Training
Aids for
Dam
Safety

MODULE:

HOW TO ORGANIZE A DAM SAFETY PROGRAM

TADS

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Aids for
Dam
Safety

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HOW TO ORGANIZE A DAM SAFETY PROGRAM

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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.

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Forest Service
Bureau of Land Management
National Park Service
Bureau of Indian Affairs
Fish and Wildlife Service
Department of Energy
Nuclear Regulatory Commission
International Boundary and Water Commission

TADS SUPPORTING ORGANIZATIONS

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

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MODULE INTRODUCTION

MODULE INTRODUCTION

OVERVIEW OF THIS MODULE

Are you developing a Dam Safety Program for a dam owner, or for an organization or agency that owns or operates dams? Or are you charged with developing a Dam Safety Program for a regulatory agency?

How To Organize A Dam Safety Program is a tool designed to guide you through the process step by step. You will learn about the responsibility for dam safety, the components of a Dam Safety Program, the steps needed to build those components, and resources available to help you establish and operate a program.

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.

CONTENTS OF THIS MODULE

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

- **Unit I. Overview:** Presents information about responsibility for dam safety, components of Dam Safety Programs, and roles played by owners and regulators.
- **Unit II. Planning A Dam Safety Program:** Describes the processes that dam owners and regulators follow to establish Dam Safety Programs.
- **Unit III. Operating The Dam Safety Program:** Provides information about the activities that dam owners and regulators carry out to operate Dam Safety Programs.
- **Appendix A. Services Offered By Organizations:** Describes the types of services provided by various agencies that might be useful to assist with dam safety.
- **Appendix B. Sample Dam Inventory Data Forms:** Discusses various agencies' procedures for developing dam inventory files.
- **Appendix C. Priority Ranking Systems:** Presents sample criteria used by the Bureau of Reclamation and the State of Maryland to prioritize an inventory of dams for dam safety inspections, analyses, and corrective action.
- **Appendix D. Training Courses:** Provides a list of courses offered by Federal agencies and other sources that pertain to dam safety.
- **Appendix E. References:** Lists recommended references that can be used to supplement this module.

MODULE INTRODUCTION

DESIGN OF THIS MODULE

This module is comprised solely of text instruction. There is no accompanying video presentation.

UNIT I

OVERVIEW

I. OVERVIEW: WHAT IS A DAM SAFETY PROGRAM?

INTRODUCTION

A Dam Safety Program is an organized effort to ensure that dams included in a program will be safe for continued operation. Laws, regulations, guidelines, policies, and prudent practice govern the conduct of Dam Safety Programs.

A Dam Safety Program includes two phases . . .

Planning: During the planning phase, the program activities are determined. Required administrative and technical resources are identified.

Operating: During the operating phase, administrative and technical resources are obtained. Dam Safety Program activities are performed. Systems are established for tracking dam safety activities and expenditures. Finally, information is collected and records are maintained.

This module provides general guidance on how to establish and operate Dam Safety Programs. However, before discussing details, we will first review some general concepts related to Dam Safety Programs.

WHO IS RESPONSIBLE FOR DAM SAFETY?

People and organizations who own dams are responsible for the safe operation of their dams, and for the consequences of accidents or failures.

Regulatory agencies have the responsibility to monitor dams for hazardous conditions that endanger life or property, and to enforce those laws, regulations, guidelines, and policies that direct owners to correct deficiencies.

All dam owners/operators and regulators with the responsibility for dams whose failures have the potential to cause loss of life must consider adopting a formal Dam Safety Program. Such a program should be established by a person or organization regardless of whether they own one dam or many dams. The program should consider the same elements regardless of dam size.

Dam owners and dam regulators each operate Dam Safety Programs. A dam will often be included in two different Dam Safety Programs: one conducted by the owner or operator and the other conducted by a regulatory agency.

Some large Federal agencies serve a dual role, both as owners and as regulators of their dams. States also can play dual roles. A State may own dams, especially dams constructed for recreation or conservation, and in addition may regulate all other dams within the State that are required by law to be regulated by the State Dam Safety Program.

Dam Safety Program operation for an owner or operator includes financial responsibility for each dam's operation, maintenance, and correction of deficiencies. A strictly regulatory agency, while charged with verifying compliance with a Dam Safety Program, does not physically maintain or operate dams, nor bear the cost of correcting deficiencies.

I. OVERVIEW: WHAT IS A DAM SAFETY PROGRAM?

HOW DO DAM SAFETY PROGRAMS VARY?

Will the program you organize be small-scale or large-scale? The size and complexity of Dam Safety Programs depend upon:

- The number of dams in the program.
- The complexity of maintaining and operating the dams.
- Whether a regulatory function is required.

Small-Scale Dam Safety Programs

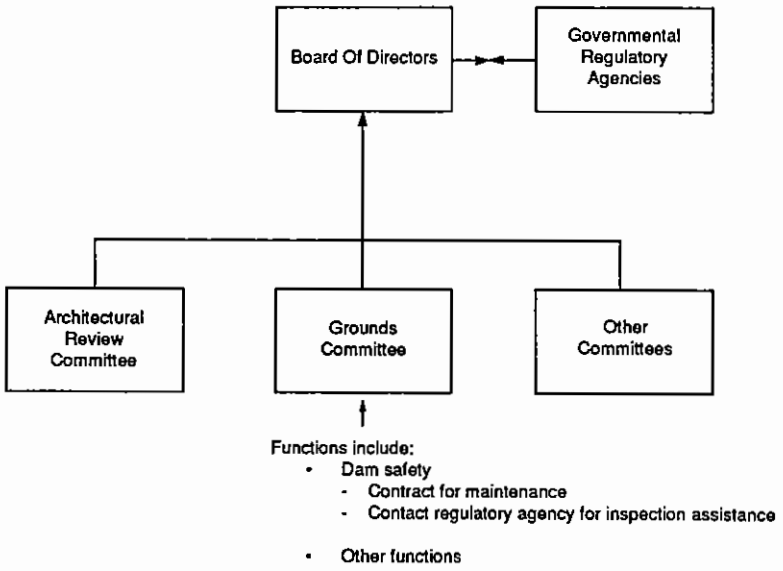
Small-scale Dam Safety Programs may be conducted by an owner/operator with one dam, or a small inventory of dams. Often, the dams in a small-scale Dam Safety Program are not complex to maintain and operate. Typical owners/operators of these type dams may include:

- Individuals
- Local governments
- Water companies
- Homeowners' associations
- Recreational groups
- Special purpose districts, such as watershed or irrigation districts
- Mining companies

If your program fits into this category, most program components provided in this module will apply.

Figure I-1 illustrates how dam safety functions may be allocated in a homeowners' association.

FIGURE I-1. TYPICAL ORGANIZATION: HOMEOWNERS' ASSOCIATION



I. OVERVIEW: WHAT IS A DAM SAFETY PROGRAM?

Large-Scale Dam Safety Programs

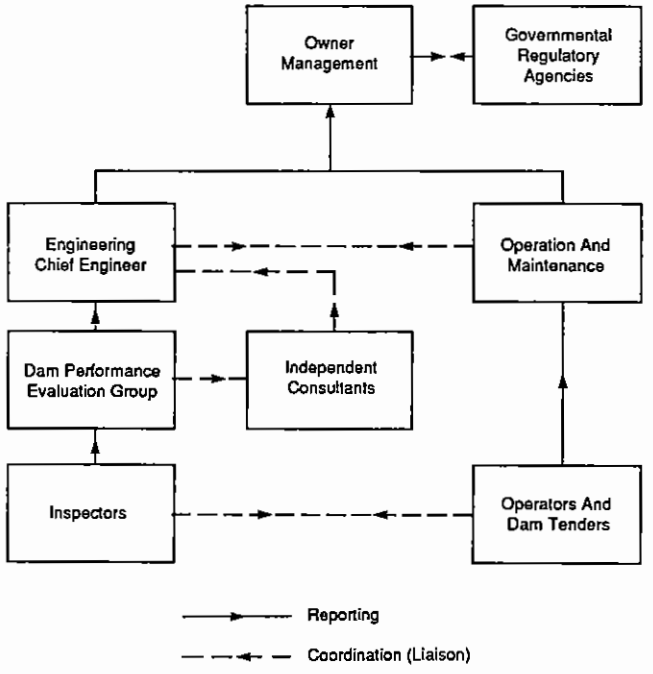
A large-scale Dam Safety Program is required for an owner/operator of a large inventory of dams that may be complex in operation and maintenance, or for a regulatory agency. This module discusses all necessary components for organizing large-scale programs.

Government or private owners/operators with many dams that have high or significant hazard classifications should have extensive Dam Safety Programs. These types of owners/operatórs are usually:

- Federal agencies or State governments
- Water supply agencies
  - Municipalities
  - Counties
  - Other local government
- Water supply companies
- Power-generating utilities
  - Investor-owned utilities
  - Municipalities
  - Cooperatives
- Irrigation districts

Figure I-2 shows how the staff of a large hydroelectric power-generating utility might be organized.

FIGURE I-2. STAFF ORGANIZATION: LARGE HYDROELECTRIC POWER-GENERATING UTILITY



I. OVERVIEW: WHAT IS A DAM SAFETY PROGRAM?

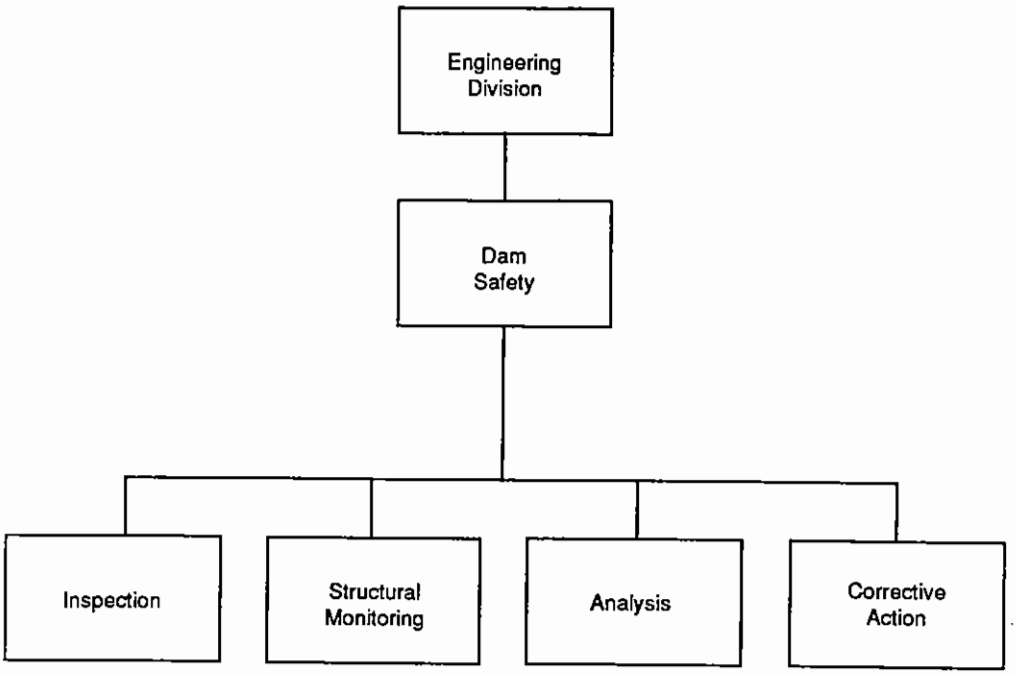
Regulatory Dam Safety Programs

Regulatory Dam Safety Programs cover a broad range of functions and enforce a wide variety of laws or regulations. The following are examples of agencies that regulate their own dams, dams owned by other governmental agencies, or privately owned dams:

- Bureau of Reclamation
- Corps of Engineers
- Federal Energy Regulatory Commission
- Tennessee Valley Authority
- Department of Energy
- Nuclear Regulatory Commission
- Forest Service
- International Boundary and Water Commission
- State agencies
- Local government agencies

Figure I-3 shows a typical organizational structure for a large organization that both owns and regulates dams.

FIGURE I-3. DAM SAFETY PROGRAM ORGANIZATION: AGENCY OWNING AND REGULATING DAMS



I. OVERVIEW: WHY ORGANIZE A DAM SAFETY PROGRAM?

INTRODUCTION

Dam Safety Programs are important because they help to protect people and property from the disastrous effects of avoidable dam accidents and failures. Also, Dam Safety Programs help owners/operators and regulators to attain important goals.

WHAT ARE THE GOALS OF A DAM SAFETY PROGRAM?

The goals of a Dam Safety Program are to help owners/operators and regulators to . . .

- Prevent accidents and failures at dams.
- Detect and correct dam safety deficiencies.
- Protect investments.
- Meet legal obligations.

A review of the goals of a Dam Safety Program and the resulting benefits are presented in this section.

Prevent Accidents And Failures At Dams

An effective Dam Safety Program can help to ensure that potentially dangerous conditions are recognized before accidents or failures occur. Advanced planning allows emergency repair or procedural measures to be used when needed.

Detect And Correct Dam Safety Deficiencies

Inspection, investigation, and analysis included in a Dam Safety Program allow deficiencies to be recognized and remedies made. Early detection may avoid major risks to safety and major costs for correction.

Protect Investments

A dam represents an investment that should be protected. A Dam Safety Program is one means to protect that investment.

Meet Legal Obligations

Dam owners and operators have certain legal obligations to meet. Owners and operators may have to comply with requirements contained in . . .

- Federal, State, and local regulations
- Land and water rights and rules

In addition, owners and operators may be liable for any damage that results from a dam failure. Owners and operators must try to prevent dam failures. An effective Dam Safety Program can help to prevent dam failure by detecting and correcting dam safety deficiencies.

I. OVERVIEW: HOW IS A DAM SAFETY PROGRAM ORGANIZED?

INTRODUCTION

You may be convinced that you need a Dam Safety Program, but might not be sure how to go about it. Organizing a Dam Safety Program requires good planning and management skills.

The process presented in this module describes how to organize the "ideal" or model Dam Safety Program. It may not be realistic for every dam owner and operator to implement all aspects of the Dam Safety Program described in this module. Financial constraints may limit the scope of a Dam Safety Program. Or, a simple dam structure may call for a simplified Dam Safety Program.

However, all dams--simple or complex, small or large--need to have established Dam Safety Programs! A Dam Safety Program should match the unique requirements of each dam and its appurtenances.

The same process is used to organize Dam Safety Programs regardless of differences in the complexities of the dams. However, the steps needed in the process should be based on the overall needs of the dams in the program.

This section presents a brief overview of the process used to organize a Dam Safety Program. The information presented in this section may be sufficient if your requirements for a Dam Safety Program are simple. However, if your requirements for a Dam Safety Program are more complex, or if you want more information about a specific area, you should read the remaining units. The remaining units will cover each phase in the process of organizing a Dam Safety Program.

PHASE I: PLANNING A DAM SAFETY PROGRAM

The first phase in the process is **Planning.** In the planning phase, the following steps are completed:

Step 1: Determine program activities.

The first phase in the planning process is to identify the activities to be performed within the Dam Safety Program. To determine program activities, you need to start with information about your dams and about the requirements your program must meet. Identifying the dam safety activities to be performed involves:

- Gathering technical data to develop a complete information base for the dams, appurtenances, and dam sites to be included in the Dam Safety Program.

  Technical data include design and construction records for individual dams, and a centralized file called a **dam inventory** that contains information about all dams included in the Dam Safety Program.

  Appendix B contains examples of dam inventory data forms.

Continued . . .

I. OVERVIEW: HOW IS A DAM SAFETY PROGRAM ORGANIZED?

PHASE I: PLANNING A DAM SAFETY PROGRAM (Continued)

Step 1: Determine program activities. (Continued)

- Identifying regulated dams to determine Dam Safety Program requirements.

  If you own one or more dams that meet certain criteria for size of the dam and development downstream from the dam, your State will probably require a Dam Safety Program. Requirements vary among States. Your State dam safety agency will tell you what activities you must perform for regulated dams.

- Establishing program activities for your Dam Safety Program.

  The following activities are basic to any Dam Safety Program:

  - Performing operation and maintenance
  - Developing Emergency Action Plans
  - Conducting inspections, investigations, and technical analyses
  - Correcting deficiencies

  Ask your agency or your State's dam safety agency about any specific requirements your Dam Safety Program must meet in performing these activities. For example, different types of inspection may be required at certain time intervals.

Page references: II-2 through II-15.

Step 2: Design the program.

The second step in the planning process is to design the program. When you design the program, you decide how the activities needed for your program will be carried out. Designing the program involves:

- Designating program responsibility within your organization.

- Choosing in-house and/or contracted activities for such functions as operation and maintenance and technical services.

- Developing recordkeeping systems for Dam Safety Program activities, including determining use of computers.

- Estimating staffing requirements for the activities that will be accomplished by in-house personnel.

- Developing an organizational structure for the personnel who will work in the program.

Continued . . .

I. OVERVIEW: HOW IS A DAM SAFETY PROGRAM ORGANIZED?

PHASE I: PLANNING A DAM SAFETY PROGRAM (Continued)

Step 2: Design the program. (Continued)

Consult your State dam safety agency for examples of other organizations that have established Dam Safety Programs, and discuss the choices that were made in designing those programs. Some existing programs may serve as models for your Dam Safety Program.

Page references: II-16 through II-24.

Step 3: Secure funding.

The third step in the planning process is to secure funding for the Dam Safety Program. Securing funding involves:

- Determining funding sources such as . . .
  - Your agency/organization
  - User fees
  - Tax or membership assessments
- Estimating costs, including . . .
  - Annual costs (e.g., personnel, equipment, etc.)
  - Emergency and unanticipated costs

Your agency or State dam safety agency may be able to help you identify potential funding sources for your Dam Safety Program.

Page references: II-25 through II-30.

Step 4: Obtain technical resources.

The fourth step in the planning process is to obtain technical resources for the Dam Safety Program. Obtaining technical resources involves one or a combination of the following actions:

- Establishing an in-house engineering staff
- Contracting with governmental agencies
- Contracting with civil engineering firms

If the dams in your program are simple, low-hazard structures, you are most likely to contract for technical resources. Your State dam safety agency can tell you what governmental and non-governmental sources might provide technical services.

Continued . . .

I. OVERVIEW: HOW IS A DAM SAFETY PROGRAM ORGANIZED?

PHASE I: PLANNING A DAM SAFETY PROGRAM (Continued)

Step 4: Obtain technical resources. (Continued)

Page references: II-31 through II-33.
Appendix A presents a list of services offered by organizations, including providing technical resources.

PHASE 2: OPERATING A DAM SAFETY PROGRAM

The second phase in the process is **Operation.** In the operation phase, the following steps are completed:

Step 1: Conduct program activities.

The first step in operating a Dam Safety Program is to conduct the activities in the program. The following activities are involved:

- Operation and maintenance
- Emergency Action Plan development
- Inspection, investigation, and technical analyses
- Deficiency correction
- Regulatory activities

Page references: III-2 through III-21.

Step 2: Administer the Dam Safety Program.

The second step in operating a Dam Safety Program is to administer the program. Administering a Dam Safety Program involves management of:

- In-house and contract personnel, including:
  - Assigning work
  - Scheduling work
  - Monitoring work performance
  - Training personnel
- Resources, including purchasing and controlling . . .
  - Operation and maintenance tools, equipment, and supplies
  - Engineering and administrative staff equipment and supplies
- Information, by keeping the records and systems current.

Page references: III-22 through III-29.

Continued . . .

PHASE 2: OPERATING A DAM SAFETY PROGRAM (Continued)

Remember, if your Dam Safety Program requirements are not simple, or if you want more information about a specific area, you should read the remaining units. If you do not plan to read the remaining units, you should skim through the entire text and read those areas that are relevant to your needs. Although the information presented in this module may represent the "ideal" Dam Safety Program, there is no reason that all Dam Safety Programs should not strive to achieve the "ideal."

UNIT II

PLANNING A DAM SAFETY PROGRAM

II. PLANNING A DAM SAFETY PROGRAM: OVERVIEW

INTRODUCTION

As stated in Unit I, the first phase of organizing a Dam Safety Program is **Planning.** Good planning is vital to an effective Dam Safety Program.

This unit will present guidance on how to plan a Dam Safety Program. If you already have a Dam Safety Program, you can use the material presented in this unit to help you revise or update your program.

DAM SAFETY PROGRAM PLANNING STEPS

The following steps are used to plan a Dam Safety Program . . .

Step 1: Determine program activities.

Step 2: Design the program.

Step 3: Secure funding.

Step 4: Obtain technical resources.

Next, each step will be discussed.

II. PLANNING A DAM SAFETY PROGRAM: DETERMINE PROGRAM ACTIVITIES

INTRODUCTION

The first step in the planning process is to determine the dam safety activities to be performed. Determining the dam safety activities to be performed involves . . .

- Gathering technical data.
- Identifying regulated dams.
- Establishing program requirements.

GATHERING TECHNICAL DATA

Effective planning demands good information. To begin outlining Dam Safety Program activities, you first must compile an accurate and complete information base for the dams in the program. Collection and maintenance of data are ongoing activities that, if not already in place, should be established.

A number of different types of technical data provide an information base for planning a Dam Safety Program. After implementation, these data will be the basis for program activity.

GATHERING TECHNICAL DATA: RECORDS FOR INDIVIDUAL DAMS

Dam owners and operators should gather and maintain basic information about each dam in a Dam Safety Program.

☞ **The following information is <u>essential</u> for evaluation of performance and will prove <u>vital</u> if the need for modification or repair should arise.**

- Engineering and geological data (including original calculations) used for design, construction, maintenance, repair, and/or modification of a project
- Reports, permits, and licenses from regulatory agencies
- Dam safety inspection reports
- Operation and maintenance records
- Instrumentation readings and data interpretation, including tabular records and graphic presentations of data
- Drawings and photographs

The information listed also will be needed for review by engineers and geologists who perform inspections, investigations, and technical analyses.

Continued . . .

GATHERING TECHNICAL DATA: RECORDS FOR INDIVIDUAL DAMS (Continued)

Technical information for older dams often is hard to find. You may have to check with local libraries, local power companies, or the original owner of the dam for historic information.

Typically, most technical information is kept in file folders, looseleaf binders, or bound volumes. All technical information for a single dam may be physically stored in one file, or the information may be in separate files (embankment and spillway, for example).

Sometimes only one copy of a file exists, and the loss of that copy leaves a serious information gap. Many organizations choose to protect files with checkout systems, by requiring that research be performed in the file area, or by making available microfiche copies of files.

Since records containing technical information tend to be bulky, microfilm or microfiche often are used for easy accessibility. Original drawings, calculations, and reports should be preserved, if possible. If original records have to be destroyed, a second microfilm copy should be made for backup, and all microfilm reviewed to ensure that it is readable.

Technical files are a good source of information for engineers and inspectors who perform dam safety inspections. Information can be compiled prior to the inspection and placed in a binder for use during the inspection. After dam safety inspections, copies of inspection reports, including recommendations, instructions, and records of when and by whom inspections were conducted should be added to the binder.

Such binders can be kept readily available for future dam safety inspections, or more importantly for use in an emergency such as an earthquake or extremely heavy rainfall.

Owners/operators of power-generating facilities should establish additional files as required for facility operation and by the Federal Energy Regulatory Commission.

Technical data and information to be used by technical personnel should be well-organized and placed in a file for each dam. The file may be a series of folders or perhaps a notebook with dividers labeled by subject area. The following subject areas might be considered:

- Aerial photographs
- Statistical summary
- Bibliography of records
- Listing of historical events
- Emergency preparedness
- Geology
- Hydrology
- Reservoir area
- Foundation
- Dam structure
- Spillway

Continued . . .

GATHERING TECHNICAL DATA: RECORDS FOR INDIVIDUAL DAMS (Continued)

- Outlet works
- Powerplant
- Mechanical equipment
- Other features
- Instrumentation
- Operation and maintenance
- Inspection reports (civil, electrical, mechanical)
- Drawings

GATHERING TECHNICAL DATA: DAM INVENTORY

If you own or operate several dams, your Dam Safety Program must allocate resources among the dams. To match resources to needs, you need to compare dams and judge relative priorities within the Dam Safety Program.

All dams in the Dam Safety Program need to be identified and information about them compiled to create a dam inventory. The inventory then can be organized into a dam inventory file.

A Dam Safety Program that includes a large number of dams could make good use of a computerized inventory file. A variety of computerized dam inventory programs are available.

The Corps of Engineers conducted a survey between 1978 and 1980 that compiled data on all privately owned dams above a certain size as well as locks, Federal dams, and power-generating dams. Identification numbers were assigned to dams, and basic technical data were recorded. Survey results were reported in Recommended Guidelines For Safety Inspection Of Dams. Appendix B includes the data entry form used to compile the Federal inventory.

Information from the Corps of Engineers survey can serve as a base for building your dam inventory file. You can obtain survey data on dams within your Dam Safety Program by contacting the Corps of Engineers district that was responsible for the non-Federal Dam Safety Program for your State. (The data should be checked for accuracy before being incorporated in your file.)

The Association of State Dam Safety Officials (ASDSO) has developed a methodology to update the Federal inventory, including a standard file format. The updated inventory is titled the National Inventory of Dams, or NATDAM. Table II-1 shows the data items included in the NATDAM file. Contact your State dam safety agency to determine whether NATDAM inventory data could be used to build your dam inventory file.

You also may physically obtain data through surveys and measurements at the dam site.

Continued . . .

GATHERING TECHNICAL DATA: DAM INVENTORY (Continued)

TABLE II-1. NATIONAL INVENTORY OF DAMS DATA ITEMS

NATIONAL INVENTORY OF DAMS
DATA ITEMS

Field #	Field Label	Field Type	Field Size
1	Dam Name	Alphanumeric	65 var*
2	Other Dam Names	Alphanumeric	65 var
3	State Id	Alphanumeric	15 var
4	National Id	Alphanumeric	7
5	Latitude Deg	Number	2
6	Latitude Min	Number	4 var
7	Latitude Sec	Number	2
8	Longitude Deg	Number	3
9	Longitude Min	Number	4 var
10	Longitude Sec	Number	2
11	Section, Township, Range Location	Alphanumeric	30 var
12	County	Alphanumeric	30 var
13	River or Stream	Alphanumeric	30 var
14	Nearest City-Town	Alphanumeric	30 var
15	Distance Nearest City-Town (Miles)	Number	3 var
16	Owner Name	Alphanumeric	50 var
17	Owner Type	Alphanumeric	1
18	Priv Dam On Fed Prop	Alphanumeric	1
19	Dam Type	Alphanumeric	6 var
20	Purposes	Alphanumeric	8 var
21	Years Completed	Number	4
22	Dam Length (Feet)	Number	7 var
23	Dam Height (Feet)	Number	6 var
24	Structural Height (Feet)	Number	6 var
25	Hydraulic Height (Feet)	Number	6 var
26	Maximum Discharge (Cu Ft/Sec)	Number	7 var
27	Maximum Storage (Acre-Feet)	Number	10 var
28	Normal Storage (Acre-Feet)	Number	10 var
29	Surface Area (Acres)	Number	8 var
30	Drainage Area (Square Miles)	Number	10 var
31	Downstream Hazard	Alphanumeric	1
32	Emergency Action Plan	Alphanumeric	2
33	Phase 1 Inspection	Alphanumeric	1
34	Inspection Date	Date	11 var
35	State Regulatory Agency	Alphanumeric	30 var

* The field size *65 var* designates a variable field size, within the range 1 - 65. The actual field size is set by the state, within the designated range, to accommodate state data.

Continued . . .

GATHERING TECHNICAL DATA: DAM INVENTORY (Continued)

Possible data sources for adding to the information compiled in the Federal inventory include:

- Aerial photography
- Permit and license files
- Satellite imagery
- Field measurements
- Soil Conservation Service inventory
- Counties (for inventories of public facilities)

Your dam inventory file should include at least the following data:

- Federal inventory file information (verify the data: some are incorrect)
- Hazard classification
- Names and telephone numbers of owners/operators

There are a number of established formats for dam inventory files. Inventory files may be in alphabetical order by dam name, or in numerical order, with each dam assigned an identification number. Compare several different types and choose a format that best fits the needs of your program.

Federal inventory numbers are usefui in setting up dam inventory files. But as new dams are added to an inventory, new identification numbers have to be assigned, since the Federal inventory was completed in 1980. An alphabetical cross-reference list is needed when data about dams are kept in consecutively numbered files. Appendix B contains sample forms for dam inventory files.

GATHERING TECHNICAL DATA: REGULATORS

If you are establishing a program for a State agency, the Association of State Dam Safety Officials has developed a uniform file format for the States. Each State will participate in developing and maintaining a National Dam Inventory. Data items included in the uniform inventory are shown in Table II-1.

IDENTIFYING REGULATED DAMS

Your Dam Safety Program may need to be coordinated with a regulatory Dam Safety Program. If you are organizing a Dam Safety Program for a dam owner with one or more dams, consider each dam individually. Is the dam now being regulated, or will it be? Your program should be designed to meet regulatory requirements and to be consistent with any regulatory program applied to that dam. For example, you may wish to plan your inspection cycles to complement the regulatory agency's inspection schedule.

Continued . . .

IDENTIFYING REGULATED DAMS (Continued)

Beyond basic requirements for maintenance, periodic dam safety inspections, and correction of deficiencies, legislation or other program authority usually specifies criteria to determine which structures are included in regulatory Dam Safety Programs. Non-Federal dams that do not generate hydroelectric power generally are regulated by State dam safety agencies.

Applications to repair or modify a dam often result in the dam's inclusion in a regulatory program. This participation can alert the owner to potential hazards at the dam, and help avoid accidents and failures for which the owner would bear full liability.

Criteria used to include a dam in a regulatory Dam Safety Program are . . .

- Hazard classification
- Size of dam

IDENTIFYING REGULATED DAMS: HAZARD CLASSIFICATION

Many dams, if they were to fail, could cause loss of life and property damage. Most dams in the U.S. have been assessed to determine the consequences of failure.

Hazard classifications are assigned to dams. A hazard classification is a rating (e.g., low, moderate/significant, or high) that represents the potential loss of life and property damage downstream from a dam if a sudden release of the reservoir occurred.

Hazard classification is the most important basis for inclusion in a Dam Safety Program. Any dam with the potential to cause loss of life or moderate property damage should be monitored through a Dam Safety Program. Downstream development may place any dam in this category.

States and other regulatory agencies generally concentrate resources on high-hazard dams and inspect low-hazard dams less frequently (as long as downstream development is monitored to make changes in hazard classifications as needed).

IDENTIFYING REGULATED DAMS: SIZE OF DAMS

Size often serves to identify low-hazard structures judged too small for inclusion in a Dam Safety Program. Low dams creating farm ponds and other small structures often do not meet minimum size limits written into the legislation, regulations, guidelines, or policy authorizing a Dam Safety Program. (However, any dam that poses a threat to life if it were to fail should be included in a Dam Safety Program.)

All dams should be monitored, regardless of size. Without a full inventory, a complete accounting of hazard classification changes is impossible.

Size limits vary among agencies. Table II-2 shows examples of size limits set by the Federal Guidelines for Dam Safety in 1979 and by several States.

Continued . . .

IDENTIFYING REGULATED DAMS: SIZE OF DAMS (Continued)

TABLE II-2. SIZE CRITERIA FOR DAM SAFETY PROGRAMS

Agency	Height (feet)	Max. Storage Capacity (In acre-feet)	Other Criteria
Federal Guidelines	25 or more	50 or more	Excluded are dams that are not in excess of 6 feet in height, regardless of storage capacity, and dams with a maximum storage capacity not in excess of 15 acre-feet regardless of height. The lower size limitation should be waived if there is a significant hazard potential.
Oklahoma	Same as Federal guidelines		
Maryland	15 or more*		Contributory drainage area at least 1 square mile or more than 12 acres of surface water area. Additional restrictions in some areas.
South Carolina	25 or more	50 or more	A smaller dam with a hazard potential to cause loss of human life would be included regardless of size.
Connecticut	3 or more	no limit	

*Above the original stream bed.

Some States use the product of dam height and storage volume as a measure of size. Other States have four or more categories to gauge size.

ESTABLISHING PROGRAM ACTIVITIES

Some activities are basic to all Dam Safety Programs. However, an authority may require that you implement a Dam Safety Program that meets specified criteria. Regulators have some additional requirements.

II. PLANNING A DAM SAFETY PROGRAM: DETERMINE PROGRAM ACTIVITIES

ESTABLISHING PROGRAM ACTIVITIES: BASIC ACTIVITIES

Every dam you own or operate needs to be a part of a basic safety program that includes maintenance, periodic dam safety inspections, and correction of deficiencies. Facilities with operable appurtenances should follow the Standing Operating Procedures. A Dam Safety Program integrates these efforts into a single program.

A formal Dam Safety Program requires . . .

- Performing operation and maintenance
- Developing Emergency Action Plans
- Conducting inspections, investigations, and analyses
- Correcting deficiencies

Very likely, you now perform many activities needed for a Dam Safety Program, even though you may lack a formal program.

The TADS program provides guidance to owners and operators on the elements of a formal Dam Safety Program.

Performing Operation And Maintenance

A dam owner/operator should perform maintenance on each dam owned regardless of dam size or downstream hazard classification, and should follow the Standing Operating Procedures if facilities include operable appurtenances.

The TADS module How To Organize An Operation And Maintenance Program provides comprehensive guidance for establishing operation and maintenance programs.

Developing Emergency Action Plans

If you or your organization own a dam whose failure would endanger life or property, an Emergency Action Plan (sometimes referred to as an EAP) must be developed for that facility. When a facility undergoes rehabilitation or modification, a temporary construction EAP should be considered.

The TADS module How To Develop And Implement An Emergency Action Plan can guide you in emergency preparedness planning.

Conducting Inspections, Investigations, And Analyses

You need to ensure that dam safety inspections are conducted, and that investigations and technical analyses are carried out if deficiencies are discovered.

II. PLANNING A DAM SAFETY PROGRAM: DETERMINE PROGRAM ACTIVITIES

Dam Safety Inspections

Owners should conduct inspections periodically unless regulators' inspections are sufficient.

Some large, complex dams (hydroelectric projects, for example) have staff inspectors conducting inspections in addition to the dam safety inspections performed by regulators. However, many dam owners do not employ inspectors. Instead they retain civil engineering firms or rely on governmental regulatory agencies to perform the necessary inspections.

In some cases, Federal agencies that are dam owners may employ engineers who perform inspections as part of project management staffs at dam sites. In other situations, dam safety inspection is a function of separate agency divisions with regulatory or program operation duties.

The observations of individuals who work at or frequent a facility can provide a timely source of information about potentially hazardous conditions. Your personnel working at a dam site should be trained to observe and report conditions that might threaten dam safety. The TADS booklet and video Identification Of Visual Dam Safety Deficiencies can aid in training facility employees.

The TADS program also includes a series of modules that provide indepth instruction on performing dam safety inspections.

Investigations And Technical Analyses

Field investigations and technical analyses may be performed to gather additional information about deficiencies found during inspections or possible deficiencies in design or construction.

Subsurface investigations and surveys may be required to obtain data needed to perform technical analyses. Instrumentation may need to be installed and monitored.

The cost of subsurface investigations, laboratory testing of soil samples, and installation of instrumentation is high, but the cost of failure also is high.

Correcting Deficiencies

Dam safety inspections often uncover dam safety problems, or personnel working at the facility may observe deficiencies. When an unsafe condition or situation is found at a dam, you should take immediate steps to correct the problem.

II. PLANNING A DAM SAFETY PROGRAM: DETERMINE PROGRAM ACTIVITIES

ESTABLISHING PROGRAM ACTIVITIES: REQUIRED ACTIVITIES

When planning a formal Dam Safety Program, you need to know . . .

- What rules and standards apply to required programs.
- Which agencies and organizations may oversee or regulate the program.

Various government agencies are required to conduct Dam Safety Programs or to ensure that owners and operators install Dam Safety Programs.

- All Federal agencies owning dams should have Dam Safety Programs.

- Each State is responsible for regulating the safety of dams within the State. State legislation determines which agency is responsible for dam safety and outlines the agency's responsibility and authority. The agency then requires dam owners and operators to establish Dam Safety Programs according to State law.

- Local governments such as counties, municipalities, or special districts often regulate dams and issue permits and licenses. The regulating agencies may require that dam owners and operators have Dam Safety Programs.

ESTABLISHING PROGRAM ACTIVITIES: REGULATORS

If you are planning a regulatory Dam Safety Program, additional activities are . . .

- Providing technical assistance.
- Disseminating program information.
- Verifying program compliance.

Providing Technical Assistance

Technical assistance consists of . . .

- Providing training.
- Setting technical guidelines.

Your agency may provide technical assistance in dam safety to . . .

- Dam owners and operators.
- Private sector engineers and developers.
- Emergency management agencies.

Find out if your agency is required to provide technical assistance, and if policies have been formulated concerning technical assistance beyond such requirements.

II. PLANNING A DAM SAFETY PROGRAM: DETERMINE PROGRAM ACTIVITIES

Disseminating Program Information

An important function of your agency will be to inform and educate various groups and individuals about the Dam Safety Program. Information about the program may be important to . . .

- Dam owners and operators
- Legislators
- The media
- Emergency management agencies
- Local governments
- Administrators
- The public

Verifying Program Compliance

A regulatory Dam Safety Program must make sure that owners and operators comply with the program. Compliance may be ensured by:

- **Issuing permits and licenses**

  States are a primary permitting authority. Local governments also may issue permits and licenses for dams. The Federal Energy Regulatory Commission (FERC) licenses almost all hydroelectric power-generating dams in the United States, but does not license Federally-owned dams. Some municipalities and special districts are exempt from licensing by FERC.

  If you are organizing a Dam Safety Program that includes a permitting and licensing function, legislation or regulations probably define the conditions which owners must meet to receive permits and licenses, and actions which your organization must take to verify that required conditions are met.

  Anticipate, if possible, how many applications will be submitted. Will permitting and licensing be a major part of your program? When owners of dams not in your agency's inventory apply for a license or permit, you probably will want to add those dams to the inventory for future regulation.

  Within limits set by legislation, how can your program most effectively exercise the permitting authority? Look for effective techniques used elsewhere, and determine if they could be adapted for your program.

Continued . . .

Verifying Program Compliance (Continued)

- **Issuing permits and licenses** (Continued)

FOR EXAMPLE:

A typical State permitting process is the two-step system used by Maryland.

For the first step, State authorities issue a plan development permit. This permit:

- Designates an engineer as a point of contact with the Dam Safety Program.
- Describes the preliminary concept (including environmental aspects and public hearings).
- Initiates study to establish the class of dam.
- Justifies the need for the dam (documented, if for water supply).
- Supplies documentation concerning possible alternative dams.
- Explains reasons for choosing this type of dam.

For the second step, State authorities issue a construction permit. This permit covers design, development, plans, and construction details. All maintenance, repair, operations, and land restrictions are described and approved before this permit is issued. Owners of new dams are required to prepare Emergency Action Plans as a condition for permit approval.

- **Enforcement**

To be effective, a Dam Safety Program that issues permits and licenses and directs owners to correct unsafe conditions must have enforcement authority.

If your regulatory agency has enforcement authority, legislation or guidelines define the sanctions the program may exercise. Find several agencies that successfully conduct enforcement programs to serve as possible models for your agency. You might be able to recommend new legislation or guidelines that would make the enforcement component of your program more effective.

Continued . . .

Verifying Program Compliance (Continued)

- **Enforcement** (Continued)

☞ **FOR EXAMPLE:**

One effective enforcement tool is Maryland's authority to do corrective work and then charge the owner. (This policy is more effective than criminal penalties, because judges are reluctant to sentence otherwise law-abiding violators to criminal penalties. Usually, the threat to have the State perform the work persuades the owner to take action.)

Verifying Program Compliance: Monitoring Dam Safety Inspections

Your agency will perform dam safety inspections or monitor owners' inspections to ensure that safety requirements are met. When permits and licenses are issued, dam safety inspections often are required as a condition for approval. Different jurisdictions set different requirements.

To determine whether a dam needs to be inspected and how often inspections should be conducted, regulators apply criteria that are usually based on:

- Hazard classification
- Various measurements of impoundment size and dam height

Regulators notify owners/operators of facilities requiring dam safety inspections, and describe the type of inspection(s) to be conducted, and the inspection standards and schedules to be followed. (Statutes and regulations usually define facilities needing dam safety inspections and prescribe requirements.) Regulatory agencies often maintain technical staffs to conduct dam safety inspection programs.

The scope of a regulatory dam safety inspection program depends upon two factors set by legislative or administrative decisions:

- **Inspection Cycle Time:** The time span during which the entire inventory of dams is inspected.

- **Inspection Frequency:** The time intervals set between dam safety inspections for different categories of dams.

Some dams might be inspected only once during an inspection cycle, while others are inspected several times.

Dam safety inspections should include all elements of the facility relevant to dam safety, including evaluation of the Emergency Action Plan.

Continued . . .

Verifying Program Compliance: Monitoring Dam Safety Inspections (Continued)

If you are organizing a regulatory program, you can use the number of dams in your program inventory to calculate the approximate number and types of inspections the program must conduct within specific periods of time. For this task, you must have information from the dam inventory, because high-hazard dams, for example, may require more frequent dam safety inspections than less significant or low-hazard dams.

II. PLANNING A DAM SAFETY PROGRAM: DESIGN THE PROGRAM

INTRODUCTION

Now that you have determined the activities that your Dam Safety Program will perform, you must decide how the program will operate.

Designing a Dam Safety Program involves . . .

- Designating program responsibility.
- Choosing in-house and/or contracted activities.
- Developing recordkeeping systems.
- Estimating staffing requirements.
- Developing an organizational structure.

Who will perform the various tasks included in the Dam Safety Program? How will decisions be made and implemented? How does the dam safety function relate to other organizations, and to the rest of your own organization? Consider all of these issues when designing your program.

DESIGNATING PROGRAM RESPONSIBILITY

A unit of your organization may add a Dam Safety Program to existing functions. Or you might decide to add a new organization to administer the Dam Safety Program.

If you are organizing a dam safety program for a few relatively small, noncomplex dams, consider what existing positions might logically include administration of a Dam Safety Program.

Often, the manager of a Dam Safety Program is an administrator with duties and responsibilities aside from dam safety. The manager typically might hold any of the following positions:

- Project manager
- Dam superintendent
- Public works official
- Park superintendent
- Official or employee of a private association or corporation
- Individual dam owner

However, if you are organizing a safety program for many dams, or for large, complex dams, an administrative staff devoted exclusively to dam safety will be necessary.

II. PLANNING A DAM SAFETY PROGRAM: DESIGN THE PROGRAM

CHOOSING IN-HOUSE VERSUS CONTRACTED ACTIVITIES

All the activities of your Dam Safety Program may be performed by your own employees, or some activities may be contracted. Functions contracted typically include . . .

- Operation and maintenance
- Technical services
- Training

Could a contractor perform some activities more efficiently and at less cost than your own employees? You may currently be using contracted services, and will continue those services as elements of your Dam Safety Program.

Program size always plays a key role in determining the source(s) of technical services. Large programs tend to employ engineers and technicians, while smaller programs often find contracted services more cost-effective.

Investigate possible sources for technical services such as dam safety inspection, field investigations, and technical analyses. Some aspects of an owner's Dam Safety Program may be provided by contracting with a Federal or State agency. These might include . . .

- Downstream hazard classification
- Dam design and construction
- Emergency Action Plan development
- Dam safety inspections
- Technical analyses and field investigations
- Cost estimates and feasibility studies for dam repairs and modifications (including cost/benefit analyses)

Appendix A describes the types of services provided by different agencies.

You may decide to contract with civil engineering firms for technical services, either instead of or in addition to contracting with governmental agencies.

Training is a service you may obtain by contracting. A list of courses offered by Federal agencies and other sources is included in Appendix D.

II. PLANNING A DAM SAFETY PROGRAM: DESIGN THE PROGRAM

DEVELOPING RECORDKEEPING SYSTEMS

Aside from technical data, recordkeeping systems for a Dam Safety Program typically may include . . .

- Payroll
- Accounting
- Inspection scheduling
- Status of work in progress
- Tracking applications for regulatory approval
- Tracking progress on recommendations
- Equipment inventories
- Vehicle inventories
- Contract administration files

Make sure that accounting categories fit program activities so that meaningful cost figures result. You may want to identify program elements with associated costs. Information from recordkeeping systems may be used to generate budget figures.

If you anticipate that your organization will perform inspections on a cost-reimbursable basis, keep detailed records on the cost of performing inspections. Each type of inspection, for example, might be recorded separately for budget purposes. These expense records will provide a realistic basis for the cost you will charge to perform inspections.

If your Dam Safety Program is included in the recordkeeping systems of a larger organization, make sure that quantifiable costs for dam safety are itemized if the size of the program justifies tracking those costs. You can use the information to budget for future dam safety activities.

If monitoring of construction will be a responsibility of your Dam Safety Program, consult your State dam safety agency for guidelines on setting up a quality control system for construction. All work should be inspected and documented.

Another use for recordkeeping systems is to generate statistics and reports on the activities in your program. Design reports that alert you to problems such as failure to complete inspections during scheduled times.

DEVELOPING RECORDKEEPING SYSTEMS: DETERMINING USE OF COMPUTERS

Dam safety program managers have developed a number of computerized systems for storing dam statistics, scheduling inspections, and producing reports. Find out about systems that you might be able to use for your program.

If your organization has access to a computer, you probably will prefer to find systems that are compatible with that computer. Or you may consider purchasing a computer for the Dam Safety Program.

Continued . . .

DEVELOPING RECORDKEEPING SYSTEMS: DETERMINING USE OF COMPUTERS (Continued)

If you decide to use a computerized system, decide who will enter original inventory data, and estimate how long the process will take. Find out what level of expertise will be necessary to use and maintain typical systems, and identify positions to perform needed functions.

ESTIMATING STAFFING REQUIREMENTS

You will need a staff that actually performs program activities, and managers and other administrative personnel to direct and support the program staff. Dam Safety Programs range in staffing requirements, depending upon . . .

- Number and complexity of dams included.
- Activities performed by employees.
- Activities performed by contractors.

Considerable managerial and clerical support are required for programs that are responsible for inspecting many dams or dams that are complex and require the application of specialized technical knowledge. Management of such Dam Safety Programs usually involves sizable staffs whose sole responsibility is dam safety administration.

Contact your State dam safety agency for guidance in determining the relative complexity of your program and estimating the size of your total staff.

DEVELOPING AN ORGANIZATIONAL STRUCTURE

The organizational structure you choose for your Dam Safety Program should be consistent with the structure of your total organization.

A range of organizational structures is possible. Figure I-1 in Unit I shows how a dam safety function is included in a typical homeowners' association. Figures I-2 and I-3 in Unit I show sample organizational charts for two large-scale Dam Safety Programs, one for a large hydroelectric power-generating utility, and the other for a large agency that both owns and regulates dams.

Consult your State dam safety agency for suggestions on how best to organize your program's administration.

DESIGNING THE PROGRAM: REGULATORS

Regulating dam safety may be the sole function of your agency. In some cases, however, a regulatory program for dam safety may not be the agency's only responsibility. As an example, mining reclamation and dam safety functions could be located in the same office.

Continued . . .

DESIGNING THE PROGRAM: REGULATORS (Continued)

Some regulatory programs (considered inadequate) include only a minimum inspection function, employ no technical experts, and are administered by very few people. For example, some State Dam Safety Programs are administered by only one person.

Make sure that recordkeeping and budget categories allow you to match program elements with costs. Resources devoted to a permitting and licensing activity may be tracked in a separate budget category, for example.

When your agency recommends corrective action, one major responsibility of the Dam Safety Program will be to make sure that work is actually done to correct the deficiency. Recommendations may be numbered to correspond to particular dams or particular reports, and a tickler file or other system used to track response to the recommendations.

Your agency will need to describe the Dam Safety Program to legislators to obtain funding, to dam owners to explain program requirements, and to the media and general public in response to requests for information. You may decide that pamphlets, videos, or some other material is necessary to explain the program and disseminate information.

Statistics and reports about the status of dam safety in your regulatory area provide a vital component of the information offered to interested parties. Plan the types of statistics and reports your program should generate. The following reports can be generated from dam inventory files:

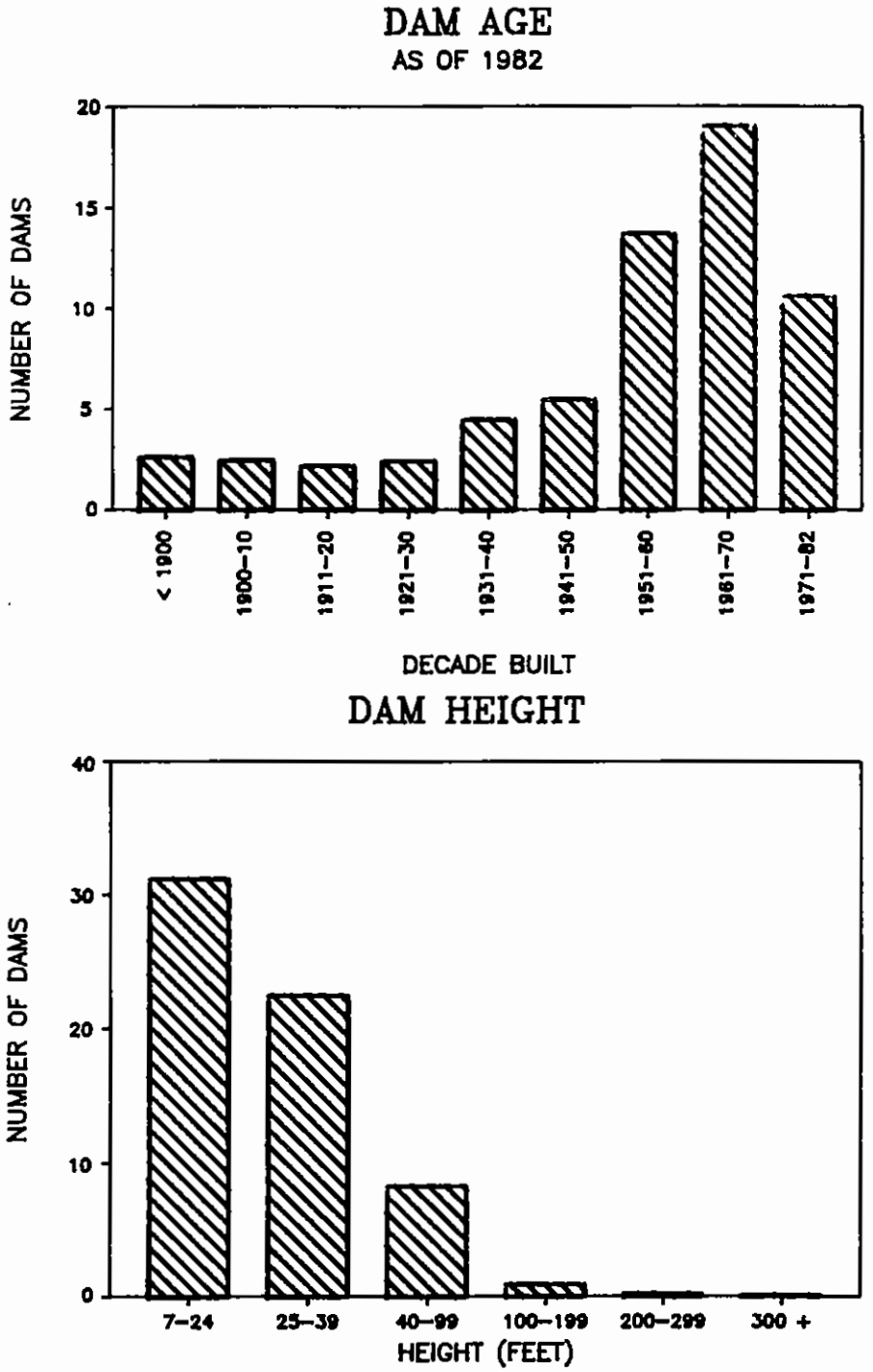
- Analysis of problem areas
- Dam sizes
- Dam types
- Reservoir storage
- Locations of dams

Figure II-1 shows examples of graphics that can be generated from dam inventory data.

Continued . . .

DESIGNING THE PROGRAM: REGULATORS (Continued)

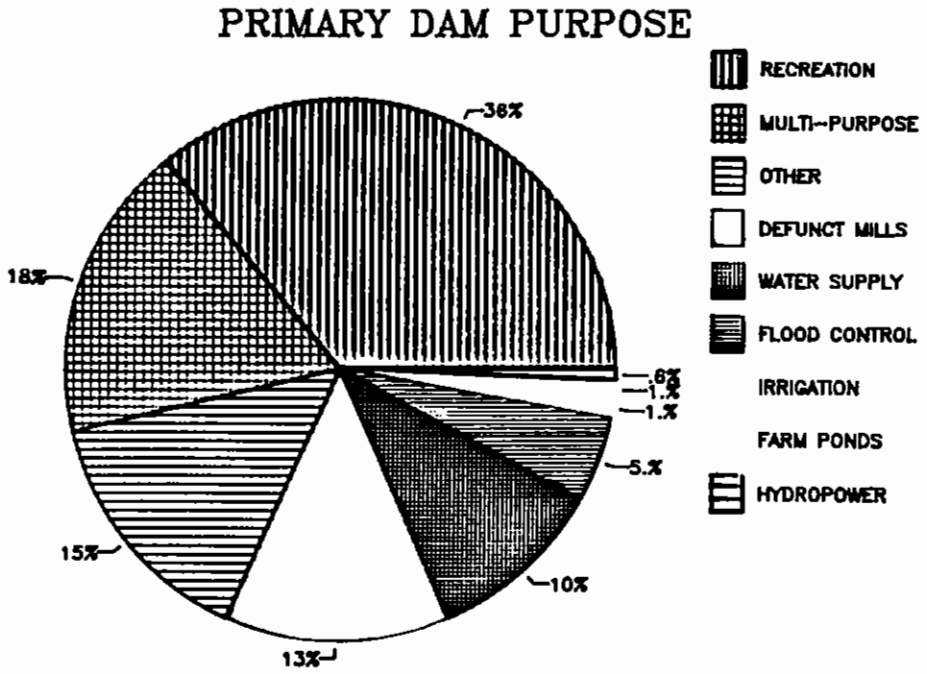
FIGURE II-1. EXAMPLES: DAM INVENTORY GRAPHICS

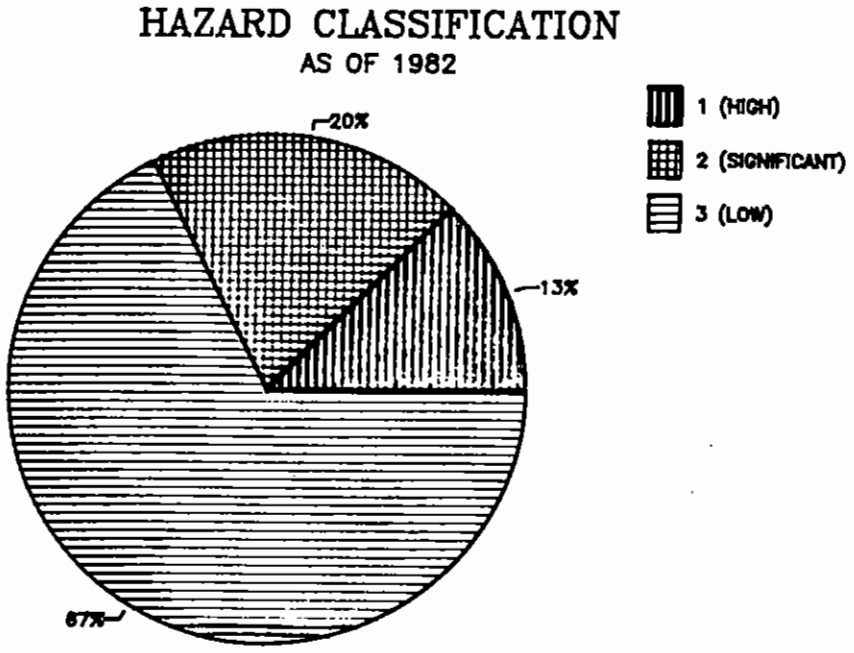


Continued . . .

DESIGNING THE PROGRAM: REGULATORS (Continued)

FIGURE II-1. EXAMPLES: DAM INVENTORY GRAPHICS
(Continued)





Continued . . .

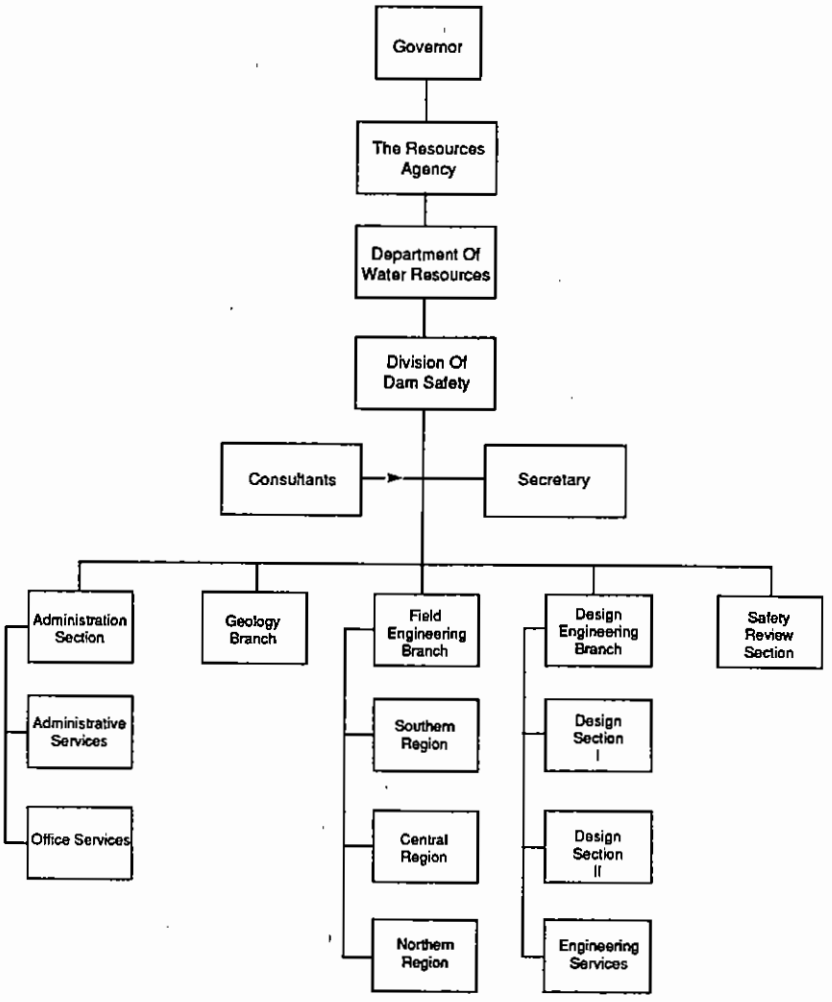
DESIGNING THE PROGRAM: REGULATORS (Continued)

When organizing a regulatory Dam Safety Program, you must place your program somewhere on the scale between minimum and maximum requirements.

A variety of possible organizational structures are used in regulatory Dam Safety Programs. Find some successful programs that operate at approximately the same level as your program will, and compare administrative structures.

Figure II-2 shows two alternative types of organizations that may be used in State Dam Safety Programs.

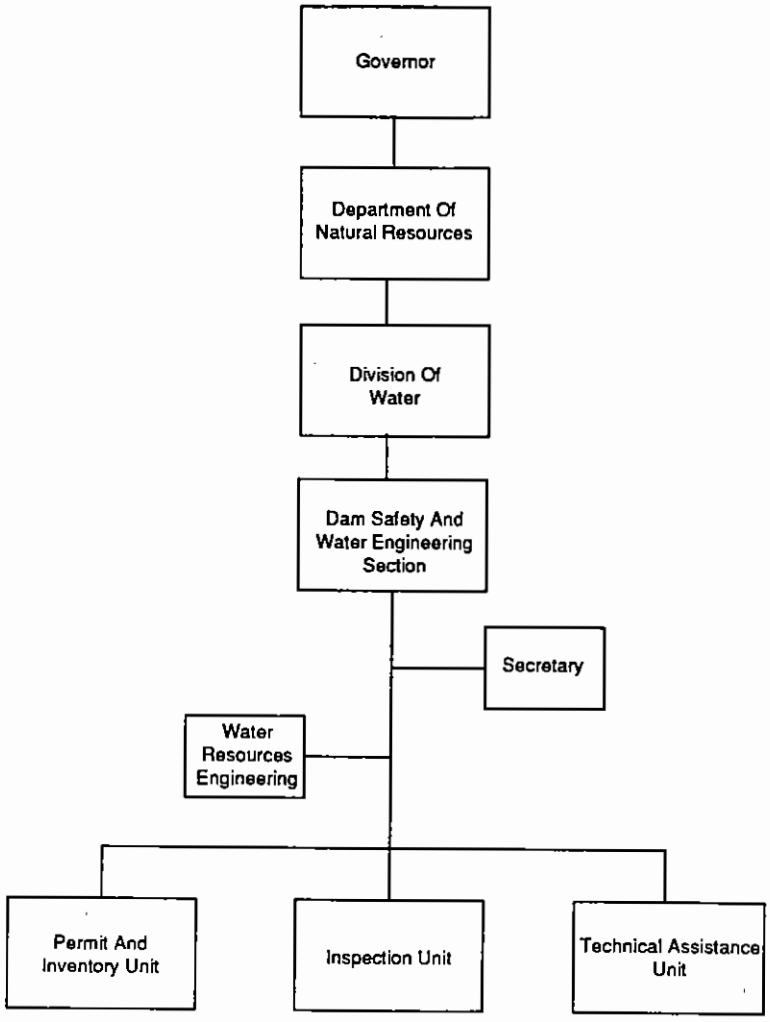
FIGURE II-2. STATE DAM SAFETY ORGANIZATIONAL STRUCTURES



Continued . . .

DESIGNING THE PROGRAM: REGULATORS (Continued)

FIGURE II-2. STATE DAM SAFETY ORGANIZATIONAL STRUCTURES (Continued)



II. PLANNING A DAM SAFETY PROGRAM: SECURE FUNDING

INTRODUCTION

An effective Dam Safety Program must be assured of adequate long-term funding. If possible, a 5-year funding plan or budget should be prepared and updated annually to reflect additional information about the deficiencies that need to be corrected or investigations that must be initiated.

Funding a Dam Safety Program requires . . .

- Determining funding source(s)
- Estimating costs

DETERMINING FUNDING SOURCES

Sources to pay for a Dam Safety Program (including the costs of repairs and modifications) might be:

- **Taxes:** Local governments, municipalities, and other similar dam owners/operators with the authority to tax may do so.
- **Assessments On Members:** Many private owners, such as homeowners' associations, make special assessments to cover the cost of maintaining dams. Association bylaws contain language concerning dam maintenance. In such instances, the State often must approve the language in the bylaws.
- **Fees:** Corporate office parks serve as an example of another arrangement for funding dam upkeep. A single developer often collects fees from individual building owners for maintenance of common ground, including dams.
- **Appropriations:** Dam Safety Program funding for dams owned and operated by States or by the Federal Government often is appropriated to agencies responsible for operating and maintaining those dams.

ESTIMATING COSTS

To develop cost estimates, you need to identify all possible costs for operating your Dam Safety Program.

Costs for a Dam Safety Program should be projected for at least a 5-year span. Many new programs have experienced crises because of a failure to establish funding far enough into the future.

Cost categories for Dam Safety Programs include . . .

- Annual costs
- Emergency and unanticipated costs

ESTIMATING COSTS: ANNUAL COSTS

Examples of annual Dam Safety Program costs include . . .

Item . . .	Examples Of Costs Included . . .
Personnel	Salaries, overtime, benefits, training (in-house)
Contracts	Technical resources, training
Equipment, Office Space, And Supplies	Rent, vehicles, cameras, office equipment
Travel	Per diem and transportation

☞ **PROGRAM TIP:** Contact your State dam safety agency for advice about estimating costs. Ask the agency to locate operating Dam Safety Programs that most resemble your planned program. Next, obtain budgets and other information from those programs. Finally, base your estimates on the experience of those programs.

To project costs for your Dam Safety Program over 5 years, identify known future events (adding hydropower to a dam or demolishing a dam, for example). Estimate the probable impact on your Dam Safety Program. Finally, add a factor for inflation to projected costs.

Estimating Personnel Costs

The type of personnel needed for a Dam Safety Program include . . .

- Engineers and technicians
- Administrative personnel

You will need to estimate the costs for each personnel category.

☞ **PROGRAM TIP:** Study the budgets of operating Dam Safety Programs and note costs for salaries, benefits, and in-house training. Compare the proportions of technical to administrative employees. If compensation levels in your geographic area differ, adjust the figures to reflect that difference.

First, estimate the cost of technical personnel. Consider whether any of the employees who presently manage and operate the dam(s) could assist with the Dam Safety Program. If you are establishing a program for a complex facility, such as a power-generating dam, engineers will undoubtedly be included in your facility's staff. Can the duties involved be added to current positions, or must your organization hire additional people?

Continued . . .

Estimating Personnel Costs (Continued)

If you hire inspectors and engineers, base your cost figures for salaries, benefits, and in-house training on the budgets of operating Dam Safety Programs. Allow for time and expenses that may be incurred in receiving training (such as in identification of potential dam safety problems). List the number and types of technical employees that will be hired, and estimate costs for salaries, benefits, and in-house training.

Next, estimate the costs for administrative personnel. Compare the number and types of administrative personnel in the budgets of operating Dam Safety Programs. Consider the reports and records your program might require, and allow for clerical time to perform those requirements. Then list the administrative positions needed for your Dam Safety Program and estimate costs for salaries, benefits, and in-house training.

The cost of in-house training for technical and administrative personnel includes . . .

- Absence of personnel from regular duties.
- Cost for instructors.
- Cost of materials.

Training costs may be greatest during the first years of the program operation.

Finally, combine the costs for technical and administrative personnel to estimate total personnel costs.

Estimating Costs Of Contracted Services

Costs of a Dam Safety Program that may be contracted include . . .

- Operation and maintenance
- Technical services
- Training

Maintenance is contracted more frequently than operation. A contractor currently may perform your operation and maintenance, or cost comparisons may have led you to plan contracting one or both functions in the future. Use past cost figures to estimate the annual cost of contracting for maintenance and operation.

Discuss the total annual cost of contracts for technical services with governmental agencies and civil engineering firms supplying the services. If you will pay travel and per diem expenses for the contractor, be sure that these costs are included in your estimates. If you contract for computer services, add the estimated costs to your budget.

Estimate the annual cost of contracts for training. Training costs may be greatest in the first years of the program.

Estimating Costs Of Equipment, Office Space, And Supplies

Costs for equipment depend on the activities of your Dam Safety Program and upon whether some equipment already is available.

Office equipment such as desks and copying machines is required for any Dam Safety Program.

If an in-house engineering staff will perform inspections and analyses, equipment such as vehicles, cameras, and field inspection equipment are needed.

Use of a computer is another expense. If a computer will be purchased for the Dam Safety Program, estimate costs to buy and maintain the computer and to buy and adapt software. Consider whether your organization will supply programming assistance. Estimate the cost.

To determine costs for equipment . . .

1. List the number and types of equipment needed for the program.
2. Review the equipment you now have available, and determine if any unused or underutilized items could be devoted to the Dam Safety Program.
3. List the equipment items that must be purchased.
4. Develop purchase and annual cost estimates for each item (cost/average years of service life).
5. Total the costs per year.

The cost of office space depends upon . . .

- The cost of leased space, if no available space can be used for the program.
- Remodeling costs.

Supplies include office supplies and maintenance supplies. Use historical data to estimate the annual cost for supplies.

Estimating Travel/Per Diem Costs

Travel expenses and living expenses (per diem) will need to be estimated in your total costs. Such travel and per diem would be for periodic visits to dam site(s) or for training. The cost of travel and per diem is based on the number and locations of dams in the program, and inspection frequencies and types.

Historical data from operating Dam Safety Programs that would have similiar requirements for travel and per diem are an excellent source of estimated annual costs.

II. PLANNING A DAM SAFETY PROGRAM: SECURE FUNDING

ESTIMATING COSTS: EMERGENCY AND UNANTICIPATED COSTS

Even if you have made very careful budget estimates, costs associated with emergencies and other unanticipated events may exceed your annual budget. For example, seismic activity may cause structural damage, or an inspection might reveal a hazardous condition that requires extensive modification or reconstruction.

Many dam owners and operators establish Emergency Reserve Funds to deal with emergency and unanticipated costs. To determine how much money should be set aside in your Emergency Reserve Fund, consider the following factors . . .

- Annual operation and maintenance expenditures
- Conditions at dam sites (topography, weather, seismic activity, etc.)
- Condition and vulnerability of features at project sites

Your State dam safety agency can advise you about problems encountered at dams similar to those in your inventory. The amount of money set aside in an Emergency Reserve Fund can range from 10 percent to 100 percent of your annual operation and maintenance budget.

Accumulation of the Emergency Reserve Fund should begin as soon as possible. The Emergency Reserve Fund should be fully funded within the first 10 years of the Dam Safety Program. As money is withdrawn from the fund, it should be replaced as soon as possible. Your annual budgets should include provisions for the initial establishment of the Fund and for the replacement of money withdrawn from the Fund.

SECURING FUNDING: REGULATORS

If you are planning a regulatory program, you must deal with funding concerns that do not affect owners and operators. These concerns involve . . .

- Estimating costs
- Resolving budget and funding issues

Estimating Costs

Estimating costs of regulatory programs involves additional considerations concerning . . .

- Equipment, office space, and supplies
- Travel

Estimating Costs: Equipment, Office Space, And Supplies

If the Dam Safety Program office will be located within a space devoted to your agency, agency policy determines whether cost of office space becomes part of the program budget. The cost of leased space probably will be included in the budget for the Dam Safety Program.

Estimating Costs: Travel

Even if your agency provides the training of technical personnel, travel to other localities for such training and related living expenses often are involved. Be sure not to overlook this expense.

Resolving Budget And Funding Issues

After you estimate the cost of a regulatory Dam Safety Program, you must determine how the program will be funded. Federal and State governments fund most regulatory Dam Safety Programs. Fees also may offset some program costs.

Resolving Budget And Funding Issues: Federal Funding

Federal agencies request funding based on anticipated needs, and Congress determines actual funding. Staffing may be more difficult to obtain than money for contracted services, depending on current policies. Cost studies now are done on contractable functions such as drafting, surveying, inspection, and operation and maintenance. A decision to use in-house staff or contracted services largely depends on the program scope and program priorities.

Resolving Budget And Funding Issues: State Funding

Funding for State Dam Safety Programs is obtained by submitting budget requests to the State legislatures, which determine actual funding. Some states charge fees for inspection to help pay for the Dam Safety Program.

II. PLANNING A DAM SAFETY PROGRAM: OBTAIN TECHNICAL RESOURCES

INTRODUCTION

Decisions about the source(s) of technical services for your Dam Safety Program will have been made during the program design process. Now you will take action to obtain those services for your program.

Your organization may have decided to obtain technical resources by:

- Establishing an in-house engineering staff.
- Contracting with governmental agencies.
- Contracting with engineering firms.
- Combining an in-house engineering staff with contracted services.

If the program you are planning will employ engineers and technicians, your organization must set technical qualifications for the staff, and provide training in dam safety.

ESTABLISHING AN IN-HOUSE ENGINEERING STAFF

Managers of large Federally owned dams and owners or operators of hydroelectric projects or other large and complex dams often employ their own technical staffs. Larger utilities generally use in-house engineering staffs supported by independent consultants, while smaller utilities are more likely to contract with consulting engineering firms.

Establishing an in-house engineering staff requires the following actions:

- Setting technical qualifications
- Providing training

Setting Technical Qualifications

The technical staff for a large or complex dam should consist of engineers and geologists with a minimum of 10 years of experience in design, construction, and performance monitoring of dams.

In addition to experience with several aspects of dam and foundation engineering, look for experience in specialties such as:

- Dam-break analysis
- Emergency action planning
- Instrumentation
- Equipment and structural operation and maintenance

Continued . . .

Setting Technical Qualifications (Continued)

For hydroelectric projects staff, familiarity with hydroelectric facilities and experience with several aspects of hydropower also contribute to program success.

Program supervisors should be familiar with regulatory requirements, and should know how large utilities and Federal agencies inspect and monitor dams. Experience should include dam performance analyses, working with technical specifications, and implementing remedial measures.

The following technical positions may be included in staffing a Dam Safety Program:

- Engineers
  - Water resources (hydrology and hydraulics)
  - Geotechnical
  - Structural
  - Construction
  - Mechanical
  - Electrical
- Engineering geologists
- Technicians
  - Construction
  - Inspection
  - Surveying
  - Drafting
- Professional support
  - Environmental scientists
  - Computer scientists
  - Emergency planners
  - Soil scientists
  - Remote sensing specialists
  - Attorneys

Consider which specialties your program might utilize. Be sure to seek out operating organizations with similar functions and dam inventories, and gather information about their engineering and technical staffs. Ask for copies of job descriptions that include qualifications and duties of various positions. When hiring, try for a mix of experienced and junior engineers.

II. PLANNING A DAM SAFETY PROGRAM: OBTAIN TECHNICAL RESOURCES

Providing Training

Training resources for your staff include these TADS modules and training courses offered by Federal agencies. Appendix D provides a list of courses offered by each agency and contact points with agency training offices.

If the program you are establishing is small, cross-training allows each position to handle more than one specialized field in the program. For example, an engineer specializing in hydrology and hydraulics could also be trained to develop or evaluate Emergency Action Plans.

The Federal Emergency Management Agency provides funding for regional dam safety workshops. The Association of State Dam Safety Officials conducts seminars with speakers and holds annual meetings. The Electric Power Research Institute represents utilities, and does research on dam safety, among other subjects.

CONTRACTING WITH GOVERNMENTAL AGENCIES

During the budgeting process you may have identified an agency that could supply your project with certain technical services. To obtain those services, you may contract with the agency. The agency might supply services, such as dam safety inspection, or assist in setting up Dam Safety Programs without cost to the owners. The Soil Conservation Service, for example, will inspect construction and provide technical assistance in operation and maintenance for dams constructed under SCS programs. SCS also can provide consultation.

CONTRACTING WITH CONSULTING ENGINEERING FIRMS

Not all consulting engineering firms have experience in dam design, inspection, modification, or repair. Try to find a water resources firm that has adequate experience working with dams. Regulatory agencies generally prefer not to recommend particular firms, but may give you the names of dam owners/operators who can tell you about their experiences with engineering firms.

II. PLANNING A DAM SAFETY PROGRAM: SUMMARY

In this unit, we discussed the process of planning a Dam Safety Program. Program planning includes the following steps:

#	STEP	EXPLANATION
1	Determine program activities	Determining program activities involves . . . . Gathering technical data, including: - Records for individual dams. - Dam inventory. . Identifying regulated dams. . Establishing program activities, including: - Basic activities. - Required activities. - Activities for regulatory programs.
2	Design the program	Designing the program involves . . . . Designating program responsibility. . Choosing in-house versus contracted activities. . Developing recordkeeping systems. . Estimating staffing requirements. . Developing an organizational structure.
3	Secure funding	Securing funding involves . . . . Determining funding source(s). . Estimating costs. . Securing regulatory funding. - Estimating costs. - Resolving budget and funding issues.
4	Obtain technical resources	Obtaining technical resources involves one or a combination of the following actions: . Establishing an in-house engineering staff. . Contracting with governmental agencies. . Contracting with civil engineering firms.

UNIT III

OPERATING THE DAM SAFETY PROGRAM

III. OPERATING THE DAM SAFETY PROGRAM: OVERVIEW

INTRODUCTION

The second phase of organizing a Dam Safety Program is **Operating.** Operating Dam Safety Programs requires skilled management.

This unit will present guidance on how to operate a Dam Safety Program. Operating a Dam Safety Program can be very complex. You may need to supplement the general advice provided in this unit with additional training programs or by receiving technical assistance from your organization or State Dam Safety Program.

DAM SAFETY PROGRAM OPERATION STEPS

The following steps are performed in operating a Dam Safety Program . . .

Step 1: Conduct program activities
- Operation and maintenance
- Emergency Action Plan development
- Inspections, investigations, and analyses
- Deficiency correction
- Compliance verification (regulators)

Step 2: Administer the program
- Personnel management
- Resource management
- Information management

Next, each step will be discussed.

III. OPERATING THE DAM SAFETY PROGRAM: CONDUCT PROGRAM ACTIVITIES

INTRODUCTION

Operating a Dam Safety Program involves conducting program activities, including . . .

- Performing operation and maintenance
- Developing Emergency Action Plans
- Conducting inspections, investigations, and analyses
- Correcting deficiencies
- Verifying program compliance (regulators)

PERFORMING OPERATION AND MAINTENANCE

The TADS module How To Organize An Operation And Maintenance Program provides comprehensive guidance for planning, implementing, and evaluating operation and maintenance programs. If you contract for operation and maintenance, arrange for the contractor's employees to be trained in the visual detection of dam safety deficiencies.

DEVELOPING EMERGENCY ACTION PLANS

Refer to the TADS module How To Develop And Implement An Emergency Action Plan for information about preparing and updating Emergency Action Plans.

Your organization may be able to get an inundation map from the Soil Conservation Service when a new dam of inventory size is designed. Regulatory agencies, State dam safety officials, and the Federal Energy Regulatory Commission also are sources for inundation maps. If none of these sources is available, your own staff may need to prepare the maps, or you may have to contract for this service.

The Federal Emergency Management Agency sponsors a regional program, Hazard Mitigation Assistance, to help local emergency management agencies develop Emergency Action Plans. Money is funneled through the State to the local agency. Assistance covers preparation of an Emergency Action Plan from inundation maps and local land use plans, including notification lists and emergency phone numbers.

CONDUCTING INSPECTIONS, INVESTIGATIONS, AND ANALYSES: INTRODUCTION

At this point you will make detailed plans and carry out the general decisions you made concerning dam safety inspections.

To implement a dam safety inspection program, you must perform the following tasks:

- Plan the inspection program.
- Conduct dam safety inspections.
- Perform field investigations and technical analyses.
- Evaluate dam safety inspection findings.
- Adjust dam safety inspection priorities.

III. OPERATING THE DAM SAFETY PROGRAM: CONDUCT PROGRAM ACTIVITIES

PLANNING THE INSPECTION PROGRAM

Your dams may be subject to two different modes of dam safety inspection:

- Self-inspection by your own personnel, who may be:
  - Engineers and technicians
  - Maintenance and operational employees (The TADS module Identification Of Visual Dam Safety Deficiencies provides useful training for these employees.)
- Dam safety inspections required by regulatory agencies and performed by regulatory agencies or other engineers independent of your organization.

If your organization arranges for engineering firms to perform independent dam safety inspections, make sure that you inform the firm of regulatory inspection requirements.

Your dam safety inspection program must fulfill certain statutory or policy requirements. You need to determine:

- How often each type of dam safety inspection should be conducted.
- If your organization performs dam safety inspections, the numbers and qualifications of staff required to perform inspections.

Guidelines to help you make these decisions can be found below and on the following pages.

Establishing Priority For Dam Safety Inspections

The dams in your inventory probably vary in size, condition, and site characteristics. The relative need for inspection also will vary. For example, dams where hazardous conditions exist or are suspected should be inspected before dams without evident problems. For a large inventory of dams, it is important to establish the initial order of inspection.

Continued . . .

Establishing Priority For Dam Safety Inspections (Continued)

Factors typically used to set the order for inspections are . . .

- **Hazard Classification**

  Each dam included in your dam inventory file should have a hazard classification assigned by the Federal dam inventory, a Federal or State regulatory agency, or your own agency. High-hazard dams generally should be inspected first.

  One of the functions of your program is to review hazard classifications, because new downstream development results in increased hazards. A reasonable interval for reviewing hazard classifications is every 5 years.

  The Bureau of Reclamation and other agencies have published guidelines on assigning hazard classifications. Material on risk analysis and hazard evaluation is available from the American Society of Civil Engineers and the Association of State Dam Safety Officials.

- **Other Factors Used To Establish Inspection Order**

  The following factors can be assigned values and used to computerize priority rankings . . .

  - Condition of the dam
  - Size
  - Type of dam
  - Age
  - Spillway type

Different techniques can be used to set inspection order. Examples of factors used in determining the order for initial inspections are included in Appendix C.

Determining Resources Needed By Inspection Type

Different terminology can be used to refer to dam safety inspections. The TADS program uses standardized terms for types of dam safety inspections, which are defined in Table III-1.

Continued . . .

Determining Resources Needed By Inspection Type (Continued)

TABLE III-1. TYPES AND FREQUENCIES OF DAM SAFETY INSPECTIONS

Inspection Type	Definition
Initial or Formal	Indepth review of design and construction records and evaluation relative to current criteria and state-of-the-art, and a thorough onsite inspection of all features including operation of all mechanical equipment.
Periodic or Intermediate	Review and evaluation of records and a comprehensive visual onsite inspection which may or may not include operation of all mechanical equipment.
Routine	A structured or unstructured visual inspection of current conditions of the dam and its features, typically conducted by field or operating personnel. Routine inspections include the observations of dam tenders, superintendents, or maintenance workers in their daily or frequent attendance at the dam.
Special	Inspection of a particular feature of a dam (such as the upstream face) which is not frequently available for inspection. Also, inspection of significant dam safety concerns (such as seepage).
Emergency	Inspection performed when the immediate safety of the dam is of concern, or because of unusual or potentially adverse conditions at the dam (such as a large flood, or immediately following an earthquake).

The different types of dam safety inspections demand a range of resources and technical knowledge. Refer to the TADS module Preparing To Conduct A Dam Safety Inspection for detailed discussion of inspection team composition and relative effort required for each level of inspection.

Staff engineers may need training in dam safety inspections. The TADS inspection modules provide a training resource. Appendix D contains a list of other training courses offered by Federal agencies.

Continued . . .

Determining Resources Needed By Inspection Type (Continued)

Initial or formal dam safety inspections usually involve teams of inspectors with specialized knowledge who produce detailed reports. Such inspections are expensive.

Emergency inspections and some special inspections cannot be anticipated, but resources should be available to perform those inspections when the need arises.

The type of inspection determines the inspection intervals. An inspection schedule permits the timely assembly of technical data and previous inspection reports for the inspectors to use when preparing for inspections.

Some State Dam Safety Programs have developed computerized inspection scheduling programs that respond to changes in dam safety ranking and produce periodic inspection schedules. The Association of State Dam Safety Officials (listed in Appendix A) can provide information on available systems.

CONDUCTING CONSTRUCTION INSPECTIONS

Your organization may perform construction inspections on new dams or contract this activity. Dam safety, of course, applies to new dams as well as to existing dams. Concept, design, specification review, and construction review all are important. Contractors may purposely or inadvertently fail to follow specifications during construction. Quality assurance by the owner and the regulator are necessary to ensure construction is in compliance with specifications and good engineering practice.

The Bureau of Reclamation has prepared a series of training modules, the Comprehensive Construction Training Program, that includes self-instructional courses on dam construction inspection. Checklists for new dam construction in these courses can be used to help organize construction inspection activities.

When documenting new dam construction, photographs or slides are very important. The date, dam name, feature or area being photographed, and inspector's initials should be marked on the photographs and slides. Automatic dating cameras are excellent for documentation.

Most State dam safety agencies issue permits to construct dams, and use a variety of systems to monitor the construction process.

Continued . . .

CONDUCTING CONSTRUCTION INSPECTIONS (Continued)

FOR EXAMPLE:

In Maryland, before a newly permitted dam is filled, a State inspector uses a checklist to record observations at the site and to make sure all permit conditions have been met. The Soil Conservation District and county are checked for permits issued, and the owner is contacted for information. The checklist and a followup letter are sent to the owner to provide information about items requiring correction, or to notify the owner that filling may proceed.

Following construction, new dams may be inspected on a schedule similar to the following:

- First filling
- After 1 year
- Annually for 4 years
- Every 2 years for 4 years
- Every 3 to 5 years thereafter

The first inspection after construction would not include evaluation of design and construction, which have just been evaluated. Generally design and construction are reevaluated after several years against changes in the state-of-the-art. The first formal inspection of a new dam usually comes after several periodic inspections.

CONDUCTING DAM SAFETY INSPECTIONS

Standardized procedures should be established and followed when conducting dam safety inspections.

The inspection team may begin the field inspection with a discussion with dam personnel to review activity since the previous dam safety inspection, address personal safety concerns for the inspectors, and discuss needs for special equipment. After the inspection, significant observations may be discussed in an exit briefing or meeting.

Dam safety inspection reports vary in detail and are prepared to document inspection findings and recommendations, and to create histories for dams. Photographs provide an excellent supplement for written reports. Recommendations may be assigned identifying numbers for later reference to track progress in correcting deficiencies. For more information see the TADS module entitled Documenting And Reporting Findings From A Dam Safety Inspection.

III. OPERATING THE DAM SAFETY PROGRAM: CONDUCT PROGRAM ACTIVITIES

Conducting Formal Dam Safety Inspections

Dams should receive formal dam safety inspections at reasonable time intervals to reevaluate design, construction, performance, and present condition in light of advances in the state-of-the-art. New data for making hydrologic evaluations, for example, can change the safety status of existing dams. Major problems that may involve design or construction flaws also can trigger a formal dam safety inspection.

Conducting Periodic Dam Safety Inspections

A periodic or intermediate dam safety inspection differs from a formal dam safety inspection in that while all available data are reviewed (in order to become thoroughly familiar with the dam and its features), they are not evaluated with regard to advances in the state-of-the-art.

Periodic dam safety inspections are performed more frequently than any other type of inspection, and probably will compose the bulk of your inspection program. Your program manager must decide such issues as . . .

- The best time of year for inspections, and whether inspections at alternate operating conditions are desirable (high reservoir versus low reservoir).
- Whether inspectors will conduct periodic dam safety inspections in teams or individually.
- How much time to schedule for periodic inspections of the various dams in the program.

Conducting Periodic Dam Safety Inspections: Regulators

As a regulator scheduling dam safety inspections, you send the owner written notification of inspections and requests for relevant data. Notifications may include special conditions for the inspection, such as operation of mechanical equipment or access to difficult areas. The owner's operational personnel need to be informed of such requirements so they can plan for them.

Conducting Special Dam Safety Inspections

Events such as reservoir drawdown or dewatering a stilling/hydraulic jump basin provide opportunities for inspection of normally inundated features. In addition, it may be desirable to inspect significant dam safety problems such as seepage or instability more frequently than the interval established for periodic inspections so that any changes that could adversely affect the dam can be monitored more closely.

Conducting Emergency Dam Safety Inspections

You should anticipate the need for emergency dam safety inspections and give some forethought to the process of designating inspectors with the appropriate qualifications. All existing dam safety files should be readily available for use by an emergency inspection team.

ADJUSTING DAM SAFETY PRIORITY RANKINGS

Inspection findings or other information may change the priority of a dam for investigations, evaluations, or modification. Inspection findings also may change a dam's priority for future dam safety inspections (for a regulatory agency or division).

Computerized systems have been developed to adjust inspection priorities.

FOR EXAMPLE:

In the Maryland Dam Safety Program, a computer assigns a ranking number, adjusted after each inspection, based on:

- Time intervals between the previous and current inspections
- Comments
- Overall condition

The Bureau of Reclamation has a similar system for scheduling annual inspections. A computerized flowchart generates an examination schedule for the year with a list of dams and types of inspections needed.

Appendix C contains forms and information about these priority ranking systems.

PERFORMING INVESTIGATIONS AND ANALYSES

Potential safety problems may be discovered during an inspection or by other means. Investigation and analysis of suspected deficiencies may be required to evaluate the safety of a dam. A number of technical subject areas are involved in investigation and analysis, including . . .

- Hydrology
- Hydraulics
- Seismotectonic evaluation
- Seismic stability/liquefaction
- Static stability
- Settlement/deformation/movement
- Seepage
- Siltation

Continued . . .

PERFORMING INVESTIGATIONS AND ANALYSES (Continued)

If your Dam Safety Program lacks proficiency in a technical subject, sources are available to guide you. A series of TADS modules has been developed on the subjects listed containing technical information for use by engineers. The TADS component is entitled "Data Review, Investigation and Analysis, and Remedial Action."

Instrumentation may be added to dams to diagnose problems and monitor the success of correction. The TADS module Instrumentation For Embankment And Concrete Dams contains detailed information about instrumentation.

You may need to consult engineers with technical specialties not available among staff of your organization. Your program manager should know sources of specialized expertise that can be called upon when needed, whether from State or Federal agencies or from engineering firms.

Field investigations and technical analyses tend to be costly. You need to develop or obtain guidelines for determining when the expense is justified.

EVALUATING DAM SAFETY FINDINGS

After gathering data during an onsite dam safety inspection, your inspectors compare observations and findings, and data and observations recorded during routine dam safety inspections by employees who work at the site, with structural behavior (instrumentation) and other technical data and prior inspection reports. During this process, the causes or consequences of deficiencies may be defined, or further study may appear to be necessary.

Evaluating Design And Condition

When evaluating inspection findings, the need for modification or repair of a dam or its appurtenances may emerge. Two different types of defects can trigger a recommendation for modification or repair:

- Condition and structural defects, such as cracks, misalignment, or erosion.
- Design defects. (The most common design defect is inadequate spillway capacity.) Design defects are more commonly cited than serious condition and structural defects, and are detected by new data for computing the Probable Maximum Flood (PMF) or other changes in standards and in the state-of-the-art.

Evaluating The Operation And Maintenance Plan

Your inspectors need to review the operation and maintenance manual during the inspection, to determine if the plan needs revision to meet safety concerns.

Evaluating The Emergency Action Plan: Regulators

Your agency should evaluate the Emergency Action Plan as part of the inspection program. The written plan needs to be examined to assure that it is current and complete. Factors such as communications systems, auxiliary power equipment, and access to the site also must be considered, since these elements are vital to the plan's workability. Periodic testing of the plan should be required.

CORRECTING DEFICIENCIES

As a dam owner, you must take corrective action when deficiencies are found that threaten a dam's safety.

Determining The Need For Corrective Action

The need for corrective action is established by:

- Direction from a regulatory agency.
- Recommendations from your organization's staff engineers.
- Recommendations of consulting engineers.

Examples of reasons for recommending corrective action include:

- Structural deficiencies.
- Changes in engineering criteria, such as new methods for computing dynamic stability, updated hydrologic data, or advancements in the state-of-the-art understanding of dam performance that call into question a dam's continued safe performance.

Recommending Corrective Action

Before recommending that a potential dam safety deficiency be corrected, you must complete the following steps:

- Investigate to verify the existence of a deficiency
- Determine the severity of the deficiency

Inspection findings concerning condition affect a dam's priority for modification or repair.

Continued . . .

Recommending Corrective Action (Continued)

FOR EXAMPLE:

The Bureau of Reclamation sets new priorities for modification and repair in response to a detailed analysis of inspection findings. Categories such as seepage and stability are broken into degrees of seriousness for impact on dam safety, and each level is weighted. See Appendix C for information about this system.

Priorities for modification or repair also change in response to updates in hazard classifications.

Your engineers may lack the specialized knowledge to recommend corrections.

FOR EXAMPLE:

If Maryland inspectors find a problem with a concrete structure, the owner is directed to have a qualified engineer evaluate the problem, since the State engineers do not have this expertise.

An owner may need to be advised about available options to correct a dam safety deficiency.

Evaluating Alternative Actions

There are usually a number of possible actions that will correct a deficiency. Alternatives include . . .

- Making structural corrections.
  - Constructing new structures.
  - Modifying existing structures.
  - Making extensive repairs to existing structures.
- Taking nonstructural corrective action.

Nonstructural measures should be fully considered when selecting corrective actions. If structural corrections are necessary, nonstructural measures may also be used in combination to reduce total costs.

Your organization may have sufficient expertise to determine the best solution. Consider the following points when choosing an alternative:

- **Cost**

  Consulting or staff engineers can identify alternative actions, and do preliminary cost studies to determine cost associated with each alternative.

Continued . . .

Evaluating Alternative Actions (Continued)

- **Impact**

  Environmental, political, social, and economic impacts are factors in many decisions.

- **Risks**

  Risk analysis compares the monetary cost of making a particular modification to the risk in lives and property of a failure that might result from taking no action. A continuum of alternatives with increasing costs and decreasing risks is evaluated during this procedure.

Decision analysis weighs all of the alternative actions being considered and assigns numerical values to each alternative. Such analyses can be complex and expensive due to the many scenarios that must be evaluated. Your organization may choose in some instances to forego decision analysis and instead devote funds toward the cost of a specific modification or repair.

During the decision-making process, regulatory officials usually must be contacted for approval.

Making Structural Corrections

Your organization may decide upon a structural correction as the best action to correct the dam's deficiency. Reasons for making structural corrections include:

- Repair or replacement of damaged or deteriorated components (for example, lining a badly rusted outlet works conduit).

- Modifying the structure to make it meet revised engineering criteria (for example, by increasing spillway capacity or increasing the freeboard).

- Upgrading the structure to meet standards for a higher hazard classification caused by new downstream development (for example, by increasing spillway capacity).

Continued . . .

Making Structural Corrections (Continued)

In order to make a structural correction, the dam owner must go through the following process:

- Obtaining funding

  Possible sources for funds include:

  - Taxes
  - Agency budget (appropriated funds)
  - Assessments on members
  - Fees
  - Sinking funds

- Preparing a final design

- Obtaining regulatory agency review of the proposed correction

- Preparing specifications

☞ **PROGRAM TIP:** Specifications for simple actions such as tree removal or concrete repair may be available from your State's dam safety office. The dam owner otherwise might pay an engineering firm to prepare such specifications. The cost savings then can be devoted to paying for repairs.

- Awarding the contract

- Establishing a quality control program for construction

- Obtaining permits or other regulatory requirements

- Constructing the remedy

- Monitoring the corrective action to ensure the deficiency was corrected

One structural action, breaching the dam, results in taking the dam out of service rather than correcting the deficiency through repair or modification. Requirements for funding, specifications, and the amount and type of work done by the contractor may be fewer than for other structural actions for smaller dams with marginal benefits.

Continued . . .

Making Structural Corrections (Continued)

If appropriate, your organization should evaluate the possibility for breaching the dam when evaluating alternatives for correcting a deficiency. In some cases, the most economical solution is to take the dam out of service. But breaching a dam also requires engineering to ensure that the remnant will not impound water during heavy flows or floods. An Environmental Impact Statement may be required. Also, there may be the expense of reclaiming the reservoir area, and the problem of stabilizing a silted-in reservoir full of unstable sediment. Finally, development may have encroached on the downstream channel once protected by the dam from floods. Removal of the dam may subject the development to flooding even during small storms.

Taking Nonstructural Corrective Actions

In some instances, nonstructural corrective actions may be taken to remedy a problem. Most nonstructural corrective actions are solutions that require minimal funding, but could result in environmental damage or lost benefits from the reservoir. Examples of nonstructural corrections include:

- Breaching the dam so that it will not impound water.
- Establishing a reservoir restriction that will alleviate the deficiency.
- Establishing flood forecasting systems.
- Restricting development in the flood plain.
- Installing automatic early warning systems.
- Removing homes or other development downstream from the dam to reduce the hazard classification. (In many cases, this solution would be far less expensive than modifying or repairing the dam.)

Relying on warning systems involves some element of risk, since there is no guarantee that all affected persons will be warned and respond in time to reach safety. Therefore, regulatory agencies are likely to scrutinize this type of action and impose strict conditions.

CONDUCTING PROGRAM ACTIVITIES: REGULATORS

If your agency serves as a regulator, your Dam Safety Program may include the following activities:

- Providing technical assistance
- Disseminating program information
- Verifying program compliance

III. OPERATING THE DAM SAFETY PROGRAM: CONDUCT PROGRAM ACTIVITIES

Providing Technical Assistance

Your regulatory agency may be able to offer two kinds of technical assistance:

- Training
- Technical guidelines

Providing Technical Assistance: Providing Training

A regulatory Dam Safety Program should consider providing two types of training:

- Technical training for engineers, technicians, and operation and maintenance personnel can be provided.

  Training aimed at the dam owner's operation and maintenance personnel can be provided by bringing instructors to projects. Dam site workers need information about the visual signs of dam safety deficiencies and how to recognize those signs.

- Information about complying with the program can be provided for owners, operators, and emergency management organizations.

☞ **FOR EXAMPLE:**

A typical presentation for owners, operators, and emergency management agencies might include:

- Dam failures and near failures and the consequences.
- Evaluation of your agency's regulatory program and how it functions.
- An explanation of owner liability.
- How a particular dam or emergency management program fits into your agency's Dam Safety Program.

Providing Technical Assistance: Setting Technical Guidelines

Your staff will give technical guidance to engineers and developers seeking to meet requirements of your Dam Safety Program. The inspection process will trigger much of the technical advice that is provided. Make sure the technical guidelines you provide are tailored to your State or other jurisdiction.

Continued . . .

Providing Technical Assistance: Setting Technical Guidelines (Continued)

Your program manager may want to seek advice about appropriate technical guidelines from:

- The Association of State Dam Safety Officials.
- Soil Conservation Districts. Dam safety requirements for the agricultural community usually are coordinated with Soil Conservation Districts.
- Federal agencies such as the Bureau of Reclamation, the Corps of Engineers, Soil Conservation Service, the Federal Emergency Management Agency, and the Federal Energy Regulatory Commission.

Consistency is important. Many possible standards could be cited for modification and construction, inspection, and operations. The program manager and technical staff must choose which among these standards will apply, particularly when consulting engineers are involved in the design or modification of dams.

You may receive numerous telephone questions about such matters as acceptable methods of analysis for dam safety evaluations, inundation mapping, and classification ratings.

Encourage consulting engineers to contact you early in the planning process to learn about required standards, methods of analysis, and requirements for obtaining a planning or construction permit for a new dam.

Providing Technical Assistance: Obtaining Technical Resources

You may obtain information from various sources to help you provide technical assistance. The TADS module Preparing To Conduct A Dam Safety Inspection contains inspection checklists.

Several computer programs are available for determining hydraulic conditions for specific facilities:

- Water surface profiles
  - HEC II (Corps of Engineers)
  - TR-6, WSP II (Soil Conservation Service)
- Dam breach models
  - DAMBRK (National Weather Service)
  - TR-66 (Soil Conservation Service)

Continued . . .

Providing Technical Assistance: Obtaining Technical Resources (Continued)

The following are some hydrology computer programs.

- HEC I (Corps of Engineers): Flood routing
- TR-20 (Soil Conservation Service): Flood routing
- TR-55 (Soil Conservation Service): Urban Hydrology for small watersheds

Soil Conservation Service programs are available for purchase from the National Technical Information Service (NTIS) in Springfield, Virginia. Copies of Corps of Engineers programs can be made for consulting engineers.

These programs tend to have biases toward different conditions; some work better in certain situations than others. There is a movement to try to standardize programs, but up to this point the issue has proved too complex to resolve.

Technical assistance on various topics may be available from the Soil Conservation Service or your State dam safety agency.

Assistance may include . . .

- Engineering studies
- Performance of surveys
- Inundation maps

Disseminating Program Information

The effectiveness of your Dam Safety Program is related to how effectively you inform affected parties about the program. Information needs to be provided to the following groups:

- **Dam owners and operators**

  Dam owners and operators need to know their obligations and potential liability in relation to dam safety. They should know your program's requirements, and also what assistance your agency might provide.

- **Legislators**

  Legislators may receive briefings as preparation for writing legislation. Funding for dam safety is more likely to be provided when legislators receive descriptions of the consequences of dam failures.

Continued . . .

Disseminating Program Information (Continued)

- **Media**

  The media should receive information about Dam Safety Program achievement. Media coverage can result in public understanding of the need for dam safety and the importance of your activities. Publicity about unsafe conditions may lead to public pressure to correct deficiencies.

- **Emergency management agencies**

  There is a real need to make emergency management agencies more aware of dam safety. Civil Defense and county sheriffs usually are responsible for evacuation when notified as a result of implementation of the Emergency Action Plans.

  The Federal Emergency Management Agency has prepared a pamphlet listing emergency management officials by State.

- **Local governments**

  Zoning and floodplain development usually are the jurisdiction of the county or other local government. Floodplain regulation and zoning are important means to limit development downstream from dams, and therefore to avoid higher hazard classifications. Many counties buy or otherwise obtain easements on floodplain property to prevent development. The Federal Emergency Management Agency studies do not forecast development, but document existing development. Federal Emergency Management Agency maps locating 100-year floodplains are used to set insurance rates, while maps identifying 500-year floodplains are used to prevent hospitals and other vital facilities from being built in those areas.

  Local governments need to be aware of the importance of avoiding floodplain development.

- **Administrators**

  A dam safety function usually is part of a larger organization. The managers and administrators of your organization may require information about the Dam Safety Program for the sake of better understanding.

Continued . . .

Disseminating Program Information (Continued)

- **Public**

  The program should help people living downstream from a dam to understand dam safety problems and alternatives.

  When the dam owner is a local government, meetings can be held to raise support for correction of dam safety problems. Explanations about responsibility, potential liability, and the need for correction usually convince the public of the importance of dam safety.

Verifying Program Compliance

Your agency can verify that dam owners and operators comply with the Dam Safety Program by . . .

- Issuing permits and licenses
- Taking enforcement measures

Verifying Program Compliance: Issuing Permits And Licenses

When construction of a new dam that falls within regulatory criteria is proposed, regulators review design plans and issue licenses. Applications to make major repairs or modifications to existing dams also are reviewed before issuing permits and licenses.

☞ **PROGRAM TIP:** The Maryland Dam Safety Program requires applicants to post surety bonds before permits and licenses for dam construction modification or repair are granted. The bond ensures that either the applicant will complete the work, or the State will use the bond to pay for completion.

Verifying Program Compliance: Taking Enforcement Measures

Enforcement includes:

- **Educating dam owners about the enforcement process.**

  ☞ **PROGRAM TIP:** Education and enforcement are interrelated. The consequences of failure need to be made clear to owners, and the permitting process and penalties explained. (In an area with small dams, slides or videos showing small dam failures are effective tools.)

Continued . . .

Verifying Program Compliance: Taking Enforcement Measures (Continued)

- **Monitoring new dam construction.**

☞ **PROGRAM TIP:** The person observing the construction must be technically competent. Incidents involving unacceptable materials or methods are relatively common during construction. Close monitoring is important.

- **Establishing and administering enforcement procedures.**

  Enforcement procedures vary among agencies.

☞ **FOR EXAMPLE:**

The Federal Energy Regulatory Commission has an inspection program for all non-Federal power-producing dams. Independent consultants perform inspections every 5 years and prepare reports. Emergency Action Plans must be updated annually. Licenses may be revoked if safety violations are not corrected.

If a Soil Conservation District issues a construction permit for a small structure and construction does not meet specifications, the District either enforces the permit conditions or calls in the State for enforcement. The District may or may not have enforcement power, depending upon State laws.

III. OPERATING THE DAM SAFETY PROGRAM: ADMINISTER THE PROGRAM

INTRODUCTION

The final step in operating is to administer the Dam Safety Program. Administering a Dam Safety Program involves the management of . . .

- Personnel
- Resources
- Information

MANAGING PERSONNEL

Effective management of personnel is an important aspect of operating a Dam Safety Program. A Dam Safety Program can use in-house personnel and contracted personnel. Next, the management of in-house personnel and contracted personnel will be discussed.

MANAGING PERSONNEL: OVERVIEW

The categories of personnel in your Dam Safety Program include . . .

- In-house operation and maintenance staff
- In-house engineering staff
- Contracted personnel

Managing in-house personnel involves . . .

- Assigning and scheduling work
- Monitoring work performance
- Troubleshooting work performance problems
- Training personnel

MANAGING PERSONNEL: MANAGING AN IN-HOUSE OPERATION AND MAINTENANCE STAFF

The TADS module How To Organize An Operation And Maintenance Program provides information about managing an in-house operation and maintenance staff.

MANAGING PERSONNEL: MANAGING AN IN-HOUSE ENGINEERING STAFF

Managing your in-house engineering staff involves . . .

- Assigning work
- Scheduling work
- Monitoring work performance
- Troubleshooting work performance problems

Assigning Work To An In-House Engineering Staff

The design of your Dam Safety Program designated the technical qualifications of your in-house engineering staff.

General principles applying to assignment of technical work include . . .

- Matching background and experience of staff members to the levels and types of work assignments.
- Teaming less experienced with more experienced staff members, when possible.
- Building staff expertise through assignments that allow experience in various techniques and subject areas.
- Providing precise information about expectations concerning work assignments, including:
  - Actions to be completed
  - Reports or other documentation to be prepared
  - Time limits for completion of assignments
  - Quality standards that will be applied

Scheduling Work For An In-House Engineering Staff

Annual schedules of technical work to be performed should be prepared and maintained. Such schedules may be subject to changes in response to unanticipated events. Effective management of your technical staff requires that the schedule be updated as changes occur, and that all staff members receive accurate information about scheduled work.

Steps in scheduling inspections, investigations, and analyses for your in-house technical staff include . . .

1. Listing the inspections and other activities due for dams in the inventory during the scheduling period.
2. Ranking activities in order of priority, or order to be completed.
3. Estimating the staff time required to conduct each activity (including time to gather technical data, travel time to and from dam sites, and time to prepare required reports).
4. Scheduling activities that must be performed at certain times of the year.
5. Scheduling remaining activities in priority order, spreading dates throughout the year.

Continued . . .

Scheduling Work For An In-House Engineering Staff (Continued)

Leave some open time in the schedule to allow for emergency inspections and other unanticipated demands on your technical staff.

Scheduling may be done manually using charts and calendars. In addition, computer programs can be used to develop and update work schedules for your in-house technical staff.

Monitoring Performance Of An In-House Engineering Staff

Sources for monitoring performance of your in-house engineering staff include . .

- Reviews of written work
- Discussions about projects

The written reports of your technical staff provide one means to judge work performance. Review reports for . . .

- Completeness
- Clarity
- Technical accuracy

If a report does not meet standards, point out areas needing improvement to the employee, and provide examples of written work that illustrate the desired qualities. In addition, recognize items that were done well. Make sure to comment on improvements, when made.

If technical accuracy is a problem, the employee may need training to attain the desired level of expertise.

Frequent discussion about ongoing projects allows problems to be aired, and gives you a means to offer help and advice.

Training An In-House Engineering Staff

New engineers joining the staff of your Dam Safety Program should be trained when they are hired. All staff members should receive training in safety procedures and the hazards of the work.

Training can include . . .

- **Classroom training:** Classroom training sessions can be used to provide information.

- **Self-Instructional Training:** Self-instructional training provides information through the individual study of written materials, audiotapes, and videotapes.

Continued . . .

Training An In-House Engineering Staff (Continued)

- On-The-Job Training: During on-the-job training, an inexperienced engineer is paired with an engineer experienced in dam safety activities. The inexperienced engineer performs various activities under the supervision of the experienced engineer.

MANAGING PERSONNEL: MANAGING CONTRACTED PERSONNEL

The advantages and disadvantages of using contracted personnel are . . .

Advantages

- Flexibility: You can use contracted personnel to supplement your own in-house personnel during peak workload periods without having to add full-time positions.

- Cost: Some organizations find contracted personnel less expensive than salaried personnel.

Disadvantages

- Lack Of Control: When you use contracted personnel, you may have to accept the personnel provided by the vendor. The quality of work produced by contracted workers may be more difficult to control.

Managing contracted personnel involves . . .

- Writing contract specifications.
- Selecting a contractor.
- Monitoring the contractor's performance.

Your State dam safety agency may maintain a resource file of standard specifications that can be adopted and modified for use by your organization.

☞ **It is important to review your organization's contracting policies and procedures.**

If your organization lacks contracting policies and procedures, you may want to get technical assistance from your State dam safety agency on how to develop and manage contracts.

MANAGING RESOURCES

In addition to personnel, there are other resources used by Dam Safety Programs. These resources include . . .

- Equipment such as tools, vehicles, cameras, and computer equipment.
- Operation and maintenance supplies such as fuel and fertilizer.
- Office supplies such as paper and pens.
- Technical resources such as periodicals, reference books, and computer programs.

Managing resources involves . . .

- Purchasing resources
- Controlling resources

Purchasing Resources

Purchasing resources requires that you have a system in place for . . .

- **Identifying potential sources.**

  Maintain a list of potential sources for various types of equipment and supplies. You should check the reliability of the sources on your list. It is important to establish that vendors can deliver items on time and for the price quoted.

  Your in-house engineering staff can suggest necessary references and periodicals. Computer programs are available from sources listed in Appendix A.

- **Getting competitive price quotations.**

  You may be able to save money by getting competitive quotes for needed equipment and supplies.

- **Issuing purchase orders or some other authorization.**

  A system needs to be in place for authorizing purchases. All personnel involved in purchasing should know who is required to authorize purchases.

- **Inspecting purchased items and approving payments.**

  When items are received from vendors, they should be inspected. Payments should not be made until there is verification that the order includes the quantity and quality of items ordered.

Continued . . .

Purchasing Resources (Continued)

Your organization may have specific policies and procedures governing the purchase of resources.

It is important to review your organization's purchasing policies and procedures.

Controlling Resources

You must guard Dam Safety Program equipment and supplies against vandalism, theft, loss, and breakage. Controlling resources can reduce costs.

Resources to be controlled include . . .

- Operation and maintenance resources.
- Engineering and administrative staff resources.

Controlling Resources: Operation And Maintenance Resources

The TADS module How To Organize An Operation And Maintenance Program contains information about establishing a stockroom and using a tool crib.

Controlling Resources: Engineering And Administrative Staff Resources

Designate one staff member to maintain an equipment inventory with backup files containing information about warranties, getting repair services, and ordering replacement parts.

Some equipment, such as field inspection equipment, may be stored in a secure location and signed out to individuals as needed. Items needing replacement or repair should be noted upon return of the equipment. Repairs and replacements should be ordered promptly. If your organization needs to approve the costs involved, the approval process should be initiated.

Maintain records for vehicles, including . . .

- Mileage by date
- Fuel costs
- Servicing types and costs by date
- Repair types and costs by date

If your staff contains many engineers, you may want to establish a central reference area for basic texts and periodicals and establish a sign-out system.

Finally, compare costs actually incurred for equipment, supplies, and technical resources with budgeted amounts. If costs exceed the budget by significant amounts, look for explanations such as emergencies or other unanticipated expenses. You may have to increase the budget in certain categories in future years, or look for ways to reduce costs.

III. OPERATING THE DAM SAFETY PROGRAM: ADMINISTER THE PROGRAM

MANAGING INFORMATION

Dam Safety Program managers use information to carry out management functions. Accurate and timely information is a key ingredient of an effective Dam Safety Program.

Information is like any other resource--it needs to be managed. Without good management, your information resources may become less reliable.

Managing information involves . . .

- Keeping recordkeeping systems current.
- Reviewing information systems.

Keeping Recordkeeping Systems Current

In the previous unit, development of recordkeeping systems was discussed. Once a recordkeeping system has been established, the difficult job of keeping the system current begins.

The key to maintaining a recordkeeping system is to be disciplined about completing the needed paperwork and making required entries into the system. As manager of the Dam Safety Program, you need to be a good model. If you fail to do your end of the paperwork, everyone else will follow suit.

Make sure that your engineering and administrative staff understands why various records are important. During training, explain why each type of record is required. Tell personnel what should be included in inspection reports and other records. Provide models of good records.

Part of your monitoring of work performance should include a review of records completed. Provide feedback about accuracy and timeliness.

Reviewing Information Systems

Periodically you should review the systems used to collect, store, analyze, and report information. To review your information systems, ask yourself . . .

- Is any of the information being collected unnecessary?
- Is there any information not being collected that should be collected?
- Are the methods used to collect information efficient? Are there more efficient means to collect needed information?
- Is information being stored in a way that allows quick access? Are there more efficient ways to store and retrieve information?

Continued . . .

Reviewing Information Systems (Continued)

- Are there analyses being done that are unnecessary? Would new or different types of analyses be beneficial? Are there more efficient ways to analyze information?

- Are all reports generated being used? Can some of the reports be eliminated? Should new or different types of reports be generated? Are there more efficient ways to generate reports?

- How much is it costing to collect, store, analyze, and report information? Do the benefits justify this level of expenditure?

Information systems can be outdated. Information needs can change over time. Information systems that are not reviewed periodically may collect information that is no longer needed. It is important to review and modify your information systems based on changing needs.

III. OPERATING THE DAM SAFETY PROGRAM: SUMMARY

In this unit, we discussed the process of operating a Dam Safety Program. Program operation includes the following steps:

#	STEP	EXPLANATION
1	Conduct program activities	Conducting program activities involves . . . . Performing operation and maintenance. . Developing Emergency Action Plans. . Conducting inspection and analysis. - Planning the inspection program. - Conducting construction inspections. - Conducting dam safety inspections. - Adjusting dam safety priority rankings. - Performing investigations and analyses. . Evaluating dam safety findings. . Correcting deficiencies. . Conducting regulatory program activities. - Providing technical assistance. - Disseminating program information. - Verifying program compliance.
2	Administer the program	Administering the program involves . . . . Managing personnel. - Managing in-house operation and maintenance staff. - Managing in-house engineering staff. - Managing contracted personnel. . Managing resources. . Managing information.

APPENDIX A

SERVICES OFFERED BY ORGANIZATIONS

APPENDIX A: SERVICES OFFERED BY ORGANIZATIONS

Association of State Dam Safety Officials
P.O. Box 11910
Lexington, Kentucky 40578 (606) 252-2291

- Issues quarterly newsletters providing information and describing activities related to dam safety.
- Maintains a library on dam failures.
- Sponsors seminars with speakers and an annual meeting of State dam safety officials.
- Develops model regulations and guidelines for hazard classification.
- Offers standardized dam inventory file format, advising States about creating and maintaining a National Dam Inventory.

Bureau of Reclamation

- Assists foreign countries to develop Dam Safety Programs.
- Conducts training seminars on evaluating the safety of existing dams, instrumentation, and risk analysis.
- Publishes technical and administrative literature concerning dam safety.
- Offers technical advice and assistance.

Corps of Engineers

- Offers extensive training courses for engineers in technical specialities. (See Appendix D. Training Courses.)
- Provides technical advice upon request through the office of the Chief of Engineers. To obtain assistance from a District Office, a request can be forwarded through a State's water resources authority.

Electric Power Research Institute (EPRI)

- Operates the EPRI Energy Storage and Hydroelectric Generation Program to assist utilities in the design, operation, maintenance, and modernization of hydroelectric projects.

Federal Emergency Management Agency

- Through a regional program, supplies Hazard Mitigation Assistance to emergency management agencies to prepare Emergency Action Plans. Assistance includes using inundation maps, reviewing development, and compiling emergency contact lists of names and telephone numbers.
- Issues a pamphlet listing State dam safety officials and emergency management officials.
- Prepares floodplain maps.
- Issues a variety of publications on dam safety. (See Appendix E. References.)
- Sponsors workshops and meetings on dam safety issues.

APPENDIX A: SERVICES OFFERED BY ORGANIZATIONS

Federal Energy Regulatory Commission

- Conducts operation and maintenance, construction inspection, and special inspections of non-Federal hydroelectric project works.
- Issues guidelines for developing Emergency Action Plans for hydroelectric projects.

Soil Conservation Service

- Maintains a national inventory of dams which can be accessed from each Soil Conservation Service State office.
- Furnishes inundation maps when new dams of inventory size are designed.
- Works with States to develop regulations and legislation, primarily with State agencies such as water resources or land resources. Gives technical assistance.
- Provides computer programs for purchase from National Technical Information Service in Springfield, Virginia.
- For dams in P.L. 46 (individually-owned) and P.L. 566 (group-owned), will design dams or certify designs, provide specifications, and inspect construction.
- Performs hydraulics and hydrology studies and survey work.

National Weather Service

- Provides industry-standard software for routing unsteady flows from dam breaks or large spillway releases for inundation studies.

USDA Soil Conservation Service
Director, Engineering Division
P.O. Box 2890 Room 6126-5
Washington, DC 20013
(202) 447-2520

Federal Energy Regulatory Commission
Director, Division of Dam Safety and Inspection
825 North Capitol Street, N.E.
Washington, DC 21046
(202) 376-9223

National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
(703) 487-4650

Electric Power Research Institute
3412 Hillview Avenue
P.O. Box 10412
Palo Alto, CA 94303
(415) 855-2000

U.S. Army Corps of Engineers
HQ USACE (CECW-EG)
20 Massachusetts Avenue, N.W.
Washington, DC 20314-1000
(202) 272-0207

National Weather Service
Hydrologic Research Laboratory
Silver Spring, MD 20910
(301) 427-7640

Bureau of Reclamation
Code D-3300
P.O. Box 25007
Denver, CO 80225
(303) 236-4200

Federal Emergency Management Agency
Earthquakes and National Hazards
Programs Division
Room 625
500 C Street, S.W.
Washington, DC 20472
(202) 646-2817

APPENDIX B

SAMPLE DAM INVENTORY DATA FORMS

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

The Interagency Committee on Dam Safety is working on a methodology to implement a National Inventory of Dams. This National Inventory would be controlled by the appropriate Federal agencies for Federal dams and by the regulatory agency of each State for non-Federal dams. The public would have access to the inventory for information.

Following is a description of a procedure for developing a dam inventory file and sample data forms used by several Federal and State agencies.

BUREAU OF RECLAMATION PROCEDURE

Inventory Of Dams

While policy and regulations are being established, an inventory of the dams to be studied needs to be developed. A minimum amount of data is needed at this point for the purpose of scheduling dams for inspection and hazard classification. As dams are inspected, the data base can be expanded. A listing of this preliminary data is as follows:

1. Name of dam
2. Year constructed
3. Location - latitude and longitude
4. River
5. Type of dam (embankment, gravity, arch, etc.)
6. Hazard classification, if known
7. Known problems or deficiencies
8. Capacity of reservoir
9. Hydraulic height of dam
10. Hydrologic adequacy
11. Seismic zone
12. Structural behavior adequacy

These preliminary data can be obtained from a number of possible available sources, such as the National Inventory of Dams compiled by the Army Corps of Engineers, design and construction records, drawings (preferably as-built), aerial photographs, topographic maps, project histories, existing data compilations, etc. In some cases data may not be readily available in records; under these circumstances, basic information may be available through contact with people at the dam site.

Once these data are collected, a computer data base needs to be developed for each dam and can be expanded as additional data are collected. The program that is utilized for managing the data should be capable of providing statistical lists based on location by area or region, or on type of dam. The usefulness of the data base is multifold because it can be used as a scheduling device for inspections, analyses, and modifications, for preparing budgets, and for statistical analyses.

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

U.S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service

SCS-INM-3
6-80

SCS DAM INVENTORY

1. State
2. County
3. Congressional district
4. SCS ID
5. Corps of Engineers ID
6. Name of dam
7. Popular name
8. Impoundment name
9. Latitude
   (deg.) (min.)
10. Longitude
    (deg.) (min.)
11. Hydrologic unit no.
12. River or stream
13. Major land resource area no.
14. Nearest downstream town
15. Distance from dam (miles)
16. Population
17. Authorization
    ( ) CO-01 ( ) Pilot ( ) RC&D ( ) Other (specify)
    ( ) PL-566 ( ) GPCP ( ) WF-03
18. SCS watershed no. (if PL-566)
19. Owner name
20. Engineering by ( ) SCS ( ) state agency
    ( ) A&E ( ) other
21. Construction by (name of contractor or builder)
22. Regulatory Agency (names)
    design-
    construction-
    operation-
    maintenance-
23. Last safety inspection by : ( ) SCS ( ) state agency
    ( ) A&E ( ) other ( ) none
    Name (unless done by SCS)
24. Date of last safety inspection (mo., day, year)
25. This inventory form completed
    by: date:
26. This is an: ( ) initial form for the dam
    ( ) update
27. Classification, as-built
    ( ) (a) ( ) (b) ( ) (c) ( ) unknown
28. Classification, current
    ( ) (a) ( ) (b) ( ) (c) ( ) unknown
29. Year construction completed
30. Drainage area
    acres
31. Height of dam
    ft.
32. Storage capacity
    sediment ac. ft.
    other benefical ac. ft.
    flood storage ac. ft.
    surcharge ac. ft.
    total ac. ft.
33. Purposes (more than one may be checked)
    ( ) flood prevention ( ) recreation ( ) irrigation
    ( ) debris control ( ) hydro power ( ) M&I
    ( ) grade stabilization ( ) livestock
    ( ) fish & wildlife ( ) other
34. Type of dam
    ( ) earth ( ) gravity ( ) rockfill ( ) other
35. Volume of dam
    cu. yds.
36. Crest length of dam
    ft.
37. Principal spillway ( ) conc.pipe ( ) conc.box
    ( ) open concrete ( ) CMP ( ) other
38. Emergency spillway: type ( ) veg. ( ) earth ( ) rock
    ( ) structural ( ) other ( ) none
    width_____ft. capacity_____CFS
39. Remarks

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

SCS DAM INVENTORY

NOTE: Items on this page to be completed at the option of the State Conservationist.

40. Date plan approved (if PL-566 Dam)

41. Surface area-normal pool acres

42. Length of shore line-normal pool miles

43. Max. depth-normal pool ft.

44. Is there cold water release facility?
( ) yes ( ) no

45. Drainage area controlled by upstream structures acres

46. Drainage area not controlled by upstream structures acres

PRINCIPAL SPILLWAY FEATURES

47. Number of stages
( ) 1 ( ) 2 ( ) other

48. Low stage capacity (at high stage crest) CFS

49. Principal spillway capacity (at crest of lowest emergency spillway) CFS

50. Major portion of principal spillway is on
( ) rock ( ) earth

51. Type of energy dissipator ( ) plunge pool
( ) impact basin ( ) SAF ( ) none ( ) other

52. Conduit (largest conduit through dam)(diam. in ft, if round) (height and width in ft. if monolithic)
a. size b. number

53. Inlet type (check applicable) ( ) concrete-open top
( ) covered top ( ) hood inlet ( ) metal-open top
( ) other

54. Height of riser ft.

55. Is discharge through principal spillway controlled by gates?
( ) yes ( ) no

EMERGENCY SPILLWAY FEATURES

56. Primary emergency spillway width (crest length for concrete) ft.

57. Percent chance of use of primary emergency spillway %

58. Capacity of primary emergency spillway (when pool is at top of dam) CFS

59. Difference in elevation between crest of primary emergency spillway and top of dam ft.

60. Secondary emergency spillway is: (check one) ( ) none
( ) earth ( ) soft rock ( ) vegetated ( ) hard rock

61. Width of secondary emergency spillway ft.

62. Capacity of secondary emergency spillway(when pool is at top of dam) CFS

63. Difference in elevation between crest of secondary emergency spillway and top of dam ft.

64. Bulk length of spillway (see TR-52) ft.

65. PI of surface material in earth or vegetated spillway

66. USCS classification of surface material

67. Volume of outflow through vegetated or earth spillways (during passage of freeboard hydrograph) ac./ft.

COST DATA

68. Landrights cost $

69. Federal share of landrights cost $

70. Construction cost (does not include landrights, engineering and project administration) $

71. Federal share of construction cost $

72. Remarks and other data

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

Dam Safety Division Procedure Manual 10.1
Inventory Data Revision Sheet

Data Changed	Data Entered
Date _____	Date _____
Initials_____	Initials_____

DAM NUMBER: ____

NDI NUMBER: ____ COUNTY __ QUAD NUMBER: __
(2 letter code)

DAM NAME:
POPULAR NAME:
LAKE NAME:
RIVER NAME: BASIN CODE:

LAT DEG: __ MIN: __.__ LONG DEG: __ MIN: __.__
MD GRIDS NORTH: ___.___ EAST: ____.___

TYPES: EARTH GRAVITY BUTTRESS OTHER ROCK FILL ARCH

PURPOSE: RECREATION FLOOD CNTL WATER SUPPLY HYDROELECT OTHER
IRRIGATION NAVIGATION DEBRIS CNTL POND

NORMAL DEPTH: ___.__ FT SURFACE AREA: _____.__ DRAINAGE AREA: _____.__
HEIGHT: FT CREST LENGTH: FT
CAPACITY NORMAL: _____ AC-FT MAXIMUM: _____ AC-FT
HAZARD(1=HIGH 2=MEDIUM 3=LOW): __ STATUS CODE:___

SPILLWAY WIDTH: FT DISCHARGE: _____ CFS
TYPE(C=CONTROLLED U=UNCONTROLLED N=NONE):

OWNER:
ADDRESS1: OWNER CODE:____
ADDRESS2:
ADDRESS3:
CITY: STATE: ZIP:
OWNER PHONE: ( ) -

ENGINEER:
FEDERAL REGULATED(Y/N):___

CB	Completely Breached	WW	Waste Water Lagoon
PB	Partially Breached	SG	Sand and Gravel Wash Pond
SW	Stormwater Mgmt-Wet	DS	Dredge Spoil Disposal
SD	Stormwater Mgmt-Dry	WM	Wildlife Mgmt
PO	Pond	OT	Other- not built, etc

A	Community Assoc
C	Corporations
G	Government (Federal,State,Local)
I	Individuals
R	Recreation.(Camps or Clubs, etc)
S	Soil Conservation Districts
W	Water Company

YEAR COMPLETED: YEAR MODIFIED:
WRA PERMIT 1: WRA PERMIT 2:

OPERATOR: PHONE: ( ) -

		YEAR	MO	DAY		Rank Score	Insp Freq (Years)
DATES	LAST INSPECTION:		/	/	YEARS BETWEEN	GE 129	1
	NEXT INSPECTION:		/	/	INSPECTIONS:_____	GE 110	2
	FOLLOW UP:		/	/		GE 100	3
	COMMENTS:					GE 82	4
	LAST CHANGED:		/	/		LT 82	5

% SDF PASSED: _____
SURVEY BOOKS: ___ ___

1 = PIPE W/EMER AT 100 YR
2 = PIPE W/EMR AT < 100 YR
3 = OVERFLOW - CHANNEL OR WEIR E = EXCELLENT P = POOR
4 = OVERFLOW - PIPE ONLY G = GOOD U = UNKNOWN
5 = OVERFLOW - RUN OF RIVER F = FAIR
___ SPILLWAY TYPE ___ OVERALL CONDITION

MONITORING DEVICES:
OBSERVATION WELLS SLOPE INDICATORS MONUMENT OTHER

DANGER REACH(/N)?___ WARNING PLAN(Y/N)?___

RANKING SCORE: _____

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

U.S. Department of Agriculture
Soil Conservation Service
POND SUMMARY SHEET

MD-ENG-14
(Rev. 10-87)
Reference:
SCS-MD-378

Maryland Coordinates

East _____
North _____

County: _____

OWNER INFORMATION

Name: _____
Address: _____
_____
_____
City: _____
State: ____ Zip: _____

TYPE OF POND: O Excavated
O Embankment
O Both

Drainage Area: _____ acres
Surface Area: _____ acres
Normal Depth: _____ ft.

HAZARD CLASS: A B C

PURPOSE OF POND (check all that apply)

O Stormwater Mgmt. - Wet
O Stormwater Mgmt. - Dry
O Infiltration
O Sediment Control
O Water Supply/Irrigation
O Livestock
O Flood Control
O Recreation
O Wildlife/Fish
O Fire Control
O Other

EMBANKMENT

Top Elev: _____ ft.
Normal Pool Elev: _____ ft.
Top Width: _____ ft.
Storage at DHW _____ ac-ft
Max Fill Height: _____ ft.
Side Slopes: U.S. ____ :1
D.S. ____ :1

PRINCIPAL SPILLWAY

Diameter: _____ inches Capacity: _____ CFS
O BCCMP O Alum O RCP O PVC O Other (Specify)_____

EMERGENCY SPILLWAY

Crest Elev: _____ ft.
Bottom Width: _____ ft.
Side Slopes: _____ :1
Design Storm Frequency: _____ yr
Capacity: _____ CFS
Max Water Elev: _____ ft.
Velocity: _____ ft/sec
Spillway Protection: O Grass O Riprap O Gabions O Other

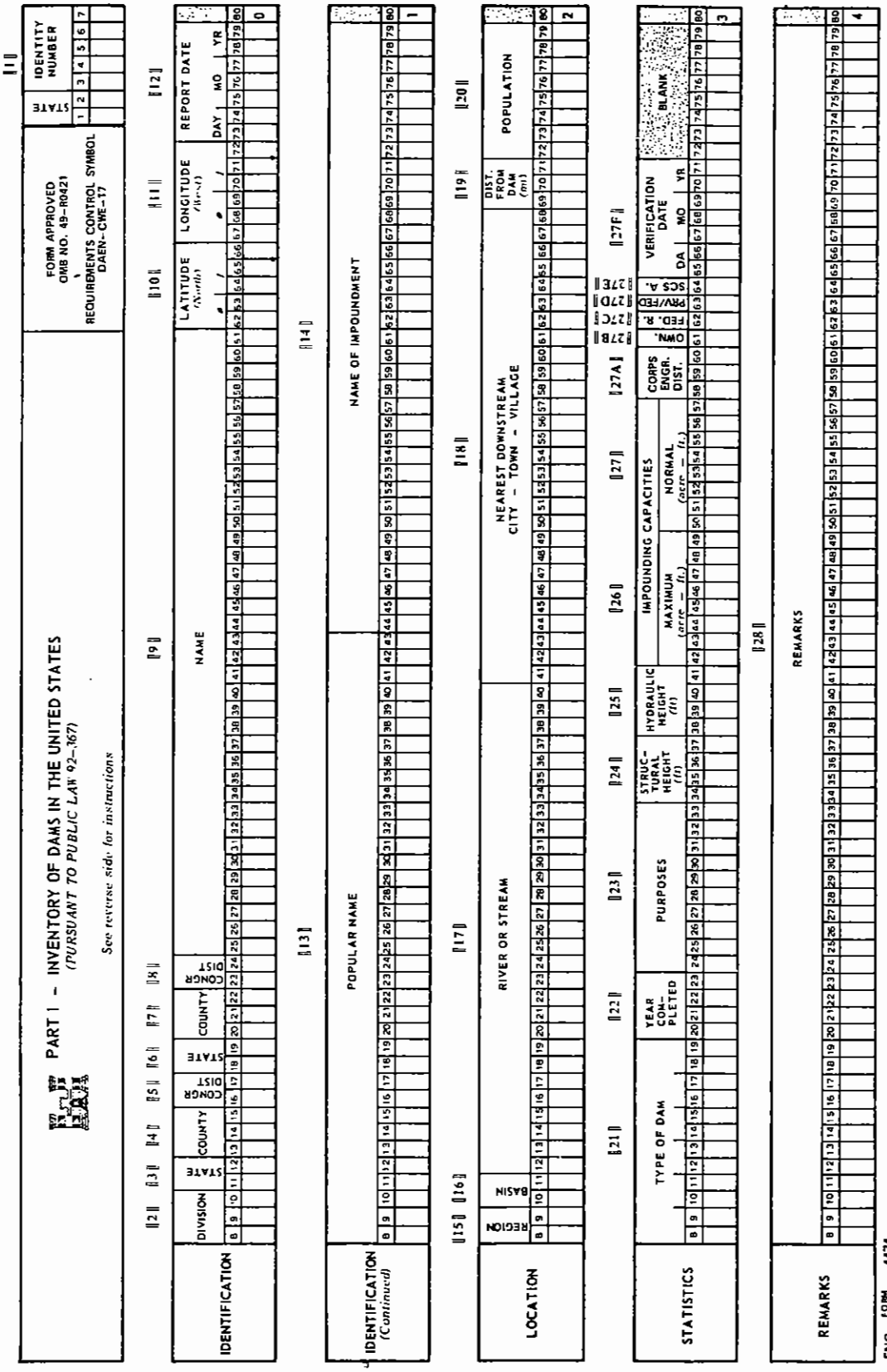
DISTANCES BELOW POND TO Property Line: _____ ft.
Public Road: _____ ft.

Soil Conservation District (Name) _____

SCS, District Conservationist (Sign) _____

Date _____

APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS



APPENDIX B: SAMPLE DAM INVENTORY DATA FORMS

[1]

PART II – INVENTORY OF DAMS IN THE UNITED STATES
(PURSUANT TO PUBLIC LAW 92-367)

See reverse side for instructions.

FORM APPROVED OMB NO. 49-R0421
REQUIREMENTS CONTROL SYMBOL DAEN-CWE-17

STATE | IDENTITY NUMBER

STATISTICS [29] D/S HAZ [30] CREST LENGTH (ft) [31] [32] SPILLWAY TYPE WIDTH (ft) [33] MAXIMUM DISCHARGE (cfs) [34] VOLUME OF DAM (CY) [35] POWER CAPACITY INSTALLED (MW) [36] PROPOSED (MW) [37] NAVIGATION LOCKS NO. [38] LENGTH (ft) [39] WIDTH (ft) [40] LENGTH (ft) [41] WIDTH (ft) [42] LENGTH (ft) [43] WIDTH (ft) [44] LENGTH (ft) [45] WIDTH (ft) BLANK 5

MISC. DATA [46] OWNER [47] ENGINEERING BY [48] CONSTRUCTION BY 6

MISC. DATA (Continued) [49] DESIGN [50] CONSTRUCTION [51] REGULATORY AGENCY [52] OPERATION MAINTENANCE 7

MISC. DATA (Continued) [53] INSPECTION BY [54] INSPECTION DATE DAY MO YR [55] AUTHORITY FOR INSPECTION 8

REMARKS [56] REMARKS 9

ENG FORM 1 DEC 77 4474A

APPENDIX C

PRIORITY RANKING SYSTEMS

APPENDIX C: PRIORITY RANKING SYSTEMS

BUREAU OF RECLAMATION PRIORITY RATING CRITERIA

The Bureau of Reclamation's priority rating system ranks dams at two stages of the dam safety process. The first priority rating is developed to prioritize the sequence of initial inspections. A second priority rating is developed to reprioritize dams for technical analyses and corrective action, if required.

A. INITIAL PRIORITY RATING SYSTEM

Initially in a Dam Safety Program, little information on the dams may be available. Consequently, a scheme using basic information on conditions and damage potential can be used to initially prioritize the dams for inspection purposes. Such a scheme is shown below and utilizes a weighting process to develop a numerical value for each dam. Dams are then prioritized in a decreasing numerical order.

ITEM	CONDITION			
Age (years)	Under 5 (0)	5 - 24 (3)	25 - 49 (4)	50 - (9)
General condition	Excellent (0)	Good* (3)	Fair (6)	Poor (9)
Seepage problems	None (0)	Slight* (3)	Moderate (6)	High (9)
Structural behavior measurements current and within acceptable range	Yes (0)		Partial (6)	No (9)

* Assumed if not given.

Note: Number within parentheses is the weighting factor.

Continued . . .

A. INITIAL PRIORITY RATING SYSTEM (Continued)

	DAMAGE POTENTIAL			
ITEM	**Low**	**Significant**	**High**	**Extreme**
Capacity -$M^3(x10^6)$	0 - 1.0 (0)	1.1 - 61.6 (3)	61.7 - 616 (6)	617 - (9)
Hydraulic Height -M	0 - 15 (0)	16 - 30 (3)	31 - 90 (6)	91 - (9)
Hazard Potential	(0)	(4)	(8)	
Hydrologic Adequacy	Yes (0)	---	---	No (9)
Seismic Zone	0 - 1 (0)	2 (3)	3 (6)	4 (9)

*Assumed if not given.

Note: Number within parentheses is the weighting factor.

B. REPRIORITIZED RATING SYSTEM

After detailed technical information gained from one or more dam safety inspections has been obtained for the dams in the Dam Safety Program, the dams should be reprioritized to reflect the significance of the problems or deficiencies at each dam. This reprioritization should be performed before proceeding with technical analyses and corrective action. This scheme is also based on a weighting process but is much more detailed than the process used at the initial stage. This scheme considers several categories of typical problem areas. Each category contains a series of potential conditions which are considered and one condition is selected to represent the current condition or situation at the dam. A weighting factor is associated with the condition and is summed with other weighting factors to obtain an overall rating factor for the dam. Dams are then prioritized in a decreasing numerical order. The categories, typical conditions, and associated weighting factors are shown on the following pages.

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
SEEPAGE	
Significant seepage stability problems with structure (structural or operational action implemented)	235*
Seepage conditions and analysis based on field data indicate inadequate seepage stability	200*
Seepage conditions and analysis based on assumed data indicate inadequate seepage stability	175*
Seepage conditions indicate potentially inadequate seepage stability	150*
Apparent adverse seepage conditions; analysis based on assumed data indicate adequate seepage stability	125*
No adverse seepage conditions; analysis based on field data indicates inadequate seepage stability	100
No adverse seepage conditions; analysis based on assumed data indicate inadequate seepage stability	75
Apparent adverse seepage conditions; analysis based on field data indicate adequate seepage stability	45*
Seepage conditions indicate adequate seepage stability	30
Seepage conditions and analysis based on assumed data indicate adequate seepage stability	15
Seepage conditions and analysis based on field data indicate adequate seepage stability	0

* Rating requires special annual examination of the deficiency

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
HYDROLOGY	
Erodible Dam	
Dam and appurtenances can accommodate less than 100-year flood	155
Dam and appurtenances can accommodate less than 20 percent of the PMF with no freeboard	145
Dam and appurtenances can accommodate 20 to 40 percent of the PMF with no freeboard	125
Dam and appurtenances can accommodate 40 to 60 percent of the PMF with no freeboard	115
Dam and appurtenances can accommodate 60 to 80 percent of the PMF with no freeboard	95
Dam and appurtenances can accommodate 80 to 100 percent of the PMF with no freeboard	65
Dam and appurtenances can accommodate 100 percent of the PMF with less than 3 feet of freeboard	25
Dam and appurtenances can accommodate 100 percent of the PMF with 3 feet or more of freeboard	0
Concrete Or Masonry Dam	
Dam and appurtenances can accommodate less than 20 percent of the PMF with no freeboard	90
Dam and appurtenances can accommodate 20 to 40 percent of the PMF with no freeboard	70
Dam and appurtenances can accommodate 40 to 60 percent of the PMF with no freeboard	60
Dam and appurtenances can accommodate 60 to 80 percent of the PMF with no freeboard	50

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
Concrete Or Masonry Dam (Continued)	
Dam and appurtenances can accommodate 80 to 95 percent of the PMF with no freeboard	15
Dam and appurtenances can accommodate 95 to 100 percent of the PMF with no freeboard	0
Flood Study - Add To Erodible Or Concrete Or Masonry Weight	
Outdated (original design) flood study, or revised flood has not been routed	100
Recent flood; revision required	25
Safety evaluation level approved flood	15
Design level approved flood	0
STATIC STABILITY	
Significant deformation of structure has occurred (structural or operational action implemented)	115*
Structural behavior (performance history) and analysis based on field data indicate inadequate safety factor	95*
Structural behavior (performance history) and analysis based on assumed data indicate inadequate safety factor	80*
Structural behavior (performance history) indicates potentially inadequate safety factor	65*
No adverse structural behavior (performance history) to date; analysis based on field data indicates inadequate safety factor	50
No adverse structural behavior (performance history) to date; analysis based on assumed data indicates inadequate safety factor	35

* Rating requires special annual examination of the deficiency

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
STATIC STABILITY (Continued)	
Structural behavior (performance history) indicates adequate safety factor	20
Structural behavior and analysis based on assumed data indicate adequate safety factor	10
Structural behavior and analysis based on field data indicate adequate safety factor	0
LIQUEFACTION	
Analysis based on field data and a site-specific seismotectonic study indicate the presence of liquefiable material and the potential for earthquake loading at the site large enough to induce liquefaction to an extent that would affect the safety of the dam	95
Analysis based on field data and a site-specific seismotectonic study indicate the presence of liquefiable material and the MCE loading will induce liquefaction to an extent that would affect the safety of the dam	85
Analysis based on assumed data and an areal seismicity review indicate the presence of liquefiable material and the potential for earthquake loading at the site large enough to induce liquefaction to an extent that would affect the safety of the dam	60
Available material descriptions and earthquake zoning of the area indicate the presence of liquefiable material and the potential for earthquake loading at the site large enough to induce liquefaction to an extent that would affect the safety of the dam	50

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
LIQUEFACTION (Continued)	
Available material descriptions and earthquake zoning of the site indicate no liquefiable material or inadequate earthquake loading to induce liquefaction to an extent that would affect the safety of the dam	25
Analysis based on assumed data and an areal seismicity review indicate that no liquefiable materials are present, and/or there is limited potential for earthquake loading at the site large enough to induce liquefaction to an extent that would affect the safety of the dam	15
Analysis based on field data and a site specific seismotectonic study indicate that no liquefiable materials are present and/or there is no potential for earthquake loading at the site large enough to induce liquefaction to an extent that would affect the safety of the dam	0
DYNAMIC STABILITY, SEICHE, ETC.	
Analysis based on field data and a site-specific seismotectonic study indicate inadequate safety factor	40
Analysis based on assumed data and an areal seismicity review indicate inadequate safety factor	30
Available material descriptions and earthquake zoning indicate potentially inadequate safety factor	20
Available material descriptions and earthquake zoning indicate adequate safety factor	10
Analysis based on assumed data and an areal seismicity review indicate adequate safety factor	5
Analysis based on field data and a site-specific seismotectonic study indicate adequate safety factor	0

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
LANDSLIDES (Rank as either major or minor)	
Major (May affect stability of the structure)	
Performance history and analysis based on field or assessed data indicate inadequate static stability	40
Performance history indicates potential inadequate static stability	30
Performance history indicates adequate static stability	15
Performance history and analysis based on field or assumed data indicate adequate static stability	0
Dynamic Stability (Use only with 30 point or lower static rating)	
Analysis based on field data indicates inadequate dynamic stability	10
Analysis based on assumed data indicates inadequate dynamic stability	5
Analysis based on field or assumed data indicates adequate dynamic stability	0
Minor (May affect operation of structure)	10
OTHER	
Structural (deteriorated condition of structure and/or appurtenances)	30
Mechanical (inoperable, inadequate, or deteriorated equipment)	15
Configuration of appurtenances (gated spillway or large outlet works representing significant percent of discharge capacity)	15
Volcanic hazards	5
Hazards from upstream dams	10

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

	WEIGHT
SAFETY OF DAMS CLASSIFICATION	
Unsatisfactory	20
Poor	15
Conditionally poor	10
Fair	5
Satisfactory	0
Unclassified	
Pre-Evaluation Report Status	15
Post-Evaluation Report Status	0

Description Of Safety Of Dams Classification - One of the following classifications is assigned to a dam following the onsite examinations and subsequent analyses using available data and state-of-the-art knowledge:

Satisfactory - No existing or potential dam safety deficiencies are recognized. Safe performance is expected under all anticipated loading conditions, including such events as the MCE and the PMF.

Fair - No existing dam safety deficiencies are recognized for normal loading conditions. Infrequent hydrologic and/or seismic events would probably result in a dam safety deficiency.

Conditionally Poor - A potential dam safety deficiency is recognized for unusual loading conditions that may realistically occur during the expected life of the structure. CONDITIONALLY POOR may also be used when uncertainties exist as to critical analysis parameters that identify a potential dam safety deficiency; further investigations and studies are necessary.

Continued . . .

B. REPRIORITIZED RATING SYSTEM (Continued)

Poor - A potential dam safety deficiency is clearly recognized for normal loading conditions. Immediate actions to resolve the deficiency are recommended; reservoir restrictions may be necessary until problem resolution.

Unsatisfactory - A dam safety deficiency exists for normal loading conditions. Immediate remedial action is required for problem resolution.

MARYLAND'S SYSTEM FOR ESTABLISHING DAM SAFETY INSPECTION PRIORITIES

BACKGROUND

The Dam Safety Division of the Water Resources Administration (WRA) is required to perform periodic safety inspections. A method therefore is needed to establish a dam inspection interval that is reasonable from a technical viewpoint and that results in a workload that allows for other Dam Safety Program elements.

The trend toward varying the inspection frequency that is based solely upon the hazard potential disregards additional important factors that can influence dam safety. Also, uniform criteria, such as the proposed "every 2 years," would require additional staff which may not produce additional benefits in the way of increased dam safety.

APPROACH

After proposing several dam rating factors in addition to hazard, it was decided to use a paired-weighting scheme to rank their relative importance (Vern Hagen method of ranking "statistics"). This method asks the user to prioritize each of the possible pairs of items. The item which gets the most votes wins. If an item was never chosen, then it obviously was not important in the overall ranking and should be eliminated. This happened several times in the WRA ranking process until a reduced list of six factors (which the Division thought might play a significant part in determining the overall inspection policy) were obtained. The matrix of pairs looked like this:

Condition / Storage-Ht	Condition / Hazard	Condition / Dam Type	Condition / Age	Condition / Spillway Type
	Storage-Ht / Hazard	Storage-Ht / Dam Type	Storage-Ht / Age	Storage-Ht / Spillway Type
		Hazard / Dam Type	Hazard / Age	Hazard / Spillway Type
			Dam Type / Age	Dam Type / Spillway Type
				Age / Spillway Type

Remembering that the objective was to arrive at a routine inspection frequency policy for the Division, one factor of each pair was chosen as the more important regardless of the other four factors. This was done by general staff agreement of the following order of decreasing relative importance: condition, storage-height product, hazard, dam type, age, and spillway type. If the objective were different, for example, allocating funds for spillway repair, not only might there be different factors involved, but they could be ranked in another order.

Continued . . .

MARYLAND'S SYSTEM FOR ESTABLISHING DAM SAFETY INSPECTION PRIORITIES (Continued)

APPROACH (Continued)

The next step was to assign values to each of the six factors. The relative importance of each factor is reflected by the range (from 0 to 60, to 0 to 10) given to each partial score. Partial scores were added because the list of dams was obtained without much clustering. For each dam, the score can potentially range between 0 and 210. The Dam Inventory has a built-in function to compute ranking scores from the data contained in the inventory. A special SAS report is then generated to sort the dams by total ranking score.

RESULT

After all the State-regulated dams are sorted by the total score, the list was divided into five groups. Dams in the first group, to be inspected annually, would include the old, earthen, high-hazard dam in an unknown condition with no emergency spillway with a large storage-height product. Dams in the last group are inspected once every 5 years. The list is dynamic and reflects changes that can occur in most of the rating factors based on the results of the periodic inspection.

Other program elements, such as inspection findings, special studies, construction and monitoring inspections, plan review, warning system design, and permit issuance are all likely to interfere with the inspection schedule. Nevertheless, the relative ranking procedure provides a rationale for deferring or swapping inspection dates. Plans for the future include scheduling the inspection dates by total score and by geographic location information already in the inventory. An immediate by-product of being able to predict the future has been an accurate projection of estimated travel funds.

APPENDIX D

TRAINING COURSES

APPENDIX D: TRAINING COURSES

FEDERAL DAM SAFETY TRAINING COURSES

BUREAU OF LAND MANAGEMENT

Design of Small Earth Dams
Small Earth Dams Construction Inspection

BUREAU OF RECLAMATION

Safety Evaluation of Existing Dams
Instrumentation and Monitoring of Dams
Risk-Based Analysis in Dam Safety Decisionmaking
Concrete Dams; a self-study course in the Comprehensive Construction Training Program
Embankment Dams; a self-study course in the Comprehensive Construction Training Program

CORPS OF ENGINEERS

Concrete Construction Inspection
Concrete Engineering Technology
Concrete Maintenance and Repair
Construction of Earth and Rockfill Dams for Resident Engineers
Construction Quality Management
Dam-Break Analysis
Drilling and Sampling for Engineering Purposes
Dynamic Analysis for Earthquake Engineering
Earthquake Analysis of Concrete Dams & Appurtenant Structures
Earthquake Soils Response
Electrical Inspection
Engineering Geology I
Engineering Seismology
Finite Element Analysis of Structures
Flood Frequency Analysis
Floodplain Hydrology and Hydraulics
Foundations of Expansive Clay Soils
Grouting & Foundation Treatment
Hydraulic Design of Flood Control Channels
Hydraulic Design of Locks and Dams
Hydraulic Design of Spillways and Outlet Works
Hydrographic Survey Techniques
Hydrologic Analysis of Floods
Inspection and Evaluation of Safety of Non-Federal Dams
Seepage Analysis & Control for Dams
Structural Design and Analysis System (STRUDL)/Advanced Applications
Structural Design and Analysis System (STRUDL)/Basic Applications

Continued . . .

FEDERAL DAM SAFETY TRAINING COURSES (Continued)

CORPS OF ENGINEERS (Continued)

Unsteady Flow Analysis
Water Surface Profile Computation Using HEC-II (Advanced)
Water Surface Profile Computation Using HEC-II (Basic)

MINE SAFETY AND HEALTH ADMINISTRATION

Construction Inspection of Dams and Coal Refuse Embankments
Design Guidelines for Impoundments

NATIONAL WEATHER SERVICE

Dam-Break Model Symposium Workshop

SOIL CONSERVATION SERVICE

Contract Administration - Construction Contracts
Engineering - Concrete
Engineering - Construction Inspection
Engineering - Hydrology (Level III)
Engineering - Structural Design (Level II)
Engineering - Structural Design (Level III)

TENNESSEE VALLEY AUTHORITY

Dam Safety Training Program for Operations and Maintenance Personnel

U.S. FOREST SERVICE

Basic Aerial Photo Interpretation
Dams Workshop
Elementary Slope Stability
Geotechnical Workshop
Inspector Workshop
Material Sampling and Testing

U.S. GEOLOGICAL SURVEY

Advanced Geological Remote Sensing Techniques

POINTS OF CONTACT FOR AGENCY TRAINING OFFICES

Bureau of Land Management
Denver Service Center
Building 50, D-420
Denver, Colorado 80225
(303) 234-2264

Bureau of Reclamation
Code D-7510
P.O. Box 25007
Denver, Colorado 80225
(303) 236-3828

Corps of Engineers
Training Management Division
Training Center for Professional Development
P.O. Box 1600
Huntsville, Alabama 35807
(205) 722-5800

Mine Safety and Health Administration
ATTN: Chief of Mine and Geotechnical Engineering Division
Bruceton Center
4800 Forbes Avenue
Pittsburgh, PA 15213
(412) 675-6903

National Weather Service
Tulsa River Forecast Center
333 W. 4th Street
Room 3031
Tulsa, Oklahoma 74103
(918) 581-7121

Tennessee Valley Authority
400 West Summit Hill Drive
Knoxville, Tennessee 37902
(615) 632-6130

USDA, Forest Service
Engineering Division
P.O. Box 2417
Washington, D.C. 20013
(703) 235-8030

U.S. Geological Survey
EROS Data Center
Sioux Falls, South Dakota 57198
(303) 594-6114

National Employee Development Staff
National Technical Center
U.S. Department of Agriculture
Soil Conservation Service
P.O. Box 6567
501 W. Felix, FWFC, Building 23
Ft. Worth, Texas 76115
(817) 334-5401

APPENDIX E

REFERENCES

APPENDIX E: REFERENCES

Bibliography on Dam Safety Practice. United States Committee on Large Dams and Association of State Dam Safety Officials, March 1989.

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