:

EVALUATION OF FACILITY EMERGENCY PREPAREDNESS


Training
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EVALUATION OF
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PREPAREDNESS
TADS

PREFACE

There are presently more than 80,000 dams in use across the United States. Like any engineering works, these dams require continual care and maintenance, first to ensure that they remain operational and capable of performing all intended purposes, and then to preclude endangering people and property downstream.

The safety of all dams in the United States is of considerable national, state, and local concern. Given that, the principal purpose of the TADS (Training Aids for Dam Safety) program is to enhance dam safety on a national scale. Federal agencies have responsibility for the safe operation, maintenance, and regulation of dams under their ownership or jurisdiction. The states, other public jurisdictions, and private owners have responsibility for the safety of non-Federal dams. The safety and proper custodial care of dams can be achieved only through an awareness and acceptance of owner and operator responsibility, and through the availability of competent, well-trained engineers, geologists, technicians, and operators. Such awareness and expertise are best attained and maintained through effective training in dam safety technology.

Accordingly, an ad hoc Interagency Steering Committee was established to address ways to overcome the paucity of good dam safety training materials. The committee proposed a program of self-instructional study embodying video and printed materials and having the advantages of wide availability/marketability, low per-student cost, limited or no professional trainer involvement, and a common approach to dam safety practices.

The 14 Federal agencies represented on the National Interagency Committee on Dam Safety fully endorsed the proposed TADS program and have underwritten the cost of development. They have also made available technical specialists in a variety of disciplines to help in preparing the instructional materials. The states, through the Association of State Dam Safety Officials, also resolved to support TADS development by providing technical expertise.

The dam safety instruction provided by TADS is applicable to dams of all sizes and types, and is useful to all agencies and dam owners. The guidance in dam safety practice provided by TADS is generally applicable to all situations. However, it is recognized that the degree to which the methods and principles are adopted will rest with the individual agency, dam owner, or user. The sponsoring agencies of TADS assume no responsibility for the manner in which these instructional materials are used or interpreted, or the results derived therefrom.

ACKNOWLEDGMENTS

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TADS SUPPORTING ORGANIZATIONS

Association of State Dam Safety Officials
U.S. Committee on Large Dams

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MODULE INTRODUCTION

OVERVIEW OF THE MODULE

In this module, you will learn what constitutes facility emergency preparedness, and the recommended methods for inspecting and evaluating the various components of emergency preparedness.

OBJECTIVES

At the completion of this module, you will be able to:

- Explain why facility emergency preparedness is essential to:
  - The safe operation of a dam.
  - Responding effectively to failure of a dam.
- Discuss factors that constitute emergency preparedness at a facility.
- Evaluate a facility's emergency preparedness by evaluating emergency preparedness factors.
- Document the results of your inspection and evaluation.

HOW TO USE THIS MODULE

This module is designed to be used in conjunction with other Training Aids for Dam Safety (TADS) modules. The TADS Learner's Guide lists all of the TADS modules and presents a recommended sequence for completing the modules. You may want to review the Learner's Guide before completing this module.

The Evaluation Of Facility Emergency Preparedness module is an introductory module. Therefore, it is not necessary to complete any other modules before beginning this module.

CONTENTS OF THIS MODULE

This module is divided into three units, followed by two appendixes:

- **Unit I. Introduction To Facility Emergency Preparedness:** Explains the reasons why facility emergency preparedness is important and describes facility emergency preparedness factors.
- **Unit II. Evaluating Site Conditions And Procedures:** Provides guidelines for evaluating hazard classifications, access, security, operating procedures, and Emergency Action Plans.
- **Unit III. Inspecting And Evaluating Emergency Preparedness Equipment:** Discusses inspection and evaluation of communications systems, warning systems, auxiliary power systems, remote operational capability, and reservoir drawdown capability.

Continued . . .

MODULE INTRODUCTION

CONTENTS OF THIS MODULE (Continued)

- **Appendix A. Glossary:** Defines a number of technical terms used in the module.
- **Appendix B. References:** Lists recommended references that can be used to supplement this module.

DESIGN OF THIS MODULE

This module is a self-paced instructional package. You may move through it as slowly or as rapidly as is comfortable for you. You may stop and review the material at any time. Since the module is designed for independent study, you may take breaks whenever you wish.

There are several components of this module that are designed to help you master the material being presented. These components include:

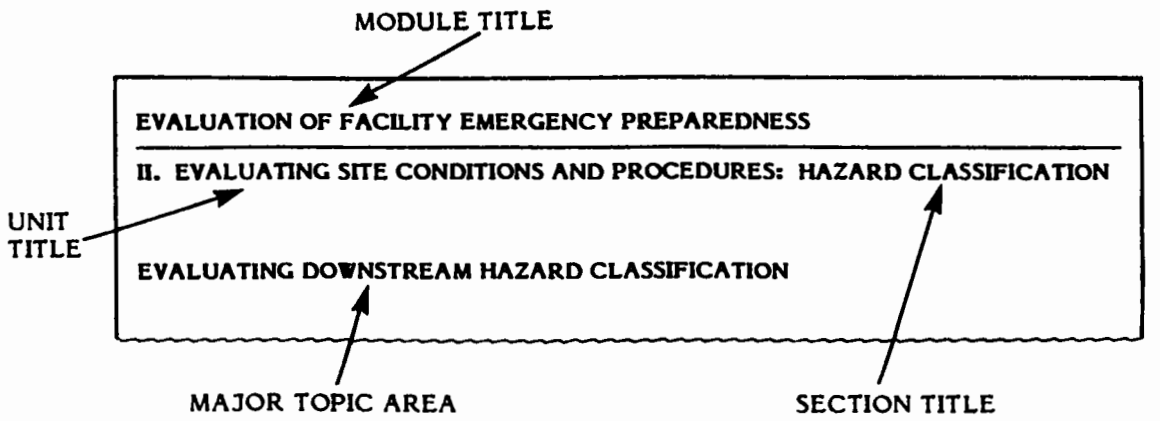
- Text Instruction
- Unit Exercises
- Final Review Exercise

We will now look at how you will use each component individually.

Text Instruction

The text instruction is presented in this workbook. Always begin by reading the text instruction, since it explains how to proceed through a given block of instruction.

As you read the text instruction, you will notice that every page has a header. The header is designed to let you know where you are in the module. Let's look at how information is presented in the header.



MODULE INTRODUCTION

Unit Exercises

Most units include exercises to help you determine how well you are mastering the information presented. These exercises are **not** tests and will not be used to grade you or to rate your performance. Rather, the exercises are tools to help you assess your own learning.

Instructions for completing the exercises appear at the beginning of every exercise. Answers to the exercises are presented immediately following each exercise.

Final Review Exercise

After reading the text instruction, you will complete a final review exercise. The final review exercise is designed to help you determine how much you have learned from the module. The final review exercise will not be used to grade you or to judge your performance.

REQUIRED MATERIALS

To complete this module, you will need this workbook and a pencil or pen. You may want to find a quiet place to work while you study these materials.

UNIT I

INTRODUCTION TO FACILITY EMERGENCY PREPAREDNESS

I. INTRODUCTION TO FACILITY EMERGENCY PREPAREDNESS: OVERVIEW

INTRODUCTION

This first unit of the Facility Emergency Preparedness module will introduce you to . . .

- **Facility Emergency Preparedness Factors:** Explains why facility emergency preparedness is necessary, and describes the following components of facility emergency preparedness:
  - Site conditions and procedures
  - Emergency equipment
- **Importance of Facility Emergency Preparedness Inspection And Evaluation:** Emphasizes the need for thorough and regular inspection and evaluation of the emergency preparedness of a facility.

UNIT OBJECTIVES

After completing this unit, you will be able to . . .

- Discuss the reasons why facility emergency preparedness is important.
- List the factors to be considered in the evaluation of facility emergency preparedness.
- Explain the importance of routine inspection and evaluation of the emergency preparedness of a facility.

I. INTRODUCTION TO FACILITY EMERGENCY PREPAREDNESS: FACTORS

INTRODUCTION

In this section, we will explain the factors that make up facility emergency preparedness.

WHAT IS FACILITY EMERGENCY PREPAREDNESS?

The emergency preparedness of a facility reflects its relative ability to respond effectively to emergencies. Emergency preparedness is assessed in order to define the hazards that a dam represents and to reduce loss of life and property damage that may be caused by flooding due to dam failure or unusually high flow through the spillway system.

COMPONENTS OF FACILITY EMERGENCY PREPAREDNESS

Components constituting facility emergency preparedness are grouped into the following categories:

- Site conditions and procedures
- Emergency preparedness equipment

Site Conditions And Procedures

Site conditions include:

- **Downstream Hazard Classification:** A downstream hazard classification is a rating (e.g., low, moderate/significant, or high hazard) that is a representation of the probable loss of life and property damage downstream from a dam, based on the results of breaching studies of the dam and an identification of the area downstream that would be inundated. Generally, worst-case scenarios (such as failure of the dam at night with little or no warning) are used in assigning hazard classifications.

- **Access:** Access to the site of the dam includes not only the capability of dam personnel to reach the site under adverse conditions to operate electrical and mechanical equipment, but also the transportation of construction equipment and material to the site, if the nature of the emergency makes averting or alleviating dam failure possible.

- **Security:** At a minimum, a dam's security system should effectively prevent trespassers from gaining access to and operating or damaging dam electrical and mechanical equipment. Additional security may be needed against other damage or destruction to the facility by trespassers.

Continued . . .

I. INTRODUCTION TO FACILITY EMERGENCY PREPAREDNESS: FACTORS

Site Conditions And Procedures (Continued)

Site procedures include:

- **Standing Operating Procedures:** The document containing instructions for normal operation, including the passage of floods, often is referred to as the Standing Operating Procedures (SOP).

- **Emergency Action Plan:** The Emergency Action Plan (EAP) contains procedures to be followed if structural problems, equipment malfunctions, or a natural event such as a flood or earthquake causes the design limits of a dam to be approached or exceeded.

In some agencies, the SOP includes both normal operating procedures and the EAP. Other agencies maintain two separate documents. The dam owner or operator is responsible for drafting and maintaining the SOP and the EAP.

Emergency Preparedness Equipment

The adequacy of emergency preparedness equipment is fundamental to the successful execution of an EAP. Your inspection must include an assessment of various features or equipment that would be utilized during an emergency. The EAP prepared by the dam owner/operator must contain descriptions or assessments of such equipment, which includes:

- **Communications Systems:** The available communications systems must be adequate during adverse situations to serve the needs of persons or organizations responsible for emergency operations.

- **Warning Systems:** Dams may have electrical/mechanical devices to alert onsite or remote personnel of adverse conditions. However, dam attendance is the major means of warning for most sites.

- **Auxiliary Power Systems:** In the event of failure of the primary power system, auxiliary power, which could be manual operation, must be available to operate mechanical equipment and lighting and communications equipment, if necessary.

- **Remote Operation:** Remote operation is the ability to operate equipment, such as spillway gates, from a location other than the dam site.

- **Reservoir Drawdown Capability:** During an emergency at a dam, the time required to lower the reservoir to a safe level often becomes extremely important. Reservoir drawdown is generally accomplished with the low-level outlet works.

I. INTRODUCTION TO FACILITY EMERGENCY PREPAREDNESS: IMPORTANCE

INTRODUCTION

In this section, we will discuss why regular evaluation and inspection of the components of facility emergency preparedness are so important.

THE COST OF FAILURE

The failure of a dam and the release of the dam's reservoir without adequate warning to those affected can result in catastrophic losses of life and property. By planning in advance for quick and prudent action and by devising an effective, timely method for warning downstream residents, the disastrous results of a dam failure may be mitigated.

THE NEED FOR REGULAR INSPECTION AND EVALUATION

Site conditions at a dam, including the area downstream, and the condition of emergency preparedness equipment may change. Facility emergency preparedness may be affected by:

- Changes in access, security, or downstream development
- Deterioration or failure of electrical and mechanical equipment

Thorough and regular inspection and evaluation of these factors is the best way to identify problems or deficiencies with emergency preparedness which, if left uncorrected, could cause an emergency or reduce the effectiveness of response to an emergency.

UNIT II

EVALUATING SITE CONDITIONS AND PROCEDURES

II. EVALUATING SITE CONDITIONS AND PROCEDURES: OVERVIEW

INTRODUCTION

During an inspection, you must evaluate site conditions and procedures to determine if proper emphasis is being given to emergency preparedness, if facility site conditions are described accurately, and if procedures are adequate. Factors to consider include:

- Downstream hazard classification
- Access to the dam
- Security of the facility
- The SOP and the EAP

UNIT OBJECTIVES

After completing this unit, you will be able to:

- List criteria used to assign downstream hazard classifications.
- Outline issues related to transporting personnel and equipment to a site during emergencies.
- Explain conditions that compromise security at a facility.
- List items that should be included in operating instructions.
- Describe the elements of an emergency warning and notification system.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: HAZARD CLASSIFICATION

IMPORTANCE OF EVALUATING DOWNSTREAM HAZARD CLASSIFICATION

A dam's hazard classification is an expression of the potential for death and destruction to downstream population and property if a dam were to fail. The dam's condition, or potential for failure, has no bearing on hazard classification.

Greater emergency preparedness measures can be expected for dams with higher hazard classifications. Compared to dams with lower hazard classifications, higher hazard dams may:

- Be inspected more frequently, depending on owner or regulating agency policy.
- Receive a greater share of maintenance funds.
- Be given a higher priority for any necessary corrective actions.

PREPARING TO EVALUATE DOWNSTREAM HAZARD CLASSIFICATION

Hazard classification schemes vary from agency to agency, but usually consist of three or more categories, defined by the consequences of sudden failure of a dam and uncontrolled release of the reservoir. The extent of anticipated property damage and loss of life determines the categories. Specific numbers of lives and the dollar value of property damage may not be defined. (Normally, property damage does not include loss of the dam itself nor loss of the economic benefits of the dam.) A typical hazard classification scheme is:

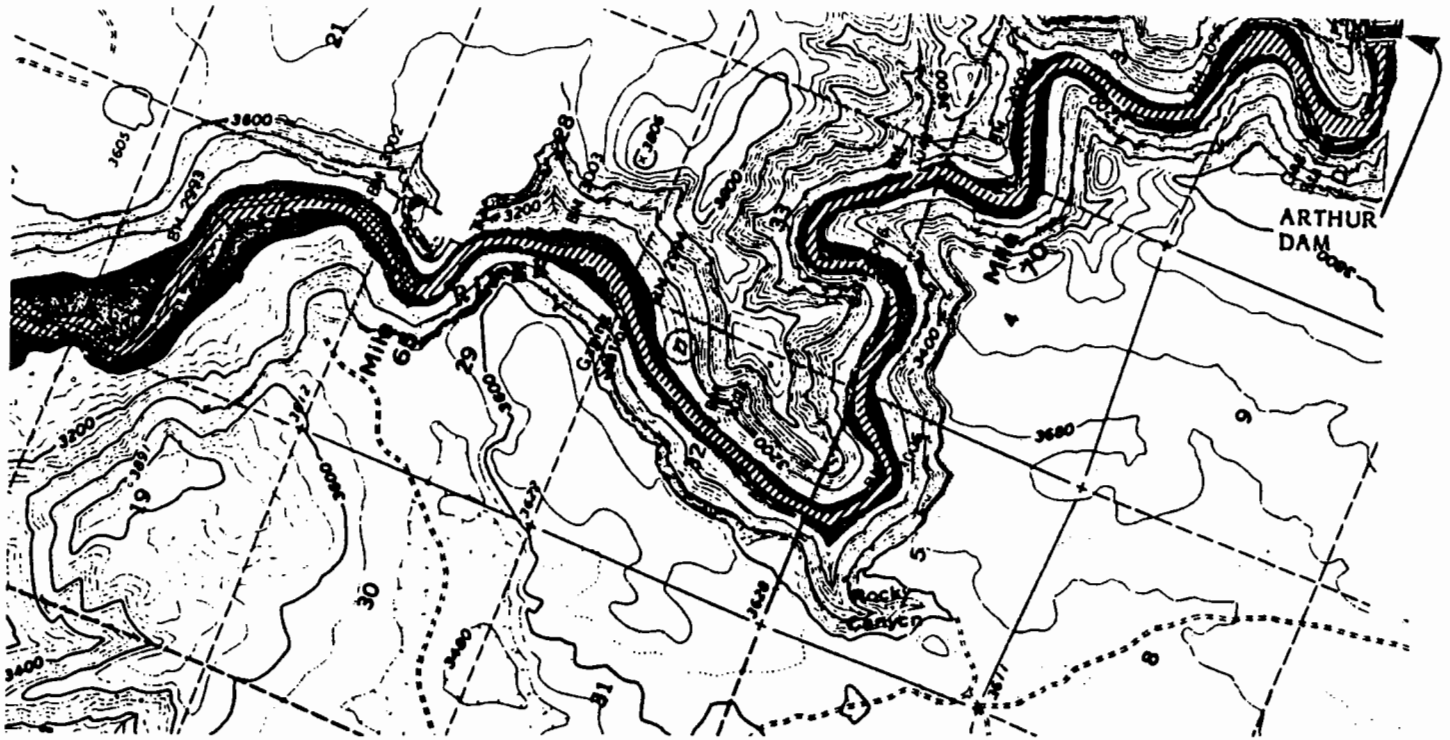
- High-hazard dams are those whose failure would cause large losses of life and extensive property damage.
- Moderate-hazard or significant-hazard dams are those whose failure would cause moderate property damage and the loss of a few lives.
- Low-hazard dams are those whose failure would cause little property damage and no loss of life.

Inundation maps are usually developed during dam-break inundation studies. These maps show areas that would be inundated by the uncontrolled release of reservoir water, and also the area inundated by the passage of the design flood. Figure II-1 shows an example of an inundation map.

Downstream inundation maps have been prepared for many dams. If such records are available, note their existence and current hazard classification in your inspection report. If the dam has been rated previously, you should review the basis for this evaluation in your report. If the dam has not been rated, you will need to provide a preliminary rating, if possible, and recommend that a formal evaluation be performed. Your review prior to inspection will include aerial photographs and all available maps.

Continued . . .

FIGURE II-1. INUNDATION MAP



OVERFLOW LIMITS

SUDDEN FAILURE of ARTHUR DAM

MAJOR FLOOD

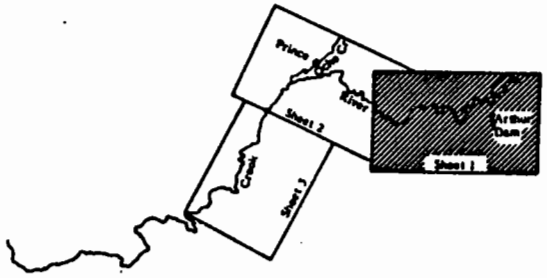
MILES

0 ½ 1 2

0 1 2 3

KILOMETERS

INDEX MAP



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The inundated areas shown on this map reflect events of an extremely remote nature. These results are not intended to reflect upon the integrity of Arthur Dam.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: HAZARD CLASSIFICATION

PREPARING TO EVALUATE DOWNSTREAM HAZARD CLASSIFICATION (Continued)

The amount of downstream channel data required to classify a high-hazard structure may be less than information required for moderate-hazard or low-hazard dams. This seeming contradiction results from the fact that high hazard classifications may be obvious because towns and other development are clearly within the inundated area. A more sophisticated evaluation may be required, however, for smaller dam break flood releases and rural damsites.

EVALUATING DOWNSTREAM HAZARD CLASSIFICATION

If a classification has not been made, or if reevaluation of a dam's downstream hazard classification is deemed necessary after your initial research, or if required by your agency's policy, you should inspect the downstream floodplain during the onsite inspection.

Compare the actual conditions at the site with the information presented on any maps or other materials that you reviewed when preparing for the inspection, to verify that the existing studies accurately depict field conditions.

> ☞ **INSPECTION TIP:** Additional development in the floodplain might result in a higher hazard classification. Therefore, the floodplain of low-hazard and moderate-hazard dams should be reinspected periodically.

Your data review may identify some structures that would be peripherally affected by flooding. Such structures should be viewed during your inspection, if possible, to better determine their potential for damage from flooding. Prior to the inspection, note predicted flood depths at the location of these structures from dam breach analyses, if possible.

In a majority of cases, unfortunately, examination of potentially affected locations is limited by the constraints associated with access to private property. Site personnel are often knowledgeable about downstream habitation and conditions. A review of maps in the field with these personnel can help offset the limited access for inspection.

Methods used to initially classify downstream hazard potential for a dam include:

- Use of an existing dam-break/inundation study
- Engineering judgment based on field reconnaissance
- Performance of a dam-break/inundation study

The methods used by most agencies are not complex, and they conservatively estimate the peak discharges at downstream locations. In most cases, such methods will identify the inundated area with enough accuracy to establish hazard. However, in some borderline cases, recommending a more sophisticated analysis to determine potentially inundated areas may be warranted.

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: HAZARD CLASSIFICATION

EVALUATING DOWNSTREAM HAZARD CLASSIFICATION (Continued)

Remember, if hazard classification is incorrect, limited dam safety resources may be earmarked for lower hazard structures, while dams actually representing a higher hazard may not receive deserved resources or priority to correct any dam safety deficiencies. Furthermore, proper emergency action planning may not be done and lives may thus be endangered.

Hazard classifications based on anticipated loss of life and economic loss, as determined by locating and describing potentially inundated areas, vary from agency to agency. A degree of judgment is always involved in assigning a hazard classification, particularly in assessing potential loss of life under adverse conditions in temporary-use areas such as parks and campsites.

Hazard classifications should be based on the values of property and the number of persons estimated to be in the potentially inundated area and exposed to risk, regardless of the potential for dam failure detection, warning, and evacuation of people in the floodplain under advantageous conditions. In other words, classification is based on a worst-case scenario for dam failure.

REPORTING ON DOWNSTREAM HAZARD CLASSIFICATION

The information on downstream hazard classification that you include in your report should cover the following areas:

- The guidelines on which the hazard classification is based.
- Changes to population and property that might affect the current hazard classification.
- Conclusions about the suitability of the hazard classification, and reasons why reclassification might be necessary.
- Recommendations for a formal classification or a reevaluation of the existing hazard classification, if needed.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: ACCESS

IMPORTANCE OF EVALUATING ACCESS

As an emergency develops, successful execution of an Emergency Action Plan (EAP) may depend upon:

- Personnel arriving at the site to operate equipment or evaluate conditions and issue warnings as appropriate.
- Transportation to the project site of construction materials and equipment needed for repairs and damage control.

Any access problems caused by weather or flood conditions should be anticipated, and measures to overcome those problems should be planned.

PREPARING TO EVALUATE ACCESS

If an initial inspection report exists for the dam, access should have been discussed in that report. The EAP for the dam may include a narrative description of access to the site from project headquarters, or from the owner's office. The written description and available highway and topographic maps should be reviewed. If a description has not been prepared, one should be prepared for your inspection report.

EVALUATING ACCESS

Site personnel are the best source of information on access. Meet with them and discuss the following issues:

- Potential hindrances to access that have been identified in previous inspection reports, or that you identified in your pre-inspection research.
- Seasonal access conditions.
- Alternate access routes. (Such routes often are not discussed in operating documents, and may not have been used for access during your inspection.)
- Any problems with access that operating personnel are aware of, or have experienced themselves.

During your onsite inspection, you should also verify that there is a clear delineation of who is responsible for day-to-day operation of the dam, the locations of the residences and offices of these people, and distance and travel time for them to reach the site.

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: ACCESS

EVALUATING ACCESS (Continued)

Occasions requiring access might include:

- Normal operation and inspection
- Inspection after or during an event that may affect the dam
- Operation for flood releases
- Operation for reservoir drawdowns or emergency repairs to the structure

A realistic estimate of time required for various essential personnel to reach the dam site should be established. Make sure access during non-business hours and/or darkness has been considered.

Evaluation of ground access should begin with a review of normal access conditions. If dam access is marginal under normal conditions (for example, only on foot or with a four-wheel-drive vehicle), it is likely that access under adverse conditions is inadequate.

Evaluation of accessibility under adverse conditions should include a minimum consideration of normal winter access and access during potential flooding of rivers near the site. Total coverage of potential problems that may arise due to large-scale earthquakes and flooding remote from the site will not be possible within the scope of your examination.

The ability to transport construction equipment and materials to a site should be considered. In some circumstances, a developing dam failure can be prevented. Some dams have access problems at certain times of the year. For instance, some dams are accessible only by snowmobile in the winter. To allow access for construction equipment and materials, an access road might be kept open for vehicular traffic, or an agreement made with a local entity to open a road under emergency conditions. Such arrangements should be discussed in the Standing Operating Procedures (SOP).

Personnel access to the site in most cases should be evaluated on the basis of persons who are responsible for the day-to-day operation of the dam. In many cases, access to the dam from the owner or operator headquarters is unreliable, but access for a dam tender at or near the site is adequate. Access for construction equipment and materials should be reviewed.

You should evaluate the availability and suitability of access to the site by air. The location of the nearest Government or commercial helicopter service should be identified in the operating documents. Note if this information is not given, and state the need to include it.

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: ACCESS

EVALUATING ACCESS (Continued)

Evaluation of the site for helicopter access is often limited to the availability of landing sites. Air access should not be considered a solution to all access problems. Only personnel and small equipment can be transported by air, and adverse weather conditions (which may be the reason why access to the site is needed) could preclude helicopter use. If any topographical considerations are impediments to air access (e.g., a narrow windy canyon), such problems should be noted in your inspection report.

REPORTING ON ACCESS

Your inspection report should include the following information about access to the site:

- A description of the site location, access routes (including alternate routes), and locations of airports in the vicinity
- Year-round and potential emergency access conditions
- Use and availability of special equipment (i.e., four-wheel-drive vehicles, snowmobiles, helicopters, etc.)

If in the course of your inspection you conclude that access to the site is less than adequate, include in your report the reasons for your conclusion, and discuss the need for additional access capability. You should also make recommendations for providing safe and reliable access to the site, as needed.

Table II-1 on the next page provides excerpts from inspection reports concerning access to project sites.

Continued . . .

REPORTING ON ACCESS (Continued)

TABLE II-1. SAMPLE INSPECTION REPORTS: ACCESS

BAKER'S CREEK DAM

Description Of Access

Baker's Creek Dam is accessed from U.S. Highway No. 26 via a graveled access road which is 4 miles in length. The intersection of the access road and U.S. Highway No. 26 is approximately 35 miles west of Martinsboro and 34 miles southeast of Elkton.

U.S. Highway No. 26 is a major all-weather highway, but can be hazardous in winter because of snow and ice. The access road is not maintained with snow-removal equipment in winter, and the dam cannot be accessed by vehicles for approximately 5 months each year. During these periods of time, the primary mode of transportation to the dam is snowmobile. Snowmobiles are available at the regional offices in Martinsboro and Wayne.

Should the need arise to access the dam by helicopter, there is a parking area near the right abutment that would be adequate for landing. However, this area may not be suitable for landing in winter due to deep snow cover in the area. A helicopter can be obtained from Elkton Air Service at the county airport in Elkton.

The nearest city that has regular commercial airline service is Sumner, which is approximately 93 miles east of the dam on U.S. Highway No. 26.

Conclusions

Access to the site is marginal.

Contingency arrangements to open the access road in winter, if the need to do so should arise, should be made with a local entity that has the capability to do so. Such an agreement should be identified in the SOP.

Continued . . .

REPORTING ON ACCESS (Continued)

TABLE II-1. SAMPLE INSPECTION REPORTS: ACCESS
(Continued)

LOST FOREST DAM

Description Of Access

Access to Lost Forest Dam from Charleston is as follows:

a. Interstate 90, an all-weather, well-maintained, paved road, to Milton;

b. Milton-Frostburg Road, an all-weather, well-maintained, paved road, through the town of Frostburg to the hamlet of Jones Ranch;

c. Richards and Blackstone Roads, graveled-surfaced roads, to the dam.

Although snow removal is not performed on the Milton-Frostburg Road beyond Jones Ranch or on the graveled roads, the dam site can be reached under most adverse weather conditions by district personnel equipped with four-wheel-drive vehicles.

A municipal airport operates in the north part of the city of Milton and a private landing strip exists at the Frostburg Paper Products Corporation mill in Frostburg. Helicopter access to the site is possible. A helicopter can be leased at the Milton City Airport.

Conclusions

Access to the site is satisfactory.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: SECURITY

IMPORTANCE OF EVALUATING SECURITY

If unauthorized persons operate equipment at a project, the safety of the dam and of downstream residents and property can be jeopardized. Security problems need to be recognized and corrected before such incidents occur.

PREPARING TO EVALUATE SECURITY

Your pre-inspection review should focus on the following areas:

- Areas and structures that should be secured
- Potential inadequacies that should be given special consideration at the site (e.g., an outlet works or spillway operating area that apparently should be fenced off and is not)
- The presence of public-use areas around the dam that might increase unauthorized access at the site
- Known breaches of security

EVALUATING SECURITY

Note the existence and condition of fences, barriers, gates, windows, doors, locks, access hatch covers, log booms, and signs, as well as the condition of any remote monitoring devices for security, such as cameras or door alarms.

Discuss the following items with site personnel:

- The condition and capability of monitoring systems
- Site patrolling in addition to normal attendance
- Responsibility for enforcing restrictions
- Recent changes in security
- Historical problems with security

Protection from vandalism is the primary reason for site security. Sabotage may be possible, but few dams can be considered secure from sabotage, nor could most dams be made secure by extending traditional security measures. Historically, sabotage or the threat of sabotage has not been a problem, but certainly the possibility exists.

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: SECURITY

EVALUATING SECURITY (Continued)

Your evaluation of potential damage due to vandalism should be limited to areas that might possibly affect the safety of the dam. Controls for a gated spillway or large-capacity outlet works are typical examples of elements that could directly affect safety. Damage resulting in extended inoperability of an outlet works should be considered a safety issue due to the loss of reservoir drawdown capability caused by the damage.

Determination of the required level of security for these types of components is a matter of judgment. If you conclude that security measures probably are inadequate, recommend that increased security for the site be considered.

Security measures that may prevent costly damage but do not directly affect operability of the installation, or those that may reduce hazards to the public, usually are considered operation and maintenance responsibilities rather than matters crucial to the safety of the dam.

REPORTING ON SECURITY

You should cover the following security topics in your inspection report:

- Features or equipment that might present a dam safety problem if damaged
- Any known vandalism, and the likelihood of recurrences of such incidents
- Your evaluation of site security, and the basis for the evaluation
- Additional security measures that reasonably could be provided, and/or modifications and repairs to existing features that would improve security

Table II-2 on the following pages contains samples from inspection reports concerning site security.

Continued . . .

REPORTING ON SECURITY (Continued)

TABLE II-2. SAMPLE INSPECTION REPORTS: SECURITY

LOST FOREST DAM

Description Of Security

There is a security fence around the spillway and the control and chlorination structure. All gates and doors are locked. The only problem reported has been unauthorized persons entering the spillway crest structure despite the warning signs and fencing. However, the spillway does not have any operable features that could be damaged.

The Frostburg Public Utility District Office is located in the town of Frostburg, approximately 12.1 km (7-1/2 miles) north of the dam. The dam tender resides in the general area of Frostburg and generally visits the dam twice a week, or as dictated by needed operations. Less frequent visits are made during the winter months, when inclement weather may limit access.

Conclusions

Site security measures and attendance are considered adequate.

Continued . . .

REPORTING ON SECURITY (Continued)

TABLE II-2. SAMPLE INSPECTION REPORTS: SECURITY
(Continued)

BAKER'S CREEK DAM

Description Of Security

Public access to Baker's Creek Dam is not restricted. The access road to the dam crosses the dam and provides a means of access to recreation areas west of the dam.

There are cables across the access roads to the outlet works stilling basin and upper level outlet works vent structure. These are intended to impede vehicular access to these areas but would not restrict foot access to these areas. At the time of examination, the cable restricting the lower access road was not in use, due to the requirement for access by drill crews working at the site.

There is a small parking area immediately east of the shaft house which is used by persons fishing from the dam. The shaft house is a simple structure which is secured by appropriate locks and louvers. However, the electric service facilities are on a pole immediately east of the shaft house parking area. To date, no breaches of security have been reported, but security measures at the facilities are weak for the long term.

Conclusions

Due to the unlimited public access to the parking area east of the shaft house and the vulnerability of the present service facilities to vandalism, the electric service facilities should be placed in a protective enclosure or in the auxiliary power engine generator room of the shaft house. The parking area east of the shaft house and the shaft house should be fenced and appropriate signs posted to limit access and parking in this area.

Security of the site is considered inadequate.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: OPERATING PROCEDURES

INTRODUCTION

Standing Operating Procedures (SOP) consist of documented operating instructions for dam personnel, including:

- Posted operating instructions for specific equipment
- Clear and complete operating instructions at the dam site

IMPORTANCE OF EVALUATING OPERATING PROCEDURES

A comprehensive SOP ensures that:

- A dam and its components will be operated according to design intent. Misoperation could itself create an emergency or dam safety problem.

- Operating instructions are available for authorized persons unfamiliar with the facility who may have to operate equipment when the regular operator is absent.

EVALUATING OPERATING PROCEDURES

Regardless of how apparently simple a piece of equipment may be to operate, instructions should be prepared and included as part of the dam's SOP. Review operating instructions for clarity, and determine whether instructions can be accessed quickly by site personnel. If at all possible, instructions should be kept at the site.

Check for continuity among operating documents and note whether they match actual site conditions. Assess the operator's understanding of instructions and adherence to them. Commonly encountered problems include:

- Lack of labeling on equipment controls

- Inconsistency between notation in operating instructions and labels on equipment

- Actual operation differing from operating instructions

If an operator appears to lack proper knowledge of equipment operation, or (in cases where hand operation of gates may be required) lacks the physical ability that may be required for operation under adverse conditions, note the situation in your inspection report. Note also the level of emergency response training for operators and other personnel, and how often training is provided.

The adequacy of operating instructions, including those for operation with auxiliary power, should be evaluated for normal and emergency conditions.

Continued . . .

EVALUATING OPERATING PROCEDURES (Continued)

Generally, facilities should have posted operating instructions if there is a reasonable, secure place to post them, such as a gate house. For outdoor facilities, posted instructions may be impractical.

The operating equipment at some dams is of such a basic nature that no posted operating instructions are required. At other facilities, posted operating instructions are deliberately avoided in case unauthorized persons were to gain access to the equipment. In those cases, considerable downstream damage might result from such unauthorized operation. However, trespassers still might operate equipment even without posted instructions, so the proper approach in those circumstances would be to improve security at the site.

Documentation of problems with posted operating instructions, or the lack of instructions, should be contained in your inspection report. Your report should also include the following items:

- An evaluation of available operating instructions against your agency's guidelines and requirements
- Inaccuracies or omissions discovered during your review of other emergency preparedness factors
- Inaccurate instructions for operating equipment
- Errors in the calibration of operating controls

Table II-3 contains excerpts from inspection reports concerning operating instructions.

Continued . . .

EVALUATING OPERATING PROCEDURES (Continued)

TABLE II-3. SAMPLE INSPECTION REPORTS: OPERATING INSTRUCTIONS

FORK RIVER DAM

Examination Of Operating Instructions

The current SOP has been revised March 1984, and meets May 1980 guidelines. The SOP is understood by operating personnel, who would be able to satisfactorily operate the equipment in an emergency.

Conclusions

Operating instructions are considered to be adequate.

BAKER'S CREEK DAM

Examination Of Operating Instructions

The SOP in use at the present time is preliminary and was issued in 1978.

Operating instructions for gates and valves are posted in the outlet works control cabinet. Operating personnel are knowledgeable of the proper procedures to be executed.

Conclusions

The SOP should be revised to comply with current criteria. Operating instructions therefore are considered to be inadequate.

Continued . . .

EVALUATING OPERATING PROCEDURES (Continued)

TABLE II-3. SAMPLE INSPECTION REPORTS:
OPERATING INSTRUCTIONS
(Continued)

LOST FOREST DAM

Examination Of Operating Instructions

No formal SOP for this dam is presently available. A copy of the Filling Operating Procedures (FOP), which was prepared for and used during the initial filling of the reservoir, is available at the dam and is being used until the SOP is completed. The FOP is similar in content to the SOP but the operational information is not current.

The District was scheduled to finalize the SOP for this facility this past summer. It is understood the regional office will then coordinate the review and approval of the document as soon as it is received. To emphasize the necessity of such a document for present operations and to ensure its timely completion, a formal recommendation is being made. The SOP should conform to the current guidelines dated January 1986.

Conclusions

The lack of an SOP is considered unsatisfactory. An SOP needs to be prepared as soon as possible.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: EMERGENCY ACTION PLAN

INTRODUCTION

An EAP is a set of procedures for responding to an emergency. You need to evaluate the EAP with the SOP. The two procedures are interdependent, and may be combined in one document.

IMPORTANCE OF EVALUATING THE EMERGENCY ACTION PLAN

Outdated, confusing, or incomplete procedures and instructions could result in an ineffective response to an emergency.

The purpose of emergency warning and notification procedures is to provide a clear set of instructions for:

- Taking action at the dam site in response to hypothetical emergencies such as floods, earthquakes, or equipment or structural failures such as piping.
- Notifying designated owner or agency personnel of the emergency and issuing warnings to public officials responsible for evacuation.

EVALUATING THE EMERGENCY ACTION PLAN

The EAP should contain a directory with names, titles, telephone numbers, and addresses of persons, authorities, and agencies to notify if an emergency develops at a dam. You should note how often the information is updated, and whether it is presently up-to-date. Check for the following items on emergency warning and notification plans:

✓ A clear description of circumstances under which a warning is issued, and to whom it is issued.

✓ Names, organizations, telephone numbers (day/night), and alternate communications means for individuals responsible for operation of the dam, and the sequence of contacts.

✓ Names, titles, telephone numbers (day/night), and alternate communications means for representatives of local, State, and Federal agencies, and other officials, including:

- Law enforcement officials
- Operators of other dams or water retention facilities
- Managers/operators of recreational facilities

✓ Materials and equipment for emergency dam repair, including:

- Description, location, and intended use of materials
- Description and location of equipment, and name(s) or title(s) of operator(s)
- Procedure for contacting equipment operator(s)

Continued . . .

EVALUATING THE EMERGENCY ACTION PLAN (Continued)

Figure II-2, on the next page, shows a notification flowchart, which is one type of record containing notification procedures and information. Such a flowchart ordinarily would be posted near a telephone or radio transmitter at the dam. Timely notification is crucial during an emergency.

The time for the floodwave caused by a dam failure to reach the nearest dwelling and downstream community and each subsequent endangered community should be estimated. Responsible authorities can base the sequence of warning and defensive actions on this estimate.

Warning time would be very limited for residents of property located immediately downstream of the dam within the potentially inundated area. Names, telephone numbers (day/night), and alternate means of communications with these residents should be recorded.

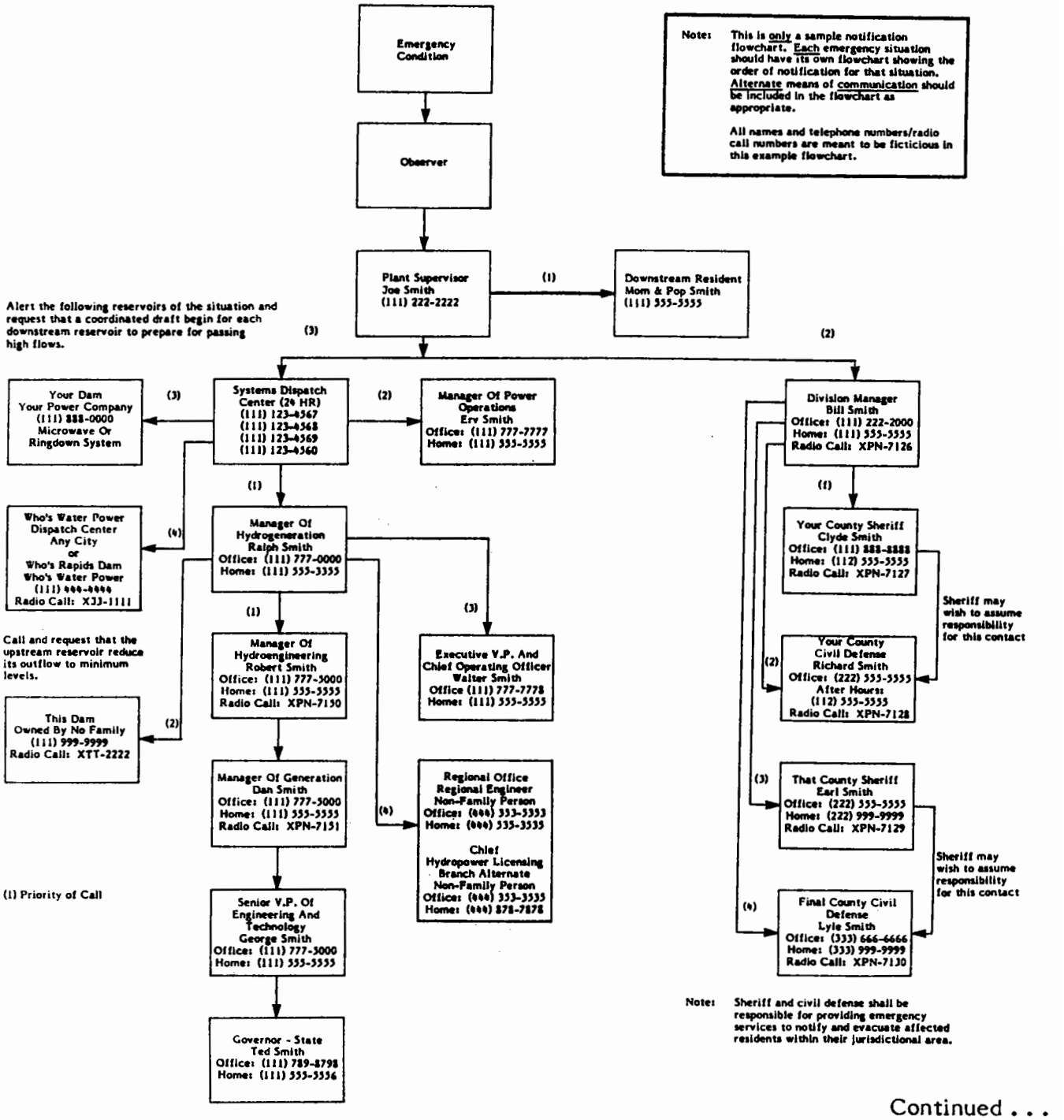
When a timely personal warning is not feasible for people downstream from the dam, sirens or other alarms may be installed to give a timely warning. This may be effective for people who live very close to the dam, or people who may be in areas that are difficult to reach, such as canyons, or who may lack telephones. The affected population generally needs to be educated in order to understand and respond effectively to the siren or alarm. (A warning system also can be used when the safety of the dam is not threatened. Sirens or alarms sometimes warn boaters and fishermen in downstream river channels before large spillway releases or unusual power releases.)

Some agencies maintain tables or charts of warning and notification procedures with associated operating instructions to be followed during different types of emergencies. Table II-4 on page II-22 is a sample page from an emergency action chart.

Continued . . .

EVALUATING THE EMERGENCY ACTION PLAN (Continued)

FIGURE II-2. NOTIFICATION FLOWCHART



Continued . . .

TABLE II-4: EMERGENCY ACTION TABLE

PROBLEM	HOW TO EVALUATE	EMERGENCY ACTION	REQUIRED EQUIPMENT, MATERIALS, AND LABOR	NOTIFICATION	DATA TO RECORD
Boils (continued); see page 4-5.	Failure Imminent - Emerging water is muddy, rate of flow is increasing, and upstream swirl (whirlpool) develops in reservoir. Tailwater flows and elevation increasing with no increase in powerhouse or spillway discharge.	Lower reservoir by generating to full capacity and opening spillway gates. Handle boils as described on page 4-5. For whirlpool in reservoir an attempt should be made to plug the entrance with large rock or anything else. Use any available riprap if necessary. If rate of flow is reduced follow with progressively smaller material. Safety precaution: In no case shall the personnel making repairs be placed in danger.	Equipment: Trucks, dozer, crane, and shovels; see equipment list. Materials: Sand, bags, gravel, bales of straw or hay, and riprap; see materials list. Labor: Equipment operators, 2 or 3 laborers; see labor list.	For failure in less than one day: see actual or imminent failure notification procedure.	Size, location, rate of flow, and how fast flow is increasing for boil. Also, size and location of whirlpool.
c. Piping - Uncontrolled leak with the removal of fines from foundation.	Serious - Could lead to failure. Tailwater flows and elevation increasing with no increase in powerhouse or spillway discharge.	Lower reservoir by generating to full capacity and opening spillway gates. Control using a blanket filter. An attempt should be made to locate the entrance on the upstream face and plug.	Equipment: Trucks, dozer, crane, and shovels; see equipment list. Materials: Sand, bags, gravel, bales of straw or hay, and riprap; see materials list. Labor: Equipment operators, 2 or 3 laborers; see labor list.	For failure in more than 5days: see slowly developing condition notification procedure. For failure in 1-5 days: see rapidly developing condition notification procedure.	Size and location of areas and approximate rate of flow.

II. EVALUATING SITE CONDITIONS AND PROCEDURES: EXERCISE

INSTRUCTIONS: Use the information presented in this unit to answer the following questions. When you have completed all the questions, check your answers against those presented in the answer key. The answer key can be found immediately following this exercise.

1. In the space below, discuss why you should compare actual site conditions with existing hazard classification studies.

_____

_____

_____

_____

_____

2. Sometimes you will need to collect very little additional downstream channel data for a high-hazard dam because _____

_____

3. Write the letter of each emergency preparedness factor next to the consideration(s) it relates to. Each factor may relate to more than one consideration.

FACTORS		CONSIDERATION	
a.	Hazard classification	_____	Proximity of public-use areas to dam
b.	Site access	_____	Fencing
c.	Site security	_____	Inundation maps
d.	Warning and notification procedures	_____	Operator training
e.	Operating instructions	_____	Emergency action chart

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: EXERCISE

4. List below at least two issues concerning site access that you should discuss with facility personnel.

   • _____

   • _____

5. Place a checkmark (✓) next to each security problem listed below that directly affects the safety of the dam.

   _____ A fence around the parking area is in poor condition.

   _____ The spillway gate controls are located on the crest of the dam in a locked control panel; the public has access to the crest of the dam.

   _____ The lock is broken on the outlet works control room door.

   _____ There is inadequate protection for boaters near the spillway entrance.

6. The following passage is an excerpt from an inspection report concerning site access. In the space below the passage, list at least one type of information which should be added to complete the evaluation of access.

   WHITMAN DAM

   The primary means of access to the dam is U.S. Highway No. 36, a well-maintained paved road. The intersection of the access road and U.S. Highway No. 36 is 27 miles north of Smithfield and 31 miles west of Riverton.

   _____

   _____

   _____

   _____

II. EVALUATING SITE CONDITIONS AND PROCEDURES: EXERCISE -- ANSWER KEY

INSTRUCTIONS: Compare your answers to those given below to see how well you learned the information presented in this unit.

1. In the space below, discuss why you should compare actual site conditions with existing hazard classification studies.

   Development may have taken place in the floodplain since the existing classification was assigned.

2. Sometimes you will need to collect very little additional downstream channel data for a high-hazard dam because **the hazard may be obvious.**

3. Write the letter of each emergency preparedness factor next to the consideration(s) it relates to. Each factor may relate to more than one consideration.

FACTORS		CONSIDERATION	
a.	Hazard classification	**a,c,d**	Proximity of public-use areas to dam
b.	Site access	**c**	Fencing
c.	Site security	**a**	Inundation maps
d.	Warning and notification procedures	**b,c,d,e**	Operator training
		d	Emergency action plan
e.	Operating instructions		

4. List below at least two issues concerning site access that you should discuss with facility personnel.

   Any two of the following:

   - **Potential hindrances discussed in previous reports**
   - **Seasonal access problems**
   - **Alternate access routes**
   - **Access problems experienced by operating personnel**

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: EXERCISE -- ANSWER KEY

5. Place a checkmark (✓) next to each security problem listed below that directly affects the safety of the dam.

   _____ A fence around the parking area is in poor condition.

   __✓__ The spillway gate controls are located on the crest of the dam in a locked control panel; the public has access to the crest of the dam.

   __✓__ The lock is broken on the outlet works control room door.

   _____ There is inadequate protection for boaters near the spillway entrance channel.

6. The following passage is an excerpt from an inspection report concerning site access. In the space below the passage, list at least one type of information which should be added to complete the evaluation of access.

   WHITMAN DAM

   The primary means of access to the dam is U.S. Highway No. 36, a well-maintained paved road. The intersection of the access road and U.S. Highway No. 36 is 27 miles north of Smithfield and 31 miles west of Riverton.

   Any of the following:

   - **Alternate access routes**
   - **Air access to the site**
   - **Availability of special equipment (four-wheel-drive vehicles, construction equipment, snowmobiles, etc.)**
   - **Accessibility under adverse weather conditions**
   - **Locations of nearest airports**

II. EVALUATING SITE CONDITIONS AND PROCEDURES: SUMMARY

REPORTING ON SITE CONDITIONS AND PROCEDURES

When you evaluate site conditions and procedures, your report will include:

- Your observations about hazard classification, access, security, operating procedures, and the Emergency Action Plan.
- Points raised in discussions with dam personnel about site conditions and procedures.
- Any deficiencies or failures to meet your agency's guidelines for the portions of an emergency preparedness plan that concern site conditions and procedures.

INSPECTION POINTS FOR SITE CONDITIONS AND PROCEDURES

In this unit, information was presented on evaluating site conditions and procedures. Listed below are key points to remember.

SITE CONDITION OR PROCEDURE . . .		INSPECTION ACTIONS . . .
Hazard Classification	✓	Review existing downstream hazard classification studies and inundation maps.
	✓	Use a method approved by your agency to assign a hazard classification if a dam has never been classified.
	✓	Identify changes to population and property that might make reclassification necessary.
Access	✓	Identify hindrances to access, seasonal conditions, alternate routes, or other access issues.
	✓	Describe the use and availability of special vehicles, such as snowmobiles, and air access to the site.

Continued . . .

II. EVALUATING SITE CONDITIONS AND PROCEDURES: SUMMARY

SITE CONDITION OR PROCEDURE . . .		INSPECTION ACTIONS . . .
Security	✓	Note the presence and condition of fences, locks, gates, log booms, and other security measures.
	✓	Describe monitoring systems, site attendance, enforcement of restrictions, security changes, and past security problems.
Operating Procedures	✓	Check operating instructions for accessibility, consistency, completeness, and accuracy.
Emergency Action Plan	✓	Make sure emergency warning and notification procedures are complete and current.

UNIT III

INSPECTING AND EVALUATING EMERGENCY PREPAREDNESS EQUIPMENT

III. INSPECTING AND EVALUATING EQUIPMENT: OVERVIEW

INTRODUCTION

During an emergency, the successful execution of an EAP will depend upon proper performance of emergency preparedness equipment. An important part of your evaluation of emergency preparedness is to judge the adequacy of site features and equipment related to emergency operations.

UNIT OBJECTIVES

After completing this unit, you will be able to:

- List emergency preparedness considerations related to communications systems.
- Outline items to evaluate when inspecting site warning systems.
- Describe points to check when inspecting auxiliary power systems.
- List factors important to remote operational capability.
- Explain typical procedures used to determine reservoir drawdown capability.

III. INSPECTING AND EVALUATING EQUIPMENT: COMMUNICATIONS SYSTEMS

IMPORTANCE OF INSPECTING COMMUNICATIONS SYSTEMS

Communications systems form the link between a dam, the project or owner's office, and the authorities responsible for the safety of the affected population downstream of the dam. If a threatening situation develops, immediate communication from the site may allow time for flood preparation or evacuation. Failure of communications equipment could have disastrous consequences. Consequently, some agencies require backup communications for high- and moderate-hazard dams.

PREPARING TO INSPECT COMMUNICATIONS SYSTEMS

Telephone, two-way radio, and microwave are the principal communications systems used at facilities. Descriptions of communications equipment at a site are usually included in operating documents used by site personnel, and will be noted in inspection reports. Pre-inspection review of this information will prepare you for discussing communications performance with operating personnel, and enable you to compare the written descriptions to the actual equipment.

INSPECTING COMMUNICATIONS SYSTEMS

To inspect communications systems, you should . . .

- ✓ Verify available communications systems. Note any differences between the written descriptions of the communications systems and the equipment you observe at the site. Discuss changes and additions with project personnel.

- ✓ Review communications systems performance. Determine what locations and/or offices the communications system can reach reliably from the site, and the attendance at those locations and/or offices. Compare this information with your pre-inspection data review.

  Ask field personnel whether the communications systems have failed or been unreliable in the past, and record the reasons for any problems. Ask also for opinions about potential weak links in the systems.

- ✓ Evaluate the need for backup communication.

- ✓ Evaluate auxiliary power requirements. Make sure that a communications system relying upon auxiliary power will receive adequate power.

☞ **INSPECTION TIP:** If telephone is the primary communications system, check to see if the telephone lines come into the dam site along the downstream channel (often the case because the channel is the easiest route for installation). These lines could be knocked out during large spillway flows or by a dam failure flood, rendering communications impossible.

III. INSPECTING AND EVALUATING EQUIPMENT: COMMUNICATIONS SYSTEMS

REPORTING ON COMMUNICATIONS SYSTEMS

Include the following information in your inspection report about the communications systems:

- A description of communications facilities at the site.
- Your conclusions concerning the suitability of the communications capability and the potential unreliability of individual communications modes.
- A discussion of available auxiliary power for communications and its reliability.

Table III-1 contains excerpts from inspection reports concerning communications.

TABLE III-1. SAMPLE INSPECTION REPORTS: COMMUNICATIONS SYSTEMS

SUNNYDALE DAM

Description Of Communications System

Communications at the dam site include telephone, microwave, and two-way radio. Telephone facilities at Sunnydale include an in-plant system with access to commercial lines. The microwave system is installed to provide a continuous multipurpose communications network between the Sunnydale facility and the COCO (Central Operations Coordinating Office). A two-way radio base station is located in the sloping intake structure, with remote radio telephones in the powerplant, control room, and office, and mobile units in the employees' vehicles. This radio allows two-way voice communication from the dam to the Brooks Field Office or COCO, independent of the microwave system.

Conclusions

The communications system is considered adequate.

Continued . . .

REPORTING ON COMMUNICATIONS SYSTEMS (Continued)

TABLE III-1. SAMPLE INSPECTION REPORTS: COMMUNICATIONS SYSTEMS
(Continued)

BAKER'S CREEK DAM

Description Of Communications System

There are no permanent telephone or radio communication facilities at the dam site. The only means of communication with persons at the dam is mobile radio.

The nearest telephone is at Baker's Creek field station, located on U.S. Highway No. 26 approximately one-half mile west of the junction of the dam access road. This office is not maintained in the winter. Telephones are available at service stations on U.S. Highway No. 26 approximately 7 miles east and 12 miles west of the dam access road and the U.S. Highway No. 26 junction. The State Road Commission equipment yard is located on U.S. Highway No. 26 approximately 10 miles west of the dam access road junction. This facility is equipped with a radio compatible with the Highway Patrol network and telephone service.

Conclusions

Due to the isolated nature of Baker's Creek Dam and the normal means of access during the winter months, stationary radio equipment or a telephone should be installed in the outlet works shaft house. If radio equipment is installed, it should be capable of operation on Water Conservancy District and Highway Patrol network frequencies.

LOST FOREST DAM

Description Of Communications System

The communications system at the dam consists of a commercial telephone, located in the control and chlorination structure, and two-way radios in district vehicles.

Conclusions

The communications system is considered adequate.

III. INSPECTING AND EVALUATING EQUIPMENT: WARNING SYSTEMS

IMPORTANCE OF INSPECTING WARNING SYSTEMS

Some means must exist to detect a developing emergency and convey a warning to persons responsible for taking emergency actions. Electrical/mechanical warning systems may be included in project instrumentation, but most sites rely upon warnings transmitted by site personnel. Without warnings, evacuation or preventative actions may be delayed or made impossible.

PREPARING TO INSPECT WARNING SYSTEMS

Relatively few dams have electrical/mechanical devices to warn of potential adverse conditions at a site. In most cases, you will be evaluating the frequency of attendance at the dam and the effectiveness of the communications system for notifying appropriate personnel in an emergency. You should review attendance requirements in the SOP and in the EAP prior to your examination.

INSPECTING WARNING SYSTEMS

If a dam you are inspecting is equipped with a warning system, you should examine the condition of the system. Discuss the capabilities and reliability of any existing electrical/mechanical system with site personnel. Determine the actual attendance pattern at the dam, and the accuracy of the written description of the warning system. Remote monitoring of the site cannot automatically be considered a warning system.

REPORTING ON WARNING SYSTEMS

Your inspection report on a dam's warning system should include:

- A description of the warning system
- Specific considerations upon which the evaluation of the warning system (or the determination of the need for a warning system) is based

If the site presently does not have a warning system, your inspection may indicate that the installation of a system should be considered.

To decide whether a mechanized warning system might be needed, consider:

- Hazards downstream from the dam
- Proximity of hazards to the structure
- Risk of the structure
- Attendance at the site under normal and various potential emergency situations
- Type of dam
- Configuration of appurtenances
- Access to the site
- Communications systems available at the site

Continued . . .

REPORTING ON WARNING SYSTEMS (Continued)

Requirements for warning systems vary among agencies. You might recommend that the installation of a warning system be considered, subject to evaluation by an experienced and qualified engineer.

Table III-2 contains excerpts from inspection reports concerning warning systems.

TABLE III-2. SAMPLE INSPECTION REPORTS: WARNING SYSTEMS

SUNNYDALE DAM

Description Of Warning System

Mechanical/Electrical Components: When fully operational, the Sunnydale Powerplant and Dam will be operated by the COCO operator at the regional office. Remote monitoring and control are facilitated by the CWPSC (Centralized Water and Power System Control) which allows the COCO operator to maintain a 24-hour watch on the facility and operate the dam's outlet works and powerplant. Operational data will be under constant surveillance and will be transmitted to the COCO operator via a microwave system. Over 300 individual data parameters can be monitored by the system.

Attendance: Operating instructions indicate that any time reservoir elevation 1088 is exceeded, two persons will be stationed at the dam 24 hours a day. One will remain in the operations center to maintain communication, while another can inspect the dam and appurtenances for signs of stress.

Presently, a mechanic and an electrician are normally at the powerplant 8 hours a day, 5 days a week. Until the CWPSC becomes completely operational, a powerplant operator is also stationed there as required during generation.

A resource manager is presently stationed in the Sunnydale field office located about 2 miles south of the dam on the main access road. His responsibility is to oversee the recreation and land management activities at the reservoir.

Conclusions

With the present attendance at the site and the planned automated monitoring of the site, the system to warn responsible personnel of adverse conditions at the site is considered adequate.

Continued . . .

REPORTING ON WARNING SYSTEMS (Continued)

TABLE III-2. SAMPLE INSPECTION REPORTS: WARNING SYSTEMS
(Continued)

BAKER'S CREEK DAM

Description Of Warning System

There are no automated systems to warn responsible personnel of adverse conditions at the dam site. Reporting of emergency conditions due to earthquakes, high water, or discharge is by radio or telephone, but no detailed plan exists for downstream warning in such emergencies.

A seismic monitoring device is presently being installed at the site.

Conclusions

The SOP should be revised to meet current criteria and should include additional coverage of the operation of outlet works in emergency situations.

An inundation study for this dam is underway. Completion of the study should be given a high priority. Based on the results of this study, the need for a formal warning system should be evaluated.

FARMVILLE DAM

Description Of Warning System

A warning system has been developed for areas downstream from Farmville Dam. The SOP contains an "Emergency Procedure for Failure or Impending Failure of the Dam," which lists persons to be notified in the event of an emergency at the dam. Site attendance consists of weekly visits by the dam tender, and is adequate for this low-hazard dam.

Conclusions

The warning system is considered adequate.

III. INSPECTING AND EVALUATING EQUIPMENT: AUXILIARY POWER SYSTEMS

IMPORTANCE OF INSPECTING AUXILIARY POWER SYSTEMS

If normal power is disabled during an emergency, auxiliary power may be needed to operate equipment such as gates and communications facilities. Ability to carry out the EAP could be severely hindered without auxiliary power.

PREPARING TO INSPECT AUXILIARY POWER SYSTEMS

Two common types of auxiliary power systems are:

- Engine generator set
- Engine-driven pump

Previous inspection reports and operating procedures probably will contain descriptions of auxiliary power sources, equipment to be operated by auxiliary power, and records of breakdowns and repairs. Review this information before the actual inspection for possible check points at the site.

INSPECTING AUXILIARY POWER SYSTEMS

Your onsite examination of an auxiliary power system should begin with the operation of the auxiliary power device. Equipment requiring operational capability under auxiliary power should be operated using the auxiliary system, including a representative gate or valve on each appurtenance so equipped. To the extent possible, operation should reflect the largest loads on the operated equipment to verify auxiliary power capability.

When you test power-operated equipment, make sure the following criteria are met:

- The device moves through full travel operation.
- The maximum probable load is applied (to the degree conditions permit).
- Normal and adverse conditions are simulated.
- Available personnel (usually one person) can reasonably operate the device.

Your discussions with site personnel should cover the following issues:

- Any changes in, or modifications of, auxiliary power equipment
- Repair of any defects identified in the pre-inspection review
- Historical performance of the equipment
- Actual exercising of the equipment
- Reliability of normal power

Continued . . .

III. INSPECTING AND EVALUATING EQUIPMENT: AUXILIARY POWER SYSTEMS

INSPECTING AUXILIARY POWER SYSTEMS (Continued)

The SOP should include a schedule for exercising auxiliary power equipment, description of the fuel needed, periodic replacement of fuel to keep it fresh, and a description of the procedures for using the auxiliary power source.

You should also examine the condition of the auxiliary power equipment to the extent possible, and consider potential performance problems under adverse conditions. If the auxiliary system requires fuel, an adequate supply of fresh fuel must be available.

☞ **INSPECTION TIP:** Diesel engine generators tend to have problems with fuel supply lines, particularly under adverse conditions.

Evaluation of auxiliary power systems should be performed in view of problems that might affect facility safety if auxiliary power were nonexistent or if it malfunctioned. Items that you should inspect include (but may not be limited to) spillway gate operation and outlet works gate operation. Also, consider the adequacy of auxiliary power for venting, lighting, and other auxiliary equipment only if a potential safety problem, such as backup power for communications equipment, is involved.

Your evaluation should be based on whether the equipment is suitably functional, rather than on whether it is state-of-the-art. Antiquated equipment may perform the intended functions, even though it may appear to be in an inefficient manner when compared to modern equipment. The determination of the reliability of older equipment under adverse conditions is often a subjective judgment. The suitability of auxiliary power equipment should be assessed in light of the type and reliability of normal power.

☞ **INSPECTION TIP:** In some systems with powerplants, switching auxiliary power to appurtenant devices under unusual operating conditions may be a complicated process. This process should be documented and tested.

REPORTING ON AUXILIARY POWER SYSTEMS

Your inspection report concerning auxiliary power systems at a dam should include the following items:

- A description of the existing auxiliary power equipment
- A brief discussion of equipment that is to be operated under auxiliary power, and additional equipment that should be considered for auxiliary power operation
- Your evaluation of the existing auxiliary power equipment, and the basis for the evaluation

If you conclude that the auxiliary power system probably is inadequate, recommend that the system be fully checked and rehabilitated or replaced.

Continued . . .

REPORTING ON AUXILIARY POWER SYSTEMS (Continued)

Table III-3 contains excerpts from several inspection reports concerning auxiliary power systems.

TABLE III-3. SAMPLE INSPECTION REPORTS: AUXILIARY POWER SYSTEMS

BAKER'S CREEK DAM

Description Of Auxiliary Power System

Auxiliary power for operation of the outlet works in the event of normal power interruption is provided by an engine generator set. The fuel used to power the engine generator set is liquid propane. Test operation of this auxiliary power system under full load was satisfactory.

Conclusions

The auxiliary power system is considered adequate.

LOST FOREST DAM

Description Of Auxiliary Power System

Auxiliary power consists of a propane-fueled engine-driven oil pump, located in the control and chlorination structure, which can operate all of the outlet works gates and valves. The engine started satisfactorily and the oil pump provided the necessary oil pressure to successfully operate the 42- by 42-inch high-pressure gates. The engine is test operated every 2 months.

Conclusions

The auxiliary power system is considered adequate.

Continued . . .

REPORTING ON AUXILIARY POWER SYSTEMS (Continued)

TABLE III-3. SAMPLE INSPECTION REPORTS: AUXILIARY POWER SYSTEMS (Continued)

SUNNYDALE DAM

Description Of Auxiliary Power System

Normal power at the site is provided by turbine generators via the station-service circuits in the powerhouse. When the generators are not in operation, station service is provided by feedback from a local utility via the 230-kV transmission lines connected to the switchyard.

Standby station-service power is provided by an emergency engine generator set located in the control house on the sloping intake structure. The diesel-engine-driven generator is rated at 115kW. Besides the essential powerplant equipment, the generator supplies power to the intake gate, low-level outlet works, butterfly valves, outlet works, and radio facilities located in the control house. Upon loss of station-service power, fully automatic transfer to emergency power is accomplished by an automatic transfer switch. This equipment is tested every month and has always operated satisfactorily.

Separate DC lighting and power supply circuits are provided in the powerhouse for basic controls and emergency power for priority circuits. The remote monitoring control computers and transmitters will automatically switch to this battery power when the normal electric supply is lost.

Conclusions

The auxiliary power capability provided is adequate.

III. INSPECTING AND EVALUATING EQUIPMENT: REMOTE OPERATION

IMPORTANCE OF INSPECTING REMOTE OPERATIONAL SYSTEMS

The ability to control equipment such as spillway gates or outlet works gates from a location away from the dam permits timely response to emergencies requiring the operation of this equipment, particularly if the dam is not fully attended and access to the site is relatively difficult. If remote operation is a part of the EAP, the system must operate reliably when needed.

PREPARING TO INSPECT REMOTE OPERATIONAL SYSTEMS

Examine previous inspection reports and project operating procedures for descriptions of the remote operation devices. (**NOTE:** Remote operation is the operation of an appurtenant device from a location away from the dam site, rather than from a separate location at the site.)

INSPECTING REMOTE OPERATIONAL SYSTEMS

The review of remote operational capability during the onsite examination is often limited by operational situations. You should verify the capability of an existing system to direct remote operations by gathering pertinent information that describes the system. You also should examine the operating logbook to review test performance and to ascertain whether problems have been experienced.

During the inspection, discuss the following issues with site personnel:

- Testing of remote operational systems
- Historical reliability of the system
- Potential weaknesses of the system

Evaluation of the reliability of remote operational equipment under adverse conditions is often difficult, since a review of complex electrical control systems is beyond the expertise of most inspectors, and potential physical weaknesses in the system may be far from the site.

Your determination of the need to provide for remote operational capability will be based largely on previously discussed emergency preparedness considerations, and the configuration of appurtenances of the dam structure.

A dam with an uncontrolled spillway of adequate capacity for Inflow Design Flood (IDF) discharges would be less likely to require remote operation than an installation with a gated spillway or large outlet works that significantly contributes to flood routing.

An accessible site with a warning system or comprehensive required attendance would be less likely to require remote operation than a site of similar configuration with marginal attendance and accessibility.

III. INSPECTING AND EVALUATING EQUIPMENT: REMOTE OPERATION

REPORTING ON REMOTE OPERATIONAL SYSTEMS

Your inspection report on remote operations should include the following information:

- A description of the remote operational capability of the dam you are inspecting
- If a remote operational system is present, an evaluation of how well the system capabilities match the site requirements for remote operation
- A discussion of the reliability of any existing remote operational equipment, to the extent possible

If a remote operational system is not present at the site, you should discuss and justify the lack of or need for such a system in your report. If the improvement of other emergency preparedness considerations would eliminate the need for remote operation, you should discuss such modifications in the report.

Table III-4 contains sections from inspection reports that concern remote operation.

TABLE III-4. SAMPLE INSPECTION REPORTS: REMOTE OPERATION

BAKER'S CREEK DAM

Description Of Remote Operation

There is no remote operation capability for the outlet works at Baker's Creek Dam.

Conclusions

Routing of the Inflow Design Flood (IDF) assumed operation of the outlet works, requirements for opening the access road by March 1, and required attendance during release periods. If these assumptions are adhered to and a warning system is installed as recommended, remote operation is not considered necessary.

Continued . . .

REPORTING ON REMOTE OPERATIONAL SYSTEMS (Continued)

TABLE III-4. SAMPLE INSPECTION REPORTS:
REMOTE OPERATION
(Continued)

FORK RIVER DAM

Description Of Remote Operation

The problem previously experienced with remote operation of the 24-inch outlet-works hollow-jet valve that is described in previous inspection reports has been corrected. New shaft encoders have been installed on the valve and also on the spillway sluice gate. The project reported no further problems with remote operation from the Monroe Control Center; however, this was not verified during the onsite examination.

Conclusions

Remote operation is considered adequate.

LOST FOREST DAM

Description Of Remote Operation

Remote operation is not provided at the dam and is not considered to be necessary. The spillway is ungated and the outlet works is not needed to pass flood flows.

Conclusions

Remote operation of the appurtenances is not necessary.

III. INSPECTING AND EVALUATING EQUIPMENT: RESERVOIR DRAWDOWN

IMPORTANCE OF EVALUATING RESERVOIR DRAWDOWN CAPABILITY

The ability to lower the reservoir rapidly during an emergency is vital to emergency preparedness. If design or equipment problems make reservoir drawdown unacceptably slow, the dam could fail and release a full or nearly-full reservoir. For some dam-threatening conditions, such as piping, lowering the reservoir quickly could prevent failure.

The level of risk and the hazard potential at each site may define acceptable drawdown rates. Risk is the probability that the dam may fail, while hazard describes the probable consequences of dam failure, i.e., loss of life and property damage. A dam may be at little risk of failure, and yet present a high hazard should failure occur. Table III-5 lists some possible risk factors. Other risk factors may exist at particular dams.

TABLE III-5. RISK FACTORS FOR DAMS

Hydrologic factors
- Floods exceeding those used for design
- Uncertainty of flood estimation
- Ratio of flood to storage volumes in the reservoir
- Reservoir sediment deposition potential

Geologic factors
- General foundation conditions
- Seismicity of site
- Faulting at site
- Liquefaction potential of dam and foundation
- Rock condition (fractures, shear zones, relief jointing, solubility)
- Seepage potential

Structural factors
- Dam type and design
- Unprecedented size
- Unusual complexity
- Age and condition

Construction and material factors
- Construction material characteristics such as permeability, erodibility, and strength
- Quality of construction

Operating Factors
- Remoteness and accessibility of site
- Training and experience of operating personnel
- Reliability of commercial and auxiliary power
- Complexity of equipment and operating procedures

III. INSPECTING AND EVALUATING EQUIPMENT: RESERVOIR DRAWDOWN

IMPORTANCE OF EVALUATING RESERVOIR DRAWDOWN CAPABILITY (Continued)

Agencies develop **drawdown criteria** to judge whether a given facility meets standards for rapid drawdown. These criteria differ from agency to agency. Table III-6 gives drawdown criteria for one agency.

PREPARING TO EVALUATE RESERVOIR DRAWDOWN CAPABILITY

Check design documents for the results of studies on reservoir drawdown capability. Note inadequate capability, and recommendations for modifications, repairs, or the replacement of structures that affect the reservoir drawdown rates. If such studies were never done, recommend that they be performed.

EVALUATING RESERVOIR DRAWDOWN CAPABILITY

To assess the adequacy of reservoir drawdown capability, you should examine the present condition of the dam appurtenances. If the outlet works or any other appurtenance considered in the evacuation study previously conducted for the dam is incapable of reliably discharging the flows assumed in the studies, this condition should be recognized in your evaluation.

> ☞ **INSPECTION TIP:** It is not unusual for reservoir drawdown capability to be theoretically adequate but judged inadequate due to the existing conditions of the discharge features.

Methods and criteria for evaluating the adequacy of drawdown capability vary from agency to agency. Some agencies have developed reservoir drawdown capability worksheets to provide standardized documentation of reservoir drawdown calculations.

Typical required data include:

- Beginning reservoir water surface elevation
- Reservoir inflow
- Downstream hazard classification assigned to the dam
- Level of risk associated with the integrity of the dam
- Appurtenances assumed to be used in evacuation
- The percentage of maximum capacity considered reliable for each appurtenance

TABLE III-6. EXAMPLE OF DRAWDOWN CRITERIA
Acceptable Range of Reservoir Drawdown Time
(in days)

Drawdown Stage	Degree Of Hazard And Risk								
	High Hazard, High Risk	High Hazard, Significant Risk	High Hazard, Low Risk	Significant Hazard, High Risk	Significant Hazard, Significant Risk	Significant Hazard, Low Risk	Low Hazard, High Risk	Low Hazard, Significant Risk	Low Hazard, Low Risk
75- percent height*	10-20	20-30	30-40	20-30	30-40	40-50	40-50	50-60	60-90
50- percent height*	30-40	40-50	50-60	40-50	50-60	60-70	60-70	70-90	90-120
10- percent storage**	40-50	50-60	60-70	50-60	60-70	70-80	70-80	80-120	120-160
25- percent height*	60-80	70-90	80-100	70-90	80-100	90-110	90-110	100-160	150-220

* Hydraulic height measured from the top of normal pool elevation, i.e., no flood storage.

** Remaining storage measured from the reservoir storage capacity at the top of normal pool elevation, i.e., no flood storage.

III. INSPECTING AND EVALUATING EQUIPMENT: RESERVOIR DRAWDOWN

REPORTING ON RESERVOIR DRAWDOWN CAPABILITY

Report how and why drawdown criteria are met, even if the capability is not a problem. Conclude your coverage of drawdown capability with an evaluation. If you determine that drawdown capability may be inadequate, recommend additional evaluation.

Table III-7 below contains excerpts from inspection reports concerning reservoir drawdown capability.

TABLE III-7. SAMPLE INSPECTION REPORTS: RESERVOIR DRAWDOWN CAPABILITY

BAKER'S CREEK DAM

Description Of Reservoir Drawdown Capability

Due to the large storage capacity of the reservoir (1,106,500 acre-feet), reducing the reservoir water surface from elevation 7602.4 (top of active conservation) to elevation 7517 (90 percent reservoir drawdown) would require approximately 230 days. The maximum acceptable time period is 150 days.

Conclusion

The reservoir drawdown capability of the outlet works is inadequate, and should be evaluated.

FORK RIVER DAM

Description Of Reservoir Drawdown Capability

Reservoir drawdown guidelines have changed since the previous examination. According to the current guidelines, the adequacy of reservoir drawdown capability is assessed at four evacuation stages based on the degree of hazard and risk associated with the dam. Fork River Dam is considered to be a high-hazard, significant-risk facility. The risk is considered significant because of the potentially critical seepage problems at reservoir elevations significantly above the active conservation level, and because there is a large flood surcharge pool.

Conclusions

The drawdown capability should be formally evaluated according to these criteria and the aforementioned guidelines.

III. INSPECTING AND EVALUATING EQUIPMENT: EXERCISE

INSTRUCTIONS: Use the information presented in this unit to answer the following questions. When you have completed all the questions, check your answers against those presented in the answer key. The answer key can be found immediately following this exercise.

1. Using the auxiliary power system, a representative _____ or _____ on each appurtenance should be operated under auxiliary power.

2. In the space below, list at least three factors you should consider before recommending installation of a mechanized warning system.

   - _____
   - _____
   - _____

3. You are conducting a facility emergency preparedness inspection of a dam with a 40-year-old engine-driven pump serving as the auxiliary power system. While the power is sufficient to operate the necessary gates and valves, only marginal capacity remains to operate vents and lighting. Should you report that the auxiliary power system is inadequate? Write below the criteria you would use in evaluating the situation.

_____

_____

_____

_____

_____

Continued . . .

III. INSPECTING AND EVALUATING EQUIPMENT: EXERCISE

4. The following passage is an excerpt from an inspection report concerning communications systems. In the space below the passage, list at least one type of information that should be added to complete the evaluation of communications.

> **PALMER DAM**
>
> Communications systems in use at Palmer Dam include telephone and radio. The telephone facilities consist of both in-plant and commercial systems. Two-way radios allow communication between the dam control room, project vehicles, and the regional office in Augusta.

III. INSPECTING AND EVALUATING EQUIPMENT: EXERCISE -- ANSWER KEY

INSTRUCTIONS: Compare your answers to those given below to see how well you learned the information presented in this unit.

1. Using the auxiliary power system, a representative **gate** or **valve** on each appurtenance should be operated under auxiliary power.

2. In the space below, list at least three factors you should consider before recommending installation of a mechanized warning system.

   Any three of these factors:

   - **Downstream hazards (including proximity to dam)**
   - **Hazard classification**
   - **Attendance at site**
   - **Type of dam**
   - **Configuration of appurtenances**
   - **Access to site**
   - **Communications at site**

3. You are conducting a facility emergency preparedness inspection of a dam with a 40-year-old engine-driven pump serving as the auxiliary power system. While the power is sufficient to operate the necessary gates and valves, only marginal capacity remains to operate vents and lighting. Should you report that the auxiliary power system is inadequate? Write below the criteria you would use in evaluating the situation.

   Power for auxiliary equipment such as vents and lighting should be included in your evaluation only if a potential safety problem is involved (such as backup power for communications equipment). Antiquated equipment that is performing satisfactorily is usually acceptable in spite of technological inefficiency.

Continued . . .

III. INSPECTING AND EVALUATING EQUIPMENT: EXERCISE -- ANSWER KEY

4. The following passage is an excerpt from an inspection report concerning communications systems. In the space below the passage, list at least one type of information that should be added to complete the evaluation of communications.

> **PALMER DAM**
>
> Communications systems in use at Palmer Dam include telephone and radio. The telephone facilities consist of both in-plant and commercial systems. Two-way radios allow communication between the dam control room, project vehicles, and the regional office in Augusta.

Any of the following:

- **Condition of the systems presently in use**
- **Past performance of existing systems**
- **Capability of auxiliary power for communications**

III. INSPECTING AND EVALUATING EQUIPMENT: SUMMARY

REPORTING ON EMERGENCY EQUIPMENT

When you inspect and evaluate emergency preparedness equipment your report will include:

- Descriptions of equipment
- Notes of differences between actual and reported equipment
- Descriptions of deficiencies or possible deficiencies, including histories of performance, maintenance, and failures
- Discussions of possible performance problems under adverse conditions
- Recommendations for further study, if appropriate

INSPECTION POINTS FOR EMERGENCY EQUIPMENT

In this unit, information was presented on inspecting and evaluating emergency preparedness equipment. Listed below are the key points to remember.

EQUIPMENT/FACILITY TYPE . . .	INSPECTION ACTIONS . . .
Communications Systems	✓ Determine the locations/agencies that can be reached by radio systems, and attendance at those sites. ✓ Make sure a communications system depending on emergency power will receive adequate power.
Warning Systems	✓ Record the extent of attendance at the dam. Note the effectiveness of the communications systems for conveying warnings. ✓ Consider whether a site without a mechanical/ electrical warning system should have such a system.

Continued . . .

III. INSPECTING EMERGENCY EQUIPMENT: SUMMARY

INSPECTION POINTS FOR EMERGENCY EQUIPMENT (Continued)

EQUIPMENT/FACILITY TYPE . . .	INSPECTION ACTIONS . . .
Auxiliary Power Systems	✓ See that the equipment to be run on the backup system is operated, including a representative gate or valve on each appurtenance so equipped. ✓ Test or observe the operation of hand-operated devices. ✓ Make sure that the system for switching power to appurtenant devices under unusual operating conditions is well documented and tested.
Remote Operation	✓ Review the operating logbook for previous test performance and learn about previous problems experienced. ✓ Consider whether the installation of remote operation would be desirable at the site.
Reservoir Drawdown Capability	✓ Check the current condition of outlet works and spillways. ✓ Review results of studies on reservoir drawdown capability. ✓ Evaluate reservoir drawdown capability, and recommend additional evaluation if necessary.

FINAL REVIEW EXERCISE

EVALUATION OF FACILITY EMERGENCY PREPAREDNESS

FINAL REVIEW EXERCISE

INSTRUCTIONS: This exercise is designed to help you learn about your organization's expectations for evaluating facility emergency preparedness. Complete the steps described below.

STEP 1: Get a copy of any guidelines your organization has on how to evaluate facility emergency preparedness. Review the guidelines and make notes on the key points.

STEP 2: Ask your supervisor or another dam safety expert for a copy of an emergency preparedness report that is considered especially thorough or well-written. The emergency preparedness evaluation will probably be a portion of a total report on a project.

STEP 3: Go through the emergency preparedness evaluation and list what you think are the strong points (or weaknesses, if any) of the evaluation.

STEP 4: Meet with your supervisor or some other expert and go over your analysis of the evaluation. Ask if there are any other important strengths or weaknesses in the evaluation that you did not list.

STEP 5: Based on this exercise and the material in this module, make a checklist of the things to remember when you are documenting and reporting findings about emergency preparedness of a dam.

APPENDIX A

GLOSSARY

GLOSSARY

APPURTENANT STRUCTURES - Auxiliary features of a dam that are necessary to the operation of the dam project. These may include spillways, outlet works, gates and valves, power plants, tunnels, and switchyards.

DAM - A barrier constructed across a watercourse for the purpose of storage, control, or diversion of water.

EMERGENCY ACTION PLAN (EAP) - A plan designed to alleviate hazards or reduce damages that may be caused by flooding due to dam failure or unusually high flow through the spillway system. An EAP contains procedures to be followed in the event of structural malfunctions or the occurrence of a natural event that approaches or exceeds the design limits of the dam.

FLOODPLAIN - The downstream area that would be inundated or otherwise affected by the failure of a dam or by large flows.

HAZARD CLASSIFICATION - A rating (e.g., low, moderate/significant, or high hazard) that is a representation of the probable loss of life and property damage downstream from a dam based on the results of breaching studies of the dam, and an identification of the area downstream that would be inundated.

INFLOW DESIGN FLOOD (IDF) - The flooded hydrograph used in the design of a dam and its appurtenant works particularly for sizing the spillway and outlet works, and for determining maximum temporary storage and height of dam requirements.

INUNDATION MAP - A map showing areas that would be affected by flooding such as by uncontrolled release of a dam's reservoir or passage of the design flood through the spillway.

OUTLET WORKS - A system of dam components that regulates or releases water impounded by a dam. Components of an outlet works include an entrance channel, intake structure, conduit, gate or valve housing, energy dissipators, and return channel.

REMOTE OPERATION - The ability to operate equipment, such as spillway gates, from a location other than the dam site.

RESERVOIR - The body of water impounded by a dam.

RESERVOIR DRAWDOWN CAPABILITY - An estimate of the time needed to fully or partially drain a reservoir.

RISK - The probability that an adverse event such as a dam failure will occur.

SPILLWAY - A structure over or through which flood flows are discharged. If the rate of flow is controlled by mechanical means, such as gates, it is considered a controlled spillway. If the elevation of the spillway crest is the only control, it is considered an uncontrolled spillway.

STANDING OPERATING PROCEDURES (SOP) - Written guidelines to be followed for normal and emergency operation of the components of a dam.

APPENDIX B

REFERENCES

REFERENCES

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