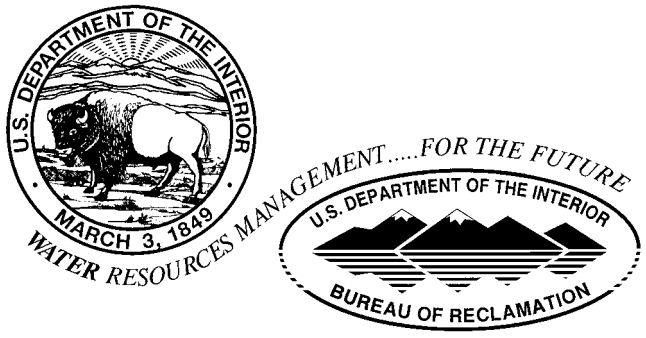
STANDING OPERATING PROCEDURES GUIDE

For

DAMS, RESERVOIRS, AND POWER FACILITIES



Prepared by

INSPECTIONS AND EMERGENCY MANAGEMENT GROUP
TECHNICAL SERVICE CENTER

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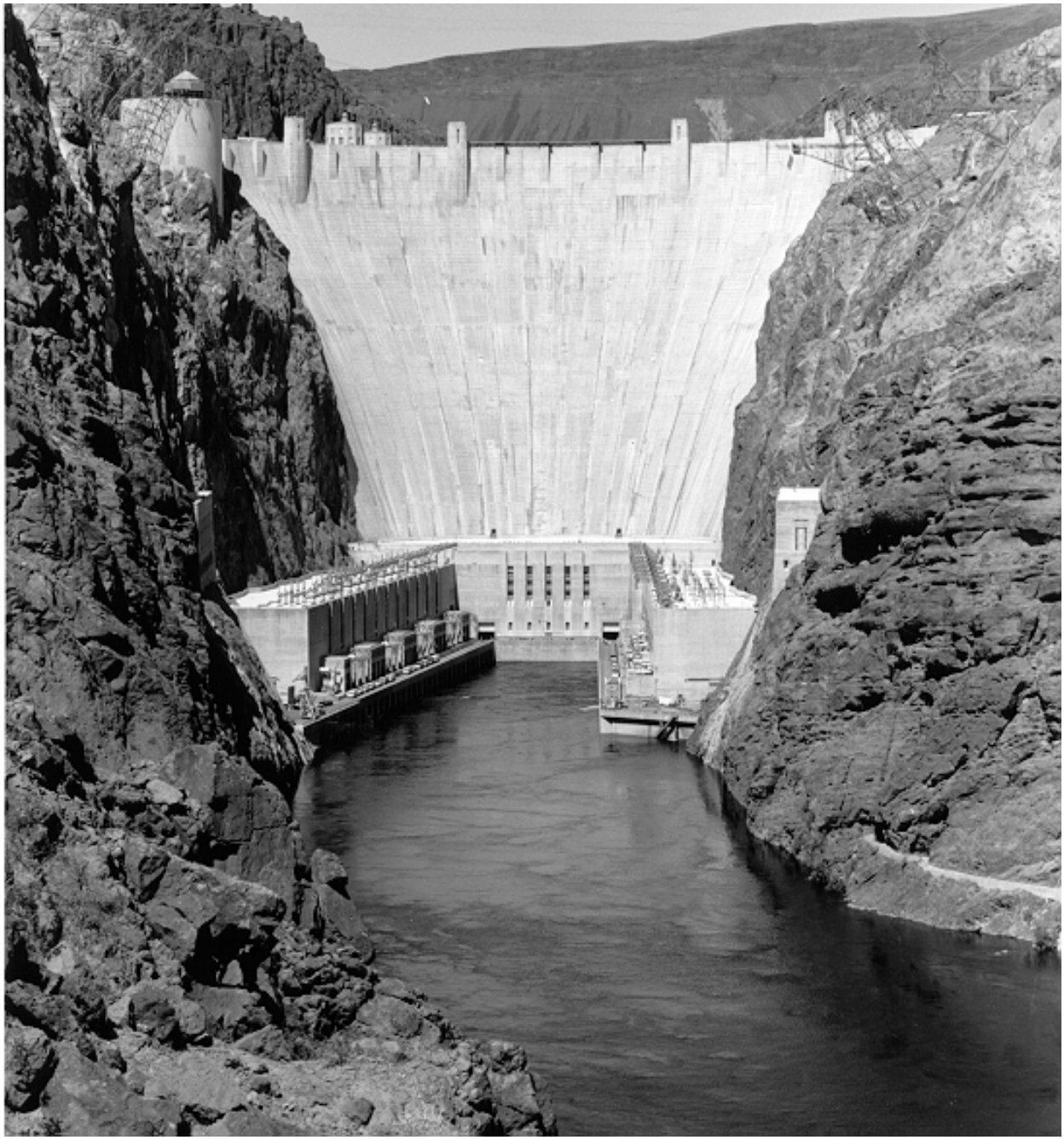

Frontispiece—Hoover Dam, Powerplants, and Visitor Center, one of Reclamation's historical structures, is located in the Black Canyon of the Colorado River about 36 miles from Las Vegas, Nevada. The dam was constructed in 1931-1935. The powerplants are capable of producing 2,078.8 MW of hydroelectric power. The visitor center was dedicated in 1995. The 726.4-feet high thick-arch concrete structure (1,244 foot crest length) contains 4,400,000 cubic yards of concrete in the dam and appurtenant structures. Photograph (P45-300-02606) by Andrew Pernick.

Standing Operating Procedures Guide

A Water Resources Technical Publication

A Reclamation guide to aid in the composition of Standing Operating Procedures in establishing operation and maintenance policy statements for dams, reservoirs, powerplants, pumping plants, structures, and appurtenances.

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PREFACE

Since origination in 1965 of an orderly method for preparing an SOP for Reclamation dams, reservoirs, power facilities, and other structures, there have been several communications to Reclamation Regional Offices from the Technical Service Center, Denver, Colorado to assist in SOP preparation. This guide represents a consolidation of all previous SOP communications issued by Reclamation.

The SOP provides a comprehensive single-source manual and establishes procedures to be used in the operation and maintenance of these facilities.

A conforming outline (comparable for SOP continuity) preserves procedures when personnel changes occur and saves time by uniform treatment.

The guide contents were coordinated by present and former staff members of the Operation and Structural Safety Group, in the Technical Service Center, and contributing Regional and Area Offices.

It is recommended that the writer/preparer of the SOP use Designers' Operating Criteria, Design Summary, Performance Parameters Technical Memorandum (TM), and any manufacturer's instructions when preparing to write the Standing Operating Procedures.

Checklists are provided at the end of each section to allow authors and reviewers of the SOP to verify whether their document addresses the major items covered in that section.

SUMMARY OF REVISIONS

The items provided below illustrate where revisions were made to the "Guide For Preparation Of Standing Operating Procedures For Dam and Reservoirs," dated January 1986.

SECTION 1 INSTRUCTIONS FOR PREPARING SOP'S

- Minor revisions were made to this section regarding "Review of Wall-Mounted Operating Instructions."

SECTION 2 SOP INTRODUCTORY PAGES, EAP, AND COMMUNICATIONS DIRECTORY

- The term "RO&M Examination" and SEED examinations are now refered to as "Facility Review."
- The term "Emergency Preparedness Plan" is now referred to as "Emergency Action Plan."
- The subsection on "Emergency Preparedness Plan" is now covered in detail in the documents, "Emergency Planning and Exercise Guidelines; Vol. I - Guidance Documents" and "Vol. II - Technical Handboook."

SECTION 3 SOP CHAPTER I—GENERAL INFORMATION

- Revised subsection K. "SOP Distribution"

SECTION 4 SOP CHAPTER II—STRUCTURAL, MECHANICAL, AND ELECTRICAL

- Revised subsection C.8. "Gates and Valves - Exercising and Testing."
- Subsection D. "Instrumentation - Monitoring and Maintenance" has been deleted.
- Add a sample form "Ongoing Visual Inspection Checklist."
- Major revision to subsection E. "Safety Procedures."
- Major revision to subsection F. "Protective Coating - Inspection and Maintenance."

SECTION 5 SOP CHAPTER III—STRUCTURAL BEHAVIOR INSTRUMENTATION

& This section has been completely revised to reflect new technology.

SECTION 6 SOP CHAPTER IV—RESERVOIR OPERATIONS

& Minor revisions were made throughout this section.

SECTION 7 SOP CHAPTER V—POWER FACILITY OPERATIONS

& This section was incorporated into this document from the ”Power Facilities Supplement,” dated October 1986.

SECTION 8 APPENDICES

& Reduced the number of appendices from the 1986 edition by incorporating the information into their respective sections.

CONTENTS

CONTENTS (Continued)

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SECTION 3 SOP CHAPTER I—GENERAL INFORMATION

SECTION 4 SOP CHAPTER II—STRUCTURAL, MECHANICAL, AND ELECTRICAL

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FIGURES

1 INSTRUCTIONS FOR PREPARING AN SOP

A. Purpose

Bureau of Reclamation SOP's for dams, reservoirs, and power facilities are prepared to establish in one primary controlled document (with associated supporting documents) the complete, accurate, current, and structure-oriented operating instructions for each storage reservoir and its related structures and/or power facilities. The purpose is to ensure adherence to approved operating procedures over long periods of time and during changes in operating personnel. The instructions also will permit responsible persons knowledgeable in reservoir and/or power facility operations, but unfamiliar with the conditions at a particular dam, to operate the dam and reservoir or power facility during an emergency situation and at times when regular operators cannot perform their normal duties.

The Regional Office has the responsibility to issue SOP's. In some regions, this responsibility has been delegated to the area offices.

The SOP is prepared primarily for operating personnel located at or nearest to the dam or power facility and their immediate supervisors who are assigned the responsibility for the physical operation and maintenance of the structure. As a minimum, the SOP should contain all information and instructions necessary for operators to perform their duties.

In addition to dam, reservoir, and power facility operating instructions for operating personnel, the SOP should include all the instructions for personnel at other locations having operating responsibilities at the dam. The extent to which data and instructions should be included in the SOP will vary considerably. This will depend mainly on circumstances relating to the particular dam or power facility, such as the complexity of operation and the locations and respective responsibilities of the various operating offices. For each dam or power facility, the responsible office should determine the best arrangements that will promote use of the instructions. The SOP and its supporting documents, such as the DOC (Designers' Operating Criteria), Design Summary, and Performance Parameters Technical Memorandum, should establish complete operation and maintenance procedures for all levels of responsibility, regardless of the plan selected for the grouping of instructions. For dams and reservoirs where there is an authorized flood control pool, the Corps of Engineers may have supplied a Water Control Manual or similar document to describe flood operating procedures.

An SOP shall be available at the dam or operating facility according to the requirements in the applicable **directives in the Reclamation Manual**.

B. SOP Guide Contents

Section 1, ***Instructions for Preparing an SOP*****,** summarizes information and instructions that a typical SOP would encompass, but is not limited to headings and outline shown below.

Section 2, ***SOP Introductory Pages, Emergency Action Plan (EAP), and Communications Directory.*** This section contains communications, responsibilities, and precautionary measures to be observed. An outline of Section 2 is as follows:

A. SOP Introductory Pages
1. *Cover*
2. *Title page*
3. *Letter of transmittal*
4. *SOP revision sheet*
5. *Certification of SOP review by operating personnel*
6. *SOP preface*
7. *Items of special importance*
8. *SOP contents*

B. Emergency Action Plan
C. Communications Directory

Section 3, ***SOP Chapter I—General Information*****,** contains information and instructions concerning administration of the dam, reservoir, or power facility, and SOP distribution and its revisions.

SOP CHAPTER I—GENERAL INFORMATION

A. Purpose of the Project
B. Directions and Access to Dam And/or Power Facility
C. Assignment of Responsibility
D. Attendance, Communications, and Warning Systems
E. Cooperation With Other Agencies
F. Data Reporting
G. Operating Log
H. Public Safety And Health
I. Restricted Areas
J. Emergency Management And Facility Security Plans
K. SOP Distribution
L. SOP Revisions
M. Supporting Documents
N. Reference Material

Section 4, ***SOP Chapter II—Structural, Mechanical, and Electrical*****,** contains detailed descriptions and instructions for operating, maintaining, and examining the structures and equipment.

SOP CHAPTER II— STRUCTURAL, MECHANICAL, AND ELECTRICAL

A. General Description of Dam and Appurtenances
B. O&M Instructions for Spillway, Outlet Works, and Other Appurtenances

C. Miscellaneous O&M Instructions
- *1. Overtopping Spillway Radial Gates*
- *2. Multiple Gate Openings*
- *3. High-pressure Slide Gate Minimum Openings*
- *4. Drop-inlet Outlet Works Operation*
- *5. Ventilation Systems Operation*
- *6. Rock Removal from Chutes and Basins*
- *7. Isolation and Bypass Valves*
- *8. Gates and Valves—Exercising and Testing*

D. Dam Maintenance and Inspection
E. Safety Procedures
F. Protective Coating—Inspection and Maintenance

Section 5, ***SOP Chapter III—Structural Behavior Instrumentation*****,** contains notes on special instrumentation at the facility. If instrumentation installations are significant, the chapter would include such items as the extent of installed instrumentation, monitoring, and maintenance requirements.

SOP CHAPTER III—STRUCTURAL BEHAVIOR INSTRUMENTATION

A. General Description of Instrumentation and Reading Schedule
B. Identification of Unexpected Data
C. Responsibilities
D. Specifics for Each Installation
- *1. Detailed Description of Installations*
- *2. Purpose*
- *3. Reading and Maintenance Schedule Instructions*

E. Seismic Monitoring/strong Motion Program

Section 6, ***SOP Chapter IV—Reservoir Operations*****,** contains detailed instructions and information on all aspects of reservoir operation.

SOP CHAPTER IV—RESERVOIR OPERATIONS

A. Reservoir Capacity Allocations
B. Design Flood Study and Routing
C. Filling Schedule and Release Procedures
D. Inflow Forecasting
1. Hydrometeorological System
2. Early Warning System

E. Flood Operating Criteria
F. Special Report During Flood or High Water
1. Surcharge Capacity
2. Attendance

G. Filling and Drawdown Limits
H. Landslide Surveillance
I. Preventing Oil Pollution of Water
J. Fish and Wildlife Considerations
K. Recreation Management Plan
L. Off-road Vehicle Regulations
M. Hydropower Release Criteria
N. Operating Criteria for Other Functions

Section 7, ***SOP Chapter V—Power Facility Operations*****,** contains detailed instructions and information on all aspects of power facility or pumping facility operations.

SOP CHAPTER V—POWER FACILITY OPERATIONS

A. Facility Information
1. General
2. Items of Special Interest

B. Major Rotating Equipment and Auxiliaries
1. Turbines (Pumps)
2. Generators (Motors)
3. Governors
4. Excitation Systems
5. Braking, Lifting and Jacking Systems
6. Fire Protection Systems
7. Bearing Lubrication Systems
8. Generator (Motor) and Bearing Cooling Water Systems
9. Penstock (Discharge) and draft (Suction) Tube Features

C. Major Operational Sequences
1. *Station Generators*
2. *Main Generators*

D. Station Service DC Systems
1. *Station Service DC Power Distribution*

E. Station Service AC Systems
1. *Station Service AC Power Distribution*

F. Plant Services
1. *Water Supply System*
2. *Compressed Air Systems*
3. *Oil Systems*
4. *Oil Entrapment, Drainage, and Sewage Systems*
5. *Emergency Unwatering*
6. *Lighting Systems*
7. *Heating and Ventilating Systems*
8. *Oil Storage Fire Protection Systems*
9. *Annunciator and Signal Equipment*

G. Power Circuit Breakers
1. *Powerplant Circuit Breakers*
2. *Switchyard Circuit Breakers*

H. Power Transformers
1. *General*
2. *Components and Description*
3. *References*

I. Protective Relaying
1. *Generator (Motor) Relaying*
2. *Transformer Relaying*
3. *Station Service Relaying*
4. *Switchyard Relaying*

J. Manual and M/O Disconnect Operation and Interlocks
1. *General*
2. *Components and Description*
3. *References*

K. Major Dam Equipment and Auxiliaries (if not described in chapter II)
1. *Spillway Gates*
2. *Outlet Works*
3. *Other Dam Equipment and Services*

L. Additional Sections as Required
1. *Cables*
2. *Switchyards*

The Appendices contains memoranda, glossary, and definitions should be helpful in composing the SOP document.

The SOP appendices could incorporate drawings, logs, maps, photographs, charts, copies of selected supporting documents, Schedule for Periodic Monitoring (L-23), Focused summary of Performance Parameters TM, applicable Spill Prevention Control and Countermeasure (SPCC) plan, and other related reference material that complete the SOP.

NOTE: The preceding suggested sop contents is not intended to restrict any office from including additional chapters or sections for special purposes.

Because of the variation in size and complexity of dams and/or power facilities and because DOC's have not been prepared for many older dams, the SOP section headings to be included and the detail required will vary. In addition, in some SOP's unusual dam and reservoir conditions may require more topical headings than previously listed. Nevertheless, the suggested Contents can be adapted readily for use at all dams, reservoirs, and power facilities. This guide includes a complete SOP checklist as an aid. It is suggested that the "Standing Operating Procedures Checklists," provided at the end of each section, be reproduced and used as an outline in formatting the SOP composition.

C. Editorial Suggestions

Each SOP should give clear, concise, and complete instructions since it is the guide used to operate and maintain the dam or power facility during normal and emergency conditions. Dam and power facility operators should be able to follow instructions in the SOP without having to determine the function of each switch or valve by making a detailed study of the system. A responsible person knowledgeable in reservoir and power system operation, but unfamiliar with the operation and maintenance of a particular dam or power facility, should be able to read the SOP instructions and successfully and safely operate and maintain the dam, or powerplant, or pumping plant, its structural appurtenances, and related equipment.

It is recommended to supplement step-by-step instructions in the SOP and DOC or Design Summary by using posted operating instructions, marked photographs, color coding, and numbering to identify valves and switches mentioned in the operating instructions for the spillway, outlet works, and service equipment. Using these aids considerably simplifies the operating instructions and reduces the margin for error.

Some suggestions to improve the quality and to aid in the SOP draft composition are:

- Begin each major section on a new page (to aid in revisions).
- Print on only one side of the paper.
- Insert colored dividers (8-3/4 or 9 inches wide with chapter heading on the margin) in front of the EAP, Communications Directory, each chapter, and appendix.
- Start each chapter with a separate page numbering sequence (e.g. page EAP-1, Comm-1, I-1, II-1, etc.).
- Write clear, concise, complete sentences and paragraphs. Remember, the operator may be in a crisis situation and require operating information immediately.
- Use lists rather than narrative to outline instructions and information whenever possible.
- Reference all drawings, figures, photographs, etc., included in the appendix, at least once in the text.
- State the exact location of dam operator's SOP copy (at the dam or power facility) under SOP Distribution (e.g., in office at dam operator's house, in powerplant or pumping plant control room, in desk at gatehouse, etc.)
- Use exact title of dam operating personnel throughout (e.g., dam tender, reservoir superintendent, ditchrider, powerplant foreman; or if no other designated title, use dam operator.)
- Avoid indefinite words (e.g., regular intervals, frequent, periodically, supervisory office).

D. SOP For Other Structures

The program for preparing an SOP was initiated to fulfill the need for organized operating and maintenance instructions for dams, reservoirs, and power facilities.

Offices may deem it appropriate to prepare SOP's for other types of major structures and features of water systems such as major canals, pipelines, pumping plants, etc. Of particular concern are major diversion dams having gated overflow crests, or those included in the Corps

of Engineers' Inventory of Dams which is contained in the publication "National Program of Inspection of Dams."[1]

Preparation and distribution of the SOP's should follow the same procedures as prescribed for dams, reservoirs, and power facilities.

SOP's have been prepared and are maintained for most Bureau of Reclamation powerplants and pumping plants on reservoirs. Even though SOP powerplant instructions are available at a dam, some of which may relate to the operation of the dam and its nonpower appurtenances, a separate SOP should not be prepared for dam and reservoir operation but should be combined.

E. Related Activities

Preparation of a dam, reservoir, and/or power facility combined SOP requires a detailed review and analyses of operation and maintenance procedures. Because this entails appreciable time and effort, effective management dictates the desirability of making certain reviews and studies before or simultaneously with the SOP preparation. The following reviews should be made in conjunction with SOP preparation and appropriate action taken if at all possible:

1. **Review of DOC and Design Summary.**—Where conditions at a dam have changed so that portions of the DOC or Design Summary are no longer applicable; comments on discrepancies or deficiencies in the DOC or Design Summary should be noted, the DOC or Design Summary voided and the correct or revised information entered into the SOP.

2. **Review of Wall-Mounted Operating Instructions.**—The installation of durable operating diagrams and instructions adjacent to the controls for gates and valves logically complements complete operating instructions for dams and power facilities. When reviewing the need to openly post operating instructions, adequate security measures will be in place to deter, delay and detect intruders into the control facility. These measures may include, but are not limited to, perimeter fencing, electronic security measures, tamper-resistant lockout devices, and the adequacy of storage containers. At each dam and/or power facility status of posted operating instructions should be reviewed while preparing the SOP. When posted instructions are considered inadequate, corrective action should be initiated. The SOP should include the wording and drawings of all instructions and diagrams that are to be posted and should state specific testing requirements.

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[1]Appendix F, Inventory of Dams in the United States - Index, In: "National Program of Inspection of Dams," vol. V of 5 vol., Department of the Army, Office of the Chief of Engineers, Washington, D.C., May 1975.

Also, the SOP should require that operating personnel replace these instructions before they become illegible.

Upon request, the Technical Service Center can provide area offices with drawings of gate and valve operating instructions specifically prepared for posting.

3. **Review of Identification of Valves, Pipes, and Equipment.**—Preparation of operating instructions for the SOP requires the identification of valves, levers, piping, etc., used during equipment operation. Installing nameplates and color coding pipes is one identification method. If this method is used, the coding should be coordinated closely with criteria contained in the American National Standard Institute, ANSI A13.1 entitled Scheme for the Identification of Piping Systems. Legends should be applied close to valves or flanges and adjacent to changes in direction, branches, where pipes pass through walls or floors, and at intervals on straight pipe runs sufficient for identification. Colors should be used to identify the characteristic hazards of the piping system contents.

4. **Facility Review (Periodic and Comprehensive) Reports.**—Information regarding suggestions for improving the SOP may be discussed or recommended in the reports.

2

INTRODUCTORY PAGES, EAP, AND COMMUNICATIONS DIRECTORY

A. Introductory Pages

1. **Cover.**—The SOP and its Supporting Documents should be bound with fasteners to facilitate revisions. Covers should be of a heavy, flexible, durable material, and sized to match the chapter dividers. A spine labeled or stamped "Standing Operating Procedures, (*facility name*) Dam, and/or Power Facility" helps identify the SOP when shelved. The cover has the U.S. Department of the Interior and the Bureau of Reclamation logos. Also, the Reclamation region is noted.

   A control number should be stamped legibly or printed on the upper left-hand corner of the cover, on the spine, and on the title page. The number serves as a control for each SOP copy for a particular dam and/or power facility. The numbers should be shown for all copies on the SOP Distribution list in the "letter of transmittal," further assuring control.

   Instructions regarding the issuance and distribution of the SOP are provided in the applicable **directives in the Reclamation Manual**.

   It is desirable to use an aerial photo of the dam, reservoir, and power facility either on the cover or preferably as a frontispiece.

2. **Title Page.**—The SOP should have a title page showing:

- Name of reservoir[1]
- Operating entity (Reclamation or water-user)
- Name of dam and/or power facility[1]
- Date published (month and year)
- Project, and State
- Department and Reclamation logos[2]
- Copy control number

The office responsible for SOP preparation and the Regional Office having jurisdiction should be included.

3. **Transmittal Letter.**—The initial letter of transmittal shall be dated and signed by the Regional Director according to the applicable **directives in the Reclamation Manual**. Letters transmitting SOP revisions should not replace the initial "letter of transmittal" unless a complete new SOP is to be issued.

4. **SOP Revision Sheet.—**The SOP revision sheet should be transmitted with the revised pages of the SOP. The revision sheet should be inserted after the letter of transmittal. This provides a quick, convenient method for checking that each copy is up to date. The sheet includes the revision number, date, and instructions whether to replace or add specific page numbers, drawings, etc. The revision number and date must be shown on the bottom of each revised page. All previous revisions should be listed until a complete reissue of the SOP is made. This ensures that copyholders are aware of these previous changes should they have been omitted from their copies.

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[1]Active Names of Reclamation Projects and Major Structures, U.S. Department of the Interior, Bureau of Reclamation, current issue.

[2]Department Manual, U.S. Department of the Interior, Part 314, "Printing and Publications," Chapter 3, Publications.

5. **Certification of SOP Review by Operating Personnel.**—This SOP subsection provides procedures to prepare a required certification by the operating personnel and supervisors. Document the occurrence of the following:

   a. Receipt and initial review of SOP and SOP revisions.
   b. Review of EAP and SOP at least on an annual basis.
   c. Classroom and onsite dam operators training course completions.

   A certification paragraph is suggested (in the SOP) as:

   Certification of SOP Review by Operating Personnel

   The purposes of this certification are to verify that the SOP is correct and current, the EAP is adequate, and the __(*title of dam operator*)__ and __(*title of supervisor*)__ are familiar with its content, use, and intent. Operating procedures presented in the SOP are complete, accurate, and current or suggested changes will be furnished. The __(*title of dam operator*)__ and __(*title of supervisor*)__ understand that under normal communication conditions, changes in operating procedures shall not be made without approval of the Regional Director and, if necessary, the Director, Program Analysis Office.

   All operating personnel will certify the above and sign the Operating Log.

6. **SOP Preface.**—The SOP *preface* states the purpose of the document; the following is a suggested statement.

   SOP's for Bureau of Reclamation dams, reservoirs and power facilities are prepared to establish in one primary controlled document (with associated supporting documents) the complete, accurate, current, structure-oriented operating instructions for each dam, reservoir and/or power facility and its related structures. The SOP purpose is to ensure adherence to approved operating procedures over long periods of time and during changes in operating personnel. The instructions also will permit responsible persons who are knowledgeable in reservoir operation, but are unfamiliar with the conditions at a particular dam, to operate the dam, reservoir and/or power facility during emergency situations and at such times when the regular operator cannot perform his/her normal duties.

   The SOP is prepared primarily for the use of operating personnel located at or nearest to the dam and/or power facility and their immediate supervisors who are assigned the responsibility for the operation and maintenance of the dam. THIS SOP CONTAINS, AS A MINIMUM, ALL INFORMATION AND INSTRUCTIONS NECESSARY FOR OPERATING PERSONNEL TO PERFORM THEIR DUTIES. Operating procedures shall not deviate from those stated in the SOP without appropriate authorization and shall be reviewed and updated periodically by qualified Regional Office (or Area Office) personnel.

7. **Items of Special Importance.**—Any cautions, specific noteworthy directives, or construction and design problems at the specific dam should be noted in this subsection.

   If a DOC or Design Summary has been issued, those items listed either on the backside of the DOC or Design Summary preface or on the DOC or Design Summary foreword pages should appear also on the facing preface or foreword page of the SOP, if still applicable.

8. **SOP Contents.**— The SOP contents lists all chapters, section headings, and page numbers (including the EAP and Communications Directory).

   It is desirable that SOP drawings, charts, maps, and photos be numbered numerically as figures (exhibits within an appendix) and should be referenced at least once in the text.

   A listing of the appendix(es) (CONTENTS—Continued) should be included immediately following CONTENTS. Tables should be numbered and similarly listed.

   Most full-page tables, figures (exhibits) - particularly those that are folded should be assembled at the back of the SOP. Current drawings are to be used in preparing the SOP. In some cases, where a number of drawings are included in the SOP, it may be desirable to bind them into a separate volume. Each volume should be labeled ***SOP—Volume I, SOP—Volume II, SOP—Drawings Appendix,*** etc.

   An appendix can be placed at the end of each chapter. Readers would not need to go to the back of the SOP for figures, drawings, etc. pertinent to that chapter.

B. Emergency Action Plan

Detailed information for preparing, writing, and reviewing EAP's is provided in *Emergency Planning and Exercise Guidelines; Vol. I - Guidance Documents and Vol. II - Technical Handbook*.

C. Communications Directory

The Communications Directory section should contain specific communication contacts for all levels of responsibility, as well as any other pertinent Federal, State, local, or private entities, emergency assistance agencies, public utilities, and any cooperators that the operating personnel and the supervisory office may need to contact in case of an emergency.

Persons to be contacted should be listed by:

- Name
- Title
- Location
- Office and phone number
- Home phone number
- Backup numbers or radio communication (if necessary)

Pages from the regional (emergency) Communications Directory for Dams[3] are suggested for current names and phone numbers, including sheets for:

1. The particular dam.

2. Emergency services and cooperators.

3. Area/Field Office(s).

4. Regional Office(s).

5. Emergency Notification System.

6. Disaster and alternate communications sources, including National Weather Service, Environmental Protection Agency, Federal Emergency Management Agency, National Response Center (U.S. Coast Guard), and other possible sources of emergency communications.

7. Sources of construction equipment, materials, labor, engineering expertise, and underwater examiners.

[3]The regional Communications Directory for Dams supports the Communications Directory contained in the SOP for each dam. A copy of the regional (emergency) Communications Directory should be kept in the same area as the SOP document. The regional communications directory lists each dam, the nearest Reclamation office having jurisdiction, the operating office, the dam operator, whom to contact in the event of unusual occurrence, and any notes of special importance.

The Communications Directory should be prepared as a complete and separate document which can be reproduced along with the EAP. However, if reproduced, home telephone numbers should be deleted. Contacts and telephone numbers should be verified at least annually.

NOTE: Do not include phone numbers or names in the SOP text. To avoid revising the pages, use official titles. In the text, reference should be made to the Communications Directory at the beginning of the SOP for current phone numbers. When changes occur, a few sheets will need to be revised in the Communications Directory. An example of a communications directory is shown on the following pages.

TABLE OF CONTENTS

COMO DAM

COMMUNICATIONS DIRECTORY

SAMPLE

COMO DAM
Bitter Root Project, Montana

A. BUREAU OF RECLAMATION SUPERVISORY OFFICE HAVING JURISDICTION

Point of First Contact (for an emergency or an unusual occurrence):

John Moody (EPH-2005) Flathead Irrigation Project, Manager . . St. Ignatius MT . . . . . (8-4:30) xxx-xxx-xxxx
(St. Ignatius MT is on Mountain time) . . . . (cellular) xxx-xxx-xxxx . . . . . (home) xxx-xxx-xxxx

Ephrata Field Office
Box 815, Ephrata, Washington 98823
8 a.m. - 4 p.m. (Pacific time)
General Information: xxx-xxx-xxxx

William Gray . . . . . Ephrata Field Office Manager . . . . . EPH-2000 . . . . . (office) xxx-xxx-xxxx
Francis Jensen . . . . . Irrigation Operations Manager . . . . . EPH-2900 . . . . . (office) xxx-xxx-xxxx
Thomas Mahler . . . . Construction Coordinator . . . . . EPH-2003 . . . . . (office) xxx-xxx-xxxx
Fax . . . . . xxx-xxx-xxxx
Other . . . . . Refer to page COMM-4 for complete communications listings.

B. OPERATING OFFICE

Bitter Root Irrigation District ***Note:*** as of ***April 1995*** new address for district:
Box 151 (99 Marcus Avenue) 1182 Lazy J Range, Corvallis MT 59828
Hamilton, Montana 59840-0151 Office Ph. (xxx) xxx-xxxx Fax Ph. (xxx) xxx-xxxx
Gary Shatzer . . . . . Manager . . . . . (8-5) xxx-xxx-xxxx
Fax . . . . . xxx-xxx-xxxx
Radio: Frequency xxx.xx Mhz; Call sign "_____." Base station at Bitter Root Irrigation District office with eight mobile units and five hand-held units. Manager and Foreman have portable units in their homes.

After Hours

Gary Shatzer . . . . . Manager . . . . . Mobile Radio #5 . . . . . (home) xxx-xxx-xxxx
Butch Aarrestad . . . . Foreman . . . . . Mobile Radio #8 . . . . . (home) xxx-xxx-xxxx
Elaine Culletto . . . . . Secretary-Treasurer . . . . . (no radio) . . . . . (home) xxx-xxx-xxxx

C. DAMTENDER No resident at dam. No telephone at dam. Damtender lives about 15 miles from dam.

Woody Woodburn . . Damtender . Hamilton . Mobile radio #1 . . . . . (home) xxx-xxx-xxxx
Damtender portable telephone (irrigation season only) . . . . . xxx-xxx-xxxx
Radio: Frequency xxx.xx Mhz; Call sign "_____." Base station at Bitter Root Irrigation District Office; eight mobile units and five hand-held units.

Emergency Backup

Gary Shatzer . . . . . Manager . . . . . Mobile Radio #5 . . . . . (home) xxx-xxx-xxxx
Butch Aarrestad . . . . Foreman . . . . . Mobile Radio #4 . . . . . (home) xxx-xxx-xxxx
Elaine Culletto . . . . . Secretary-Treasurer . . . . . (no radio) . . . . . (home) xxx-xxx-xxxx
Other: Ground vehicle from dam approximately 5 miles to private ranch house.

D. UNUSUAL OCCURRENCE *In case of emergency, notify:*

Ravalli County Sheriff . . . . . Hamilton . . . . . (county) 911 . . . . . (24-hr) xxx-xxx-xxxx
Montana Highway Patrol, Dist. 1. . . . . Missoula . . . . . (24-hr) xxx-xxx-xxxx

E. NOTES

1. Dam is 15 miles south of Hamilton, Montana. To reach it from the Bitter Root Irrigation District office—
   - Travel south on Highway 93 for about 12 miles;
   - Turn right on "Lake Como Road," travel southwest about miles on paved road to the left (north) abutment of dam.
2. The dam is located in Ravalli County and the Sheriff's office is located in Hamilton, Montana. All emergency numbers for key personnel are also listed with the Sheriff's office.

SAMPLE

Emergency Services and Cooperators
Como Dam

A. Law Enforcement and Civil Emergency

Ravalli County Sheriff	Hamilton	(county) 911	(24-hr) xxx-xxx-xxxx
(law enforcement, ambulance, fire, civil emergency)			
Missoula County Sheriff	Missoula	(county) 911	(24-hr) xxx-xxx-xxxx
(after hours, a long message, then will be answered by jailer upstairs)			
Montana Highway Patrol (from Kalispell)	Missoula	xxx-xxx-xxxx	(admin only) xxx-xxx-xxxx
Federal Bureau of Investigation	Missoula		(7-6) xxx-xxx-xxxx
After hours, or if no answer	Salt Lake City		(24-hr) xxx-xxx-xxxx
Bitterroot National Forest			
Law Enforcement Officer	Darby		xxx-xxx-xxxx

B. Medical Aid

Ambulance *(dispatched by sheriff's office)*	Hamilton	(24-hr) xxx-xxx-xxxx
Marcus Daly Hospital	Hamilton	(24-hr) xxx-xxx-xxxx

C. Fire Prevention and Protection

Bitterroot National Forest			
Darby Ranger District	Darby	(dispatch) xxx-xxx-xxxx	(7-4:30) xxx-xxx-xxxx
Rural Fire Dept. #1	Hamilton	(sheriff) xxx-xxx-xxxx	(variable) xxx-xxx-xxxx

D. Montana State Agencies

Disaster & Emergency Services (Military Affairs)	Helena	(24-hr) xxx-xxx-xxxx
Fish, Wildlife & Parks, Dept. of	Helena	
Fisheries Division		(8-5) xxx-xxx-xxxx
Fish, Wildlife & Parks, Dept. of	Kalispell	(8-5) xxx-xxx-xxxx
Governor's Office	Helena	(8-5) xxx-xxx-xxxx
After hours, Highway Patrol HQ	Helena	(24-hr) xxx-xxx-xxxx
Health & Environmental Sciences, Dept. of		
Water Quality Bureau	Helena	(8-5) xxx-xxx-xxxx
Dam Safety Engineer	Gary Fischer	(8-5) xxx-xxx-xxxx
(after hours, contact Disaster and Emergency Services)		
Natural Resources and Conservation, Dept. of	Helena	
Director	Mark Simonich	(8-5) xxx-xxx-xxxx

E. Federal Agencies

Environmental Protection Agency		
Region 8 *(MT, WY)* Emergency Response	Denver	(24-hr) xxx-xxx-xxxx
Federal Bureau of Investigation	Missoula	(7-6) xxx-xxx-xxxx
After hours, or if no answer	Salt Lake City	(24-hr) xxx-xxx-xxxx

SAMPLE

Federal Emergency Management Agency
Region 8 (MT, WY) . . . . . Denver, CO . . . . . (7-4:30) xxx-xxx-xxxx
(after hours, calls internally forwarded to the duty officer's phone)
Forest Service — Region 1 (Northern) — *serves Montana, northern Idaho*
Bitterroot National Forest . . . . . Hamilton
Darby Ranger District . . . . . Darby . . . . . (dispatch) xxx-xxx-xxxx . . . . . (7-4:30) xxx-xxx-xxxx
Law Enforcement Officer . . . . . Darby . . . . . xxx-xxx-xxxx
Supervisor, Bitterroot N.F. . . . . Hamilton . . . . . (7-5:30) xxx-xxx-xxxx
Regional Forester . . . . . Missoula . . . . . (7:30-5) xxx-xxx-xxxx
After hours: Coordinator, Aerial Fire Depot . . . . . (24-hr) xxx-xxx-xxxx
National Earthquake Information Center . . Golden, Colo. . . . . (8-5) xxx-xxx-xxxx
(after hours, a recording provides the duty officer's name and phone number)
National Response Center (Coast Guard) . . Washington, D.C. . . . . (24-hr) xxx-xxx-xxxx
(for reporting oil and hazardous waste spills at all locations)
National Weather Service
Montana Forecast Office . . . . . Great Falls . . . . . (24-hr) xxx-xxx-xxxx
Northwest Montana Office . . . . . Kalispell . . . . . (24-hr) xxx-xxx-xxxx
(Office of Environmental Assistance, Dept. of the Interior) (for MT, UT, WY)
Regional Environmental Officer . . Robert Stewart . Denver (office) xxx-xxx-xxxx . . . . . (home) xxx-xxx-xxxx
Regional Environmental Ass't Barbara Schmaltz . . Denver (office) xxx-xxx-xxxx . . . . . (home) xxx-xxx-xxxx
Secret Service . . . . . Great Falls, MT . . . . . (24-hr) xxx-xxx-xxxx
Army [Bomb] Explosive Ordnance Disposal Detachment
53rd EOD . . . . . Yakima Firing Center, WA. . . . . (24-hr) xxx-xxx-xxxx
(Washington east of the Cascades; Oregon east of Cascades; northern Idaho, including Washington, Valley and Lemhi counties; Montana)

F. Downstream Facilities

Burlington-Northern Railroad . . . . . Whitefish
Yardmaster . . . . . Whitefish MT . . . . . (24-hr) xxx-xxx-xxxx

Montana Rail Link *(all 24-hr)* . . . . . Missoula . . . . . (dispatch) xxx-xxx-xxxx
. . . . . (customer service) 406-523-1421 . . . . . (switchboard) xxx-xxx-xxxx

SAMPLE

EPHRATA FIELD OFFICE
(of the Upper Columbia Area Office)
Box 815, Ephrata, Washington 98823
8 a.m. - 4 p.m. (Pacific time)
General Information: xxx-xxx-xxxx

NORMAL COMMUNICATIONS

(Any extension in the Field Office may be reached by dialing 509-754-0+ext)

William Gray . . . . . Ephrata Field Office Manager . . . . . EPH-2000 . . . . . (office) xxx-xxx-xxxx
Francis Jensen . . . . . Irrigation Operations Manager . . . . . EPH-2900 . . . . . (office) xxx-xxx-xxxx
Thomas Mahler . . . . Construction Coordinator . . . . . EPH-2003 . . . . . (office) xxx-xxx-xxxx

Fax . . . . . xxx-xxx-xxxx

Radio Frequency: xxx.xxx Mhz. VHF-FM radio network through repeater station located on Wahatis Peak connecting with the following fixed and mobile stations:

- Base Station Ephrata Field Office KOD-800
- Dry Falls Dam Coulee City KOD-807 Car 430 (Visker)
- O'Sullivan Dam KOD-808
- Pinto Dam c/o KOD-807 Car 430 (Visker)

AFTER HOURS

Duty Officer . . . . . Irrigation Operations Branch . . . . . (office) xxx-xxx-xxxx
William Gray . . . . . Ephrata Field Office Manager . . . . . (home) xxx-xxx-xxxx
Francis Jensen . . . . . Irrigation Operations Manager . . . . . (home) xxx-xxx-xxxx
Thomas Mahler . . . . Construction Coordinator . . . . . (home) xxx-xxx-xxxx

Radio VHF-FM radio from Irrigations Operations office in Ephrata, and includes all mobile units and fixed stations at district and watermaster headquarters offices throughout the project.

- East Columbia Basin I.D. radio net xxx.xxx Mhz
- Quincy-Columbia Basin I.D. radio net xxx.xxx Mhz
- South Columbia Basin I.D. radio net xxx.xxx Mhz

UNUSUAL OCCURRENCE *In case of emergency, notify:*

Grant County dispatch (sheriff) . . . . . Ephrata . . . . . (county) 911 . . . . . (24-hr) xxx-xxx-xxxx
(law enforcement, ambulance, fire, civil emergency; 911 is not centralized, but various entities within county)

(Serves these counties: southwest corner of Adams; all of Chelan, Douglas, Grant, Kittitas, and Okanogan)

Washington State Patrol Regional Dispatch . . . Wenatchee (state) xxx-xxx-xxxx . . . . . (24-hr) xxx-xxx-xxxx
from Ephrata and Quincy . . . . . Wenatchee . . . . . (24-hr) xxx-xxx-xxxx
from Moses Lake and Warden . . . . . Wenatchee . . . . . (24-hr) xxx-xxx-xxxx

UPPER COLUMBIA AREA OFFICE

Box 1749, Yakima, Washington 98907-1749 (1917 Marsh Road)
Area Manager . . . . . James Cole . . . . UCA-1000 (8-4:30) xxx-xxx-xxxx . . . . . (Fax) xxx-xxx-xxxx

SAMPLE

PACIFIC NORTHWEST REGIONAL OFFICE
Bureau of Reclamation
1150 N. Curtis, Boise, Idaho 83706-1234
Office Hours: 7:45 a.m. - 4:15 p.m. (Mountain)

In an emergency situation, refer to the facility's Standing Operating Procedures to determine the appropriate contacts to make. If those contacts cannot be determined, call the contacts below, in the order listed, until someone in authority is reached.

		OFFICE	HOME
For Emergencies Related to Existing Structures — Fax: xxx-xxx-xxxx			
Mike Marriott	Facility O&M	xxx-xxx-xxxx	xxx-xxx-xxxx
Steve Brawley	Facility O&M	xxx-xxx-xxxx	xxx-xxx-xxxx
Terrald Kent	Facility O&M	xxx-xxx-xxxx	xxx-xxx-xxxx
Daniel Yribar	Water Systems Operations	xxx-xxx-xxxx	
For Emergencies related to Construction, Geologic, or Safety of Dams activities — Fax: xxx-xxx-xxxx			
James Mumford	Engineering Support/Safety of Dams	xxx-xxx-xxxx	xxx-xxx-xxxx
Brent Carter	Geology	xxx-xxx-xxxx	xxx-xxx-xxxx
David Jennings	Design & Specifications	xxx-xxx-xxxx	xxx-xxx-xxxx
For Emergencies that Warrant a Direct Call to the Regional Director:			
1. John W. Keys, III	Regional Director	xxx-xxx-xxxx	xxx-xxx-xxxx
2. Debee Schwarz	Public Affairs Officer	xxx-xxx-xxxx	xxx-xxx-xxxx
3. Ken Pedde	Deputy Regional Director xxx-xxx-xxxx	xxx-xxx-xxxx	
5. Paul Rachetto	Regional Administrative Manager	xxx-xxx-xxxx	xxx-xxx-xxxx
6. Max E. Van Den Berg	Resources & Technical Services	xxx-xxx-xxxx	xxx-xxx-xxxx
Regional Hazardous Materials Coordinator			
Scott Lund	Group Leader, Hazardous Materials Branch	xxx-xxx-xxxx	xxx-xxx-xxxx

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ALTERNATE COMMUNICATIONS SOURCES

Listed below are some of the groups and agencies which may be able to render communication assistance during emergencies when regular communications modes are disrupted or inadequate:

State, County, and City police	radio nets
State Department of Highways	radio nets
U.S. Forest Service	radio nets
U.S. Bureau of Land Management	radio nets
Federal Aviation Agency	teletype circuits
State Boards of Aeronautics	ground-to-air radio
State National Guard	radio net
Private and public electric utilities	radio and leased lines
Bonneville Power Administration	radio, teletype, and leased lines
Western Union Telegraph Co.	private and leased lines
Organized radio amateur systems	ARRL (American Radio Relay League) RACES (Radio Amateur Civil Emergency Service) MARS (Military Affiliate Radio Service) AREC (Amateur Radio Emergency Corporation) Citizen band radios

SAMPLE

DIRECTOR, OPERATIONS, DENVER
(Dam Safety Office D-6600)
ALL OTHER DENVER OFFICES
COMMISSIONER, BUREAU OF RECLAMATION, WASHINGTON, D.C.
SECRETARY OF THE INTERIOR, WASHINGTON, D.C.

When it is necessary for Area and Regional Office personnel to contact Reclamation officials for technical assistance, to report incidents, or to advise these officials of "emergency situations" or "unusual conditions", the 24-hour duty-officer pager system will be used.

> *"... A 24-hour duty officer pager system was established to respond to DOI information requests and to receive reports from Reclamation personnel at area and regional offices on incidents occurring at our facilities. Reclamation's duty officer will ensure that the Commissioner/back-up personnel and DOI's 24-hour duty officer are notified as appropriate."*[1]

- Dial xxx-xxx-xxxx (purposely deleted). A computer voice will answer and instruct the caller to enter Reclamation's personnel identification number (PIN), which is "xxxxxxx" (purposely deleted). Using the telephone keypad, enter the PIN, then press the # sign.
- An operator will answer and ask you to leave a short verbal message. This message should also include your name and a telephone number where you can be reached.
- *If you have a "rotary" (dial) phone or reason to believe the phone lines may become jammed, call another office and have personnel there make the pager call, while you remain on the line while they relay information for you. Once communications have been established, it is recommended that you keep this line open.*
- The operator will activate the duty officer's pager. The duty officer will contact you. If the duty officer does not return your call within 15 minutes, you should repeat the process.
- When the duty officer returns your call, describe the situation, and request either the type of assistance you require, or if known, the specific offices you wish to be put in touch with. The duty officer will arrange to have the necessary personnel contact you. The precautions concerning availability of telephone service apply to these calls also.

SAMPLE

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[1]Commissioner's memo of May 24, 1994
To: All Regional Directors
Subject: Emergency Notification System —

> *"...This memorandum defines procedures for ensuring timely notification of the Commissioner and the Department of the Interior (DOI) in the event of incidents occurring at Reclamation and DOI facilities that meet the criteria in the December 1, 1993, Assistant Secretary — Policy, Management and Budget memorandum on reporting criteria for significant domestic emergency-related events."*

D. Introductory Pages, EAP, and Communications Directory Checklist

_____Dam

_____Reservoir

Reviewed by _____ Prepared by _____

Date _____ Date _____

Standing Operating Procedures Checklist	Adequate	Inadequate
A. Introductory Pages		
1. Cover		
a. SOP copy control number		
b. USDI and Reclamation logos		
c. Correct title of dam		
d. Reclamation Region		
e. Photo of dam and reservoir (frontispiece)		
2. Title Page		
a. Correct name of dam and reservoir		
b. Project and State		
c. Operating entity		
d. SOP copy publish date		
e. USDI and Reclamation logos		
f. SOP prepared by (office)		
g. Copy control number		
3. Transmittal Letter		
a. Legibly dated and signed by the Regional Director		
b. Complete distribution and copy control number(s)		
c. Note control number and location of dam operator's SOP		

Standing Operating Procedures Checklist	Adequate	Inadequate
4. SOP Revision Sheet		
a. Number		
b. Date		
c. Instructions		
5. Certification of SOP Review by Operating Personnel		
a. Standard paragraph use		
6. SOP Preface		
a. Standard paragraph use		
b. If no DOC or Design Summary, delete last paragraph		
7. Items of special importance		
a. All precautions contained in chapter II, sec. C		
b. Cautions: If contained in DOC or Design Summary, also included in SOP		
8. SOP Contents		
a. All section headings and page numbers (1) EAP and Communication Directory included in Contents		
b. All tables and figures (drawings) listed		
c. Appendix-complete listing		
B. Emergency Action Plan		
Detailed information is provided in *Emergency Planning and Exercise Guidelines; Vol. I - Guidance Documents and Vol. II - Technical Handbook*		

Standing Operating Procedures Checklist	Adequate	Inadequate
C. Communications Directory		
1. Specific Communication Sources (all levels of responsibility		
2. Persons Contacted should include; Name, Title, Location, Office, Home phone numbers, backup numbers, or radio communications		
3. Regional Communications Directory for Dams		
a. The particular dam		
b. Emergency services and cooperators		
c. Area/Field Office(s) (if any)		
d. Regional Office(s)		
e. Emergency Notification System		
f. Disaster and alternate communications		
g. Phone numbers of communication systems for construction equipment, materials, labor, engineering expertise, and underwater examiners		

SOP CHAPTER I — GENERAL INFORMATION

3

A. Purpose of the Project

This subsection should briefly:

- Identify the dam, reservoir, and/or power facility
- State the authorized purposes of the project
- Note the additional benefits

All major project features should be identified as well as other projects served.

Include significant historical data, nomination or inclusion in the "National Registry of Natural Landmarks,"[1] or other unique information.

Note that the publication *National Historic Landmarks: A Preservation Program of the National Park Service*, by the Office of Archeology and Historic Preservation, Washington, D.C., 1976, is out of print.

Names and locations of properties in "The National Register of Historic Places" (1976) are in two volumes. They were prepared in the Office of Archeology and Historic Preservation, Department of the Interior.

Historical data are under the direction of the National Park Service, Associate Director, Cultural Resources, Washington, D.C. 20240.

A more detailed description of the dam should be included under SOP ***Chapter II, A., "General Description of Dam and/or Power Facility."***

[1]Federal Register, "National Registry of Natural Landmarks," published each year in February, Federal Register, "National Register of Historic Places; Annual Listing of Historic Properties, National Park Service, U.S. Dept. of the Interior.

B. Directions and Access to Dam and/or Power Facility

This subsection should state in detail pertinent information on access to the dam from easily identified points of origin (usually operating entity headquarters) under normal, adverse, and emergency conditions. Include information such as:

- Describe the most expeditious routes of access to the dam and/or power facility from project or operating entity headquarters.
- Describe an alternate route to the structure where significant.
- Evaluate the routes and their accessibility (load limit, one- or two-lane) for year-round or emergency use (paved, gravel, dirt) under normal and adverse conditions.
- Note the availability and use of special equipment for access (helicopter, snowmobiles, four-wheel-drive, etc.).
- Mention locations of nearest commercial and small aircraft airports.
- The project location map can be referenced.

The project location map (prepared for use during dam construction) commonly is included in the SOP. However, it should be current to reflect changes in road networks. The map should be clear and precise. In some cases, project maps may be suitable for use as location maps. For multiple dam and/or power facility projects, it may be desirable to revise one project location map to show current access routes to all structures on the project.

For some SOP's, location maps have been prepared by reproducing portions of recent USGS topographic maps with the access routes clearly marked.

C. Assignment of Responsibility

This subsection should clearly identify all areas of responsibility in the chain of command with respect to dam and reservoir operation and maintenance. General areas of responsibility of the operating entity (where applicable) and Reclamation's Area and Region offices should be described briefly.

Responsibilities of the Bureau of Reclamation should be identified by the following statement. (If the dam and/or power facility is Reclamation operated, use prime; if it is water-user operated, use basic.)

> The Bureau of Reclamation has a __[*basic or prime*]__ interest in the dam, reservoir and/or power facility area and a continuing responsibility for ascertaining that unauthorized encroachments do not occur, that existing or potential conditions do not lead to public criticism or to injury to the public, and that nothing is done which conflicts with the primary purpose of the project.

This subsection should identify the organizational unit(s) or staff position(s) having responsibility for each of the following functions:

- Equipment operation in the structures at the dam and/or power facility
- Forecasting reservoir inflows
- Directing flood releases
- Directing operational releases
- Recording reservoir data
- Various maintenance work

Specifically identify the operating personnel responsibilities; if water-user operated, identify the district and its operating personnel duties. Also include the district's responsibility for obtaining approval (from the Area of Regional Office) to modify the facility.

A standard paragraph could be included as follows:

> Modification of a dam and related structures and appurtenances shall not be accomplished without the concurrence of the Regional Director.

For regularly scheduled duties, which operating personnel perform, include separate colored pages of daily, weekly, and specific yearly interval activities. Schedules serve as a checklist for operating personnel as well as for use of other persons who may operate the dam. After the duty item, consider cross-referencing the appropriate section to locate specific information regarding that duty. On many Reclamation operated projects, maintenance duties are scheduled electronically (computer) and may be too numerous to list.

The following Operating Personnel Scheduled Duties table was developed from recently published SOP. It is a typical schedule for the type of duties performed.

The following list of scheduled duties should not include any duties associated with structural behavior instrumentation. **Duties and responsibilities related to structural behavior instrumentation should be provided in SOP Chapter III, Section 5 of this guide.**

OPERATING PERSONNEL SCHEDULED DUTIES
Dam and Reservoir

DAILY

- Record water surface elevation
- Record spillway discharges
- Check and record toe and gallery drain flows
- Read weather gauges and record data
- Check in with supervisory office
- Record pertinent information in Operating Log
- Determine reservoir inflows
- Record canal/outlet works releases
- Check security and safety devices
- Make required changes in gates and valves
- Check spillway outflow channel for debris

WEEKLY

- Operate standby engine-generator set
- Run 15-30 minutes to achieve recommended operating temperature
- Keep batteries charged

MONTHLY

Dam and Reservoir

1. Check condition of:

   - Crest of dam
   - Upstream and downstream faces
   - Visible portions of foundation
   - Abutment contacts
   - Galleries
   - Spillway stilling basin
   - Outlet works stilling basin
   - Critical landslide areas
   - Reservoir area
   - Drainage systems; toe drains, gallery drains, etc.
   - Measuring devices
   - Rodent problems
   - Security and safety devices

Mechanical/Electrical System

1. Check fuel supply for engine-generator set
2. Replace light bulbs
3. Inspect and maintain ventilation system
4. Clean out debris from control cabinets and panelboards.

Outlet Works

1. Grease hydraulic gate hanger
2. Check signs and fence that warn public of hazards

   - Near trashrack of intake structure
   - Outlet works stilling basin
   - At outlet works control house

Spillway

1. Check buoy line or log boom
2. Check operation of gates
3. Check fence condition and caution signs

QUARTERLY

Outlet Works

1. Operating instructions-up to date and legible
2. Check gate air vents on downstream face
3. Clean gate control switchboxes

Spillway

1. Check and clear bridge drains
2. Clean inside of motor control cabinet

SEMIANNUALLY

Outlet Works

1. Check hydraulic oil lines
2. Check oil reservoir level in hydraulic system
3. Check pressure relief valves
4. Lubricate gate rollers
5. Check rubber seals and seal clamp bar
6. Check hoist cables - lubricate

Spillway

1. Check paint on gates
2. Check hoist cables - lubricate
3. Check mechanical hoist bearings and flexible coupling bearings
4. Check gear cases
   - Hoist gear case, replace grease
   - Spur gear units and gear motors
   - Drain accumulated water

Electrical System and Equipment

1. Change oil in standby gasoline engine-driven generator
2. Check exposed electrical wiring
   - Outlet works valve house
   - Gate hoists
   - Spillway bridge
3. Check gate limit switches - adjust

ANNUALLY

Outlet Works

1. Paint
   - Metalworks
   - Color-coded valves
   - Woodwork and trim
2. Exercise gates and valves
3. Check condition of interior and exterior of outlet conduit, including drain valves

Spillway

1. Check and repaint metalwork on spillway bridge, gates, and fences
2. Operate and exercise gates
3. Examine stilling basin and downstream channel

Dam and Reservoir

1. Review the SOP and EAP
2. Conduct facility review by Area Office personnel

Electrical

1. Check electrical conduits, pull-boxes, and switches
   - Outlet works valve house
   - Gate hoists
   - Spillway
   - Galleries

3-YEAR PERIOD

1. Conduct Periodic Facility Review with Region (or Area Office) and/or Technical Service Center personnel

6-YEAR PERIOD

1. Conduct Comprehensive Facility Review by with Region (or Area Office) and Technical Service Center Personnel
2. Examine intake structure and stilling basin which normally are underwater, less frequently if experience indicates

D. ATTENDANCE, COMMUNICATIONS, AND WARNING SYSTEMS

The attendance statement should note the following:

- Identify the responsible individual (or organizational unit).

- Note the residence location or duty station in relation to the dam and/or power facility.

- State the extent of attendance at the dam and/or power facility; e.g., whether the structure is:
  - attended continuously;
  - attended part-time (specify attendance period); or
  - unattended.

If remote control of operations is used, describe its communications and data transmittal capabilities.

If the structure is unattended, include:

- The frequency of inspection;

- The regulation of gates and valves; and

- The collection of data and other pertinent facts (e.g., hydrometeorological system, early warning system, fill-and-spill operation).

This subsection should identify and describe the various physical means of available communication:

1. Telephone facilities and providing company.

2. Radio facilities (indicate location and distance reached).

3. Powerline communication facilities.

4. Location of private or public radio facilities for emergency use and State police facilities for temporary radio communications for flood warnings.

If none of the above communications is available at the dam and/or power facility, the location and owner of the nearest phone or radio facility should be noted. These data and the phone numbers should be stated in the Communications Directory for the structure.

Justification and final determination of the attendance, communications, and warning systems at Bureau of Reclamation dams should be based on the "Guidelines" of Appendix A and stated in this subsection.

In addition to identifying communication facilities, this subsection should refer to the Communications Directory in the SOP for the names, phone numbers, and radio call letters and frequencies of persons or organizations associated with both normal and emergency operation of the dam and/or power facility. List the individual pages used in the Communications Directory from the regional (Emergency) Communications Directory for Dams.

NOTE: Telephone numbers should not appear anywhere in the SOP text. The exception is the communications directory section which provides easy reference.

The following is an example of an Attendance, Communications, and Warning Systems subsection for a fictitious dam for Big Valley Dam, XYZ Project, Colorado.

Attendance, Communications, And Warning Systems

Attendance—The Big "X" Water Conservancy District is responsible for the operation of Big Valley Dam. The dam tender is at the site Monday through Friday, except holidays, throughout the year.

Dam tending personnel are trained in recognizing danger signs and are instructed to either contact the Bureau of Reclamation's Big Valley Area Office or the North Regional Office in Slippery Rock, Montana, to evaluate the situation or, only in the event of sudden dam failure, to notify local authorities directly. In most cases of potential failure, sufficient time is available for hydrologic or stability experts to evaluate the seriousness of the situation and to notify authorities to evacuate people from the downstream flood plain. The Big Valley Area Office would contact the Regional Office to assist in the evaluation and for technical assistance.

Communications—Communication facilities at XYZ Dam consist of a telephone at the damsite.

Refer to the "Communications Directory" section of this SOP for normal and emergency telephone numbers and methods of communication for:

1. Big Valley Area Office, Flat Rock, Colorado
2. Regional Office, North Region, Slippery Rock, MT
3. Emergency Notification System
4. Emergency Services and Cooperators

It is anticipated that the telephone would be the primary means of communication. Alternate means of communication that could be employed in the event that telephone lines are dead, would be the law enforcement radio system or by direct messenger. Verification should be established between the Big Valley Area Office and the county sheriffs concerned.

The Regional Office of the Bureau of Reclamation in Slippery Rock, MT, would contact other concerned Federal agencies, and the Area Office would notify the State agencies as well as radio and television stations.

In the event of large releases from XYZ Dam due to major flooding upstream or dam safety concerns, advance warnings will be given as releases are increased; however, the above notification procedures will still be followed.

E. Cooperation with Other Agencies

This subsection should identify the relations between the operating organization (Bureau of Reclamation or water-user organization) and other agencies. Where a water-user organization operates the dam, the Bureau of Reclamation would not be considered as an other agency. Relationships between a water-user organization and the Bureau of Reclamation should be explained in the preceding subsection C, "Assignment of Responsibility" administrative and operation

Other U.S. Government agencies and their respective functions might include the following:

Bonneville Power Administration (BPA) [DOI] **Western Area Power Administration [DOE]** • Power agreement • Power marketing agreement	**Bureau of Indian Affairs (BIA) [DOI]** • Water supply • Safety of Dams
Bureau of Land Management (BLM) [DOI] • Administration of land area • Fire protection • Mineral leases	**Environmental Protection Agency (EPA)** • Water quality flows • Sewage permits • Hazardous materials
Fish and Wildlife Service (FWS) [DOI] **And State fish and wildlife agencies** • Water quality flows • Minimum flows or reservoir level	**Forest Service (FS) [DOA]** • Administration of land area • Recreation • Fire protection

Geological Survey (USGS) [DOI] • Strong motion instrumentation • Stream gauges	**National Park Service (NPS) [DOI]** • Administration of land area • Security protection • Fire protection
National Weather Service (NWS) **National Oceanic and Atmospheric Administration (NOAA) [DOC]** • Weather data • Weather forecasts • Unusual weather report	**Soil Conservation Service (SCS) [DOA]** • Snow surveys • Hydrometeorological system
U.S. Army Corps of Engineers (COE) [DOD] • Flood forecasting • Reservoir regulation/water control manual • 404 Permits	**U.S. Coast Guard (USCG) (DOT)** • National Response Center (Hazardous Materials)

DOA (U.S. Department of Agriculture), DOC (U.S. Department of Commerce), DOD (Department of Defense), DOI (U.S. Department of the Interior), and DOT (Department of Transportation).

Others local agencies and their respective functions could include the following:

County • Emergency management • Recreation • Law enforcement • Recreation	Highway Departments • Roads and bridges
Municipalities • Emergency Management • Municipal and industrial water	**Park or Recreation Department** • Land Management • Recreation
State fish and wildlife agencies • Water quality flows • Minimum flows or reservoir level	**State Water Resource Agency** **Safety of Dams Memorandum of Understanding** • Stream gages • Watermaster • Water rights • Minimum streamflow for water quality

Note the address and phone number of each cooperator in the Communications Directory.

The Memorandum of Understanding with State agencies for safety-related aspects of dam and/or power facility operation and maintenance and other agreements for cooperative activities should be summarized.

Formal agreements with other agencies should be referenced in this subsection, and include a brief summary of the terms of agreement relating to reservoir operation. If major agreements are written in detail in other SOP sections, such as discussing flood control regulations (in the "Flood Operating Criteria" of the Reservoir Operations chapter), a reference to the subsection which gives the terms of agreement in detail is sufficient.

Informal agreements with other agencies also should be explained briefly. List specific contracts or Memorandums of Understanding in SOP Chapter I (subsection N. Reference Material). Do not include entire documents in the SOP unless pertinent to operations.

Under this section, the responsible office should check for agreements with the agencies listed above. Agreements and Memorandum of Understanding should be referenced in the SOP.

F. Data Reporting

It is intended that the collection and reporting of all categories of dam, reservoir, and/or power facility data be covered in this subsection. Include only brief instructions for obtaining the measurements required for preparing the reports. If lengthy instructions for obtaining the data are required, they should be given in the appropriate SOP subsection or in Supporting Documents (SOP Chapter I, M.).

Instructions in this subsection should cover the type, frequency, form, and disposition (to whom) of the data report. Samples of reports or copies of reporting forms should be included in the SOP appendix.

At dams with Hydrometeorological stations, include:

- Location(s) (identify key stations)
- Station number
- Type of data reported
- Automated-manual status
- Reliability
- Frequency of backup data collection

Instructions for reporting routine detailed data should include hydrologic items such as:

- Reservoir water surface elevation
- Reservoir capacity
- Reservoir inflow
- Reservoir outflow
- Weather

Include a reference to "Structural Behavior Instrumentation" (SOP Chapter III), where appropriate.

Power facility reports should be reported separately as part of the various subsections in (SOP Chapter V), "Power Facility Operations."

G. Operating Log

Each SOP should include a statement of purpose for the Operating Log that is maintained at each damsite. Specific operating log requirements are provided in the applicable **directives in the Reclamation Manual**.

At some locations, portions of the information will be available from automatic recording and monitoring equipment. Specific data may vary in form and content to fit the needs and conditions of individual facilities. Typical operating log entries are provided in applicable **directives in the Reclamation Manual**.

When automatic recording and monitoring equipment is not provided or to supplement such information, a log shall be maintained in a bound book. A sample of the operating log (Figure 1) is provided on the following page. This book is applicable for use in attended, part-time attended, or unattended dams.

In event of an unusual occurrence that requires notifying the supervisory office, refer to the facility Emergency Action Plan for reporting instructions and form use.

pGPO : 1967 O-234-112

OPERATING LOG

_____DAY _____MONTH_____19___

POSITION	OPERATORS		
	12-8 SHIFT	8-4 SHIFT	4-12 SHIFT

DATE[1]	TIME *(Hour)*	ENTRIES

NOTE. - Make all entries in ink. Line out and initial all errors.

REVIEWED (Signature of Supervisor in Charge)

[1]For operations requiring small number daily entries use one sheet for several days and insert dates in this column.

Figure 1 —Sample Operating Log Sheet

H. Public Safety and Health

Since safety is of primary concern, safety instructions and protection shall comply with all applicable **directives in the Reclamation Manual**.

If the dam or power facility is attended part time, instructions should be given to operating personnel to note unsafe conditions or acts and to report them to authorities for correction.

This subsection also should include statements of the following:

- Public use at or near the facility is noted
- Distance to the nearest medical or law enforcement assistance from the facility
- Confined spaces and potential hazardous areas not discussed under restricted areas can be noted here (see following subsection.)
- Safety equipment available at the facility would be listed here; (i.e., first-aid kits, harnesses and lifelines, fire extinguishers, self-contained breathing apparatus, air-quality monitors, etc.)
- Other pertinent information concerning public health or safety

A list of law enforcement, medical aid, and fire protection agencies (city or state police, hospitals, local fire departments) should be shown with reference to the SOP Communications Directory for phone numbers.

I. Restricted Areas

All areas within or surrounding the dam, reservoir and/or power facility from which unauthorized persons are restricted should be described, listed, and outlined on a map and the map included in the SOP appendix. Explain purposes of the restrictions, the barriers, and/or the signs installed to keep out unauthorized persons.

Responsibilities of the operating personnel, operating entity, project office, and/or other concerned agencies in posting, patrolling, and enforcing the restrictions should be stated.

Restricted areas are those which are potentially hazardous to, or subject to damage by the public, such as the following:

- Active landslide/rockfall areas should be posted off limits to the public.

- Warning signs and signs prohibiting rock throwing into hydraulic chutes and stilling basins should be posted adjacent to the structures.

- Public entry into chutes, stilling basins, and control houses should be restricted.

- Areas surrounding hydraulic structures intakes and reaches of outlet channel adjacent to discharge structures subject to surging or rapid changes in water surface elevation during releases.

J. Emergency Management and Facility Security Plans

This subsection should state, in general terms, the need for security regulations and plans for protecting the facility.

Reference should be made to the EAP for specific procedures to follow in event of a bomb threat, sabotage, or nuclear attack. For dams having powerplants, specific security plans may have been developed and should be referenced here.

This subsection may include the following standard paragraphs:

Emergency Management and Sabotage Security Plans

General

Visiting of Government-owned powerplants, pumping plants, and dams is governed by security measures which vary with the importance and size of the installation. Large and important installations are patrolled continuously by guards. Smaller installations have certain areas that are kept locked except when personnel are available to escort and observe the visitors. Visitors are not allowed to wander (nor to carry packages) throughout powerplants or dam galleries without an escort.

Plan for Protection of Facilities

1. The security plan should be reviewed and revised annually. Times change and programs which functioned in the past are not necessarily adaptable to the present or future.

2. Prior planning and executing minimal strategic preparations will allow use of valuable time during an emergency, particularly on preparations that cannot be accomplished efficiently after an emergency arises. Phone numbers of the immediate supervisor and local law enforcement agencies or units shall be posted at all times.

3. Civil disturbances are sporadic in nature and are not necessarily restricted to urban areas. A remote facility could be a target for a demonstration.

4. Establish a communication link, with the local law enforcement unit and other governmental agencies, through which an alert can be received for suspected demonstrations or bomb threat and for the required anticipated assistance. Keep all doors, gates, and secured areas locked whenever possible except in cases where normal operation and maintenance would be impeded during the day shift. At the end of the workday, all main gates and local areas should be locked.

Use of Firearms by Reclamation Personnel

Reclamation employees, including those employed as guards, may not carry firearms on their person in the performance of their duties unless authorized to do so by law.

This prohibition does not apply to small-bore rifles or shotguns which are carried in vehicles by operating personnel when required for the purpose of rodent control.

K. SOP Distribution

The responsibility for publishing SOP's and distribution of official SOP's is provided in applicable **directives in the Reclamation Manual**.

To ensure that all SOP copies are kept current, a record of their location must be maintained, according the applicable **directives in the Reclamation Manual**. The record should be kept in the SOP (itself) by including the Letter of Transmittal, showing the complete distribution list, and supplying a control number for each copy to each office. This will ensure that revised pages are furnished to all copyholders whenever revised instructions are distributed.

It is important to identify and show the distribution of all SOP Supporting Documents and applicable DOC's, according to the applicable **directives in the Reclamation Manual**. This procedure assures that operating personnel know: what, where, and when Supporting Documents are available and helps keep current all Supporting Documents used for operating purposes.

A standard paragraph for inclusion in this SOP section is:

Publishing and/or distributing the Standing Operating Procedures document, Supporting Documents, addenda, and amendments thereto are the responsibility of the Regional Office. The Technical Service Center has the responsibility for the preparation and publication of the Designers' Operating Criteria. The official distribution list of SOP's and all addenda and amendments thereto follows.

L. SOP Revisions

The responsibility for revising the official SOP and distributing the revisions is provided in the applicable **directives in the Reclamation Manual**.

SOP Revisions subsection may use the following standard paragraphs:

> Operating procedures shall not deviate from those stated in the SOP and Supporting Documents without appropriate authorization. Changes are made only with the approval of the Regional Director.

M. Supporting Documents

The SOP is the key instruction document. Supporting documents, other than the SOP, comprise the necessary instructions for all phases and levels of responsibility in the operation and maintenance of the dam, reservoir, and/or power facility.

This SOP subsection should specifically list all supporting documents that are part of the total instructions for operation and maintenance of the dam, reservoir, and power facility for all offices having any responsibility in the care and operation of the facility. All supporting documents distribution should be shown in the SOP Distribution (SOP Chapter I, K.). Documents assimilated into the SOP are considered to be part of the SOP rather than Supporting Documents. Include a brief summary stating the purpose of the supporting document and who is responsible for preparing, updating, and revising, etc.

The title and a brief summary of each supporting document are included in Subsection N—Reference Material. It should be dated and revision dates shown. Where only a small portion of a publication contains pertinent O&M instructions, such instructions should be included in the SOP or separately bound as a supporting document rather than designating the entire publication as a supporting document.

The number of supporting documents will vary among SOP'S.

Suggested SOP Supporting Documents

- Designers' Operating Criteria and/or Design Summary
- Corps of Engineers Flood Control Regulations
- Corps of Engineers Flood Control Reservoir Regulation Report
- Corps of Engineers Field Working Agreements
- Corps of Engineers Water Control Agreements
- Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) Section 7
- Flood Forecasting and Operating Criteria
- Basin or River Operating Plan
- Powerplant or Pumping Plant Operating Instructions
- Administrative Procedures
- Facilities Security Plan
- Regional Oil and Hazardous Substances Pollution Contingency Plan
- Oil Spill Prevention Control and Countermeasure (SPCC) Plans
- Regional Emergency Management Handbook
- Interagency Operating Agreements
- Major Maintenance Procedures
- Reservoir Management Plan (Recreation and Fish and Wildlife)
- Manufacturer's Instructions and Drawings
- Regional Communications Directory for Dams
- Performance Parameters Technical Memorandum
- Occupant Emergency Plan
- Facility Security Plan
- Others as appropriate

There may not be a case at a dam or power facility where all documents on the preceding list are appropriate supporting documents. However, where not reproduced fully in the SOP, documents or established procedures, from items listed above, that are required for proper operation and maintenance of the dam, reservoir, and/or power facility shall always be included, as provided in the applicable **directives in the Reclamation Manual**. For example, all criteria and procedures used at any level of responsibility for hydrologic determinations for operation of the facility are an essential part of the SOP or supporting document.

N. Reference Material

Reference material is a list of all publications, manuals, contracts, Memorandums of Understanding, letters, and reports used in preparing or updating the SOP. Procedures and techniques described in the reference materials may assist personnel in performing specific O&M duties (e.g., concrete repairs, piezometer maintenance, etc.). A list of such reference materials follows.

Selected Bureau of Reclamation Manuals, Bulletins, and Other Reports

Publication	Edition	Pages	Year
Canal Systems Automation Manual		113	1991
Concrete Dam Instrumentation Manual		153	1987
Concrete Manual	8th. ed. Reprint	627	1988
Concrete Manual - Test Procedures	(In press)		
Control of Turbidity at Construction Sites		198	1977
Dams and Public Safety	Revised Reprint	332	1983
Design of Arch Dams		882	1977
Design of Gravity Dams		553	1976
Design of Small Canal Structures	Revised Reprint	435	1989
Design of Small Dams	3rd. ed. rev. rep.	860	1987
Drainage Manual	Revised Reprint	321	1993
Driller's Safety Manual	Reprint	64	1982
Earth Manual:			
. . Chapters 1, 2, & 3	3rd. Reprint	326	**1998**
. . Part 2—Soil Testing Procedures	3rd. Edition	1270	1990
Embankment Dam Instrumentation Manual		250	1987
Emergency Planning and Exercise Guidelines:			
. . Vol. I—Guidance Documents			1995
. . Vol. II—Technical Handbook			1995
Environmental Glossary		79	1986
Environmental Guidebook for Construction		61	1974
Flood Hydrology Manual		243	1989
Guide to Concrete Repair		173	1997
Ground Water Manual	2nd. Edition	661	1995
Hazardous Energy Control Program		**69**	**2002**
Herbicide Manual		346	1983
Hydrogenerator Manual	(in press)		
Metric Manual		278	1978

(Recent revisions in bold text)

Publication	Edition	Pages	Year
Motor Vehicle & Mobile Equipment Safety Standards		36	1982
Paint Manual	3rd. Edition	235	1976
Pesticide Applicators Safety Manual		131	1988
Prevention and Control of Animal Damage to Hydraulic Structures		102	1991
Project Data	5th. Edition	1463	1981
Radio Communications, Operating Procedure	Revised	8	1981
Reclamation Safety and Health Standards	Revised Reprint	**529**	**2001**
Review of O & M Program - Field Examination Guidelines		77	1991
Safety Evaluation of Existing Dams (SEED)	Revised Reprint	164	**1995**
Standing Operating Procedures Guide for Dams, Reservoirs, and Power Facilities (August 1996)	Revised Reprint		2001
Statistical Compilation of Engineering Features on Reclamation Projects		235	1990
Training for Dam Operators - Instructors Manual			1996
Transmission Line Design Manual		483	1980
Water Measurement Manual	3rd Edition	475	1997
Water Measurement Manual (Metric Supplement)		224	1971
Active/Inactive Names of Reclamation Projects and Major Structures			Annual

(Recent revisions in bold text)

Publication

ACER Technical Memorandum No. 1—"Criteria for Selecting and Accommodating Inflow Design Floods for Storage Dams and Guidelines for Applying Criteria to Existing Storage Dams," 1981

ACER Technical Memorandum No. 2—"Freeboard Criteria and Guidelines for Computing Freeboard Allowances for Storage Dams," revised 1992

ACER Technical Memorandum No. 3—"Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low–Level Outlet Works," 1990

ACER Technical Memorandum No. 4—"Criteria for Bulkheading Outlet Works Intakes for Storage Dams," 1982

Publication

ACER Technical Memorandum No. 6—"Guidelines for Determining Whether Normally Inundated Outlet-Works Features Should be Examined," 1985

ACER Technical Memorandum No. 9—"Guidelines for Controlling Seepage Along Conduits Through Embankments," 1987

ACER Technical Memorandum No. 10—"Guidelines for Using Fuse Plug Embankments in Auxiliary Spillways," 1987

ACER Technical Memorandum No. 11—"Downstream Hazard Classification Guidelines,"

Contracts and Memorandums of Understanding
Design and Construction Report
Facilities, Instructions, Standards, Techniques, Volumes 1-1 through 4-12

Facilities, Instructions, Standards, Techniques:
- Volume 1-2 "Operations and Maintenance Improvement Program," rev., 28p.,1989 (Formerly Power O&M Bulletin No. 10)
- Volume 4-1 "Maintenance Schedules and Records," rev., 87p., 1965 (Formerly Power O&M Bulletin No. 19)

Reclamation Manual Directives and Standards

Memorandum from Acting Assistant Commissioner—Engineering and Research to Chief, Division of Dam Safety - "Isolation and Bypass Valves in Control Lines for Emergency and Regulating Gates," March 14, 1984

Memorandum from Manager, Project Operation Services Staff to all Regions — "Testing of Outlet Works Emergency/Guard Gates and Valves Under Unbalanced Head Conditions (Outlet Works)," September 27, 1991

Planning Instruction No. 82-11 — "Guidelines for Defining Inundated Areas Downstream from Reclamation Dams", June 15, 1982, Addendum - Planning Instruction No. 83-05, April 6, 1983

Power Maintenance Instruction Sheets, Numbers 1 through 68
Reclamation Solicitation/Specifications, Invitations, and Contracts
RO&M report files
SEED Data Book
Hydraulic Model Study for the dam
Technical Records of Design and Construction
Water Operation and Maintenance Bulletins:

No. 97—"Equipment for the Prevention, Control, and Disposal of Weeds on Irrigation Projects," September 1976

No. 138—"Guidelines for Manual Maintenance Management Systems (MMS) for Water O&M Projects" 24p., December 1986

No. 146—"Guidelines for Testing Gates and Valves at Major Facilities", pp. 11-13, December 1988

No. 150—"Guidelines for Removal of Trees and Other Vegetative Growth from Earth Dams, Dikes, and Conveyance Features", pp. 1-3 December 1989

No. 160—"Maintenance and Periodic Inspection of Mechanical Equipment at Hydroelectric Plants," 104p., June 1992.

No. 155—"Pumping Plant Maintenance" (supersedes Bulletin No. 60) 110p., March 1991

No. 171—"Seismic Monitoring/Strong Motion Program and Notification System", pp. 7-12, March 1995

Index—Water O&M Bulletins No. 1 through 176, July 1996, revised annually

Others as appropriate:

"ASCE Manuals and Reports on Engineering Practice No. 57. - Management, Operation and Maintenance of Irrigation and Drainage Systems," - American Society of Civil Engineers, 2d. ed. 432 p., 1991

"Guidelines for Inspection of Dams Following Earthquakes", U. S. Committee on Large Dams, 40p., U. S. Government Printing Office: 1983-680-268/384

"Technical Dictionary on Dams", Appendix , A glossary of words and phrases related to dams, English, Francais, Deutsch, Espanol, Italiano, Portugues, International Commission on Large Dams, 1978

"Landslides — Analysis and Control", Special Report No. 176, Transportation Research Board, Commission on Sociotechnical Systems, National Research Council, - National Academy of Sciences, Washington, D. C., 234 p., 1978

"Nomenclature for Hydraulics", Committee on Hydraulic Structures, American Society of Civil Engineers, 1962

"Safety of Existing Dams", Evaluation and Improvement, National Research Council - Committee on the Safety of Existing Dams, Water Science and Technology Board, National Academy Press, Washington, D. C., 1983 * - The Project Data "Separates (extracts kept current to Project Data) are appropriate.

"Training Aids for Dam Safety", Bureau of Reclamation, Technical Service Center, D-8470, P.O. Box 25007, Denver, Colorado 80225

O. General Information Checklist

_____Dam

_____Reservoir

_____

Reviewed by Prepared by

_____ _____

Date Date

General Information Checklist	Adequate	Inadequate
A. Purpose of the Project		
1. Identify the dam and reservoir		
2. Authorized purposes		
3. Note informal benefits		
4. All major project features (should agree with statistical compilations and Project Data Book)		
a. Other projects served		
5. Historical data or designation		
6. Other unique information		
B. Directions and Access to Dam		
1. Most expeditious route from project or operating headquarters under normal and emergency conditions		
2. Alternative route description if significant		
3. Evaluation of nature of routes and availability for year-round use (paved, gravel, dirt)		
4. Availability and use of special equipment (helicopter, snowmobile, 4-wheel drive, etc)		
5. Locations of commercial and small aircraft airports		
a. Clear and precise		
6. Project location map		

General Information Checklist	Adequate	Inadequate
C. Assignment of Responsibility		
1. Basic responsibility described		
a. Reclamation [basic or prime] responsibility (standard paragraph use)		
b. Area Office responsibility, if any		
c. Regional Office responsibility		
2. Identify organizational unit or position responsible		
a. Equipment operation in the structures at dam		
b. Forecasting reservoir inflows		
c. Directing flood releases		
d. Directing irrigation releases		
e. Recording reservoir data		
f. Various maintenance work		
g. Alerting for emergency situation or unusual condition		
3. Dam operator's responsibilities (or District and its operating personnel responsibilities)		
a. Modification of facility (standard paragraph use)		
b. Checklist of operating personnel scheduled duties		
(1) Separate colored pages		
(2) Daily, weekly, specific yearly interval (period) activities		
(3) See SOP Guide for example		
D. Attendance, Communications, and Warning Systems		
1. Responsible individual (or unit)		
2. Location or duty station		
3. Period of attendance		
a. If unattended		
(1) Frequency of inspection		
(2) Regulation of gates and valves		
(3) Collection of data		

General Information Checklist	Adequate	Inadequate
(4) Other pertinent facts		
4. Justification		
5. Description of communication facilities		
a. Phone, radio, powerline communications		
b. Other private or public radio facilities		
c. Justification		
6. Refer to Communications Directory for current phone numbers		
7. Warning systems		
E. Cooperation with Other Agencies		
1. Identify administrative and operational relations between operating organization and other agencies		
2. Include reference to agreements with Federal or State agencies, and local agencies under “Reference Material”		
a. Summary of terms of agreement included b. If pertinent to operations include in appendix		
3. Reference Corps of Engineers formal flood control regulations, specifically the paragraph “Flood Operating Criteria, “SOP chapter IV, Reservoir Operations, for details		
4. List address and phone number for each cooperator in the Communications Directory		
5. Informal agreements briefly explained		
F. Data Reporting		
1. Type of report required, its frequency, form of the report, and disposition to whom		
2. Sample forms in appendix		
3. Hydrometerological stations		
a. Location(s)		
b. USGS station number		
c. Type of data reported		
d. Automated manual status		
e. Frequency of backup data collection		

General Information Checklist	Adequate	Inadequate
4. Routine data reporting instructions		
a. Reservoir water surface (elevation)		
b. Reservoir capacity (acre-feet)		
c. Reservoir inflow (ft^3/s) average		
d. Reservoir outflow (ft^3/s) average		
e. Weather		
5. Reference SOP Chapter III, "Structural Behavior Instrumentation"		
G. Operating Log		
1. Statement of purpose of Operating Log		
2. Information required listed		
3. Include form in appendix		
H. Public Safety and Health		
1. List unsafe conditions, confined spaces, and other hazardous areas		
2. Note location of log boom (if any), public safety fences, and posted warning signs		
3. Statement of public use near or at the facility		
4. Distance to nearest medical or law enforcement		
5. Confined spaces and potential hazardous areas		
6. Safety equipment available		
7. Other pertinent information concerning public health or safety		
8. List of assisting agencies		
a. Law enforcement		
(1) Sheriff		
(2) State police		
b. Medical aid		
(1) Hospital		
(2) Ambulance		

General Information Checklist	Adequate	Inadequate
c. Fire protection		
(1) Local		
(2) Forest Service or BLM (if any)		
d. Reference to Communications Directory		
I. Restricted Areas		
1. List of restricted areas outlined on map		
a. Map in appendix		
b. See SOP Guide		
2. Purposes for restrictions		
3. Barriers, signs, and locations explained		
4. Responsibilities of the dam operator		
5. Active landslide/rockfall areas posted		
6. Warning and prohibiting rock throwing-signs		
7. Restricted access into chutes, basins, and control houses		
8. Restricted access to areas subject to rapid changes in water level		
J. Emergency Management and Facility Security Plans		
1. Security regulations and plans for protecting the facility		
2. Guidelines covering firearms (delete if operation is other than by Reclamation)		
3. Reference EAP for specific event procedures		
4. At powerplants, specific security plans referenced		
5. Standard paragraph use		
K. SOP Distribution		
1. Complete distribution list		
2. Control number of each copy		
3. Identify and show distribution		
a. Supporting documents		
b. Companion DOC if available		

General Information Checklist	Adequate	Inadequate
4. Standard paragraph use		
L. SOP Revisions		
1. Standard paragraph use		
M. Supporting Documents		
1. Specific list		
2. Distribution shown		
3. Summary of purpose for each document		
4. Prepared by		
5. Revision responsibility		
6. See list in SOP Guide		
N. Reference Material		
1. Available Bureau of Reclamation publications list (see SOP Guide)		
2. Other appropriate material		

SOP CHAPTER II—STRUCTURAL, MECHANICAL, AND ELECTRICAL

A. General Description of Dam and Appurtenances

This SOP chapter should contain a description and detailed operation and maintenance instructions for the dam, hydraulic structures, and all electrical and mechanical equipment related thereto.

Descriptive information and instructions presented in this section should be similar to, but need not be as comprehensive as, the information and instructions for similar structures and equipment given in a DOC or Design Summary as prepared by the Technical Service Center. It is recommended that a list of features, sizes, and capacities similar to those in the Reclamation's Project Data book (see Section 3 N.) be used to summarize the SOP General Description of Dam paragraph. Separates (extracts) from the Project Data book (kept current), or Project DataWeb off the Internet, are appropriate. Recent improvements or Safety of Dams Modifications should be described. Longitude and latitude for the dam should be listed.

B. O&M Instructions for Spillway, Outlet Works, and Other Appurtenances

The kinds of instructions that should be included under each heading, and the amount of detail to be used in explaining the instructions, may be determined by referring to DOC or Design Summary's and other SOP containing instructions for similar equipment. However, instructions should agree with actual approved operating procedures in effect at the structure. Drawings and photos (noted as figures) of the existing installation should be included to help clarify instructions.

NOTE: Description and instructions should be detailed and complete in the SOP at dams for which a DOC or design summary was not prepared.

At dams where the DOC or Design Summary has been used as a supporting document, circumstances and conditions at the structure and supervisory offices should be considered in determining which operating instructions should be clarified or expanded, or repeated in the SOP.

Other DOC or Design Summary instructions that are considered adequate for SOP use should be included in the SOP and reference made to the DOC or Design Summary.

Where DOC or Design Summary operating instructions are included in an SOP (and referenced):

NOTE: Photographs showing valves, levers, switches, etc., are recommended. Terminology used in figure captions identifying valves, etc., should be identical, to terminology in the DOC, design summary, or the most recent 'as-built' drawings.

Systems such as the following require description and clear instructions regarding operation and maintenance:

- Outlet works
- Spillway
- Electrical system and equipment
- Auxiliary equipment and service system
- Hydrometeorological network and early warning system

Information regarding the adequacy of reservoir evacuation criteria should be included.

C. Miscellaneous O&M Instructions

Conformance to these instructions is important for continuing safety and economical operation of the structures. Therefore, it is imperative that the SOP contains the applicable instructions below. Instructions should be used as a checklist in preparing the SOP to ensure these instructions are included in the SOP where applicable. The instructions and precautions also should be listed under Items of Special Importance (see Section 2):

1. **Overtopping Spillway Radial Gates.**—Most Reclamation spillway radial gates have not been designed to support an appreciable waterflow over the gate tops. Explicit operating instructions that prohibit releasing water over the tops of spillway radial gates should be given in the SOP section for spillways with radial gates not designed specifically for overtopping.

2. **Multiple Gate Openings.**—Optimum stilling basin operating condition is produced usually when waterflow is distributed uniformly across the chute when it enters the basin. A hydraulic control structure having more than one control gate produces flow distributed uniformly into the stilling basin when all gates are opened equally. Where all gates cannot be opened equally, the most desirable flow patterns usually are produced by equally opening gates located symmetrically about the structure centerline. Unless specific information is available to the contrary, the SOP should contain specific operating instructions requiring patterns of gate operation. Refer to the hydraulic model study of the dam for detailed information on gate operation sequence.

3. **High-Pressure Slide Gate Minimum Openings.**—To prevent damage to the gate leaf and frame, high-pressure regulating slide gates should not be operated at small gate openings for long periods of time. Recent DOC or Design Summary's establish minimum gate opening (limit). If gate openings were not established previously, the SOP should state a conservative minimum gate opening referenced to the gate leaf bottom (in the direction of flow) unless special conditions require further analysis of the limit. (The minimum gate opening should be greater than the thickness of the gate leaf to prevent cavitation/erosion).

4. **Drop-Inlet Outlet Works Operation.**—Several Reclamation drop-inlet outlet works have been damaged when operating at a shallow flow depth over the intake structure sill. Damage was caused by violent blowback of air and water from the shaft and conduit resulting from pressure of air trapped in the conduit by flowing water. When the reservoir water surface drops below a critical elevation, a vortex forms due to sill-control rather than by the regulating gate (or control valve) and results in air entrainment in the conduit. Operating instructions should be provided in the SOP for all outlet works with drop-inlets. Operating instructions have been established for the critical water surface elevation. Operating instructions for drop-inlet outlet works, where limiting operating criteria are not available for inclusion in the SOP, may be obtained from the Waterways and Concrete Dams Group, D-8130, Technical Service Center.

5. **Ventilation Systems Operation.**—Ventilating systems are installed at dams to provide adequate fresh air in confined areas such as tunnels, conduits, galleries, and gate chambers. To ensure safe operating conditions in these areas the, SOP should require operating the ventilating fan a sufficient time period to permit one complete air change before entry by personnel. The time period required to accomplish this change should be stated.

6. **Rock Removal From Chutes and Basins.**— Medium and large rocks do not wash from a stilling basin, even during high discharge. Instead, they are swirled by water and pounded against the concrete walls and floor of the stilling basin, causing damage. It is important to remove all rocks in the stilling basin.

   The SOP should establish procedures for removing of rocks from a stilling basin. Since most rocks which enter the chute and stilling basin are thrown or rolled there by people, the SOP should require signs near the structures prohibiting throwing rocks into them. The SOP should require, at least annually, that before release of water through the structures, those rocks that can be reached without draining the basin be removed from the chute and basin.

In many instances, schedules for examining and cleaning the stilling basin have been established; the schedules should be stated in the SOP. If schedules have not been established, the SOP should require basin examination at 6-year intervals until experience indicates a schedule more consistent with local operating conditions.

7. **Isolation and Bypass Valves in Control Lines for Emergency and Regulating Gates.**—Caution is suggested regarding the use of isolation and bypass valves in hydraulic control systems for gates and valves. Under an emergency condition, malfunctioning and improper positioning of isolation or bypass valving could render the emergency or regulating gates inoperable.

   Isolation and bypass valves have been used for many years by the Bureau of Reclamation in hydraulic control systems. Control systems must be tested periodically to verify that components such as pressure switches and relief valves will function properly. This requires isolation and bypass valves. Isolation valves are also required to isolate components of hydraulic systems so required maintenance can be performed without completely draining all oil from the system. The designers of the hydraulic control systems and operation and maintenance personnel have determined that isolation and bypass valves are essential when installing, over-hauling, servicing, and testing the control systems.

   To reduce the possibility of improper operation of a gate or valve control system, the following items are necessary:

   - Clear and concise operating instructions located in the vicinity of the control system
   - Identification of all valves
   - Training of operating personnel
   - Locking or removing valve handles should be considered where vandalism or sabotage is a concern. (Note: Handles should available to operating personnel.)
   - Adequate maintenance of the valves to ensure the valves can be operated

8. **Gates and Valves - Exercising and Testing.**—Procedures should be developed for exercising and testing the operational control devices. Safety of the structure and good operation and maintenance practices require that each gate (valve) be tested to confirm that it will operate as designed. Circumstances at each site will govern the extent and frequency of testing. Whether criteria in this SOP guide are used or other criteria are developed, SOP procedures should provide detailed instructions so the operator can exercise and test control devices. A note of caution should appear in the SOP similar to the following:

CAUTION: Contingency plans should be developed prior to performing any tests. A written copy of the contingency plan should be included or attached to the report detailing the test procedures and results. If, during any test, the gate (valve) will not close from any position or otherwise malfunctions, stop the test and determine the cause of the malfunction and correct it. Contact the responsible Reclamation office before further testing.

Exercising and testing machinery should be done by using normal and auxiliary power sources to ensure the operation of each. All exercising and testing results should be recorded and dated in the Operating Log at the dam.

a. ***Spillway Gate Testing.***—Spillway gates should be tested annually to confirm that the gates will open and close satisfactorily. However, because there are different types of spillway gates, a common test procedure cannot be established. The following covers three types of spillway gate tests:

(1) An ***unbalanced (differential) head test*** should be performed at least once every six years (to coincide with the year of the Comprehensive Facility Review) while the gate is subjected to the maximum head expected for the season. Testing should be conducted in the following sequence:

Open the gate 10 percent — then close. If the gate has not been operated in the past year, the 10-percent test should be made in progressive steps as follows:

(a) Barely open (crack) the gate so that it will produce additional leakage — then close.

(b) Open the gate 1 inch — then close.

(c) Open the gate 6 inches — then close.

(d) Open the gate 10 percent — then close. If 10-percent gate opening is not possible because of downstream restrictions, open it as far as possible — then close.

(2) A ***full travel test*** should be performed for each spillway gate every 6 years. Each gate should be raised to the fully open position and then closed while in a balanced head (no-flow, wherever possible, to prevent downstream damages) condition. This part of the test should be scheduled during the season at proper reservoir conditions. In the event of a continuously high reservoir, which prohibits a fully open gate for operational testing, tests should be postponed until conditions allow or stoplogs can be installed. Postponement of maximum gate operational testing should not exceed a 6-year period. If the gate has not been operated in 6 years, it should be exercised first in a balanced condition prior to any differential-head test.

Test data for spillway gate testing should be recorded such as test date, opening/closing times, maximum voltage and current readings for the motors, etc. A copy of the test data should be sent to the Technical Service Center, Hydroelectric Research and Technical Services Group, Attention: D-8450 for inclusion in a Reclamation-wide data base for gate and valve tests.

If unbalanced head or full travel testing cannot be performed within a 6-year period, a decision memorandum should be developed and signed by all required parties in accordance with Reclamation Manual policy FAC P02. Where the full travel testing cannot be performed, an indirect means of testing is needed to verify that the gate structure will not impede full travel operations. Surveys will need to be performed to ensure the position of the gate bay walls, embedded wallplates, and pedestals conforms with design drawings. Clearances need to be measured between gate faceplates/guide shoes and gate bay walls or embedded wallplates. Underwater services need to be used to inspect submerged hoist rope/chain connections. The hoist motor should also be tested under a load similar to the loads required to raise the gate. Test data for indirect means of testing should be sent to the Technical Service Center, Inspections and Emergency Management Group, Attention: D-8470.

(3) ***Spillway crest gates***.—If the reservoir is sufficiently high to operate the gate, then a test should be performed annually. This test should be performed even if there is insufficient buoyancy loading to raise the gate fully. However, if during the course of the year there is sufficient buoyancy loading to raise the gate fully, then a full raising test should be performed. If the gates are fully raised throughout the year, there is no need to lower them for testing, as the buoyancy is the critical requirement.

*b. **Outlet works gate and valve testing.***—Gates or valves that release reservoir water through an outlet works will be tested according to the applicable **directives in the Reclamation Manual**. All gates and valves should be exercised annually through a complete opening and closing cycle under balanced head condition or with the outlet works dewatered.

An operational test under unbalanced head (flow) conditions should be performed on emergency gates/valves once every 6 years. Unbalanced head tests should not be performed on butterfly valves to avoid damaging the valve seats. All gate/valve tests should be documented in the logbook. A copy of the test data should be sent to the Technical Service Center, Attention: D-8450 for inclusion in a Reclamation-wide data base for gate and valve tests. Test data for gate/valve testing should be recorded such as test date, opening/closing times, maximum voltage and current readings for the motors, etc. The test should be developed for each specific emergency gate/valve installation and should be conducted using the following sequence:

NOTE: Before beginning the test, read through the following procedures and determine if any adverse flow effects (i.e. minimum flows, downstream surging, damaging flows, excessive water loss, etc.) would result. If such adverse effects are identified, steps will need to be outlined and variances requested in the procedures, or the test will need to be postponed until a later and more accommodating date. The reservoir level should be relatively high during the test to provide optimal test data. When possible, the gates or valves should be lubricated prior to testing.

(1) If possible, visually inspect air vent manifold and/or piping (downstream of the emergency/guard gate or valve within the pipeline) to ensure they are free of obstructions. Clean as needed.

(2) Operate the regulating gates/valves through their full cycle under unbalanced head conditions. If the resulting discharges are not permissible, operate through the maximum permissible cycle. Test data should be recorded such as opening/closing times, operating pressures, reservoir elevation, discharge flows and percentage of gate/valve opening. If the regulating gates/valves will not operate properly, discontinue the test and investigate and correct the problem, as necessary.

(3) Close the regulating gates/valves.

(4) Operate each emergency/guard gate or valve through a full cycle under balanced head conditions, ending with the gate in the closed position. Record test data for opening/closing times and operating pressures. If the gate/valve will not operate through a full cycle, discontinue the test and investigate and correct the problem, as necessary.

(5) Dewater the pipeline downstream of the emergency/guard gate or valve in accordance with the accepted procedures outlined in the SOP (Standing Operating Procedures). Ensure the proper functioning of the air valve assemblies during the dewatering process.

(6) Completely open the regulating gates/valves.

(7) For each emergency/guard gate or valve; follow these steps:

- Open the gate 10 percent (linear or rotational travel distance);
- Record the maximum operating pressure noted on the pressure gauge (or the maximum current and voltage for motor operators) for this operation; (The maximum readings should occur during the initial unseating of the gate or valve);
- Then close the gate/valve completely.

NOTE: If for some reason, the emergency/guard gate or valve does not respond to the intended operations to be performed under step 7, stop the test by slowly closing the regulating gates/valves. Allow the pipe between the emergency gate/valve and regulating gate/valve to fill, and the emergency/guard gate or valve can then be operated under balanced head conditions. The reason for the emergency gate/valve's malfunction should be determined and measures taken to ensure reliable operation under emergency conditions. All applicable safety measures, such as hearing protection, must be observed during testing.

CAUTION: Operational testing of an emergency gate/valve under an unbalanced head should not be performed unless the conduit downstream from the gate has been analyzed to determine if adequate air valving/venting is in place to prevent collapse of the downstream conduit during emergency gate closure.

*c. **Power facilities gate and valve testing.***—An operational test for penstock gates and valves preceding power generation facilities should be performed once every 5 years. The test procedures shall be developed for each specific penstock gate and valve. Test data such as opening/closing times, operating pressures, maximum current or voltage readings, reservoir elevation, etc., should be recorded during the operational test. A copy of the test data should be sent to the Technical Service Center, Attention: D-8450 for inclusion in a Reclamation-wide database for gate and valve tests.

All required lubrication and maintenance of equipment should be done prior operational testing and exercising.

A policy memorandum concerning isolation and bypass valves in control lines is included as Appendix B.

D. Dam Maintenance And Inspections

1. Maintenance.—This subsection should record the operation and maintenance procedures pertaining to the dam, its abutments, foundations, and adjacent areas such as:

a. Clearing of trees and shrubbery from the embankment dam slopes (see *Water Operation and Maintenance Bulletin No. 150*, December 1989, an article entitled "Guidelines for Removal of Trees and Other Vegetative Growth From Earth Dams, Dikes, and Conveyance Features)."

b. Cleaning and inspection of drains.

c. Exercising gates and valves.

d. Painting the parapet walls on concrete dams and miscellaneous metalwork.

e. Typical maintenance procedures.

f. Regular schedules should be included in "Operating Personnel Scheduled Duties." (See Section 3 C.) Schedule maintenance in daily, weekly, monthly, annually, 3-year, 6-year, or other suitable time periods.

g. Inspection requirements of the structure and reservoir under special conditions should be established.

h. Reference to EAP should be made for actions to be taken by the dam operator during unusual occurrences.

i. Features of the dam, abutments, reservoir, and adjoining areas requiring special attention.

j. Conditions and occurrences for which the examiner should be alert may be listed in this subsection.

k. Specific problems should be identified.

The following standard paragraph may be adapted for most dams.

Maintenance

Routine maintenance shall be performed on (*name of dam*) [*trees and shrubbery should be cleared from upstream and downstream slopes of the dam, (or) painting on parapet walls and patching concrete decks*]. Concrete repairs to the spillway and outlet works structures also will need to be done as required. Any unusual conditions that may adversely affect the safety of the structures at the dam should be reported promptly to the (*supervisory office*). That office will report to the O&M Group[1] in the Regional Office, and the Commissioners Office and Technical Service Center via the Emergency Notification System. After consulting with other offices at the Technical Service Center, the Regional Director will determine the type and number of additional reports required. If damage has occurred to the dam or appurtenances, the Regional/Area Office will collaborate with the (*operating entity*) on interim measures pending further instructions from the Regional/Area Office.

[1]The five Regional Offices of the Bureau of Reclamation use different Group names; however, all are synonymous to the O&M Group.

2. **Inspection.—** This subsection should record the inspection procedures pertaining to the dam, its abutments, foundations, appurtenant structures, and adjacent areas.

The following standard paragraph may be adapted for most dams.

Embankment Dam Inspection

The embankment, abutments, and downstream areas within 100 feet of the embankment shall be inspected __(*weekly, monthly, quarterly*)__ for evidence of the development of unfavorable conditions, including;

During rapid reservoir filling, the downstream slope of the embankment and foundations downstream from the dam shall be inspected carefully __(*daily, or weekly*)__ for indications of:

- Cracks
- Slides
- Sloughs
- Subsidence
- Undesirable vegetation
- Sinkholes
- Impairments of slope protection
- New seeps
- Changes in existing seeps or wet areas
- Animal burrows

During periods of sustained high reservoir level, __(*daily, weekly*)__ inspections shall be made of the dam with particular attention given to:

- Boils at the downstream toe area
- New seepage area, or changes to existing seepage areas
- Slides or sloughs on the downstream slope

During periods of lower reservoir level, exposed portions of the embankment, the abutments, and the reservoir floor shall be examined for:

- Sinks or seepage holes
- Beaching conditions or damage to riprap slope protection
- Cracks
- Sloughs or slides on upstream slope

Concrete/Masonry Dam Inspection

The dam crest, abutments, upstream face, downstream face of the dam, and the dam interior shall be inspected __(weekly, monthly, quarterly)__ for evidence of unfavorable conditions, including;

- Cracks
- Surface defects
- Leakage and seepage
- Concrete/Masonry deterioration
- Displacement (misalignment or differential movement)
- Drainage system, (e.g., gallery drainage gutters, formed drains (face drains and joint drains), foundation drains (drilled holes))

Appurtenant Structures Inspection

Appurtenant structures shall be inspected __(weekly, monthly, quarterly)__ for evidence of unfavorable conditions, including;

- Collection of debris at inlets
- Check condition of concrete - cracks, deterioration
- Leaks and seepage
- Surface defects
- Standby power
- Corrosion
- Check gate alignment (i.e., operability of gates/valves)
- Displacement (misalignment or differential movement)
- Erosion/Cavitation damage
- Discharge cannel conditions

Following any reported earthquakes, inspection shall be made of the dam and appurtenances for indications of physical damage such as cracks, displacements, increased drain flows, new changes in existing seepage areas, and land movements.

Refer to the Emergency Action Plan for additional instructions during unusual occurrences.

The following is a sample of an "Ongoing Visual Inspection Checklist." The site specific visual inspections checklist will be developed as part of the preparation of the Performance Parameters Technical Memorandum for each Reclamation dam.

Ongoing Visual Inspection Checklist — Sample
_____(Name)_____ Dam

Schedule: Perform an inspection using this checklist on the same schedule as readings are obtained at the seepage monitoring locations — as indicated on the "Schedule For Periodic Monitoring (L-23)."

Inspector: _____ Date: _____

Reservoir Elev.: _____ feet

Weather: _____ Temperature: _____°F

For any question below answered "YES", please provide additional information describing the situation as completely as possible under item 8, "Additional Information." Also, take photographs of the situation, if appropriate, and include with this report. A "YES" response indicates unexpected behavior that needs to be investigated.

1. Dam Crest:

< Any new transverse cracks or changes in the condition of existing transverse cracks? ☐ No ☐ Yes
< Any evidence of unusual settlements or displacements? ☐ No ☐ Yes
< Any new longitudinal cracking, or significant change in the condition of the existing longitudinal cracks? ☐ No ☐ Yes

2. Upstream Face of Dam and Areas Upstream of Dam:

< Any sinkholes, slides, sloughs, scarps, or other evidence of unusual settlements or displacements? ☐ No ☐ Yes
< Any areas where the riprap protection of dam face is deficient in any respect? ☐ No ☐ Yes
< Any whirlpools evident in the reservoir? ☐ No ☐ Yes

3. Downstream Face of Dam:

< Any sinkholes, slides, sloughs, scarps, or other evidence of unusual settlements or displacements? ☐ No ☐ Yes
< Any evidence of seepage? ☐ No ☐ Yes
< Any evidence of materials being transported by seepage flows? ☐ No ☐ Yes

4. Areas Downstream of the Dam:

Note: Extend visual observations for a distance at least 100 feet downstream from the toe of the dam, and up both abutments to the elevation of the dam crest.

< Any new seepage areas or wet areas? ☐ No ☐ Yes
< Any change in the conditions at existing seepage areas or wet areas? ☐ No ☐ Yes
< Any evidence of materials being transported by seepage flows? ☐ No ☐ Yes
< Any sinkholes, slides, sloughs, or other evidence of unusual settlements or displacements? ☐ No ☐ Yes

5. Spillway:

< Any new cracks or spalling of concrete? ☐ No ☐ Yes
< Any unusual settlements or deflections? ☐ No ☐ Yes
< Any displacements at joints? ☐ No ☐ Yes

6. Canal Headworks:

< Any new cracks or spalling of concrete? ☐ No ☐ Yes
< Any unusual settlements or deflections? ☐ No ☐ Yes
< Any displacements at joints? ☐ No ☐ Yes

7. Outlet Works:

< Any new cracks or spalling of concrete? ☐ No ☐ Yes
< Any unusual settlements or deflections? ☐ No ☐ Yes
< Any displacements at joints? ☐ No ☐ Yes

8. Additional Information:

NOTE: All descriptions should include specific location information and all other seemingly relevant information. Seepage area descriptions should include: estimated seepage amount and water clarity description (clear/cloudy/muddy, etc.). Crack descriptions should include orientation and dimensions. Descriptions of changes at joints should include the estimated amount of movement, and movement direction. Deteriorated or spalled concrete descriptions should include degree of deterioration and approximate dimensions of the affected area.

E. Safety Procedures

1. **Reference to Safety Publications.**—Safety procedures established in the publication "Reclamation Safety and Health Standards" (see Section 3 N.) apply to operating irrigation features as well as to Reclamation water and power or construction features. Applicable references to additional safety publications should be included in the SOP Reference Material. The more applicable provisions of these documents are recommended for inclusion in this SOP section.

NOTE: Specifically pertinent are the procedures for safety tagging and locking out equipment, and the requirement that more than one person be in attendance during performance of procedures which entail danger to the operator.

Particular importance should be attached to following established procedures for tagging and locking out controls for equipment being serviced or inspected to prevent operation which could endanger other employees. A listing of confined spaces could be included in this section with any possible air quality concerns identified.

Compliance with safety procedures shall be according to the applicable **directives in the Reclamation Manual**.

2. **Standard Paragraphs.**—Standard paragraphs suggested for 'tagout/lockout' and 'confined space entry' for this section on Reclamation-operated projects are:

Procedures for "Tagging and Locking Out" Equipment

Safety procedures are important and must be diligently observed at (*name of dam and reservoir*). The publications "Reclamation Safety and Health Standards," Reclamation's "Hazardous Energy Control Program, FIST Volume 1-1," and Area Office supplements to these documents will be available to all operating personnel. The appropriate standards established by these publications, particularly regarding rigging, ladders, cable, and equipment operation, will be adhered to at all times.

Safe clearance procedures shall be followed in the operation of the outlet works to safeguard personnel. When maintenance work or inspection is being performed on (*list specific items, such as electrical equipment, gates, conduits, tunnels, etc.*), all equipment that could affect personnel safety shall be appropriately locked out to ensure that the controls are not operated while personnel are vulnerable to danger.

If an energy isolation device is not capable of being locked out, the Hazardous Energy Control Procedures shall utilize tagout. When a tagout device is used in lieu of a lockout device, the following requirements shall apply.

All tagout requirements of the Hazardous Energy Control Program shall be complied with. The tagout device shall be attached to the same location that the lockout device would have been attached if possible. If this is not possible, then the tag shall be attached as close as safely possible to the device and in a position that will be immediately obvious to anyone attempting to operate the device. Additional means (e.g., placing the tag in a manner which inhibits operation of the energy isolating device, removing an isolating circuit mechanism, blocking a control switch, opening an extra disconnecting device, removing a valve handle, etc.) shall be employed to provide a level of protection equivalent to that provided by a lockout device.

Except in the case of an emergency, repairs to ___ *(electrical equipment, gates, conduits, or other specific features*) ___ will be performed with two or more persons present. Under no condition, however, will the ___ (*conduit*) ___ be entered unless at least two persons are available to enter ___ (*conduit*) ___ and one is present in the ___ (*valve house*) ____. Even in an emergency, a second person will be informed of the work to be done and when a clearance report can be expected.

Procedures for Confined Space Entry

Confined space entry procedures are important and must be diligently observed at __(*name of dam or other structure*)__. Federal OSHA regulation 29 CFR 1910.146 establishes practices and procedures for confined space entry which will be adhered to at all times.

Entry into any confined spaces at __(*name of dam or other structure*)__ will be governed by the existence and provisions of a facility confined space entry program. Entry into Permit-required confined spaces will not be made in the absence of a comprehensive program defined in the "Reclamation Occupational Health Handbook." All confined space entries will be coordinated with the facility management.

Procedures for Hazardous Materials Management

The facility shall maintain the completed MSDS (Material Safety Data Sheet), Department of Labor Form OSHA-174, or GSA-approved Alternate Form A for each hazardous material as required by Federal Standard No. 313, as amended. The information in this MSDS shall be followed to assure safe use, handling, storage, and an environmentally acceptable disposal of the commodity used at Reclamation-operated facilities.

F. Protective Coating—Inspection and Maintenance

Reclamation's coating maintenance program and the selection of specific protective coatings has been strongly influenced by increasingly more restrictive health, safety and environmental regulations. Within the limits set by these regulations, coatings have been selected which are appropriate for the exposure conditions and offer a low cost per square foot per year of satisfactory service when they are properly maintained. In some applications, appearance is important as well as protection from corrosion or degradation of the items being coated.

When an established projectwide color scheme exists, and it seems prudent or desirable to change the color scheme or to use different but harmonizing colors with the existing scheme, assistance on these changes can be requested of the Structural and Architectural Group, D-8120, Technical Service Center. This is particularly important if the surfaces being coated are exposed to public view (e.g., a visitor center, structures observable on a public guided tour, or structures which are close to well traveled public thoroughfares). Choosing colors is not the wide-open exercise it once was. Modern high performance coatings are not as easily tinted in small quantities. Consequently, durable colors which will be available "off the shelf" for touch-up operations at later dates are preferable to exotic custom colors.

The sample data collection sheet could be used to record information about coating(s) used at the facility (Figure 2).

For additional information and assistance regarding paintings and coatings contact the Materials Engineering and Research Laboratory Group, D-8180, Technical Service Center.

1. **General.**—Suggested standard paragraphs for preparing this subsection are:

   All coatings undergo gradual deterioration during their lifetimes. Prompt and effective maintenance procedures are required to minimize exposure damage and prolong coating life. Undue delay in performing required maintenance will permit the deterioration to continue, or even accelerate, to the point that expected coating life will be materially shortened.

   Coatings defects which appear within 1 year after the project has gone into operation, or soon after a complete recoating has taken place, are especially significant. A few scattered defects are not unusual or particularly significant. However, an abnormally large number of defects, either concentrated or scattered over the entire surface, are significant and may indicate faulty surface preparation, application, or, occasionally, coating material problems.

   The proper selection of a coating system for a specific operating environment, combined with good surface preparation and timely maintenance are paramount to the coating systems successfully protecting these facilities. Coating information may be found in the following references:

   - Manufacturers' data sheets and Material Safety Data Sheets (MSDS)
   - Reclamation Guide Coatings Specifications C-1000 and C-1001 (in Reclamation Specifications format), and specifications 09900 through 00904, in Construction Specifications Institute (CSI) format.
   - Reclamation Guide Specifications, 02090 For Removal and Disposal of Lead-Containing Paints and Coatings, in CSI format.
   - Steel Structures Painting Council (SSPC) Publications
   - Reclamation’s “Paint Manual—A Water Resources Technical Publication,” 1976

2. Coatings and Inspection Schedules

a. Coatings on metalwork in alternating or continuous water immersion.

(1) VR-3 and VR-6, Vinyl Resin Coating System (are being discontinued due to failure for formulation to meet air quality regulations)

NOTE: The above coating contains a high Volatile Organic Compounds (VOC) and is being replaced by newer low VOC, type coating systems.

(2) Coal-tar Epoxy Coating (formerly DOD-P-23236-A, Type I or III, Class 2).

(3) Single component, moisture cured polyurethanes.

(4) Other epoxy, polyurethane, and polyester coatings.

Touch up repair should be accomplished using the original type of coating system and methods approved by Reclamation and the coatings supplier.

NOTE: After 10 years of service, consideration should be given to surface preparation, spot touch up, and the application of a fresh topcoat. The fresh topcoat should be applied only if the existing coating is in sound condition.

b. Coatings on masonry or metalwork in other exposures.

(1) Lead and chromate free anti-corrosive primer.

(2) Federal Coating Standards (FS) paints and coatings TT-P-641G (alkyd zinc dust-zinc oxide primer for galvanized metal) and FS TT-P-1046A (chlorinated rubber zinc dust primer for galvanized metal)

(3) Waterborne primer

(4) FS TT-E-490E (silicone alkyd semigloss enamel) or FS TT-E-1593B (silicone alkyd gloss enamel)

(5) Waterborne acrylic topcoats, including FS TT-P-19C.

(6) Manufacturer's standard stain

The above short list of coating systems is changing rapidly as older traditional, high VOC, type coating systems, such as number 2 and 4, are being replaced by newer low VOC, type coating systems, such as number 1, 3, 5, and 6.

NOTE: Environmental and OSHA concerns are threatening some of the coatings which were used originally on many projects. Coatings, such as FS TT-P-86G, Type IV, Red Lead Primers are being replaced by FS TT-P-636D, alkyd oxide-chromate primers. Coating FS TT-P-636D is being replaced by either FS TT-P-664D, a lead and chromate free, corrosion-inhibiting, VOC compliant primer or similar primers (Valspar V13-R-28, V13-F-28, or performance equivalent).

c. ***Coatings on surfaces which are normally inaccessible or only occasionally exposed.***—Machinery or other mechanical/electrical equipment should not be disassembled simply for coating inspection purposes. Coating inspection should be combined with other equipment outages whenever possible. However, when the opportunity arises for inspection of surfaces which are seldom observed, a detailed report of the coating conditions observed should be prepared for later reference and maintenance work scheduled, if required. Where stored items, such as stoplogs, are used infrequently, preparation should be made for their maintenance immediately following use and prior to their return to storage.

d. ***Miscellaneous materials.***—Sealing compounds, concrete epoxy repairs, dampproofers, tape wrappings, and similar materials are susceptible to gradual deterioration comparable to that sustained by coatings. They require regular maintenance and should be included in an inspection schedule. They should be inspected at least once every three years.

3. **Cathodic Protection.**—Where cathodic protection has been provided (either impress current or sacrificial anode systems), instruction should be provided for the proper operation and maintenance of such systems to prevent corrosion of protected metalwork.

COATINGS INFORMATION DATA SHEET
NAME, ADDRESS AND TELEPHONE NUMBER OF RESPONSIBLE OFFICE

Main feature:	Classification:
Associated feature(s):	Classification:
Date(s) of inspection:	
Location:	
Unusual initial coatings system:	
Initial coatings system:	
Recoat coating systems:	
(Separate sheets should be used for the following items for main and associated features)	
Specified coatings systems:	
Manufacturer and manufacturer's designation:	
Number of coats and dry-film thicknesses (DFTs):	
Surface preparation method:	
Application method:	
Coating contractor:	

Comments: _____

_____

_____

_____

Additional categories can be added and the lines can be extended as necessary to hold the required information. Separate, but consecutive, pages following the main feature should be used for associated features.

The next section of the coatings record is the heart of the record keeping process. It is the recorded data and judgments obtained from the inspections described in previously. Because coatings changes and failures can be described numerically using *Pictorial Standards of Coatings Defects*, record keeping is simplified, particularly when a PC is used.

An example of a table used to record the results of inspections appears on the following page.

Figure 2—Coatings Information Data Sheet

G. Structural, Mechanical, and Electrical Checklist

_____Dam

_____Reservoir

_____

Reviewed by Prepared by

_____ _____

Date Date

Structural, Mechanical, and Electrical Checklist	Adequate	Inadequate
A. General Description of Dam and Appurtenances		
1. Brief statistics		
a. Dam		
b. Hydraulic structures		
c. Electrical and mechanical equipment		
2. List of features (agrees with Reclamation's Project Data book or statistical publications)		
3. Latitude and longitudinal coordinates		
B. O&M Instructions for Spillway, Outlet Works and Other Appurtenances		
1. DOC or Design Summary unavailable		
a. Instructions agree with actual operating procedures in effect		
b. Drawings and photographs included		
2. DOC or Design Summary available		
a. Operating instructions included for safe operation during flood		
b. Instructions		
(1) Clarified		
(2) Expanded		
(3) Repeated		
(4) DOC or Design Summary comments included in "Letter of Transmittal" of SOP to TSC		

Structural, Mechanical, and Electrical Checklist	Adequate	Inadequate
(5) Photographs used to identify valves, levers, and switches		
(6) Terminology in DOC/Design Summary and SOP in agreement		
c. Outlet works		
(1) Description		
(2) Operation		
(3) Maintenance		
d. Spillway		
(1) Description		
(2) Operation		
(3) Maintenance		
e. Electrical system and equipment		
(1) Description		
(2) Operation		
(3) Maintenance		
f. Auxiliary equipment and service system		
(1) Description		
(2) Operation		
(3) Maintenance		
C. Miscellaneous O&M Instructions (where applicable, SOP or supporting DOC or Design Summary contain standard paragraph)		
1. Overtopping spillway radial rates		
2. Multiple gate openings		
3. High-pressure minimum gate openings		
4. Drop-inlet outlet works operation		
5. Ventilation systems operation		
6. Rock removal from chutes and basins		
7. Isolation and bypass valves in Control Lines for Emergency and Regulating Gates		

Structural, Mechanical, and Electrical Checklist	Adequate	Inadequate
8. Gates and valves-Exercising and Testing		
a. Spillway gate testing		
b. Outlet works gate and valve testing		
c. Power facilities gate and valve testing		
D. Dam Maintenance and Inspections		
1. Maintenance		
a. Clearing trees and shrubbery		
b. Clearing drains		
c. Exercising valves		
d. Painting, parapets, walls, ladders, stairways, guardrails, and delineating safety		
e. Typical maintenance procedures		
f. Regular maintenance schedules		
g. Inspection requirements		
h. Reference to EAP for unusual occurrences		
i. Features requiring special attention		
j. Conditions and occurrences for the examiner to be alert		
k. Standard paragraph		
2. Dam, abutments, downstream areas, and appurtenant structures inspection		
a. Regular inspection intervals established		
b. Special inspections following		
(1) Sustained high reservoir level		
(2) Low reservoir level		
(3) Following reportable earthquakes		
c. Reference to EAP for instructions during unusual occurrences		

Structural, Mechanical, and Electrical Checklist	Adequate	Inadequate
E. Safety Procedures		
1. Reference to safety publications		
2. Standard paragraph use		
a. Procedures for "tagging and locking out" equipment		
b. Procedures for confined space entry		
3. Reference to Communications Directory		
F. Protective Coating—Inspection and Maintenance		
1. Standard paragraph use		
2. Coatings information data sheet		

SOP CHAPTER III—STRUCTURAL BEHAVIOR INSTRUMENTATION

Structural behavior instrumentation of dams refers to a variety of devices for measuring the structural behavior at concrete and embankment dams.

Instrumentation is provided at dams to monitor for:

- Evidence that potential dam safety problems may be developing.

- Conditions that make it more likely for dam safety problems to develop.

A Performance Parameter TM has been or will be developed for each Reclamation dam. The TM will describe:

- The most likely potential failure modes for the dam.

- The appropriate routine monitoring for the dam (visual and instrumented) to address the potential failure modes.

- The appropriate monitoring of the dam (visual and instrumented) in case of flooding or earthquake.

- The instrument readings and visual signs that would suggest unexpected (and undesirable) performance requiring investigation and follow-up.

Since the Performance Parameter TM provides an explanation of why the instruments at the dam are being monitored, and information concerning what readings are unexpected and require an immediate response, it represents a valuable reference for preparing this chapter of the SOP (and should be included as a reference under Chapter I. M. of the SOP).

Associated with this chapter would be an instrumentation appendix, which should be referenced. The appendix should include the following:

- Specific location drawings for all the instruments.

- Drawings showing the details of the instrumentation installations.

- The current “Schedule for Periodic Monitoring” (L-23), which defines the reading schedules for the instruments.

Assistance concerning structural behavior instrumentation installations, including preparing this SOP chapter, is available from the Structural Behavior and Instrumentation Group, D-8460, Technical Service Center.

A. General Description of Instrumentation and Reading Schedule

This subsection should describe the types and number of each type of structural behavior instrumentation provided at the dam and appurtenances. Include instrumentation installed on landslides near the dam, where provided.

If seismic monitoring/strong motion instrumentation is present at the dam, then this should also be noted, and the specific operation and maintenance details should be provided under subsection E below.

Types of instrumentation that may be placed in, on, or adjacent to foundations, abutments, and embankments, or on concrete structures:

- Water pressure monitoring devices such as: observation wells, uplift pressure gauges, porous-tube piezometers, slotted-pipe piezometers, hydraulic (twin-tube) piezometers, pneumatic piezometers, and vibrating-wire piezometers
- Other pressure monitoring devices such as: earth pressure cells, concrete stress cells, and load cells
- Resistance thermometers and thermocouples for measuring temperature changes
- Surveyed measurement points or locations, monitored for settlements and/or deflections, located on abutment slopes, landslide areas, embankment surfaces, or concrete structures
- Other deformation monitoring installations such as: inclinometers, extensometers, IVM (internal vertical movement) installations, baseplates, shear strips, tiltmeters, strain gauges, crack meters, joint meters, plumbline installations, and foundation deformation gauges
- Seepage monitoring devices such as: weirs and flumes

- < Seismic monitoring/strong motion instrumentation (accelerographs) and notification system (See Water O&M Bulletin No. 171, March 1995)

The L-23 lists the frequencies that specific instruments should be read at the dam. The L-23 should be placed in the appendix and should be referenced in this section.

B. Identification of Unexpected Data

This subsection should cite methods of identifying unexpected data, including;

1. Comparison with ranges of expected performance listed in the Performance Parameters TM.

2. Review of plots of the data, looking at data trends with time, and conformance of the current reading with recent data.

3. Comparison with previous readings.

Methods 1 and 3 above can be readily accomplished as the data is entered into the Reclamation instrumentation computer database, "Data Acquisition and Management System (DAMS)," as comparisons of current readings to previous readings, and to the ranges of expected performance, are automatically presented. Method 2 can be accomplished by any office, by remotely logging onto DAMS. DAMS is maintained by the Structural Behavior and Instrumentation Group, D-8460, of the Technical Service Center.

C. Responsibilities

This subsection should identify all areas of responsibility for a dam's structural behavior and instrumentation monitoring program. The information should include which office reads the instruments and transmits the data, enters the data into the Reclamation instrumentation computer database DAMS, and reviews the data for indications of anomalous performance or errors.

D. Specifics for Each Instrument Type

This subsection should provide more detailed information regarding each type of instrument present at the dam, including detailed descriptions of the installations, their purpose, and reading and maintenance instructions of each instrument installation.

1. **Detailed Description of Installation(s).**—Drawings in the appendix should be referenced to aid in describing the installations.

2. **Purpose.**—The reasons why monitoring the instruments on the specified reading schedules is important are presented in this section. The Performance Parameter TM should be used when preparing this section, as it ties the monitoring program to the potential failure modes of most concern at the dam.

3. **Reading and Maintenance Instructions.**—Instructions should be provided regarding required maintenance, reading procedures, and data transmittal methods. Detailed operation and maintenance procedures for installed instrumentation can be obtained from the Structural Behavior and Instrumentation Group, D-8460, Technical Service Center. Reclamation's "Water Measurement Manual," "Embankment Dam Instrumentation Manual" and "Concrete Dam Instrumentation Manual," are useful references for preparing the material for this section, as are the manufacturer's manuals, when available.

E. Seismic Monitoring/Strong Motion Program

A separate subsection should be provided where Seismic Monitoring/Strong Motion Instrumentation has been installed on and/or near a dam or appurtenances. The present Bureau of Reclamation Seismic Monitoring/Strong Motion Program incorporates digital and analog accelerographs at dams, powerplants, pumping plants, and pipelines. However, only digital accelerographs and automated seismic data acquisition/processing make the function of a Strong Motion Notification System possible. The Strong Motion Notification System in the form of a Seismic Event Alarm Message provides immediate notification when a strong motion accelerograph instrumented structure has experienced shaking, near real-time information about the shaking, and other critical information which provides a basis for inspection, remedial action, and other possible responses.

For information and assistance with the Seismic Monitoring/Strong Motion Program-Instrumentation, contact the Seismotectonics and Geophysics Group, D-8330, Technical Service Center.

F. Structural Behavior Instrumentation Checklist

_____Dam

_____Reservoir

_____

Reviewed by Prepared by

_____ _____

Date Date

Structural Behavior Instrumentation Checklist	Adequate	Inadequate
A. General Description and Reading Schedule		
B. Identification of Unexpected Data		
C. Responsibilities		
D. Specifics for each Instrument Type		
1. Detailed description of installation		
2. Purpose		
3. Reading and maintenance instructions		
E. Seismic Monitoring/Strong Motion Program		

A. Reservoir Capacity Allocations

Current reservoir capacity allocations should be presented in the SOP by including the current approved Reservoir Capacity Allocations (RCA), Figure 3 (Form 7-1686), sheet for the dam and reservoir. A form similar to Figure 3 could be considered to display the data. A sample RCA sheet is provided on the following page. Information presented in the text may be limited by a reference to this form with appropriate comments.

Also, it's essential to include area-capacity curves and tables (based on elevations to the nearest tenth of a foot) in the appendix or referenced as a supporting document.

The SOP should mention that sediment accumulation, as detected during reservoir resurvey, may change the capacity allocations. At that time, the RCA sheet (Figure 3), curves, and tables should be revised.

B. Design Flood Study and Routing

A description of the current reservoir IDF (inflow design flood) should be included in the SOP to give operating personnel some idea of the type and magnitude of the flood for which the dam, spillway, and outlet works are considered adequate. A discussion of the previous versions of the PMF (Probable Maximum Flood), IDF, etc. could be included in the SOP to describe how the structure was originally designed. The IDF should show the date the described flood was approved for design or review purposes. The flood description should include volume, duration, and peak inflow.

A description of the type of flood (rain, snowmelt, or combination), the months in the year during which it can occur, and the assumed antecedent hydrologic conditions would be helpful in support of some operating procedures and for operating personnel evaluating a flood event.

This subsection should contain a description of the assumptions used in routing the flood through the reservoir, including:

- Reservoir water surface elevation at beginning of flood event
- Spillway gate operation
- Outlet works release schedules
- Feeder canal operation
- Stoplog removal schedule

A statement of the resulting maximum reservoir water surface elevation and peak spillway and outlet works discharges (preferably including a hydrograph) could be included.

Hydrographs showing the reservoir routings of the IDF, flood control design flood, if flood control is an authorized project purpose; and outstanding floods of record, if available, should be included in the appendix and appropriately referenced here. Downstream routings and inundation maps of spillway and outlet releases from those floods and flow from dam failure which are prepared for the EAP should be referenced here also.

The following example of a Design Flood Study and Routing was extracted from the SOP for Norman Dam and Lake Thunderbird, Norman Project, Oklahoma:

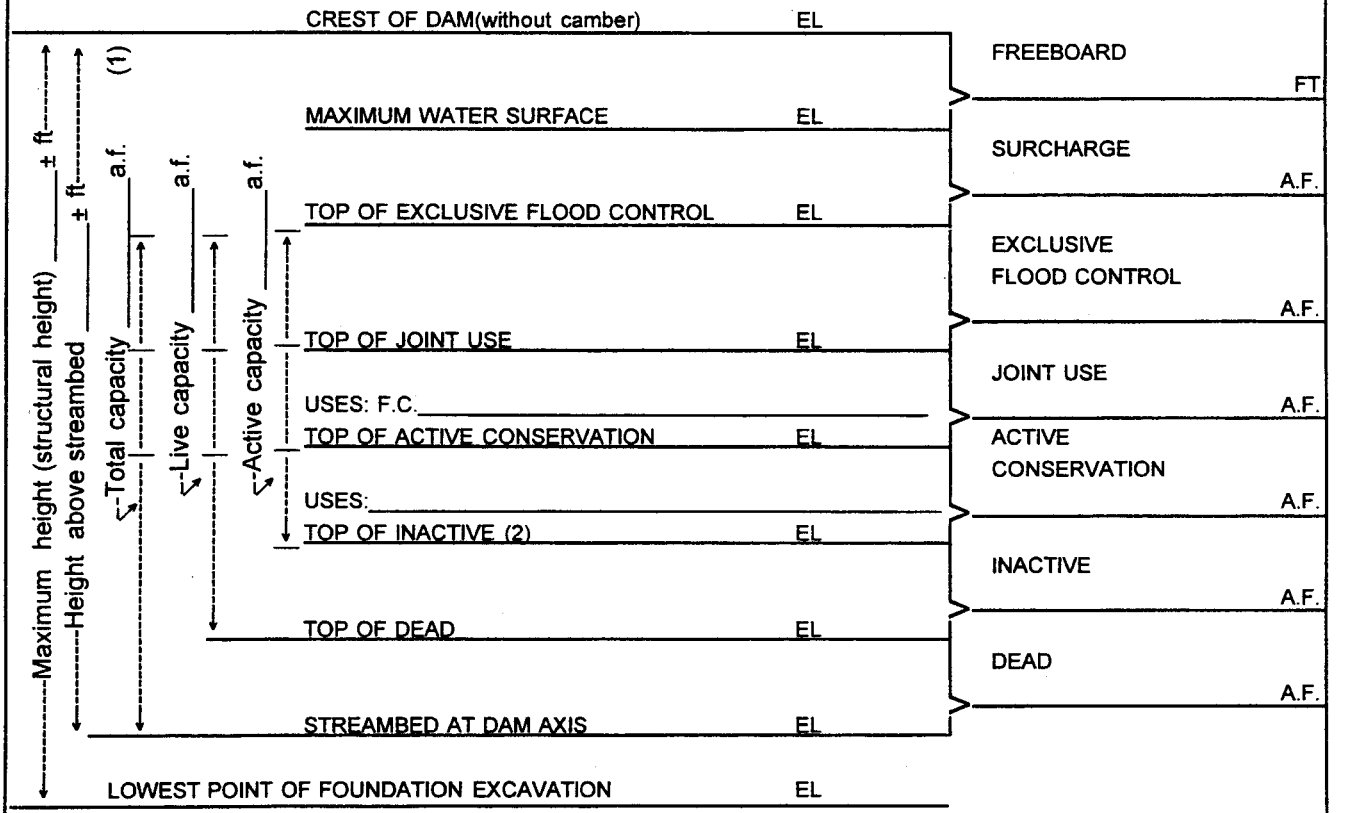
Design Flood Study And Routing

The hydrograph of the inflow design flood (IDF), approved in 1953 and having a peak inflow of 183,500 ft^3/s and a 90-hour volume of 231,000 acre-feet is shown in the appendix, plate 14. The design storm used in developing the IDF was derived by transposing and adjusting the most critical historical storm which had occurred in a nearby meteorological similar area. The design storm is characterized by an average rainfall of approximately 19 inches in 12 hours over the entire drainage basin. The design storm can occur during the months of April through October. The flood was assumed to occur with one-half of the flood control pool full (38,000 acre-feet of flood control storage) at start of the flood due to runoff from antecedent rainfall. When pool elevation reached 1049.4, crest of the uncontrolled spillway, the outlet works was operated to maintain a discharge equal to the downstream channel capacity until flood pool was empty. In this hypothetical flood, it was assumed there was an inflow into the channel below the dam. Current operation procedures are essentially the same as those used during the design studied for Lake Thunderbird. Under design flood assumptions, the flood control pool will empty in 32 days from the time of crest. For operational hydrographs, see plate 16 of the Corps' "Reservoir Regulation Manual for Norman Reservoir."

The probable maximum flood (PMF) for Norman Dam was approved by memorandum to the Regional Director, Amarillo, Texas, from Chief, Division of Planning Technical Services, on April 22, 1986. This PMF with a 100-year antecedent flood has a peak of 553,200 ft^3/s and a total volume of 408,640 acre-feet (see plate 15 of the appendix). Because there is an authorized flood control pool at Norman Dam, the initial routings will be started at elevation 1039 feet, top of the active conservation pool, prior to the onset of the 100-year flood. Further studies and analyses must be completed prior to the PMF being approved as the IDF. Subsequently, this SOP will be revised as required.

RESERVOIR CAPACITY ALLOCATIONS

TYPE OF DAM			REGION	STATE	
OPERATED BY					RESERVOIR
CREST LENGTH	FT;CREST WIDTH	FT			DAM
VOLUME OF DAM		CU YD			PROJECT
CONSTRUCTION PERIOD					DIVISION
STREAM					UNIT
RES AREA	ACRES AT EL				STATUS OF DAM
ORIGINATED BY:			APPROVED BY:		
(Initials)	(Code)	(Date)	(Initials)	(Code)	(Date)



(1) Includes _____ a.f. allowance for _____ year sediment deposition between streambed and El _____ of which _____ a.f. is above El _____.

(2) Established by _____

REFERENCES AND COMMENTS:

Figure 3—Sample Reservoir Capacity Allocation Sheet

Instructions for Use of Form 7-1686
Reservoir Capacity Allocations

Up-to-date files of RCA sheets are maintained in the Technical Service Center, and in the regional offices as a convenient record of the official reservoir capacity allocations for authorized purposes. Inquiries concerning and recommended revisions to RCA sheets are to be sent to the Operation and Structural Safety Group, Technical Service Center, attention Code D-8470.

Recommendations to revise RCA sheets are to be accompanied by supporting documentation and appropriate explanation. Such support should be in the form of copies of or references to filed reports, agreements, contracts, or official correspondence which establish physical. operational, or contractual basis for the recommended revisions. The responsible Technical Service Center code indicated above will circulate proposed revisions to the regional office and to other concerned groups in the Technical Service Center. After there is agreement between the regional office and the Technical Service Center on revision proposals, copies of the revised RCA sheet will be prepared and formally distributed by the Operation and Structural Safety Group to the regional office, the Washington office, and other Technical Service Center codes.

Reservoir capacity and elevation data on RCA sheets are to be in conformance with USBR Reservoir Data Definitions as established by the Technical Service Center for inclusion in Reclamation Instructions. Insert in footnote 2, the appropriate notation "water supply," "F&W," "recreation," "compact," "powerplant," "structure protection," or "legislation" to indicate the condition which determines the top of inactive capacity. Authorized uses of joint use and active capacities should be indicated by inserting in the spaces provided FC for flood control, I for irrigation, M&I for municipal an industrial, P for power, F&W for fish and wildlife, WQ for water quality, and S for sediment.

Capacities shown on RCA sheets may be computed using the official capacity table with volumes rounded as follows:

Capacity range - acre-feet	Use values rounded to nearest acre-feet
0-99	1
100-9.999	10
10,000-99,999	100
100,000-999,999	500
1,000,000 and over	4 significant figures

Under status of dam indicate planning, construction, or operational.

Under comments and references, list source material used in determining reservoir water surface elevations and capacities. Care should be taken to specifically identify sources for future reference purposes. Whenever possible, original sources should be used and references to summaries such as the Project Data Book should be avoided. Typical sources of information and data include capacity tables, construction drawings and specifications, final construction reports, legislation, flood control regulations, flood routing drawings, definite plan reports, etc. The nature and duration of special conditions or restrictions with regard to dam, appurtenant structures, or operations which affect capacity allocations should be noted.

C. Filling Schedule and Release Procedures

The filling plan, by which reservoir inflows are to be stored and by which stored water is to be released each year to accomplish the authorized and incidental objectives of the project, should be described in this SOP subsection. This subsection should explain when water is stored in the reservoir and should state all restrictions that exist on rates, quantities, and times for which water may be stored.

Factors governing reservoir releases for project purposes also should be discussed.

This SOP subsection should indicate specific operating instructions when releases are to be made and should list all established requirements for releases, such as maintenance of streamflows, for various purposes, and flood control options.

Detailed reservoir operating procedures given elsewhere in the SOP do not need to be repeated here. However, all procedures for reservoir operation should be briefly noted in this SOP subsection; reference the SOP section where the details can be found.

The following example of a General Filling Schedule and Release Procedures was extracted from the SOP for Norman Dam and Lake Thunderbird, Norman Project, Oklahoma:

General Filling Schedule And Release Procedures

Lake Thunderbird is to be filled to the top of the conservation pool, elevation 1039.0, by storing all inflow except water pumped from the reservoir for M&I uses and outlet works releases to meet downstream requirements.

Release procedures for flood control operations, during storage elevations above 1039.0, shall be in accordance with the Flood Control Regulations (Corps' Reservoir Regulations Manual) and as approved by Reclamation (Regional Director, Amarillo, Texas, and the E&R Center, Denver, Colorado).

During flood control operations, releases made are subject to the condition that releases shall not be made at rates or in a manner that would be inconsistent with emergency requirements for protecting the dam and reservoir from major damage or inconsistent with the safe routings of the IDF.

D. Inflow Forecasting

Inflow forecasting should include instructions and procedures for preparing, both preceding and during runoff months, periodic estimates of inflow volumes for the runoff season. These estimates provide a basis to plan reservoir and project operations before and during the flood season and to permit optimization and coordination of water supply and other reservoir functions. Also, these estimates will help in planning operating procedures consistent with operating criteria to protect the dam and its appurtenances against failure caused by high reservoir water levels and excessive discharge rates. Such procedures are mostly for reservoirs having snowmelt inflow. In some exceptional cases, short-term inflow forecasting procedures may be appropriate for reservoirs having large watersheds and only rainfall runoff.

The instructions and procedures should be described in sufficient detail and completeness in a referenced Supporting Document to enable newly assigned personnel to be effective in estimating inflow and to fully implement the procedures. Maps or drawings could be used to show locations of hydrometeorological (stream gauge, rainfall gauge) stations in the drainage basin.

Administrative and technical procedures should be included. Administrative procedures should identify organizational entities responsible for forecasting estimates and the related collection of data and conversion of forecasts into operating plans. Technical procedures to consider:

- Include information necessary to monitor hydrometeorological stations.
- Include specific correlations, equations, graphical tools, and analytical procedures used in forecasting inflow, such as early warning systems, rule curves, etc.
- Include instructions regarding at what frequency forecasts are to be made under various conditions.

If agencies (e.g., the Soil Conservation Service, National Weather Service, or others) are engaged to prepare inflow forecasts for a particular reservoir, the SOP should include a description of the procedures and criteria used by those agencies and instructions for operating personnel in the procurement and use of such forecasts.

Development of inflow forecasting procedures is a continuing process because correlations are subject to revision as more data become available. Hence, SOP instructions should include a requirement to examine the procedures annually upon each additional year of operating experience and to make revisions and improvements where needed.

E. Flood Operating Criteria

This SOP subsection establishes dam and reservoir flood operating criteria and procedures to be followed preceding and during flood inflows which are not appropriate to include in the preceding subsections Filling Schedule and Release Procedures and Inflow Forecasting.

This subsection describes established criteria for storage and release schedules preceding and during flood inflow periods (including established constraints for downstream flood control), as well as reservoir operating criteria needed for dam and public safety. Flood operating criteria and inflow forecasts provide the basis for operating plans for routing of flood inflows. Safe-channel capacities should be described for various reaches of the downstream river channel.

For structures with gated spillways, this subsection should provide specific detailed emergency operating instructions for operating personnel to use when **communication outages are experienced** during floods that require independent facility operation. Instructions should be presented in both narrative and graphical form (e.g., flood release chart, gate operating curve, etc.) to avoid possible misinterpretation of these important instructions.

Where the reservoir has an authorized flood control function, this section should reference Corps of Engineers documents:

- Flood Control Act of 1944 (58 Stat. 890, 33 U.S.C. 709) Section 7
- Field Working Agreements
- Memorandums of Understanding
- Water Control Agreements and Manuals
- Reservoir Regulation Reports and Manuals

The subsection should state the purpose of the documents and how their provisions are to be implemented for flood control operations.

The following example of a Flood Operating Criteria was extracted from the SOP for Norman Dam and Lake Thunderbird, Norman Project, Oklahoma:

Flood Operating Criteria

Flood control operations shall be in accordance with the Reservoir Regulations Manual, the DOC, and this SOP.

The Flood Control Regulations govern the use of flood control storage above elevation 1039.0 (top of conservation pool) in Lake Thunderbird and the operation of Norman Dam for flood control purposes.

Whenever the reservoir storage is between elevations 1039.0 and 1049.4, the flood control discharge facilities shall be operated under the direction of the Corps so as to reduce flood damage downstream from the reservoir. Concurrently, the Regional Office shall be advised of operation procedures and instructions by the Corps.

Whenever reservoir storage exceeds elevation 1049.4 (top of flood control pool), releases shall be made at the maximum rate possible through the river outlet works and the uncontrolled spillway and continued until the pool level recedes to elevation 1049.4 when releases shall be made equal to inflow of the maximum release permissible to reduce flood damage, whichever is greater.

Flood control operations are subject to temporary modification in time of flood if found desirable on the basis of conditions at the time by the Corps, Provided, That any flood control releases shall not be made at rates or in a manner that would be inconsistent with emergency requirements for protecting the dam and reservoir from major damage or inconsistent with the safe routing of the inflow design flood.

Flood control operations shall not restrict pumping necessary to serve M&I users.

F. Special Report During Flood or High Water

This subsection could be omitted if it is sufficiently covered in the EAP.

Because of the importance of reporting promptly and completely during floods and high-water periods, comprehensive instructions on reports required from personnel at the dam during these periods should be assembled in this subsection for ready reference. Instructions should establish:

- When initial reports are to be made
- Who shall receive reports
- Data requirements
- Reporting intervals

Presumably, further reporting procedures will be established during the first report; if not, reporting intervals and data requirements for all reports should be established in the SOP.

1. **Surcharge Capacity.**—Criteria used in routing the IDF through a reservoir require surcharge capacity[1] for that purpose. Surcharge capacity is reserved for emergency situations or extreme conditions on the reservoir or the river basin. An example is the storage of inflows which, if released, would exceed the safe-channel capacity downstream and cause significant damage if passed directly through the reservoir.

[1]Surcharge does not pertain to the exclusive flood control space authorized in some reservoirs.

An SOP statement should include notifying the Regional Office and the Emergency Notification System that reservoir rise into surcharge is imminent.

During an emergency caused by high inflows, if downstream discharge is at the maximum channel capacity and if the watershed and weather conditions indicate an acceptable risk situation, the supervisory office may decide to use surcharge space before notifying the Regional Director. Surcharge storage during emergency conditions will be considered temporary, and the downstream channel will be allowed to flow at full capacity as long as there is available reservoir surcharge. Regional Office operations personnel will be notified of the situation at the earliest possible time. Immediately, they will notify the Regional Director and the Emergency Notification System and other regional divisions.

Certain unusual conditions and circumstances may arise for which additional storage would be beneficial and justified on a one-time basis. Analyses of hydrologic, structural, operational conditions, flood routing, and risk studies are required before authorization would be granted. Authorization for temporary surcharge storage or when recurring situations require the need for surcharge storage are provided in the applicable **directives in the Reclamation Manual**.

2. **Attendance.**—The 24-hour attendance requirement at all dams, under certain conditions, is outlined in Appendix A.

G. Filling and Drawdown Limits

This SOP subsection should have all recorded special limits on rates and ranges of reservoir filling and drawdown that have been established because of landslides or other geologic conditions in the reservoir and for embankment dams because of stability requirements. Include description and location of sinkholes or other unusual geologic formations.

The results of the reservoir evacuation study, performed in accordance with ACER Technical Memorandum No. 3, "Criteria and Guidelines for Evacuating Storage Reservoirs and Sizing Low-Level Outlet Works," should be discussed in this section. This information is useful should an emergency evacuation be needed at the dam.

Design elevations shown on the Reservoir Capacity Allocations do not need to be repeated here.
Reasons for reservoir operating restrictions should be provided. Procedures for variances from the established operating requirements should be handled on a case-by-case basis.

If special limits have not been established, this subsection should have a statement that limits are not applicable.

H. Landslide Surveillance

Landslide surveillance procedures have been established for Reclamation projects. The procedures require the identification, annual examination, and preparation of data and/or data reporting of landslide areas by the Regional Geologist or designated representative. As a result of these and other examinations, operating procedures and appropriate schedules of landslide observations and reports have been or will be established for specific dams and reservoirs.

Locations of landslides or potential landslides that may be activated by drawdown should be described and a map included in the SOP appendix.

Except for reporting procedures and reservoir operating instructions, all information and instructions related to landslides and landslide surveillance should be given in this SOP subsection. Inspection requirements relative to landslides should be presented in SOP Chapter I, F., "Data Reporting" and referred to in this subsection. Reservoir operating requirements resulting from landslide conditions should be included SOP Chapter IV, G., "Filling and Release Drawdown Limits."

Special instructions for operation and maintenance personnel, may be developed as a result of the annual examination of landslide areas and which should be included in the SOP. These instructions may pertain to one or more of, but not necessarily be limited to, the following actions:

- Maintain signs posted for warning of landslide areas.
- Identify names and locations of persons and entities in established locations who would be affected by either slow or sudden movement of a critical landslide, and who could benefit from establishment and implementation of related emergency communication procedures.
- Maintain and observe landslide monitoring instruments.
- Measure landslide areas by land surveying.
- Examine and report on critical landslide areas between annual examinations as directed by the Regional Geologist.
- Adhere to special limitations on reservoir drawdown rate.
- Immediately report unusual landslide activity.

Photographs of signs, drawings of slide areas, and photographs or profile drawings of slide areas should be included in an SOP appendix. When changes occur, this material will need to show current conditions.

Landslide Surveillance should describe landslide observations and measurements to be made following an earthquake and should refer to the Emergency Action Plan for reporting procedures.

Suggested standard paragraphs for preparing this subsection are:

> There are no known landslide areas in the vicinity of __(*name of dam and reservoir*)__. The __(*title of responsible O&M official, office, or organization*)__ has a continuing responsibility to report immediately to the Regional Supervisor of Water, Land and Power Operations[1] and to the Regional Geologist all unusual land movements observed during project operations (item _____ in the EAP for emergency procedures).

or

> There are minor landslide areas in the vicinity of __(*name of dam and reservoir*)__ but none require establishing special instructions for O&M personnel in this SOP. The __(*title of responsible O&M official, office, or organization*)__ has a continuing responsibility to report immediately to the Regional Supervisor of Water, Land, and Power Operations[2] and to the Regional Geologist all unusual land movements observed during project operations (item _____ in the EAP for emergency procedures).

or

> Potential and active landslide areas in the vicinity of __(*name of dam and reservoir*)__ requiring special instructions for O&M personnel are:
>
> (Identify and describe locations—include appendix drawings and photos.)
>
> The __(*title of responsible O&M official, office, or organization*)__ has a continuing responsibility for certain observations, measurements, data reporting, warning, and other actions specified below. All unusual land movements observed during project operations should be reported immediately to the Regional Supervisor of Water, Land, and Power Operations[2] and to the Regional Geologist (item _____ in the EAP for emergency procedures).

[2]The five regional offices of the Bureau of Reclamation use different titles; however, all are synonymous to the Regional Supervisor of Water, Land, and Power Operations.

I. Preventing Oil Pollution of Water.

This subsection should identify:

- The operating personnel's pollution abatement responsibilities
- An inventory and locations of possible oil and hazardous material sources
- Sources of oil and hazardous substances clean-up

At facilities where emergency plans for dealing with accidental pollution have been published, the SOP should include the plan or the document in which it is described, and the document should be referenced in this subsection. For instance, the plans could include the Regional Oil and Hazardous Substances Pollution Contingency Plan and should include reference to the Oil SPCC Plan. Also, references should be made to other pertinent documents containing information about temporary corrective measures to perform in the event of oil and/or hazardous material incidence and reference for contacting National Response Center.

NOTE: If the SPCC plan is not included in the SOP, it should be referred to in Chapter I, M., "Supporting Documents."

J. Fish and Wildlife Considerations

This subsection should reference all contracts and agreements with other agencies for the benefit of fish and wildlife. Explain what requirements there are, if any, and how the agreements affect dam and reservoir operations. Such requirements might include minimum water surface elevations, reservoir levels during specified periods of the year, and minimum reservoir release rates to meet downstream flow.

K. Recreation Management Plan

State whether or not a recreation management plan has been established for the reservoir area. If a plan has been published, the subsection should identify:

- The agreement establishing the plan
- The agency responsible for operating the plan
- How the plan affects reservoir operation.

L. Off-Road Vehicle Regulations

This subsection should identify regulations regarding off-road vehicle use for protecting public lands:

- Identify the Federal Register issue establishing the regulations
- Indicate the agency responsible for operating the plan
- State if and how the plan affects reservoir operation or operating personnel responsibilities

Maps designating roads and trails for off-road vehicle use, as well as maps indicating prohibited areas, should be included in the SOP appendix.

M. Hydropower Release Criteria

This subsection may be useful when hydroelectric plants are non-Reclamation and operated by others. For reservoirs serving as forebays to hydroelectric plants, this subsection should state the basic criteria used in determining the time and quantity of hydropower releases and should indicate the relation of releases to other reservoir operating functions and criteria. Where the only reservoir function is hydroelectric, or where the reservoir is one of interrelated reservoirs, when operation is coordinated to maximize power generation consistent with other authorized project operation purposes, the criteria may be referenced here and included in Chapter I, M., "Supporting Documents."

This subsection should state clearly the reporting requirements, release range, and power demands before effecting sudden or large releases of water. Also describe warning signs, devices, etc., to alert people downstream of increased releases.

N. Operating Criteria for Other Functions

Operating criteria for other reservoir functions not appropriately included in other SOP subsections may be placed here. Where appropriate, this subsection may include:

- Reviews of reservoir operating criteria for downstream pollution abatement
- Structure protection during periods of the year
- Control of silt deposition in the reservoir

A detailed discussion of operating criteria (in this subsection) does not preclude reiterative criteria in other SOP chapters.

O. Reservoir Operations Checklist

_____Dam

_____Reservoir

_____

Reviewed by Prepared by

_____ _____

Date Date

Reservoir Operations Checklist	Adequate	Inadequate
A. Reservoir Capacity Allocation		
1. Use current approved RCA form 7-1686		
2. Area-Capacity tables and curves		
a. Referenced		
b. Included in appendix		
3. Sediment accumulation recognized		
B. Design Flood Study and Routing		
1. Current reservoir inflow design flood		
a. Approval data of study and hydrology		
b. Volume (magnitude)		
c. Duration		
d. Peak inflow		
e. Type of flood		
f. Occurring months of year		
g. Antecedent hydrologic conditions		
h. Description		
(1) Beginning water surface elevation		
(2) Spillway gate operation		
(3) Outlet works release schedule		

Reservoir Operations Checklist	Adequate	Inadequate
(4) Feeder canal operation		
(5) Stoplog removal schedule		
i. Peak discharge (spillway and outlet works)		
2. Hydrographs		
3. Inundation maps		
4. Outstanding floods		
C. Filling Schedule and Release Procedures		
1. Filling schedule		
2. Release schedule		
3. Restrictions		
4. Specific dam operator gate instructions		
5. Streamflow and flood control options		
6. Detailed reservoir operating procedures		
D. Inflow Forecasting		
1. Periodic estimates of inflow volumes		
a. Preceding runoff months		
b. During runoff months		
2. Reference to Supporting Documents		
a. Hydrometeorological station monitoring		
b. Specific correlations and equations		
3. SCS and NWS procedures and criteria, if applicable		
4. Examine procedures annually		
E. Flood Operating Criteria		
1. Listing of storage and release schedules		
a. Preceding flood inflow		
b. During flood inflow		
c. Safe-channel capacity included		

Reservoir Operations Checklist	Adequate	Inadequate
2. Instructions during communications outages included		
a. Narrative and graphical form		
3. Corps of Engineers documents and agreements referenced		
a. Provisions to be implemented		
F. Special Report During Flood or High Water		
1. Reporting instructions		
a. Initial report schedule		
b. Who receives reports		
c. Data requirements		
d. Reporting intervals		
2. Surcharge notification detailed		
3. Attendance requirements		
G. Filling and Drawdown Limits		
1. Special limits on rates and ranges		
a. Reasons		
b. Reporting requirements		
2. Statement if limits not applicable		
H. Landslide Surveillance		
1 Identification of slide areas		
2 Inspection requirements		
3. Special instructions		
4. Standard paragraph use		
I. Oil Pollution of Water		
1. Operating personnel's responsibilities		
2. Locations of possible oil sources		
3. Sources of oil and hazardous substance clean-up		
4. Temporary corrective measures to perform		
5. Reference to or emergency plan included		
6. Standard example use		

Reservoir Operations Checklist	Adequate	Inadequate
J. Fish and Wildlife Consideration		
1. Reference all contracts and agreements		
2. Note effect on dam and reservoir operations		
K. Recreation Management Plan		
1. Agreements establishing plan		
2. Agency responsible for its operation		
3. How plan affects reservoir operations		
L. Off-road Vehicle Regulations		
1. Federal Register denoting regulations referenced		
2. Agency responsible for operation		
3. Reservoir operations		
a. If plan affects reservoir		
b. How plan affects reservoir		
c. If plan affects personnel responsibilities		
d. How plan affects personnel responsibilities		
4. Designated areas (maps included)		
a Areas allowed to public		
b. Areas prohibited to public		
M. Hydropower Release Criteria		
1. Time and quantity release criteria stated		
2. Relation to other operating functions		
3. Reporting requirements for sudden or large releases		
4. Warning signs and devices available		
N. Operating Criteria for Other Functions		
1. Downstream pollution abatement		
2. Structure protection		
3. Control of silt deposition		

A. Facility Information

General Information should describe the powerplant or pumping plant and a brief list of facilities at the plant. Directions and access to the plant from the dam, if different from the dam, should be included in detail.

If the dam operator is also the powerplant or pumping plant operator, then the operator's duties should be integrated into the dam operator's duties list which is separated into time intervals.

If an operating orders system is used, it should be included in this section.

B. Major Rotating Equipment and Auxiliaries

This section should supply in detail all pertinent information regarding the ratings and operation of major rotating equipment and auxiliaries. At plants for which a DOC has not been prepared, the descriptions and instructions should be very detailed and complete. Where a DOC or Design Summary is available, it may be referenced if it is current and reflects equipment modifications for detailed specific information that is not directly pertinent to operation of the equipment.

This section should address turbines (pumps), generators (motors), governors, excitation systems, braking, lifting and jacking systems, fire protection systems, bearing lubrication systems, generator (motor) and bearing cooling water systems, and penstock and draft tube features.

This information for the equipment should include instrumentation and control data, checks and tests that are required, and the power and control sources. Information regarding clearance procedures, alarms, and emergency procedures should either be included in this area or referenced to the location in the SOP where it is included.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the major rotating equipment and auxiliaries and the specific location of the data should be referenced in this section.

C. Major Operational Sequences

Major operational sequences include watering, unwatering, starting, stopping, synchronizing, loading and unloading, voltage control, and emergency procedures.

This section of the SOP should contain step-by-step instructions in graphical form of major operational sequences for control of the generators.

Facilities that have station service generators should list the step-by-step instructions in graphical form for their operation in this section also.

The guidelines included in this section should include all instructions necessary in graphical form for watering and unwatering the units, starting and stopping the units, synchronizing the units to the system, loading and unloading the units, and controlling the voltage on the units.

Any emergency procedures involving the operation of the units should be in this section or their location in the SOP referenced.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the major operational sequences and the specific location of the data should be referenced in this section.

D. Station Service DC Systems

This section should contain the detailed description of the station service DC systems and the operating instructions for the systems.

In addition to the operating instructions for the systems, this section should include a description of the instrumentation and control features of the equipment, checks and tests to be performed on the equipment, and a description of any protective schemes provided for the equipment.

Clearance procedures, alarms, and emergency procedures for this equipment should also be provided in this section or the area in the SOP where these are contained should be referenced.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the station service DC systems and the specific location of the data should be referenced in this section.

E. Station Service AC Systems

This section should contain the detailed description of the station service AC systems and the operating instructions for the systems.

In addition to the operating instructions for the systems, this section should include a description of the instrumentation and control features of the equipment, checks and tests to be performed on the equipment, and a description of any protective schemes provided for the equipment.

Clearance procedures, alarms, and emergency procedures for this equipment should also be provided in this section or the area in the SOP where these are contained should be referenced.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the station service DC systems and the specific location of the data should be referenced in this section.

F. Plant Services

This section should contain the detailed description of the various plant service systems and the operating instructions for the systems.

Systems that should be referenced in this section include water supply systems, compressed air systems, oil systems, oil entrapment, drainage, unwatering, and sewage systems, emergency unwatering systems, lighting systems (including the normal and the emergency lighting systems for the facility), heating and ventilating systems, oil storage fire protection systems, and annunciator and signal equipment systems.

The data should include any checks and tests that need to be made on the equipment and the sources of power and control for the equipment.

Clearance procedures, alarms, and emergency procedures for any of the equipment should be listed in this section or their locations in the SOP should be referenced.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the plant services and the specific location of the data should be referenced in this section.

G. Power Circuit Breakers

This section should contain the detailed description of the power circuit breakers and the operating instructions for them.

Separate sections should be included for the powerplant and the switchyard breakers.

The data to be provided should include equipment operating instructions, switching instructions, instrumentation and control features, checks and tests, protective schemes, and power and control sources.

Clearance procedures, alarms, and emergency procedures should be included in this section or their location in the SOP should be referenced.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the power circuit breakers and the specific location of the data should be referenced in this section.

H. Power Transformers

This section should contain detailed descriptions of the power transformers and the operating instructions that apply to them.

The special requirements for the use, inspection, record-keeping, and operation of PCB-Filled Transformers should be included if any are in use at the facility.

Data provided should include equipment operating instructions, instrumentation and control systems, checks and tests required, and power and control sources.

Information regarding clearance procedures, alarms, and emergency procedures should be included in this section or referenced their location in the SOP.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the power transformers and the specific location of the data should be referenced in this section.

I. Protective Relaying

This section should contain the detailed description of the protective relaying for the powerplant equipment and the operating instructions that apply. Zones of protection, relay functions, and operator duties following each specific operation should be addressed.

Relay systems that should be addressed include generator (motor) relaying, transformer relaying, station service relaying, and switchyard relaying including such items as main and transfer buses, transmission lines, etc.

Data should include checks and tests required and power and control sources for the relaying systems.

Clearance procedures, alarms, and emergency procedures should be addressed in this section or referenced their location in the SOP.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the power transformers and the specific location of the data should be referenced in this section.

J. Manual and M/O Disconnect Operation and Interlocks

This section should contain the detailed description of the manual and motor operated disconnects and associated interlock systems.

The data provided should include equipment operating instructions, switching instructions, instrumentation and control features, checks and tests to be performed, protective schemes, and power and control sources.

Clearance procedures, alarms, and emergency procedures should be addressed in this section or referenced their location in the SOP.

All pertinent specifications, manufacturer's bulletins, and drawings relating to the manual and motor operated disconnects and the specific location of the data should be referenced in this section.

K. Major Dam Equipment and Auxiliaries

This section is optional as it pertains to equipment that involves operation of the dam as well as the powerplant and is normally contained in those sections of the SOP that relate to dam and reservoir equipment. This section is offered as an option for those facilities where it is desired to have the power facility chapter include all functions necessary for normal operation of the power facility and dam. In order to avoid duplication, the operating instructions for this equipment should not be included in both places in the SOP but should be referenced in one location.

Items that can be included in this section are spillway gates, outlet works, and other dam equipment and services.

Data should include equipment operating instructions, instrumentation and control features, checks and tests required, and power and control sources.

Clearance procedures, alarms, and emergency procedures should be addressed in this section or referenced their location in the SOP.

All pertinent specifications manufacturer's bulletins, and drawings relating to the major dam equipment and auxiliaries included in this section and the specific location of the data should be referenced in this section.

L. Additional Sections as Required

Additional sections may be added for equipment or procedures that are not included in the preceding sections.

Examples of possible additional subjects are cables, switchyards, computer or automated operations, butterfly valves, siphon breakers, cranes, and clearance procedures.

M. Power Facility Operations Checklist

_____Powerplant

_____Reservoir

Reviewed by _____ Prepared by _____

Date _____ Date _____

Power Facility Operations Checklist	Adequate	Inadequate
A. Facility Information		
1. General		
a. Brief Description of Powerplant or Pumping Plant		
b Number and size of Units		
c. Type of Operation (attended or unattended)		
2. Items of Special Interest		
a. Unusual Operating Limitations		
b. Operating Orders		
c. Other		
B. Major Rotating Equipment and Auxiliaries		
1. Turbines (Pumps)		
a. General		
b. Components and Descriptions		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Clearance Procedures		
(6) Alarms		
(7) Emergency Procedures		

Power Facility Operations Checklist	Adequate	Inadequate
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
2. Generators (Motors)		
a. General		
b. Components and Descriptions		
(1) General		
(2) Equipment Operating Instructions		
(3) Switching Instructions		
(4) Instrumentation and Control		
(5) Checks and Tests		
(6) Protective Schemes		
(7) Power and Control		
(8) Clearance Procedures		
(9) Alarms		
(10) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
3. Governors		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		

Power Facility Operations Checklist	Adequate	Inadequate
(3) Switching Instructions		
(4) Instrumentation and Control		
(5) Checks and Tests		
(6) Protective Schemes		
(7) Power and Control		
(8) Clearance Procedures		
(9) Alarms		
(10) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
4. Excitation Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Protective Schemes		
(6) Power and Control		
(7) Clearance Procedures		
(8) Alarms		
(9) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		

Power Facility Operations Checklist	Adequate	Inadequate
(3) Drawings		
(4) Locations Described		
5. Braking, Lifting and Jacking System		
a. General		
b. Components and Description		
(1) Equipment Operating Instructions		
(2) Instrumentation and Control		
(3) Checks and Tests		
(4) Power and Control		
(5) Clearance Procedures		
(6) Alarms		
(7) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
6. Fire Protection Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Clearance Procedures		
(6) Alarms		
(7) Emergency Procedures		

Power Facility Operations Checklist	Adequate	Inadequate
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
7. Bearing Lubricating Systems		
a. Turbine (Pump) Bearing Oil Pumps		
(1) General		
(2) Components and description		
(a) Equipment operating instructions		
(b) Instrumentation and control		
(c) Checks and tests		
(d) Power and control		
(e) Alarms		
(f) Emergency procedures		
(3) References		
(a) Specifications		
(b) Manufacturer's bulletins		
(c) Drawings		
(d) Locations Described		
b. Thrust Bearing Oil Pumps		
(1) General		
(2) Components and Description		
(a) General		
(b) Equipment operating instructions		
(c) Checks and tests		
(d) Power and control		
(e) Alarms		

Power Facility Operations Checklist	Adequate	Inadequate
(f) Emergency procedures		
(3) References		
(a) Specifications		
(b) Manufacturer's bulletins		
(c) Drawings		
(d) Locations described		
c. Greasing Systems		
(1) General		
(2) Components and Description		
(a) General		
(b) Equipment operating instructions		
(c) Checks and tests		
(d) Power and control		
(e) Alarms		
(f) Emergency procedures		
(3) References		
(a) Specifications		
(b) Manufacturer's bulletins		
(c) Drawings		
(d) Locations described		
8. Generator (Motor) and Bearing Cooling Water Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Clearance Procedures		

Power Facility Operations Checklist	Adequate	Inadequate
(6) Alarms		
(7) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
9. Penstock (Discharge) and Draft (Suction) Tube Features		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Clearance Procedures		
(6) Alarms		
(7) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
C. Major Operational Sequences		
1. Station Generators		
a. Watering		
b. Unwatering		
c. Starting		
d. Stopping		

Power Facility Operations Checklist	Adequate	Inadequate
e. Synchronizing		
f. Loading and Unloading		
g. Voltage Control		
h. Emergency Procedures		
2. Main Generators		
a. Watering		
b. Unwatering		
c. Starting		
d. Stopping		
e. Synchronizing		
f. Loading and Unloading		
g. Voltage Control		
h. Emergency Procedures		
D. Station Service DC Systems		
1. Station Service DC Power Distribution		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Protective Schemes		
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		

Power Facility Operations Checklist	Adequate	Inadequate
(3) Drawings		
(4) Locations Described		
E. Station Service AC Systems		
1. Station Service AC Power Distribution		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Protective Schemes		
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
F. Plant Services		
1. Water Supply Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Protective Schemes		

Power Facility Operations Checklist	Adequate	Inadequate
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
2. Compressed Air Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Protective Schemes		
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
3. Oil Systems		
a. General		
b. Components and Description		
(1) General		

Power Facility Operations Checklist	Adequate	Inadequate
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
4. Oil Entrapment, Drainage, Unwatering, and Sewage Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
5. Emergency Unwatering		
a. General		
b. Components and Description		
(1) General		

Power Facility Operations Checklist	Adequate	Inadequate
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
6. Lighting Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
7. Heating and Ventilating Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Instrumentation and Control		

Power Facility Operations Checklist	Adequate	Inadequate
(4) Checks and Tests		
(5) Power and Control		
(6) Alarms		
(7) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
8. Oil Storage Fire Protection Systems		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
(5) Clearance Procedures		
(6) Alarms		
(7) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
9. Annunciator and Signal Equipment		
a. General		
b. Components and Description		
(1) General		

Power Facility Operations Checklist	Adequate	Inadequate
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
G. Power Circuit Breakers		
1. Powerplant Circuit Breakers		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Checks and Tests		
(4) Power and Control		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
2. Switchyard Circuit Breakers		
a. General		
b. Components and Description		
(1) General		
(2) Equipment Operating Instructions		
(3) Switching Instructions		
(4) Instrumentation and Control		

Power Facility Operations Checklist	Adequate	Inadequate
(5) Checks and Tests		
(6) Protective Schemes		
(7) Power and Control		
(8) Clearance Procedures		
(9) Alarms		
(10) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
H. Power Transformers		
1. General		
2. Components and Description		
a. General		
b. Equipment Operating Instructions		
c. Instrumentation and Control		
d. Checks and Tests		
e. Power and Control		
f. Clearance Procedures		
g. Alarms		
h. Emergency Procedures		
3. References		
a. Specifications		
b. Manufacturer's Bulletins		
c. Drawings		
d. Locations Described		

Power Facility Operations Checklist	Adequate	Inadequate
I. Protective Relaying		
1. Generator (Motor) Relaying		
a. General		
b. Components and Descriptions		
(1) General		
(2) Checks and Tests		
(3) Power and Control		
(4) Clearance Procedures		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
2. Transformer Relaying		
a. General		
b. Components and Descriptions		
(1) General		
(2) Checks and Tests		
(3) Power and Control		
(4) Clearance Procedures		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		

Power Facility Operations Checklist	Adequate	Inadequate
(4) Locations Described		
3. Station Service Relaying		
a. General		
b. Components and Descriptions		
(1) General		
(2) Checks and Tests		
(3) Power and Control		
(4) Clearance Procedures		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
4. Switchyard Relaying		
a. General		
b. Components and Descriptions		
(1) General		
(2) Checks and Tests		
(3) Power and Control		
(4) Clearance Procedures		
(5) Alarms		
(6) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		

Power Facility Operations Checklist	Adequate	Inadequate
(4) Locations Described		
J. Manual and M/O Disconnect Operation and Interlocks		
1. General		
2. Components and Description		
a. General		
b. Equipment Operating Instructions		
c. Switching Instructions		
d. Instrumentation and Control		
e. Checks and Tests		
f. Protective Schemes		
g. Power and Control		
h. Clearance Procedures		
i. Alarms		
j. Emergency Procedures		
3. References		
a. Specifications		
b. Manufacturer's Bulletins		
c. Drawings		
d. Locations Described		
K. Major Dam Equipment and Auxiliaries		
1. Spillway Gates		
a. General		
b. Components and Descriptions		
(1) General		
(2) Equipment Operation Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Power and Control		

Power Facility Operations Checklist	Adequate	Inadequate
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
2. Outlet Works		
a. General		
b. Components and Descriptions		
(1) General		
(2) Equipment Operation Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Power and Control		
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
3. Other Dam Auxiliary Equipment and Services		
a. General		
b. Components and Descriptions		
(1) General		

Power Facility Operations Checklist	Adequate	Inadequate
(2) Equipment Operation Instructions		
(3) Instrumentation and Control		
(4) Checks and Tests		
(5) Power and Control		
(6) Clearance Procedures		
(7) Alarms		
(8) Emergency Procedures		
c. References		
(1) Specifications		
(2) Manufacturer's Bulletins		
(3) Drawings		
(4) Locations Described		
L. Additional Section as Required		
1. Cables		
2. Switchyards		
3. Computer or Automated Operation		
4 Butterfly Valves		
5. Siphon Breakers		
6. Cranes		
7. Clearance Procedures		
8. Others as Required		

APPENDICES

The following memoranda, glossary, and definitions should be helpful in composing Standing Operating Procedures document.

APPENDIX A

Guidelines for Determining Attendance and Communications and Downstream Warning Systems Required at Service Dams

(*retyped for legibility*)

COPY

D-430 April 30, 1980

Memorandum

To: Regional Director, PN, MP, LC, UC, SW, UM, LM, Attention: 400

From: Chief, Division of O&M Technical Services

Subject: Guidelines for Determining Attendance and Communication and Downstream Warning Systems Required at Service Dams (My Memorandum to Regional Directors Dated January 24, 1978, and September 25, 1979)

We have received your comments on subject guidelines as requested in my September 25 memorandum and have used them in development of the attached guidelines. The guidelines should be used to provide general direction in determining attendance and communication and downstream warning systems for dams under your jurisdiction. Specific conditions at each dam should be considered in arriving at the final requirement. The guidelines will apply to all dams which have been determined to need an SOP (Standing Operating Procedures).

The justification and final determinations for attendance and communication and downstream warning systems should become a part of the SOP. Therefore, all future SOP's prepared or revised in your region should contain this information. In this regard, we will provide revision pages to the SOP's guide to include a provision for this addition. These and other revisions to the guide should be completed and submitted to you by May 31, 1980.

/s/ BA Prichard

Enclosure

Copy to: Commissioner, Attention: 115 and 400
Assistant Commissioner - Engineering and Research, E&R Center
Assistant Commissioner - Dam and Structural Safety, E&R Center
(with copy of enclosures to each)

Guidelines for Determining
Attendance, Communication, and Warning Systems
at Bureau of Reclamation Dams

General

The purpose of the following information is to provide general guidance in determining attendance, communication, and warning systems needs at Bureau of Reclamation dams.

All Bureau of Reclamation dams which hove been determined to need SOP's (Standing Operating Procedures) should be governed by these guidelines.

Attendance

Minimum qualification to be the primary or backup operator for a Bureau of Reclamation dam is completion of the Reclamation's "Training for Dam Operators," including a general session and specific onsite drilling at all dams under the surveillance of the operator.

1. A resident operator shall be provided for each dam in the medium-to-high hazard potential[16] unless special specific site conditions justify a lesser level of attendance. Each Regional Director shall evaluate attendance requirements for each dam under his jurisdiction, document the requirements in the SOP'S, and take appropriate measures to provide the required attendance.

Residence for a resident operator should be within close proximity of the dam (30 minutes or less travel time). Two or more dams located in the same local area may be

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[16]Hazard potential:

Category	Loss of life extent of development	Economic loss extent of development
Low	None expected (no permanent structures for human habitation)	Minimal (undeveloped to occasional structure or agricultural)
Significant (medium)	Few (no urban development and no more than a small number of inhabitable structures)	Appreciable (notable agri-culture, industry, or structures)
High	More than a few	Excessive (extensive community, industry, or agriculture)

manned by one operator under certain conditions. Justification for multidam operation, or nonresident attendance for dams in medium-to-high hazard potential shall consider such items as the existence of supervisory or remote control, type and operational requirements of the spillway, location and availability of backup operator(s) to identify and meet the requirements of potential simultaneous 24-hour attendance of multidams under item 4, and the accessibility and communication determination required by these guidelines.

2. Location of the resident operator's housing shall be evaluated in terms of potential need for rapid evaluation of the conditions of dams with medium-to-high hazard potential during or following unusually severe conditions. Consideration should be given to providing temporary or permanent residence within visual distance of dam when any of the following conditions are known to be present:

a. Inability of the dam to withstand the MCE (maximum credible earthquake). The means should be available within several minutes after occurrence of a major event to evaluate the dam's response, to operate the outlet works if necessary, to call for maintenance assistance if required, or to alert the public of imminent failure.

b. Inability of the dam to safely pass the IDF (inflow design flood). The need to observe the condition of and operate to the best advantage the structures during major storm events must be evaluated under item 1 above and 4 below considering the location of the operator's residence.

c. Identified major Sl (structural integrity) deficiencies with a record of changing conditions that require daily or more frequent observation. As under b. above, location of the residence may be significant in providing the needed degree of attendance under items 1 and 4 that will also meet needs described in this paragraph.

Justification for location of the operator's residence shall also be included in the SOP.

3. Dams in the low-risk hazard potential should, as a general guideline, be visited at least weekly during the operating season. Attendance during the off-season will usually be less than during the operating period. The frequency of attendance at dams is at the discretion of the Regional Director and shall be determined by such considerations as the reservoir water level and watershed conditions, whether the dam have controlled or uncontrolled spillways or spillways with automated or remote controlled gates; the need for operational changes; and the amount of recreational activity in and around the reservoir area or downstream from the dams.

4. In addition to Items 1, 2, and 3 above, attendance is required[17] 24 hours per day, 7 days per week, for all dams while under the following conditions:

a. The reservoir inflow exceeds a predetermined quantity; i.e., an inflow which the Regional Director determines would cause a spill, or a rapidly rising reservoir water level which could endanger the dam or property around the reservoir or could cause other related activities to be hazardous. Attendance 24 hours a day may not be necessary at those dams where spills occur on a more or less periodic frequency.

b. An abnormal, non-routine spill is occurring.

c. The reservoir water surface is sufficiently high that a known or suspected landslide area has the potential to cause a wave capable of overtopping the dam.

d. The existence of a new or changed seepage condition which may affect dam structural integrity.

Communications System

A properly maintained communications system should be available at all Bureau of Reclamation dams. Dams having a medium-to-high hazard potential should have a primary and backup communications system at the dam or at some other readily accessible location such as the dam operator's residence, irrigation district office, vehicle, etc. Dams in the low-hazard potential should, as a minimum, have a primary communications system at a readily accessible location. The need for a backup system in this case should be determined by the Regional Director.

Because of the vital importance of communications during emergencies, the availability of auxiliary power for the communication system should be assured where applicable.

Below is a summary of the communications system needs at Bureau dams.

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[17]The following can be considered to constitute a 24-hour day, 7-day week attendance at a dam:

a. A resident dam operator, if backups are provided.

b. Round-the-clock attendance at a powerplant at the dam, if the shifter or an operator on duty has the responsibility for performing emergency operations involving the dam, reservoir, and related facilities until the responsibility can be transferred to a replacement.

Communications System Requirements

Hazard	Primary	Backup
Low	Primary required	Requirement at Regional Director's discretion
	Acceptable types:	Acceptable types:
	Mobile radio system or telephone	Mobile radio system
	Private telephone (Reclamation or water user)	Private telephone (business, farm, etc.)
	Public telephone (coin)	Public telephone (coin)
		Citizen band (see 2 below)
Medium	Primary required	Backup required
	Acceptable types:	Acceptable types:
	Mobile radio system or telephone	Mobile radio system
	Private telephone (Reclamation or water user)	Private telephone (business, farm, etc.)
		Public telephone (coin)
		Citizen band (see 2 below)
High	Primary required:	Backup required
	Acceptable types:	Acceptable types:
	Mobile radio system or telephone	Mobile radio system
	Private telephone (Reclamation or water user)	Private telephone (business, farm, etc.)
		Public telephone (coin)
		Citizen band (see 2 below)

1. A radio system (a base station of one or more mobile units at the dam) is the most desirable primary communications system at medium-to-high hazard dams. A private telephone communications system is acceptable if justified and if always accessible.

2. Coin-operated telephones and citizens' band radios should normally riot be used as a backup for medium-to-high hazard dams. They may be used if no other practical means are available and if high reliability can be assured. If a private telephone is used as the primary method of communication, the same method as a coin-operated telephone should not be used as the backup at medium-to-high-hazard dams.

3. Telephones at nearby homes, businesses, resorts, State and county agencies, or other Federal agency offices are acceptable as a backup communications system, but should not be used as a primary system unless 24-hour access to those telephones is assured.

Downstream Warning

Evacuation. - The Emergency Preparedness Plan for each dam should require a reliable line of communication, either radio or telephone, between the dam communications system and the local law enforcement or other appropriate agency in all instances where a dam has a medium-to-high hazard potential.

Fluctuating Releases

1. At dams where changes in the releases could endanger fishermen, hikers, or others along the river downstream from the dam, public notices in the local newspapers or frequent spot announcements in the local radio and television stations should be used to warn of the danger. Signs warning of the hazards of a fluctuating water level should be placed at river access points throughout the reach where the danger exists.

2. Where public use of the river immediately downstream from the dam is permitted, an automatic or manually operated device, such as a siren, should be considered together with appropriate placement of signs explaining what to do when the siren is heard.

3. Where a permit for fishing, boating, hiking, picnicking, camping, or other public use of the river or adjacent area is required, the material issued with the permit should include information indicating and illustrating tile hazards of a fluctuating river.

4. Other methods of informing the public should be utilized, including speeches before the local community and service organizations, presentation of water safety programs to school pupils, and employee involvement in youth organizations such as the Boy Scouts and Girl Scouts.

APPENDIX B

Isolation and Bypass Valves in Control Lines
for Emergency and Regulating Gates
(*Retyped for legibility*)
COPY

Memorandum Denver, Colorado
TO: Chief, Division of Dam Safety Date: March 14, 1984

FROM: Acting Assistant Commissioner - Engineering and Research

SUBJECT: Isolation and Bypass Valves in Control Lines for Emergency and Regulating Gates (Reference: Memorandum from Chief, Division of Dam Safety to Chief, Division of Design and Chief, Division of Operation and Maintenance Technical Services Dated September 26, 1983)

Concern has been expressed by the Division of Dam Safety regarding the use of isolation and bypass valves in hydraulic control systems for gates and valves. Under an emergency condition, malfunctioning and improper positioning of isolation or bypass valving could render the emergency or regulating gates inoperable.

Although no formal policy has been established to date, isolation and bypass valves have been used for many years by the Bureau of Reclamation in hydraulic control systems. Control systems must be tested periodically to verify that components such as pressure switches and relief valves will function properly. This requires isolation and bypass valves. Isolation valves are also required to isolate components of hydraulic systems to perform required maintenance without completely draining all oil from the system. The designers of the hydraulic control systems and operation and maintenance personnel have determined that isolation and bypass valves are essential when installing, overhauling, servicing, and testing the control systems.

To reduce the possibility of improper operation of a gate or valve control system, the following items are necessary:

1. Clear and concise operating instructions located in the vicinity of the control system
2. Identification of all valves
3. Training of operating personnel

4. Where vandalism or sabotage is a concern, valve handles should be locked or removed but available to operating personnel.
5. Adequate maintenance of the valves to ensure the valves can be operated.

By this memorandum, a formal policy is established whereby isolation and bypass valves are considered essential in hydraulic control systems for gates and valves.

This reply has the concurrence of the Division of Water and Land Technical Services.

/s/ Robert J. Towles

Copy to: D-210
D-215
D-250
D-252
D-400
D-1530
D-3200

A

Abutment, dam: That part of the valley wall against which the dam is constructed. Defined in terms of left and right as looking away from the reservoir.

Acre-foot: A term used in measuring the volume of water, or amount of water needed to cover 1 acre (43,560 square feet) 1 foot deep (325,851 gallons).

Afterbay: The body of water immediately downstream from a powerplant or pumping plant (also referred to as tailrace)

Air release valve: A valve, usually manually operated, which is used to release air from a pipe or fitting.

Alkali-aggregate reaction: A deterioration of concrete by which the alkali in cement reacts chemically with the silica present in some aggregates.

Apron: A level section of concrete or riprap constructed upstream or downstream from a control structure to prevent undercutting of the structure.

Associated facility: A term used by Reclamation to describe those facilities examined by the respective regional or area office. These facilities include most carriage, distribution, and drainage systems, small diversion works, small pumping plants and powerplants, open and closed conduits, tunnels, siphons, small regulating reservoirs, waterways, and class B bridges.

Axis, dam: A plane or curved surface, appearing as a line in plan or cross section, to which horizontal dimensions can be referred.

Axis, dam (concrete): A vertical reference surface coincident with the upstream face at the top of the dam.

B

Baffle block: One of a series of upright obstructions designed to dissipate energy as in the case of a stilling basin or drop structure (also referred to as dentate).

Balanced head condition: The condition in which the water pressure on the upstream and downstream sides of an object are equal (such as a emergency or regulating gate).

Ball-milling: The repeated churning action of cobbles, gravel, and sand caused by the force of water in a stilling basin or other structure by which severe concrete abrasion can occur.

Bank storage: Water that has infiltrated from a reservoir into the surrounding land where it remains in storage until water level in the reservoir is lowered.

Beaching: The action of water waves by which beach materials settle into the water because of removal of finer materials.

Benchmark: A permanent or temporary monument of known elevation above sea level, used for vertical control at construction site.

Berm: A horizontal strip or shelf built into an embankment or cut to break the continuity of the slope, usually for the purpose of reducing erosion or to increase the thickness of the embankment at a point of change in slope or defined water surface elevation. Usually 10 to 15 ft in width.

Bridge, class A: A bridge located on a Federal-aid highway. Examination of this type of bridge is required every 2 years with an in-depth examination every 6 years.

Bridge, class B: A bridge not located on a Federal-aid highway that is used by the public. Examination of this type of bridge is required every 3 years.

Bridge, class C: A bridge not located on a Federal-aid highway that can be designated as being a private or operating bridge and could be gated or closed to the public, if desired.

Bulkhead: A one-piece fabricated steel unit which is lowered into guides and seals against a frame to close a water passage in a dam, conduit, spillway, etc.

C

Camber: The extra height added to the crest of embankment dams to ensure that the freeboard will not be diminished by foundation settlement or embankment consolidation. The amount of camber is different for each dam and is dependent on the amount of foundation settlement and embankment expected to occur.

Canal: A channel, usually open, that conveys water by gravity to farms, municipalities, etc.

Canal prism: The shape of the canal as seen in cross section.

Cavitation: The formation of partial vacuums in fast-flowing water caused by subatmospheric pressures immediately downstream from an obstruction or offset. Usually accompanied by noise and vibration.

Cavitation damage: The attack on surfaces caused by the implosion of bubbles of water vapor.

Check structure: A structure used to regulate the upstream water surface and control the downstream flow in a canal.

Chute: A conduit for conveying free-flowing materials at high velocity to lower elevations.

Clearance: A procedure used to establish, under tightly controlled discipline, a safe environment for maintenance, repair, or inspection. It includes systematically isolating pertinent equipment from all sources of hazardous energy (hydraulic, electrical, mechanical, pneumatic, and chemical) and attaching safety tags or locks to the appropriate controls. Also, it includes a written statement that documents isolation of the equipment (also referred to as “lockout” or "tagout").

Coating: The protective material applied to the outer surface of metalwork.

Conduit: A pipe, box, or horseshoe structure, or natural channel that is constructed by means of "cut and cover". A conduit can convey water or house other conduits or pipes.

Crest: The top surface of the dam. A roadway may be constructed across the crest to permit vehicular traffic or facilitate operation, maintenance, and examination of the dam. Also the high point of the spillway control section.

Crown: The highest point of the interior of a circular conduit, pipe, or tunnel.

Cubic feet per second (ft^3/sec): A unit of discharge for measurement of a flowing liquid equal to a flow of 1 cubic foot per second, 449 gallons per minute, 1.98 acre-foot per day.

Curtain grouting: The process of pressure grouting deep holes under a dam or in an abutment to form a watertight barrier and effectively seal seams, fissures, fault zones, or fill cavities in the foundation or abutment.

Cutoff (keyway) trench: An excavation in the foundation of an embankment (earth or rockfill) dam, usually located upstream of the dam axis or centerline crest which extends to bedrock

or to an impervious stratum. The excavation is backfired with impervious material to reduce percolation under the dam.

Cutoff wall: A wall of impervious material (e.g., concrete, asphaltic concrete, timber, steel sheet piling, or impervious grout curtain) located in the foundation beneath the dam and which forms a water barrier and reduces seepage under a dam or spillway.

D

Dam: A barrier built across a watercourse to impound or divert water.

Dam tender: The person responsible for the daily or routine operation and maintenance activities of a dam and its appurtenant structures. The dam tender commonly resides at or near the dam.

Deflection: Upstream or downstream movement of a dam or dike.

Dentate: See "baffle block."

Designated frequency flood: See "flood" etc.

Designers' Operating Criteria (DOC): Detailed operating criteria which stresses the designers' intended use and operation of equipment and structures in the interest of safe, proper, and efficient use of the facilities. Includes drawings and tables, etc.

Design summary: A document that summarizes the designers' development of the design that results in the specifications. It may include a section on the Designers' Operating Criteria.

Differential head condition: The condition in which the water pressure on the upstream and downstream sides of an object differ (also called unbalanced head).

Downstream face: The inclined surface of the dam away from the reservoir.

Drain, blanket: A layer of pervious material placed to facilitate drainage of the foundation and/or embankment.

Drop structure: A structure that conveys water to a lower elevation and dissipates the excess energy resulting from the drop.

E

Elevation-capacity table: A table giving reservoir storage capacity in terms of elevation increments.

Emergency Action Plan (EAP): A formal plan of procedures designed to minimize an emergency situation or unusual occurrence at a given dam or reservoir.

Emergency Preparedness Plan (EPP): Predecessor to the term Emergency Action Plan.

Emergency reserve fund: Money reserved or required by contract to be reserved by an operating entity for use in emergency situations involving facilities under the entity's jurisdiction.

Epicenter, earthquake: Focal point on earth's surface directly above the origin of seismic disturbance.

Erosion, concrete: Surface disturbance caused by abrasion from moving particles in water, impact of pedestrian or vehicular traffic, or impact of ice flows.

Erosion, soil: Surface displacement of soil caused by weathering, dissolution, abrasion, or other transporting.

Examination report: A written report that documents the condition of the facility during the examination, operation and maintenance activities accomplished since the last examination, and recommendations necessary for the continued safe and efficient operation of the facility.

Exit conference: A discussion following a facility review examination involving examination team members and interested representatives of the water users, project, and region. The topics of discussion include the overall condition of the facility, any recommendations made as a result of the examination, and any other pertinent topics.

F

Face, dam: Exposed surface of dam materials (earth, rockfill, or concrete), upstream and downstream.

Facility review, comprehensive: A detailed examination performed on dams with a senior dam engineer. State-of-the-art design characteristics are also evaluated.

Facility review, periodic: An examination on dams generally without the involvement of a senior dam engineer.

Failure: An incident resulting in the uncontrolled release of water from a dam.

Fault, earthquake: A fracture in rock along which the adjacent rock surfaces are differentially displaced.

Flashboard: Wooden board or structural panel anchored to the crest of a spillway used as a means of increasing the reservoir storage.

Flood, designated frequency and its probability: A 100-year flood is often considered in the design of diversion dams and for diversion-during-construction requirements. Service spillways, stilling basins, and some outlet works components may also be designed to pass certain level of floods designated by a return period. The return period should be thought as the chance that such a flood will be equaled or exceeded in any one year. For example, the 100-year flood is the flow level with a 0.01 annual exceedance probability, or there is 1 chance in 100 that this flood flow level will be equaled or exceeded in any given year.

Flood, inflow design (IDF): That flood used for design of a safe structure. It may be the PMF (probable maximum flood), but in sparsely developed areas where judgment indicates minimal property damage and no probable loss of life, the design flood may be less than the PMF.

Flood, moderate frequency: A flood of lesser magnitude than the IDF used for the service spillway design when supplemented by a separate auxiliary spillway.

Flood, probable maximum (PMF): The largest flood reasonably expected at a point on a stream because of a probable maximum storm and favorable runoff conditions.

Flume: Flumes are shaped, open-channel flow sections that force flow to accelerate. Acceleration is produced by converging the sidewalls, raising the bottom, or a combination of both.

Long-throated: Long-throated flumes control discharge rate in a throat that is long enough to cause nearly parallel flow lines in the region of flow control. Parallel flow allows these flumes to be accurately rated by analysis using fluid flow concepts. The energy principle, critical depth relationships, and boundary layer theory are combined to rate flumes and broad-crested weirs by Ackers et al (1978) and Bos et al. (1991). Thus, these flumes and modified broad-crested weirs shown in figure 1 are amenable to computer calibrations. Long throated flumes can have nearly any desired cross-sectional shape and can be custom

fitted into most canal-site geometries. The Ramp flumes also considered a version of broad-crested weirs is an examples of this kind of flume.

Parshall Flume: A Parshall flume is a specially shaped open channel flow section that may be installed in a drainage lateral or ditch to measure the rate of flow of water.

Short-throated: Short-throated flumes are considered short because they control flow in a region that produces curvilinear flow. While they may be termed short-throated, the overall specified length of the finished structure including transitions may be relatively long. The Parshall flume is the main example of this kind of flume. These flumes would require detailed accurate and accurate knowledge of the individual streamline curvatures for calculated ratings which is usually considered impractical. Thus short-throated flumes are determined empirically by comparison with other more precise and accurate water measuring systems.

Forebay: The body of water immediately upstream from a powerplant.

Foundation, dam: The excavated surface upon which a dam is placed.

Foundation drains: Tile or pipe for collecting internal seepage water of dam.

Freeboard: The difference in elevation between the maximum reservoir water surface and the dam crest.

Freeze-thaw damage: Damage to concrete caused by extreme temperature variations as noted by random pattern cracking. Damage is accelerated by the presence of water and commonly more severe on the south-facing side of structures.

G

Gallery: A passageway within the body of a dam, its foundation, or abutments.

Gate: A device that controls the flow in a conduit, pipe, or tunnel without obstructing any portion of the passageway when in the fully open position.

Gate chamber: A chamber in which a guard gate in a pressurized outlet works or both the guard and regulating gates in a free-flow outlet works is located.

Gate, cylinder: A gate that resembles a large barrel, reinforced to withstand external pressure, with no top or bottom.

Gate, drum: A movable crest gate in the form of a sector of a cylinder hinged at the centerline. The arc face effects a seal with edge of a recess and the gate is operated by a reservoir pressure. Design permits overtopping.

Gate, emergency (guard): The first gate in a series of flow controls, remaining open while downstream gates or valves are operative.

Gate, fixed-wheel: A gate consisting of a rectangular leaf mounted on wheels, particularly suited for high head situations.

Gate, high-pressure: A gate consisting of a rectangular leaf encased in a body and bonnet and equipped with a hydraulic hoist for moving the gate leaf.

Gate, jet-flow: A gate consisting of a wheel-mounted leaf moved vertically by a motor-driven screw hoist.

Gate, operating (or regulating): A gate used to regulate the rate of flow through an outlet works.

Gate, radial: A pivoted crest gate, the face of which is usually a circular arc, with the center of curvature at the pivot about which the gate swings (same as tainter gate).

Gate, ring-follower: A gate consisting of a rectangular leaf and an opening equal in diameter to that of the conduit that forms an unobstructed passageway when the leaf is in the raised or open position.

Gate, ring: A ring- or annular-shaped steel drum operating in a recess or gate chamber in the spillway crest and controlled in a manner similar to a drum gate.

Gate, roller: A gate rolled up or down inclined supporting rails by a hoist through sprocket chains around the ends of a cylinder.

Gate, slide: A steel gate that upon opening or closing slides on its bearings in edge guide slots.

Gate, tainter: A term used by the Corps. of Engineers to describe radial gates (see "gate, radial").

Gate hanger: A device used to maintain a set gate opening.

Groin: The contact between the upstream or downstream face of the dam and abutments.

Grout: A fluid mixture of cement and water or sand, cement, and water used to seal joints and cracks in rock foundation.

H

Hazard classification: The rating for a dam based on the potential consequences of failure. The rating is based on potential loss of life and damage to property that failure of the dam cause. Such classification is related to the amount of development downstream of a dam.

Head: The difference in number of feet between two water surface elevations.

Headrace: See "forebay."

Head loss: The energy per unit weight of water lost due to transitions, bends, etc.

Heave: The upward movement of land surfaces or structures due to subsurface expansion of soil or rock, or vertical faulting of rock.

Hydraulic height: Height to which water rises behind the dam and is the difference between the lowest point in the original streambed at the axis or the centerline crest of the dam and the maximum controllable water surface.

Hydrograph: A graph showing for a given point on a stream or conduit, the discharge, stage, velocity, available power, or other property of water with respect to time.

Hydrology: The science that treats the occurrence, circulation properties, and distribution of the waters of the earth and their reaction to the environment.

I

Inflow, reservoir: The amount of water entering a reservoir expressed in acre-feet per day or cubic feet per second.

Inflow Design Flood (IDF): See "flood, inflow design."

Instrumentation: Any device used to monitor the performance of the structure during its construction and throughout its useful life.

Inundation map: A map of the ground surfaces downstream of a dam showing the probable encroachment by water released because of failure of the dam or from abnormal flood flows released through a dams spillway.

Invert: The lowest point of the interior of a circular conduit, pipe, or tunnel.

J

Job hazard analysis: A study of a job or activity to identify hazards or potential accidents associated with each step or task, and develop solutions that will eliminate, nullify, or prevent such hazards or accidents.

Joint, contraction: Contraction joints are placed in concrete to provide for volumetric shrinkage of a monolithic unit or movement between monolithic units.

Joint, construction: Construction joints are purposely placed in concrete to facilitate construction; to reduce initial shrinkage stresses and cracks; to allow time for the installation of embedded metalwork; or to allow for the subsequent placing of other concrete.

Joint, expansion: A separation between adjoining parts of a concrete structure which is provided to allow small relative movements, such as those caused by temperature changes, to occur independently.

L

Lateral: A channel that conveys water from a canal to a farm, municipality, etc.

Lift line: Horizontal construction joint created when new concrete is placed on previously placed concrete.

Lining: Any protective material used to line the interior surface of a conduit, pipe, or tunnel.

Lockout: Clearance procedure in which physical locks replace Safety Tags (see “clearance”).

Log boom: A device used to prevent floating debris from obstructing spillways and intakes.

Logbook: A dated, written record of performed operation and maintenance items or observations pertinent to a structure.

M

Maintenance management system: Any organized system used to ensure that all preventive maintenance at a facility is accomplished and documented (e.g., 52-card system, computer system).

Major facility: A term used by Reclamation to describe those facilities for which an examination is conducted every third year, alternately conducted by the Denver and respective regional office. Major facilities include storage dams and reservoirs, diversion dams with significant storage or where major equipment and operation are complex, large pumping plants and powerplants, large canal systems, large complex closed conduit systems, and Group A bridges.

Maximum credible earthquake (MCE): The severest earthquake that is believed to be possible at the site on the basis of geologic ans seismological evidence. It is determined by regional and local studies that include a complete review of all historic earthquake data of events sufficiently nearby to influence the project, all faults in the area, and attenuations from causative faults to the site.

Moderate frequency flood: See "flood, moderate frequency."

MDA: Acronym for modification decision analysis.

Multipurpose project: A project designed for irrigation, power, flood control, municipal and industrial, recreation, and fish and wildlife benefits, in any combinations of two or more. Contrasted to single-purpose projects serving only one need.

O

O&M: Acronym for operation and maintenance.

Ogee crest: The shape of the concrete spillway crest that represents the lower profile of the undernappe of a jet of water flowing over a sharp-crested weir at a design depth.

Operating log: See "logbook."

Outflow: The amount of water passing a given point downstream of a structure, expressed in acre-feet per day or cubic feet per second.

Outlet works: A series of components located in a dam through which normal releases from the reservoir are made.

P

Piezometer: An instrument which measures pressure head or hydraulic pressures in a conduit or hydraulic pressures within the fill of an earth dam or the abutment; at the foundation because of seepage or soil compression; or on a flow surface of a spillway, gate, or valve.

Pattern cracking: Fine cracks in the form of a pattern on a concrete surface.

Penstock: A pipeline or conduit designed to withstand pressure surges leading from a forebay or reservoir to power-producing turbines, or pump units.

Pipe: A circular conduit constructed of any one of a number of materials that conveys water by gravity or under pressure.

Piping: The action of water passing through or under an embankment dam and carrying with it to the surface at the downstream face some of the finer material.

Pore-water pressure: Internal hydrostatic pressure in an embankment caused by the level of water in the reservoir acting through pressure-transmitting paths between soil particles in the fill.

Posted operating instructions: Those O&M instructions taken from the Standing Operating Procedures that pertain to the mechanical features in the immediate area.

Pound per square inch (lb/in^2): A pressure designation for pounds per square inch.

Probable maximum flood (PMF): See "flood, probable maximum."

R

Reach: The area of a canal or lateral between check structures.

Remote operation: Operation of mechanical features from an on-site location other than at the feature.

Reserved works: Facilities operated and maintained by Reclamation.

Reservoir: The body of water (pool) impounded by a dam.

Reservoir Capacity Allocations (RCA): Shows a summary of acre-feet allocations of water, to such purposes as surcharge, exclusive flood control, joint use, active conservation, inactive storage, and dead storage.

Reservoir data definitions: See Appendix D.

Richter scale: A scale of numerical values of earthquake magnitude ranging from 1 to 9.

Riprap: The broken rock or boulders placed on upstream and downstream faces of embankment dams to provide protection from erosion caused by wind or wave action.

RO&M: The Review of Operation and Maintenance program; a periodic evaluation of O&M activities at a particular facility. Also see "facility review, comprehensive" and "facility review, periodic."

S

Sand boil: Seepage characterized by a boiling action at the surface surrounded by a cone of material from deposition of foundation and embankment material carried by the seepage.

SEED: The Safety Evaluation of Existing Dams program; an ongoing evaluation of the factors that could adversely affect the safety of dams.

Seepage: The slow movement or percolation of water through small cracks, pores, interstices, etc., from an embankment, abutment, or foundation.

Seismic: Of or related to movement in the earth's crust caused by natural relief of rock stresses.

Settlement: The sinking of land surfaces because of subsurface compaction, usually occurring when moisture added deliberately or by nature, causes a reduction in void volumes.

Sinkhole: A steep-sided depression formed when removal of subsurface embankment or foundation material causes overlying material to collapse into the resulting void.

Slough: Movement of a soil mass downward along a slope because of a slope angle too great to support the soil, wetness reducing internal friction among particles, or seismic activity. It is also called a slope failure, usually a rather shallow failure.

SOD: Acronym for Safety of Dams program.

Soil cement: A mixture of Portland cement and pulverized soil placed in layers on the upstream face of a dam to provide slope protection.

Spalling: The loss of surface concrete usually caused by impact, abrasion, or compression.

SPCC: Acronym for spill prevention control and countermeasure plan.

Spillway: A structure that passes normal and/or flood flows in a manner that protects the structural integrity of the dam.

Splitter wall: A wall or pier parallel to the direction of flow in a channel that separates flows released from different sources as a means of energy dissipation.

Springline: An imaginary reference line located at midheight of a circular conduit, pipe, or tunnel. Also the maximum horizontal dimension of a circular conduit, pipe, or tunnel.

Standing operating procedures (SOP): A comprehensive single-source document covering all aspects of dam and reservoir operation and maintenance and emergency procedures. Its purpose is to ensure adherence to approved operating procedures.

Stilling basin: A pool, usually lined with reinforced concrete, located below a spillway, gate, or valve into which the discharge dissipates energy to avoid downstream channel degradation.

Stilling pool: A pool located below a spillway, gate, or valve into which the discharge dissipates energy to avoid downstream channel degradation.

Stoplogs: A set of interchangeable fabricated steel or wood units lowered between walls or piers to close a water passage in a dam, conduit, spillway, etc.; the logs are inserted in slots one at a time. A lifting beam may be used for their installation.

Structural height: Distance between the lowest point in the excavated foundation (excluding narrow fault zones) and the top of dam.

- The structural height of an embankment (earth or rockfill) dam is the vertical distance between the top of the embankment and the lowest point in the excavated foundation area, including the main cutoff trench, if any, but excluding small trenches or narrow backfilled areas. The top elevation does not include the camber, crown, or roadway surfacing.
- The structural height of a concrete dam is the vertical distance between the top of the dam and lowest point of the excavated foundation area, excluding narrow fault zones.

Sulfate attack: Damage to concrete caused by the effects of a chemical reaction between sulfates in soils or ground water and hydrated lime and hydrated calcium aluminate in cement paste. The attack results in considerable expansion and disruption of paste.

Supervisory control: A system used to monitor conditions and operate mechanical features associated with a facility from a location other than at the site.

T

Tagout: See "clearance."

Tailrace: See "afterbay."

Tailwater: The water in the natural stream immediately downstream from a dam. The elevation of water varies with discharge from the reservoir.

Toe: The contact between the upstream or downstream face of the dam and natural ground.

Toe drain(s): Open-jointed tile or perforated pipe located at the toe of the dam used in conjunction with horizontal drainage blankets to collect seepage from the embankment and foundation and conveys the seepage to a location downstream from the dam.

Trash rake: A device that is used to remove debris which has collected on a trashrack to prevent blocking the associated intake.

Trashrack: A metal or reinforced concrete structure placed at the intake of a conduit, pipe, or tunnel that prevents entrance of debris over a certain size.

Tunnel: An enclosed channel that is constructed by excavating through natural ground. A tunnel can convey water or house conduits or pipes.

Turnout: A structure used to divert water from a supply channel to a smaller channel.

U

USGS: An acronym used for U.S. Geological Survey, the agency that monitors streamflows, river hydrology, and seismic activity.

Unbalanced head condition: See "differential head condition."

Uplift pressure: See "pore-water pressure."

Upstream face: The inclined surface of the dam that is in contact with the reservoir.

V

Valve: A device used to control the flow in a conduit, pipe, or tunnel that permanently obstructs a portion of the waterway.

Valve, butterfly: A valve designed for quick closure that consists of a circular leaf, slightly convex in form, mounted on a transverse shaft carried by two bearings.

Valve, gate: A valve with a circular-shaped closing element that fit securely over an opening through which water flows.

Valve, hollow-jet: A valve having a closing member that moves upstream to shut off the flow. The hollow-jet valve discharges a hollow or annular jet dispersed over a wide area.

Valve, tube: A valve which is opened or closed by mechanically moving a tube upstream or downstream by an actuating screw.

Vortex: A revolving mass of water in which the streamlines are concentric circles and in which the total head is the same.

W

Water conveyance structure: Any structure that conveys water from one location to another.

Waterstage recorder: A motor-driven (spring wound or electric) instrument for monitoring water surface elevation.

Waterstop: A continuous strip of waterproof material placed at concrete joints designed to control cracking and limit moisture penetration.

Weep hole: A drain embedded in a concrete or masonry structure intended to relieve pressure caused by seepage behind the structure.

Weir: An overflow structure built across an open channel to measure the flow of water and is calibrated for depth of flow over the crest.

Cipolletti: A contracted weir of trapezoidal shape in which the sides of the notch are given a slope of I horizontal to 4 vertical.

Rectangular: A contracted or suppressed weir with horizontal crest, rectangular in shape, having vertical sides.

V-notch: A weir that is V-shaped, with its apex downward, used to accurately measure small rates of flow.

APPENDIX D — RECLAMATION RESERVOIR DATA DEFINITIONS

General

Dam design and reservoir operation utilize reservoir capacity and water surface elevation data. To ensure uniformity in the establishment, use, and publication of these data, the following standard definitions of water surface elevations and reservoir capacities are used throughout Reclamation. Reservoir capacity as used here is exclusive of bank storage capacity.

Water Surface Elevation Definitions

Maximum Water Surface.—The highest acceptable water surface elevation with all factors affecting the safety of the structure considered. It is the highest water surface elevation resulting from a computed routing of the inflow design flood through the reservoir under established operating criteria. This surface is also the top of the surcharge capacity.

Normal Water Surface.—The highest elevation that water is normally stored, or that elevation which the reservoir should be operated for conservation purposes.

Top of Exclusive Flood Control Capacity.—The reservoir water surface elevation at the top of the reservoir capacity allocated to exclusive use for the regulation of flood inflows to reduce damage downstream.

Maximum Controllable Water Surface Elevation.—The highest reservoir water surface elevation at which gravity flows from the reservoir can be completely shut off.

Top of Joint Use Capacity.—The reservoir water surface elevation at the top of the reservoir capacity allocated to joint use, i.e., flood control and conservation purposes.

Top of Active Conservation Capacity.—The reservoir water surface elevation at the top of the capacity allocated to the storage of water for conservation purposes only.

Top of Inactive Capacity.—The reservoir water surface elevation below which the reservoir will not be evacuated under normal conditions.

Top of Dead Capacity.—The lowest elevation in the reservoir from which water can be drawn by gravity.

Streambed at the Dam Axis.—The elevation of the lowest point in the streambed at the axis or centerline crest of the dam prior to construction. (This elevation normally defines the zero for the area-capacity tables).

Surcharge Capacity.—The reservoir capacity provided for use in passing the inflow design flood through the reservoir. It is the reservoir capacity between the maximum water surface elevation and the highest of the following elevations (1) top of exclusive flood control capacity, (2) top of joint use capacity, or (3) top of active conservation capacity.

Total Capacity.—The reservoir capacity below the highest of the elevations representing (1) the top of exclusive flood control capacity, (2) the top of joint use capacity, or (3) the top of active conservation capacity. In the case of a natural lake which has been enlarged, the total capacity includes the dead capacity of the lake. Total capacity is used to express the total quantity of water which can be impounded and is exclusive of surcharge capacity. (In those cases where the dead capacity has not been measured, specific mention of this fact should be made).

Live Capacity.—The part of the total reservoir capacity from which water can be withdrawn by gravity. This capacity is equal to the total capacity less the dead capacity.

Active Capacity.—The reservoir capacity normally usable for storage and regulation of reservoir inflows to meet established reservoir operating requirement. It extends from the highest of (1) the top of exclusive flood control capacity, (2) the top of joint use capacity, or (3) the top of active conservation capacity, to the top of inactive capacity. It is also the total capacity less the sum of the inactive and dead capacities.

Exclusive Flood Control Capacity.—The reservoir capacity assigned to the sole purpose of regulating flood inflows to reduce flood damage downstream. In some instances, the top of exclusive flood control capacity is above the maximum controllable water surface elevation.

Joint Use Capacity.—The reservoir capacity assigned to flood control purposes during certain periods of the year and to conservation purposes during other periods of the year.

Active Conservation Capacity.—The reservoir capacity assigned to regulate reservoir inflow for irrigation, power, municipal and industrial use, fish and wildlife, navigation, recreation, water quality, and other purposes. It does *not* include exclusive flood control or joint use capacity. It extends from the top of the active conservation capacity to the top of the inactive capacity.

Inactive Capacity.—The reservoir capacity exclusive of and above the dead capacity from which the stored water is normally not available because of operating agreements or physical restrictions. Under abnormal conditions, such as a shortage of water or a requirement for structural repairs, water may be evacuated from this space (after obtaining proper authorization). The highest applicable water surface elevation described below usually determines the top of inactive capacity.

- The lowest water surface elevation at which the planned minimum rate of release for water supply purposes can be made to canals, conduits, the river, or other downstream conveyance systems. This elevation is normally established during the planning and design phases and is the elevation at the end of extreme drawdown periods.

- The established minimum water surface elevation for fish and wildlife purposes.

- The established minimum water surface elevation for recreation purposes.

- The minimum water surface elevation as set forth in compacts and/or agreements with political subdivision.

- The minimum water surface elevation at which the powerplant is designed to operate.

- The minimum water surface elevation to which the reservoir can be drawn down using established operating procedures without endangering the dam, appurtenant structures, or reservoir shoreline.

- The minimum water surface elevation or top of inactive capacity established by legislative action.

Dead Capacity.—The reservoir capacity from which stored water cannot be evacuated by gravity.