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VOLUME 9 NUMBER 2

Field Notes

Energy From Water

Forest Service Safety of Dams Studies

Washington Office News

FOREST SERVICE FEBRUARY 1977

U.S. DEPARTMENT OF AGRICULTURE

ENGINEERING FIELD NOTES

Volume 9 Number 2

FOREST SERVICE
U.S. DEPARTMENT OF AGRICULTURE
Washington, D.C. 20013

ENERGY FROM WATER

Jerry M. Hyde
Structures Engineer
Washington Office

The first power source extensively used (other than men or animals) was obtained from flowing water. Waterwheel origins can be traced back to ancient Egypt, China, and Persia, where they were used to grind grain for flour and animal feed, and to raise water for irrigation and water supply.

The Industrial Revolution led to the development of water turbines. Three general classes of turbines are: Francis, Pelton, and Propeller.

The Pelton turbine is usually found in mountainous areas where several hundred feet of head is available. In New England, during the last half of the 19th century, there were more than 50 manufacturers of water turbines supplying the needs of small, rural mill owners. These turbines were also belt-connected to an electric generator, principally for lighting purposes.

The development of large-scale hydro- and thermoelectric central generating stations, with the extension of electric powerlines to rural areas, has contributed to the rapid decline of the manufacture of small water turbines.

In recent years, probably because of the energy crisis, the United States and developing nations have shown renewed interest in small-scale hydroelectric units. Small, packaged hydroelectric units (generators), Pelton wheels, and hydraulic rams are currently available from manufacturers in the United States and Europe. News reports indicate the installation of thousands of hydroelectric units of less than 100-kW capacity in China. Hydroelectric package plants for power requirements of 1.5 to 18.5 kW are being manufactured in West Germany, Hungary, England, and Canada. Small hydroelectric units are sold in the United States with electric outputs of 1/2, 1, 2, 3, 5, 7.5, and 10 kW.

Currently, the Forest Service has many remote facilities that are now relying on the installation of gas or diesel generators for electric power.

Region 4 has prepared a proposal for two small portable hydroelectric power units for remote facilities (YCC Camps located in Idaho). The initial prototype units will probably be approximately 3 to 5 kW in size. Region 4 believes that the hydroelectric system will be the least expensive system to build, operate, and maintain. We hope to obtain complete results of their experience in small waterpower plants of this type.

Because of Federal Power Commission (FPC) regulations concerning the production of power, the Washington Office does not encourage Forest Service installation of small hydroelectric power units until we have reviewed the Region 4 installation and discussed licensing with FPC.

FOREST SERVICE SAFETY OF DAMS STUDIES

James A. Wolfe
Water & Sanitation Engineer
Region 3

EDITOR'S NOTE

This paper summarizes a two part presentation made by James Wolfe, R-3, and Larry Hendrickson, WO, at a conference on "Evaluation of Dam Safety," sponsored by the Engineering Foundation, November 28-December 3, 1976, at Asilomar, California.

This article is proposed for publication in the ASCE Journal and has not been edited.

This paper presents the Forest Service's experience with adapting the "Recommended Guidelines for Safety Inspection of Dams" prepared by the Corps of Engineers to local conditions. We believe that the safety inspection phases presented in the Guidelines were conceived and based on typical Corps of Engineers, FPC, or Bureau of Reclamation dams, where considerable engineering data is available for review. This is not the case, generally speaking, for the small dams located on National Forest lands, the exception being the newer dams constructed in the last 10 to 15 years which do have engineering data available. Even so, we do not suggest that revisions be made to the guidelines.

BACKGROUND

Before I get too deeply involved in our experience with two Forest Service dams - Scholz Dam and Horsethief Dam, I believe a brief explanation of the Forest Service is needed as background information.

The basic mission of the Forest Service is to provide Federal leadership in the wise use of Forest and related watershed lands. National Forest lands are managed for five different and sometimes conflicting purposes:

1. Timber Production
2. Watershed Protection
3. Forage Production

4. Wildlife Habitat Improvement
5. Recreation

In carrying out its management responsibilities, the Forest Service engages in a wide variety of activities. One of the significant activities is the administration of special use permits for a large number of private developments, including water impoundments. These impoundments serve many important purposes, such as range improvements, recreation, flood prevention, irrigation, and water supply.

In terms of numbers of dams, Forest Service responsibilities are both significant in size and complexity. As documented by the inventory prepared in accordance with the National Dam Safety Act (PL 92-367), the Forest Service is one of the major dam managing agencies in the Federal Government. Presently, there are over 15,000 dams of all sizes, types, and condition located within National Forest boundaries. Over 1,300 of these dams meet the designated size and height criteria and are included in the inventory for the National Dam Safety Act. About 300 of the 1,300 dams are Forest Service owned.

There are several factors which present unique challenges relative to managing dams on National Forest lands. From the technical engineering aspect, problems of remote location, marginal financial resources of proponents and owners, and the need for extensive environmental protection create a challenge to efficient program administration. Another challenging factor is the number of authorizations that enable dams to be constructed on National Forest land. Excluding the legislation for Federally-owned dams on National Forest lands, there are six different authorizations that permit privately-owned dams to occupy the National Forest. These authorizations vary from Federal legislation passed in 1866 for development of western irrigation structures to the Federal Power Act of 1920. There are also many projects located on National Forest lands covered by memorandums of agreement between the Forest Service and State and local Governments. All of the foregoing authorizations grant varying degrees of rights to the private dam owner; and conversely, all reserve certain administrative rights and authorities to the Federal Government.

The Forest Service dam management program, with related policy and engineering practices, has evolved over many years. Current direction, policy, and engineering standards are documented in the Forest Service Manual (FSM 7500).

GUIDELINES

The Corps of Engineers prepared the Guidelines for Safety Inspection of Dams under the authority of Public Law 92-367, the National Dam Inspection Act, for the purpose of providing a guide for the inspection and evaluation of dams to determine if they constitute hazards to human life or property. In general, the Guidelines recommend a two-phased investigation. The Phase I investigation requires:

1. An assessment of available engineering data and the general condition of the dam with respect to safety.

2. Recommendation for additional studies and investigations which are necessary and warranted.

3. Recommend alternative remedial measures or revisions in operating and maintenance procedures which would correct deficiencies and hazardous conditions found during the investigation.

The Phase II investigation is supplementary to Phase I and is conducted only if the results of the Phase I investigation indicate the need for additional in-depth studies, investigations, or analyses. The guidelines outline requirements and procedures for the Phase II studies and analyses. The recommended requirements and procedures should also be used to evaluate engineering data during Phase I.

OBJECTIVE

The objective of the prototype dam safety inspections were to:

1. Gain experience with use of the Recommended Guidelines.

2. Develop a contract procedure and specification which would adequately describe the work for Government A&E negotiations.

3. Obtain time and cost experience for program budgeting and for job cost estimating.

SCHOLZ INSPECTION

A contract was awarded to a consulting engineering firm to perform a safety inspection on a small earthfill dam. The specifications for the contract were based on a Phase I investigation as presented in the Recommended Guidelines, Chapter 3, and the Phase I reporting requirement as outlined in Chapter 5.

The engineering data available for the dam consisted of the physical characteristics of the structure taken from the inventory and recent maintenance inspection reports. The dam was acquired by the Forest Service through a land exchange in 1972. There were no written records on the dam prior to 1972. This information, along with a field inspection of the dam, and a history search were the only basis on which the consultant could make the safety inspection.

The resulting report presented a fairly complete history on the structure, a comprehensive field investigation checklist and report, conclusions and recommendations for a Phase II inspection. Based on their investigations, the consultant concluded that the embankment was stable (assuming it did not overtop), seepage was not critical, and the side channel spillway was relatively stable. However, due to a lack of hydrologic and hydraulic studies, the recommendation relative to dam safety could not be conclusive. A Phase II investigation was required.

After completing the Scholz Dam inspection, a fourth objective was added to the three objectives already established for the prototype dam safety inspections. It was to redefine the scope of Phase I investigation to best fit Forest Service needs.

As a part of the Forest Service's present dam management system, we are required to:

1. Maintain an inventory of all dams located on National Forest lands.

2. Establish an operation and maintenance program for all dams.

3. Perform a periodic inspection of all dams, generally once a year for those dams listed in the National inventory.

Through this type of a continuing surveillance program, we are aware of the general condition of most dams. We, therefore, concluded that a Phase I inspection based on the Recommended Guidelines would produce little more than a formal report on data we already knew. Definitive data, such as maximum pool elevation, freeboard allowance, and spillway capacity, are considered necessary if a determination of structural adequacy based on a visual inspection is to be meaningful. Recognizing the lack of this engineering data for most Forest Service-owned dams, we decided to perform another Phase I inspection based on revised specifications.

HORSETHIEF INSPECTION

The contract specifications for the first Phase I investigation were modified to include an evaluation of hydraulic and hydrologic capabilities for the dam. Chapter 4 of the Recommended Guidelines presents an outline of the hydraulic and hydrologic analysis considered necessary. The specific studies required by the revised contract specifications were:

1. A spillway design flood hydrograph.
2. A spillway rating curve.

3. Reservoir area/capacity data.
4. Flood routing through the reservoir.

The second inspection contract was awarded to another consulting engineering firm for investigation of Horsethief Dam, a small masonry arch dam. The engineering data furnished to the consultant this time consisted of a set of as-built plans dated 1936, a spillway design flood hydrograph, and recent maintenance inspection reports. Horsethief Dam was acquired by the Forest Service in 1968 through the termination of a special use permit. There were no written records on the dam prior to 1968, except the as-built plans and a water supply study which preceded construction of the dam.

The recommendations and conclusions presented in the report for this study took on a more positive meaning. The existing spillway was considered inadequate, and several remedial measures were recommended; however, a Phase II investigation was not considered warranted. The consulting engineers were still apprehensive, as much of the evidence on which their conclusions were based is underground or not visible. The dam was considered safe, assuming the recommended corrective work was accomplished.

SUMMARY

The original objectives, plus the added objective, have been obtained. A sample contract and specifications for a Phase I investigation to best meet Forest Service needs have been developed. The specifications are based on the Phase I investigations (Chapter 3), plus the hydraulic and hydrologic analysis of the Phase II investigation (Chapter 4.3) of the Recommended Guidelines for Safety Inspection of Dams. The rationale for modifying the scope of a Phase I investigation to fit Forest Service needs was based on two factors, the lack of available engineering data and the need for a cost-effective inspection program.

Records for many of our older dams are nonexistent, except for periodic maintenance inspection reports. Actually, we have very little knowledge of what engineering standards, if any, were applied in designing these older dams. With the majority of small dam failures being attributed to overtopping and knowing that the hydraulic and hydrologic aspects of most Forest Service dams are unavailable, a Phase II investigation would be required in most cases. Therefore, it is considered more cost effective to include these studies in the Phase I investigation. Since they must be made ultimately, this, then, will provide adequate Phase I information for the Forest Service situation and provide a firmer basis for priority selection for Phase II investigations. In addition, the more comprehensive we make an investigation, the more the engineer can know about the dam and the closer he can come to being sure of its condition (at that time).

Most dams located on National Forest lands are small, which generally relates to a restrictive budget for design, construction, operation, and maintenance. This same budget restriction will probably carry over to the safety investigation also. Therefore, it is essential that investigatory programs managed by the Forest Service make the best use of available funding to accomplish the job.

WASHINGTON OFFICE NEWS

OPERATIONS

Harold L. Strickland
Assistant Director

LOW-VOLUME ROADS BIBLIOGRAPHY

The Forest Service manages one of the largest transportation systems in the world. For the most part, the system is made up of low-volume roads serving logging traffic and a wide variety of other users. With the system now well over 200,000 miles and with many thousands of miles yet to be built, it is important that the literature on low-volume roads be acquired, organized, and made available to Forest Service users. The analysis of information on low-volume roads and, when appropriate, the application of such information to the Forest Service Transportation System, is an important part of the engineering mission of the Forest Service.

For several years, Adrian Pelzner of the Washington Office has been collecting information on low-volume roads and has compiled nearly 400 bibliographic citations that specifically relate to low-volume roads. Using this collection as a nucleus, our Technical Information Center (TIC) Staff has been gathering additional material on low-volume roads. We are cataloging these articles and reports, which will become a permanent part of our information center. The next step will be to produce a bibliography in which all items will be listed under one of the following six categories:

Planning

Design

Construction

Operation

Maintenance

General

We plan to include information on where the publications may be obtained. Copies of this bibliography will be distributed to the field.

At this time, we would appreciate your supporting this effort by forwarding to TIC any articles you have come across on the subject of low-volume roads. If you cannot send us copies of the publications, please compile the following information on each such article, for us to use in acquiring a copy of it:

Title

Author

Publisher

Date

Volume and issue number (for magazine and journal articles)

Please send this material to:

Forest Service, USDA
Engineering Staff, TIC
Attn: Inez Fitzgerald
P.O. Box 2417
Washington, D.C. 20013

Please send information and publications to us by June 30, 1977. We will return promptly all publications sent to us on loan. Your participation in this project will be a major factor in making it a valuable working information resource.

TECHNOLOGICAL IMPROVEMENTS

Heyward T. Taylor
Assistant Director

As part of their mission, the Equipment Development Centers (EDC's) respond to current needs of field units and sponsoring staff offices. One way this response is made is by planned face-to-face contacts among key field personnel and the Centers. Events, detailed in the paragraphs that follow, are examples of the contacts that occurred in the 60-day period of November-December 1976.

REGION 5 FIRE EQUIPMENT COMMITTEE
November 9-11, Sacramento, Calif.

At this meeting Paul Hill, San Dimas' staff technician for Fire Management, and the committee discussed developmental aspects for fireline explosives, the super pulaski, crew carrier improvements, employee suggestions relating to helitack, General Services Administration items for fire suppression, and San Dimas' efforts on retardants in ground tankers and measuring devices for use at retardant airtanker bases. Paul also reported on a prior meeting of the Fire Equipment Working Group in North Carolina.

MULTIREGIONAL ANCHOR PROJECT STEERING COMMITTEE
November 12, Portland, Oreg.

Leonard Della-Moretta, the San Dimas EDC project engineer assigned responsibility for the development of substitute anchors for aerial cable transport systems, met with the project steering committee comprised of logging systems specialists Joe Gorsh (R-1), Don Studier (R-5), and Virg Binkley (R-6). Project progress, to date, includes preliminary test program planning by Dr. Ward Carson of PNW, the University of Washington; contracting to Developmental Sciences, Inc. for the preparation and operation of special test instrumentation; and Region 6's securing of Weyerhaeuser, Inc., to provide field support. Leonard will research work accomplished by the U.S. Navy Civil Engineering Laboratory related to the overall investigation of the dynamic and static behavior of skyline anchor systems.

COOPERATORS FROM THE UNIVERSITY OF CALIFORNIA-DAVIS (UCD)
December 1-2, San Dimas, Calif.

Professor John Miles and a graduate student from the UCD Agricultural Engineering Department were at the San Dimas EDC and reported progress on their feasibility study of plans to mount the San Dimas-designed reduction head on available tracked vehicles. They are formulating computer mathematical models to simulate performance of proposed designs.

AD HOC SLASH EQUIPMENT GROUP
December 7-8, San Dimas, Calif.

Regional and WO representatives for Aviation and Fire Management, Engineering, Timber Management for NFS, and Regional representatives for S&PF along with a PNW representative for Research met at San Dimas to evaluate progress and recommend future effort pertaining to slash treatment/utilization and fuels management activities at the Center. The Center was directed to continue development of the Forestland Residues Machine, which features the San Dimas-designed reduction head. The Center will also gather the additional test data required to furnish industry with complete information to commercially manufacture a machine suitable for treating slash and performing timber stand improvement work on material up to 6-in. dbh. The EDC is to develop a buncher for use on steep slopes by slash-piling crews and a directional feller for pulling trees uphill as they are felled. The buncher is to be a portable drum device powered by a small internal combustion engine; the directional feller should reduce breakage, enhance safety, and decrease yarding costs.

STEEP-SLOPE STABILIZATION GROUP
December 9-10, Portland, Oreg.

The Center relies on input from the various Workgroups established by the Vegetative Rehabilitation and Equipment Workshop for Range projects. One Workgroup on steep-slope stabilization, chaired by Region 6's Lou Spink and San Dimas' Ted Pickett, project coordinator for slope revegetation equipment, displayed the Center's prototypes of a steep-slope scarifier/seeder and a tree and shrub planter. At the same time Ted received reevaluated criteria for these devices from Workgroup members. He received favorable comments on the scarifier/seeder, which operates on cut banks or fill slopes up to 1:1, and was instructed to begin operational trail use.

AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS (ASAE) WINTER MEETING
December 14-17, Chicago, Ill.

Representatives of San Dimas EDC attended the annual ASAE meeting where highlights of San Dimas' effort to advance the state-of-the-art of slash equipment and encourage industry to make these commercially available were presented. The paper on parameters for the design of efficient forest residues reduction machinery is available from:

San Dimas EDC
444 East Bonita Ave.,
San Dimas, CA 91773

Call the Center on FTS 793-8239.

CONSULTATION AND STANDARDS

Charles R. Weller
Assistant Director

BUILDINGS HANDBOOK UPDATE

Detailers from Regions 4, 5, 6, and 9 provided assistance in reviewing and updating Forest Service *Buildings Handbook* 7309.11. Prior to publishing the new edition, copies of the draft will be sent to all Regions for their review and comment.

ALTERNATE ENERGY SOURCES

Solar: The installation of solar cells for two Region 5 lookout towers was completed last fall. The projects were photovoltaic test and demonstration projects in conjunction with NASA and ERDA. The solar electric power systems were installed on Pilot Peak Lookout on the Plumas National Forest and the Antelope Lookout on the Lassen National Forest (*Field Notes*, Vol. 8, No. 7, July 1976).

Planning and design is now under way for a new Region 3 nursery facility and solar heated greenhouse for production of containerized conifer seedlings at Albuquerque, New Mexico (*Field Notes*, Vol. 8, No. 6, June 1976).

Plans are also being made to use solar energy in a new Mimbres Ranger Station on the Gila National Forest in Region 3 near Silver City, New Mexico. The Mimbres Ranger Station is located approximately 80 air line miles north of the U.S.-Mexican border and receives very high annual solar radiation (approximate average = 1950 Btu/sq.ft./day). Preliminary solar analysis indicates a substantial annual fuel (propane gas) savings. The water system type of solar collectors and storage subsystem is also being considered. There are plans to prepare a proposal for participation in the Federal Buildings Solar Energy Demonstration Program in cooperation with the Energy, Research, and Development Administration (ERDA). If approved, ERDA would fund 80 percent of the solar heating and hot water system and may fund 80 percent of any solar cooling, dependent upon its additional cost. In addition, they would fund 100 percent of normal instrumentation costs for the solar energy system.

Water Power: Region 4 is studying the feasibility of installing two small hydroelectric power units in YCC camps (*Field Notes*, Vol. 9, No. 2, February 1977).

Geothermal: Geo-Solar Foundation, Inc., Klamath Falls, Oreg., has prepared a proposal for pilot projects in advanced fiber and food technology using geothermal and solar energy. Demonstration projects would be a joint Federal, State, and private effort. The Forest Service is interested in the use of geothermal energy for heating greenhouses to produce tree seedlings in containers. Several operational geothermally-heated greenhouses now exist in the United States and Iceland. A few hundred homes in Klamath Falls, Oreg., and Boise, Idaho, are heated by hot water from wells--the ones in Boise since 1890.

NOTES

INVITATION TO READERS OF *FIELD NOTES*

Every reader is a potential author of an article for *Field Notes*. If you have a news item or short article you would like to share with Service engineers, we invite you to send it for publication in *Field Notes*.

Material submitted to the Washington Office for publication should be reviewed by the respective Regional Office to see that the information is current, timely, technically accurate, informative, and of interest to engineers Service-wide (FSM 7113). The length of material submitted may vary from several short sentences to several typewritten pages; however, short articles or news items are preferred. All material submitted to the Washington Office should be typed double-spaced; all illustrations should be original drawings or glossy black and white photos.

Field Notes is distributed from the Washington Office directly to all Regional, Station, and Area Headquarters, Forests, and Forest Service retirees. If you are not currently on the mailing list ask your Office Manager or the Regional Information Coordinator to increase the number of copies sent to your office. Copies of back issues are also available from the Washington Office.

Each Region has an Information Coordinator to whom field personnel should submit both questions and material for publication. The Coordinators are:

R-1	Bill McCabe	R-4	Ted Wood	R-9	Norbert Smith
R-2	Royal M. Ryser	R-5	Jim McCoy	R-10	Frank Muchmore
R-3	Bill Strohschein	R-6	Kjell Bakke	WO	Al Colley
		R-8	Bob Bowers		

Coordinators should direct questions concerning format, editing, publishing dates, and other problems to:

USDA Forest Service
Engineering Staff, Rm. 1108 RP-E
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