



MONITORING DAM PERFORMANCE

Instrumentation and Measurements

Task Committee
to Revise Guidelines
for Dam Instrumentation

Edited by
Kim de Rubertis, P.E., D.GE

Monitoring Dam Performance

Instrumentation and Measurements

Prepared by the
Task Committee to Revise Guidelines for
Dam Instrumentation of the
Committee on Water Power of the
Energy Division of the
American Society of Civil Engineers

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DEDICATION

This manual is dedicated to John Dunncliff, Dist.M.ASCE, upon whose shoulders stand all who work with instrumentation. From his 1988 classic *Geotechnical Instrumentation for Monitoring Field Performance* to his continuing efforts to advance instrumentation knowledge in his contributions and editing for “Geotechnical Instrumentation News,” all have benefited. It is with this committee’s recognition of how integral Dunncliff’s work has become woven into the state of practice that, with great appreciation, this manual is dedicated.

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PREFACE

This Manual of Practice for *Monitoring Dam Performance: Instrumentation and Measurements* is an addition to the series of publications by members of the Hydropower Committee of the Energy Division of the American Society of Civil Engineers (ASCE).

The Hydropower Committee of ASCE's Energy Division was formed to develop and distribute information on all aspects of hydroelectric power to the hydroelectric community. The Hydropower Committee prepares and publishes Manuals of Practice, Guidelines, and Technical Reports about engineering and scientific issues related to hydroelectric facilities. The Hydropower Committee seeks to serve an audience beyond civil engineers to include scientists, economists, and technologists with expertise in related areas. This focus is driven by the hydropower industry's desire to integrate science, environment, economics, operation, and maintenance into the scope of its activities.

In 1997, task committee volunteers studied and reported means and methods of monitoring dam performance with instruments and measurements. The outcome of that committee's work was *Guidelines for Instrumentation and Measurements for Monitoring Dam Performance* published in 2000. Since that publication, there have been many innovations in both means and methods of monitoring dam performance. This manual presents the current state of practice with the intent of providing a convenient reference for owners, engineers, regulators, and others with an interest in dam safety.

There are no simple rules or standards for determining the proper level of instrumentation and measurements to monitor dam performance. Each dam is unique. The consequences of failure, complexity of dam and foundation, known problems and concerns, and degree of design conservatism all require consideration in deciding both what to measure and how to measure. With that understanding, the purposes of this manual are to consider the following:

- Recognizing vulnerabilities affecting dam performance,
- Identifying performance indicators,
- Understanding means and methods of measuring performance indicators,
- Planning and implementing a monitoring program,
- Acquiring data,
- Managing, presenting, and evaluating data, and
- Making decisions and taking action.

Additional advances in monitoring technology will bring new and better means and methods for monitoring, but the principles outlined in this manual will have enduring value.

This manual is intended to be informative but not prescriptive. With its foundation and appurtenant works, each dam presents its own set of challenges. Deciding on how to monitor its behavior requires skill and judgment beyond the scope of this manual.

CHAPTER 1

INTRODUCTION

When you can measure what you are speaking about, and express it in numbers, you know something about it. . . .

Lord Kelvin

Welcome to *Monitoring Dam Performance—Instrumentation and Measurements*. This manual reviews the current state of practice for monitoring dam performance as part of the American Society of Civil Engineers commitment to serve the worldwide community of dam engineering professionals.

Monitoring dam performance is a global enterprise. Almost every country in the world has dams that are monitored for performance by their owners and engineers. Many countries have agencies with monitoring guidelines and regulations for safe practice. These include agencies such as the CWC in India, U.S. Federal Energy Regulatory Commission (FERC), China's Ministry of Energy, Canadian Dam Association, The Environment Agency in England and Wales, France's Permanent Technical Committee, and ANCOLD in Australia. The intent of this manual is to capture the fundamentals and current state of practice of instrumented measurements for monitoring dam performance in the global dam engineering community.

Dam-performance monitoring is a blend of visual surveillance coupled with instruments to measure indicators that answer a basic question: "How is this dam performing?"

Visual surveillance is the backbone of all performance-monitoring programs.

Monitoring of every dam is mandatory because dams change with age and may develop defects. There is no substitute for