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DEVELOPMENT SERIES

# REGULATORY FRAMEWORKS FOR DAM SAFETY

*A Comparative Study*

Daniel D. Bradlow, Alessandro Palmieri, and Salman M. A. Salman



# **Regulatory Frameworks for Dam Safety**

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# **Law, Justice, and Development**

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# **Regulatory Frameworks for Dam Safety**

## **A Comparative Study**

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## Foreword

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*Regulatory Frameworks for Dam Safety* was conceived and prepared in response to growing concern over the safety of dams. Given the large number of dams around the world, the safe operation of dams has significant social, economic, and environmental relevance. A dam failure can result in extremely adverse impacts, including a large-scale loss of human life. For countries with large stocks of dams, the issue of dam safety is critical.

The World Bank has long recognized the importance and relevance of this issue. As early as 1977, it issued Operational Manual Statement (OMS) 3.80, “Safety of Dams.” The OMS made it clear that failure of a dam as a result of natural phenomena or of inadequate design can have disastrous consequences and underscored the importance of dam safety. This OMS has been revised and reissued twice since 1977 to reflect the evolving thinking on dam safety issues. The current version of the Bank’s policy was issued in October 2001 (Operational Policy [OP] 4.37, together with Bank Procedure [BP] 4.37). Its application now goes beyond water storage dams and extends to tailings, slimes, and ash impoundment dams.

*The Report of the World Commission on Dams*, which was released in November 2000, highlighted, among other things, the importance of the safety of dams. The standards already set by the Bank for the safety of dams under its operational policy and procedure are no less stringent than those recommended by the World Commission on Dams.

OP 4.37, on safety of dams, is one of the 10 World Bank “safeguard policies.” These policies require that potentially adverse environmental and selected social impacts of Bank-financed projects be identified, and avoided, minimized, to the extent feasible, or mitigated and monitored. As such, the principal objective of the safeguard policies is that of “doing no harm.” At the same time, application of, and scrupulous compliance with, the safeguard

policies has demonstrated that their use can achieve much more than just avoiding harm. Going beyond compliance, and making development objectives the goal of the safeguard policies, is the Bank's current endeavor.

In this context, OP 4.37 recommends, where appropriate, as part of the policy dialogue with the borrowing countries, that Bank staff discuss any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in those countries.

*Regulatory Frameworks for Dam Safety* helps to achieve this overriding goal by providing a better understanding of dam safety, thus working to ensure compliance with the World Bank's safeguard policies and, by extension, to promote sustainable, equitable, and environmentally sound development. The present study examines the dam safety regulatory frameworks of 22 countries. It draws comparisons and highlights similarities among the various systems. Most important, it makes recommendations on how to improve dam safety, thereby improving the quality of life for people throughout the world.

The Legal Vice Presidency and the Environmentally and Socially Sustainable Development Network of the World Bank are pleased to offer this publication and hope it will serve as a useful guide for policymakers and technical experts, as well as civil society organizations—indeed all those working toward increased dam safety.

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## **Abstract**

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This study is a comparative assessment of the regulatory frameworks applicable to dam safety in 22 countries. It is divided into three parts. The first part is a description of the dam safety regulatory framework in each of the 22 countries. The countries were selected based on the availability of information about their dam safety regulatory frameworks. The second part of the study is a comparative analysis of these regulatory frameworks. The analysis attempts to highlight the main similarities and differences in the approaches adopted by the countries discussed in the first part of the study. The third part offers recommendations on what a regulatory framework for dam safety should contain. It lists essential elements that should be included in all dam safety regulatory frameworks, as well as elements that would be desirable to include in such regulatory frameworks. This part also identifies and discusses a number of emerging trends in dam safety. In this connection, this part of the study can be seen as providing a tool kit that can be used in formulating a regulatory framework for dam safety.

The study has seven appendices. Appendix IV contains a dam safety statute; appendix V is a dam safety regulation; and appendix VI is a sample operations, maintenance, and surveillance manual. These appendices are provided as examples of dam safety regulations and management. There are many other examples, and the inclusion of these particular samples in this study should not be interpreted as an endorsement of these models over other models.



## Acknowledgments

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Last, we would like to acknowledge the assistance of, and funding from, the Bank-Netherlands Water Partnership Program for the preparation of this study, and to thank the colleagues who facilitated such assistance and funding.



## Acronyms and Abbreviations

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AAR	alkali aggregate reaction
ANA	National Water Agency ( <i>in Brazil</i> )
ANCOLD	Australian National Committee on Large Dams
ANEEL	Energy Regulatory Agency ( <i>in Brazil</i> )
ASDSO	Summary of State Dam Safety Officials ( <i>in the United States</i> )
BP	Bank Procedure
CDA	Canadian Dam Association
CE	chief executive
CSD	Commission for Safety of Dams ( <i>in Portugal</i> )
CWC	Central Water Commission ( <i>in India</i> )
DSA	Dam Safety Act ( <i>in Finland, India</i> )
DSC	Dam Safety Committee
DSCP	Dam Safety Code of Practice ( <i>in Finland</i> )
DSD	Dam Safety Decree
DSO	Dam Safety Organization
DUC	dam under construction
DWAF	Department of Water Affairs and Forestry ( <i>in South Africa</i> )
EDSC	External Dam Safety Committee ( <i>in Ireland</i> )
EPP	Emergency Preparedness Plan
ESB	Electricity Supply Board ( <i>in Ireland</i> )
FDSS	Federal Dam Supervisory Section ( <i>in Austria</i> )
FEMA	Federal Emergency Management Agency ( <i>in the United States</i> )
FERC	Federal Energy Regulatory Commission ( <i>in the United States</i> )
FMAF	Federal Ministry of Agriculture and Forestry ( <i>in Austria</i> )
GACG	Governmental Action Command Group ( <i>in Norway</i> )
ICOLD	International Commission on Large Dams
IDA	International Development Association

IDF	inflow design flood
LDSSC	Large Dam Safety Supervision Center ( <i>in China</i> )
MPW	Ministry of Public Works
MWAF	Minister of Water Affairs and Forestry ( <i>in South Africa</i> )
NDCD	National Department of Civil Defense ( <i>in Portugal</i> )
NDSC	National Dam Safety Committee
NDSPA	National Dam Safety Program Act
NIW	National Institute of Water ( <i>in Portugal</i> )
NLEC	National Laboratory of Civil Engineering ( <i>in Portugal</i> )
NVE	Norwegian Water Resources and Energy Directorate
NWC	National Water Commission ( <i>in Mexico</i> )
NZSOLD	New Zealand Society of Large Dams
OMS	Operational Manual Statement
OMS Manual	Operations, Maintenance, and Surveillance Manual
OP	Operational Policy
ORSEP	Organismo Regulador de Seguridad de Presas ( <i>in Argentina</i> )
PAR	population at risk
PCA	Pollution Control Act ( <i>in Norway</i> )
PREPA	Puerto Rico Electric Power Authority
RA	Reservoirs Act ( <i>in the United Kingdom</i> )
REC	Regional Environmental Center ( <i>in Finland</i> )
RMA	Resource Management Act ( <i>in New Zealand</i> )
SERCON	Chef des Services du Control ( <i>in France</i> )
TOR	terms of reference
TR	Technical Regulation
TT	task team
TVA	Tennessee Valley Authority ( <i>in the United States</i> )

## INTRODUCTION

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This study is a comparative assessment of the regulatory frameworks applicable to dam safety in 22 countries.<sup>1</sup> The purpose of the study is to provide information to policymakers and technical experts in countries that are planning to develop new or to modify existing regulatory frameworks for dam safety. The study should also be of interest to two other groups. The first is policymakers and technical experts who are interested in learning more about current approaches to the regulation of dam safety around the world. The second is that group of people who are trying to decide whether it is a worthwhile exercise for their countries to design a regulatory framework for dam safety.

The International Commission on Large Dams (ICOLD) estimated that by the end of the last century there were over 45,000 large dams.<sup>2</sup> More than half of those dams are located in developing countries, and a number of those countries are currently engaged in extensive dam-building programs. Thus, the subject of dam safety becomes an important one for a number of reasons. First and most obviously, it is essential that each dam owner be able to ensure that its dams are safe and do not pose an unacceptable risk to life, human health, property, or the environment. Second, dam safety directly influences the sustainability of dam projects and the extent of their potential environmental and social impacts. Consequently, dam safety is an important consideration at all stages of the dam's life cycle. Third, dam safety is relevant

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1. Those 22 countries are: Argentina, Australia, Austria, Brazil, Canada, China, Finland, France, India, Ireland, Latvia, Mexico, New Zealand, Norway, Portugal, Romania, the Russian Federation, South Africa, Spain, Switzerland, the United Kingdom, and the United States.

2. See International Commission on Large Dams, *World Register of Dams* (ICOLD 1998) (computer database). ICOLD defines a large dam as a dam (i) with a height of 15 meters or more from the foundation, or (ii) with a height between 5 and 15 meters, with a reservoir volume of more than three million cubic meters.

to a state's ability to comply with its international obligations. A failure to pay adequate attention to dam safety can cause a country to violate its obligations under existing international treaties and conventions, such as those relating to transboundary watercourses and the environment. It can also have an adverse impact on the state's ability to perform its international financial obligations, thereby undermining its overall development strategy.

Another reason that dam safety is a matter of such importance is that in many countries, there is now a substantial stock of dams whose failure could have significantly adverse social, economic, and environmental consequences. In these countries, the safety of existing dams is a matter of great concern. In fact, it may be the most important issue related to dams in these countries because they are no longer building many new dams or because the state of the existing dams poses a safety problem.

For the purposes of this study, "dams" refers to water storage dams used in hydropower, water supply, irrigation, flood control, or multipurpose projects.<sup>3</sup> Many of the points made in this study will be relevant to other dams, such as tailings and slime dams for mine projects and ash impoundment dams used with thermal power plants. However, in some countries different regulatory regimes may be applicable to these other types of dams, and this study did not focus on these different regimes. Consequently, the conclusions of this study may not be directly applicable to these other types of dams.

"Dam safety," as used in this study, can be understood as referring to the factors that influence the safe operation of the structure of the dam and the appurtenant structures, and the dam's potential to adversely affect human life, human health, property, and the environment surrounding it. This means that dam safety is also concerned with the adequacy of the operations and maintenance of the dam, as well as its plans for dealing with emergencies and with limiting the adverse impact of existing dams on human life, human health, property, and the environment.

This study is divided into three parts. The first part is a description of the dam safety regulatory framework in each of 22 countries. The second part of

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3. This definition is based on the definition used in World Bank, *Operational Policies and Bank Procedures: Safety of Dams (OP and BP 4.37, Oct. 2001)* in *The World Bank Operational Manual* <<http://wb1n0018.worldbank.org/institutional/manuals/opmanual.nsf>>. See appendices I, II, and III of this study. It should be noted, however, that OP and BP 4.37 apply to tailings, slime, and ash impoundment dams. The scope of this study is confined to water storage dams.

the study is a comparative analysis of these regulatory frameworks. The third part contains the recommendations of the study on what a regulatory framework for dam safety could contain. These include the essential elements that should be included in all dam safety regulatory frameworks, as well as elements that would be desirable to include in such a regulatory framework. This part also describes and analyzes some emerging trends in the regulation of dam safety.



## **PART ONE**

### **Country Study of Regulatory Frameworks for Dam Safety**

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This part of the study describes and analyzes the regulatory frameworks for safety of dams in 22 countries. It specifies the law, decree, or regulation that deals with the matter and discusses the institutional arrangements for implementing such a framework, as well as the enforcement procedures and mechanisms.

#### **Argentina**

The regulatory framework for dam safety in Argentina consists of an administrative decree, which creates the Organismo Regulador de Seguridad de Presas (ORSEP), or dam safety regulatory body. The ORSEP is an independent regulatory agency within the Secretariat for Water Resources. It replaces the ORSEP Comahue, which was established in 1993, and three transitional commissions on dam safety. The function of the ORSEP is to oversee dam safety issues in the design, construction, maintenance, and operation of privatized hydroelectric projects.

The ORSEP has police powers to deal with dam safety issues. This means that the ORSEP has the power to develop norms and technical directives relating to dam safety, to compile statistics on dams, to provide assistance to government bodies that request its assistance, and to collaborate with other bodies working on dam safety. It has the power to enforce the law relating to dam safety and to intervene in legal and judicial proceedings relating to dam safety. The ORSEP provides certificates of approval for works within its jurisdiction and is responsible for evaluating the performance of dam licensees and concessionaires. It is also responsible for evaluating the performance of dam licensees and concessionaires. The ORSEP finances its activities through fees and monthly charges paid by the entities that it regulates.

Dam licensees' contracts include obligations relating to dam safety. These include developing and maintaining environmental assessment plans, regular

monitoring and evaluating of dam performance, and periodic inspections by independent consultants. In addition, the owners of dams are required to maintain a current emergency action plan. This plan must be approved by the ORSEP. The owner must keep a copy of the plan.

The highest authority in the ORSEP is the Technical Council. This body consists of the heads of the four regional offices of the ORSEP and a chair. The president of Argentina appointed the first members of this council. However, it is expected that in the future the members of the council will be chosen in a competitive election. There are four regional offices under this council. These offices have independent technical and institutional responsibilities. Each is headed by a regional director, and there is a director for each province subject to the jurisdiction of the regional office (there can be more than one province per regional office). The ORSEP is required to provide an annual report to the government on the structural and operational condition of the 32 privatized dams in Argentina.

It is important to note that there are an additional 70 nonprivatized dams in Argentina. These dams belong to the provinces and are not subject to any national or federal dam safety regulatory framework.

## **Australia**

In Australia, dam safety is a state matter. This means that the relevant regulation can be found at the state level. Currently, there are three states that have dam safety regulations. These are New South Wales, Queensland, and Victoria. The information on Australia is drawn from the laws in these three states and the 1994 Australian National Committee on Large Dams (ANCOLD) Guidelines on Dam Safety Management.

### *New South Wales*

The Dams Safety Act (DSA) in New South Wales creates a Dams Safety Committee (DSC) that functions under the direction and control of the minister responsible for administering the act. The DSC consists of eight part-time members, seven of whom are experienced in dam engineering. Pursuant to section 8 of the DSA, they are selected in the following manner: four are nominated by statutory bodies dealing with water and power; one is nominated by the minister responsible for administering the Public Works Act; one by the minister administering the Mining Act; and two persons are

nominated by the Australian Institution of Engineers. The minister appoints the chair of the DSC.

The functions of this committee are to maintain surveillance over “prescribed dams” to ensure their safety; to investigate the location, design, construction, reconstruction, extension, modification, operation, and maintenance of prescribed dams; to obtain information and keep records relating to dam safety matters; to formulate measures to ensure safety; to make reports to the minister on the safety of prescribed dams; and to make recommendations on adding new dams to the list of prescribed dams. It should be noted that the “prescribed dams” are all those dams listed in schedule 1 of the DSA. This schedule lists the names and locations of all prescribed dams; it does not establish any criteria for determining whether a dam is prescribed.

The DSC also regulates mining activities under or in the near vicinity of dams and their reservoirs in order to ensure that such mining does not jeopardize the safety of the dam or the security of the reservoir. In accordance with the provisions of the Mining Act, the DSC enforces this regulation by advising the minister responsible for administering the Mining Act on conditions to be attached to the mining leases granted for mining under and around dams and reservoirs.

The DSC has the power, by written notice, to require the owners of a prescribed dam to make observations, take measurements, and keep records regarding the operation and maintenance of prescribed dams and their environment, and to provide this information and these records to the DSC. The DSC has the power to undertake these activities itself if the owner fails to do so. It can then recover the costs of its activities from the dam owner. Another power of the DSC is to authorize inspections of prescribed dams. The person undertaking these inspections is authorized to enter the land where the dam is located after giving reasonable notice to the dam owner. The owner must be compensated for any damage caused in the course of the inspection. If the DSC thinks a prescribed dam is unsafe or is in danger of becoming unsafe, it may, by written notice, require the dam owner to take specific actions, or to refrain from acting, so as to ensure the safety of the dam. In addition to those inspections initiated by the DSC, the minister can direct the DSC to conduct inquiries into any matter relating to the safety of a prescribed dam. In conducting this inquiry, the committee, subcommittee, or person appointed to conduct the inquiry can request all information, evidence, and records, and can order people to attend the inquiry and produce information.

The DSA also has provisions dealing with emergencies. These provide that if there is a dam failure or the minister believes that a prescribed dam could fail, the minister, whether or not on the DSC's recommendation, can declare a state of emergency in respect of the prescribed dam. This state of emergency allows the DSC, acting with the approval of the minister, to take control of the dam, release water from the dam, carry out works on the dam, or demolish and remove the dam. The DSC can recover the costs of these activities from the dam owner. According to sections 25 and 28, the DSC is empowered to appoint other public authorities or single members of the DSC to act as its agents and carry out dam safety activities for prescribed dams. It can also enter into agreements with other ministers of any state or of the Commonwealth, a university, or any other person or body to conduct investigations, studies, or research on dam safety issues. Violation of the act is an offense that can lead to trial in local courts and the imposition of a penalty.

There is further legislation in New South Wales applying to dams owned by local government authorities. The relevant provisions are found in the Local Government Act and were first enacted in 1974. These provisions are presently administered by the New South Wales Department of Land and Water Conservation, acting on behalf of the responsible minister.

### *Queensland*

In Queensland, the Water Resources Act of 1989 was superseded by the Water Act of 2000. All "referable dams" are subject to the jurisdiction of the Water Act and the chief executive (CE) of the state Department of Natural Resources and Mines, who is the party responsible for the safety of referable dams. Under the terms of the dam safety provisions of the Water Act, a dam is referable if an accepted failure impact assessment demonstrates that there will be a population at risk (PAR) in the event of dam failure.

Part 6 (sections 480–500) of the Water Act requires a person who proposes to construct a dam that meets the specified size criteria to conduct a failure impact assessment. The criteria are that the dam be more than eight meters in height and have a storage capacity greater than 500,000 liters, or be more than eight meters in height and have a storage capacity of at least 250,000 liters and a catchment area no more than three times its maximum surface area at full supply level. If a dam is below these height and volume limits and the CE reasonably believes the dam would be referable, the CE has the power to issue an order requiring the owner to assess the dam's failure impact.

A failure impact assessment is an assessment of the safety of the dam carried out and certified by a registered professional engineer, in accordance with guidelines issued by the CE. The purpose of the failure impact assessment is to determine the population at risk if the dam fails. Dams that have a PAR of fewer than two people will have no failure impact rating. Those that have a PAR of 2 to 100 people will be rated as category 1, and those that have a PAR of more than 100 people will have a category 2 failure rating.<sup>4</sup> The failure impact assessment is submitted to the CE who can accept, reject, or require a review of the assessment. In the case of category 1 dams and non-referable dams, the dam owner must repeat the failure impact assessment every five years.

The owner must pay the cost for preparing and certifying the failure impact assessment. However, if the CE has issued a notice requiring a failure impact assessment and the assessment reveals that the dam has no PAR, the department will pay the reasonable costs of carrying out the assessment. In the event that the dam has a PAR of more than two people, the dam owner must pay for the assessment.

The CE has the power to impose dam safety conditions on referable dams. Such conditions are designed to control the design, construction, alteration, repair, maintenance, operation, abandonment, and removal of all referable dams. They also typically require the preparation of an emergency action plan for the dam to cover a range of potential failure events. These requirements are applied as conditions relating to dam safety of any resulting development permit.

If the CE reasonably believes that it is in the interest of dam safety to do so, he or she can reassess and change the safety requirements in light of subsequent failure impact assessments. An example of the type of event that might trigger such a reassessment is a change in the technique for estimating the probable maximum precipitation.

The CE has the power, by written notice, to order dam owners to carry out emergency actions to prevent or minimize the impact of dam failure. Such

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4. Peter Allen, the director of the Dam Safety (Water Supply) Office in the Queensland Department of Natural Resources and Mines, estimates that the new rating system will reduce the size of the Queensland referable dam portfolio from 1,500 to 300. However, he expects that this will lead to improved management of the state dam portfolio. See Peter Allen, *A New Regulatory Framework for Dams in Queensland* (paper prepared for NZSOLD/ANCOLD 2001 Conference on Dams) (copy on file with authors).

notices also attach to the land and bind the owner and future owners of the land. If these notices are not complied with, the CE has the power to perform the work and recover the associated costs from the owner. The CE can also require the owner to give information, plans, and reports on inspections and other documents on the dam to the CE.

The CE “may from time to time” require that the preparation of designs, plans, and specifications for initial construction or subsequent alteration, repair, maintenance, operation, removal, or abandonment of a dam be under the control and direction of a “suitably qualified person experienced in the design and construction of dams.” The qualifications of the person must be satisfactory to the CE. Under the Water Act, the requirements of the “suitably qualified person” are drawn from the Professional Engineers Act of 1988.

Pursuant to section 496.1 of the Water Act, the dam owner must prepare a flood mitigation manual, if so required.<sup>5</sup> The manual must be submitted to the CE for approval. The CE may request the advice of the advisory council before approving the manual. The CE’s approval is valid for no more than five years. Thereafter it must be reviewed by the owner and then resubmitted for the CE’s approval.

Pursuant to section 500, the state and the CE are not liable for the consequences of a failure that occurs in any dam which the CE has approved for construction, operation, maintenance, alteration, repair, or abandonment. This means that the dam owner always remains responsible for the safety of the dam.

### *Victoria*

The primary law applicable to dam safety in Victoria is the Water Act of 1989.<sup>6</sup> The dam safety principles incorporated into the Water Act are that dam owners are responsible and liable for damage caused by their dams and that potentially hazardous dams need to be designed, constructed, operated, and maintained according to appropriate standards and best practices relating to dam safety.

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5. This is only done in the case of major dams with significant capacity to vary flood discharges.

6. There are also two other laws that are applicable to tailings and other dams related to projects in the mining and extractive industries sectors. These statutes are the Mineral Resources Development Act of 1990, and the Extractive Industries Development Act of 1995.

Pursuant to sections 16 and 18 of the Water Act, the dam owner is liable for any damage that results from water flow from the dam. Section 67 stipulates that dam licenses, which are required to construct, alter, operate, remove, or abandon works on a waterway, can be made subject to a range of conditions including dam safety requirements. The conditions that can be attached to a license are set out in section 71 of the Water Act. According to this section, conditions can include standards of construction, future operation and maintenance, and the qualifications of persons undertaking these works. Section 78 allows the minister to issue ministerial directions that require an owner of a dam on a waterway to operate works in a particular way or to alter the works.

The Water Act also grants the responsible minister the power to intervene and issue directions relating to inspections and dam safety. Pursuant to section 80 the minister can require dam owners to make specified improvements or to take other measures to make a dam safe. If the dam owner fails to comply with the minister's directions, section 81 of the Water Act allows the minister to carry out works and recover costs. The Water Act provides for penalties for those who fail to comply with its provisions.

The Water Act requires owners of large dams to submit their designs, surveillance plans, and emergency management plans, certified by a qualified engineer, to the licensing authorities. The operating licenses for these dams, for which private operators must pay a fee, are generally issued for a period of five years. A qualified engineer must review the dam surveillance program during the license renewal process. The Water Act also requires dam owners to supply the emergency coordinating agency with a copy of their emergency management plans.

It should be noted that in addition to the license issued pursuant to the Water Act, the planning law in Victoria requires a prospective dam owner to obtain a planning permit from a local government body before constructing a dam.

The Department of Natural Resources and Environment, which is not dedicated exclusively to dam safety issues, administers the minister's powers under the Water Act. This department maintains a comprehensive dams database, which includes nearly all referable and large dams in the state.

*ANCOLD Guidelines on Dam Safety Management*

The Australian National Committee on Large Dams (ANCOLD) issued its Guidelines on Dam Safety Management in 1994. These guidelines apply only to “referable dams,” which ANCOLD defines as dams that are either 10 meters or greater in height and have a storage capacity of at least 20,000 cubic meters, or that are more than 5 meters in height and have a storage capacity of at least 50,000 cubic meters. The guidelines are not applicable to tailings dams. They are useful in setting out some general considerations for dam safety programs. According to ANCOLD, there are a number of key elements in a dam safety program. The first is that the program should clearly identify the responsibilities of the dam owners, the government, and the dam personnel. Second, it should make the public aware of dams and dam safety issues, and the appropriate parties should consult with the public about its concerns relating to dam safety. Third, the program should ensure that the parties involved have the appropriate expertise. Fourth, the program should designate someone as being responsible for maintaining information about the dam for public reference and for use in future investigations, surveillance, and reviews. Fifth, the program should include measures to train dam personnel in the procedures for handling possible emergencies. Sixth, the program should have a quality management program that covers all aspects of dam design, construction, and operations. Seventh, the program should allow for periodic review and, if necessary, revision of dam safety policies and procedures.

ANCOLD suggests that the role of government is to enact legislation that stipulates who has the regulatory authority and responsibility to ensure that dam owners are taking appropriate actions with regard to dam safety. This legislation should include the criteria for classifying dams. The regulatory authority should also have the power to ensure that the dams are designed and operated in accordance with currently accepted standards relating to dam operation, maintenance, and surveillance. ANCOLD also suggests that the authorities need to maintain a register of dams that includes information on the size, type, purpose, location, hazard category, designer, owner, and year of completion of the dam. Finally, ANCOLD contends that even though the dam owner is primarily responsible for dam safety, there is a need to monitor and audit dam safety to ensure it remains effective.

ANCOLD maintains that the dam owner is primarily responsible for the safety of the dam. This means that the owner has a number of obligations.

The first is to provide sufficient resources to meet the safety program requirements. Second, the owner must ensure that each dam is operated and maintained in a safe manner. Third, the owner must know the hazard category of the dam and is responsible for having the classification regularly reviewed. Fourth, the owner must implement an appropriate dam surveillance program. Fifth, there should be dam emergency plans that include information about warning systems and inundation maps. The plans should be made available to the appropriate emergency authorities. These plans should be tested annually by dam personnel, and at least every five years a drill should be conducted that is coordinated with all relevant state and local officials. The plan should also be reprinted and distributed to all parties at least every five years. Sixth, the personnel engaged to work on and inspect dams during all stages of their life cycle should have suitable qualifications and levels of experience. Seventh, the owner should ensure that the regulators and other relevant parties have the following information: the dam's emergency plan, operating procedures, operations and maintenance manuals, inspection and evaluation reports as well as construction drawings of the dam, data books, design reports, construction reports, and safety reviews. This means that they should have sufficient information on the dam so that no further investigations are needed to resolve any technical issues that may arise. This information should also be maintained in a permanent archive.

ANCOLD also suggests that in addition to dam owners, populations at risk, owners of property at risk, and those with an interest in maintaining community infrastructure facilities and the environment should also be involved in dam safety. Thus, the public should be consulted about alterations to dams and their operations.

ANCOLD makes a number of suggestions about the content of dam safety programs. First, the scope of the program should be based on the size of the dam and its storage capacity, hazard category, level of risk, and the value of the dam to the owner. Second, dam surveillance should be based on inspections, monitoring, collection of information relating to dam performance, and the evaluation and interpretation of observed data and surveillance reports. There should also be an independent review of the surveillance program. The dam safety evaluations should as far as possible be made by a dam engineer who is familiar with the detailed history of the dam and its performance to date.

## **Austria**

The relevant statute for dam safety in Austria is the Federal Water Law.<sup>7</sup> Pursuant to this law, dams with a height greater than 30 meters or a volume greater than 500,000 cubic meters, dams on the Danube, and dams that significantly affect water affairs in other countries are subject to the jurisdiction of the Supreme Water Authority in the Federal Ministry of Agriculture and Forestry (FMAF). Other dams are subject to either provincial or district government regulation. The FMAF has a Federal Dam Supervisory Section (FDSS), which examines the dam owner's annual safety reports and carries out inspections of dams subject to the jurisdiction of the FMAF. The FDSS is assisted by the Austrian Commission on Dams, which provides background information to the FDSS and passes judgment on, among other things, the safety of dam projects.

The dam owner has the primary responsibility for dam safety. In the case of dams subject to the jurisdiction of the FMAF, the dam owner must appoint qualified civil engineers with sufficient authority to oversee dam safety.

Dams must comply with current engineering practices. The approval process for dam projects involves a public hearing and, in the case of dams subject to the jurisdiction of the FMAF, the approval of the Austrian Commission on Dams. Since dam projects are expected to comply with the current state of the art, there are very few technical standards included in the applicable law.

The Water Authority (at the appropriate governmental level) supervises construction of the dam. Before it will authorize the filling of the dam, the Water Authority conducts a preliminary technical examination of the dam. After some time, when sufficient data to make an informed judgment are available, the Water Authority conducts a final examination, after which it issues a final decree of acceptance. This decree allows for the normal operation of the dam.

The operational rules of the dam are defined in the preliminary and final decrees of acceptance. The monitoring and surveillance of the dam involves periodic visual inspections, regular measurements, and data collection. It also involves annual inspections by the dam safety engineer. Every 10 years, the

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7. The information in this section is derived from *Dam Legislation* (European Club of ICOLD Feb. 2001).

reservoir of the dam is drawn down, and there is a comprehensive inspection of the dam's safety. In the case of dams subject to the FMAF, the Dam Supervisory Section conducts this overall safety assessment.

The law requires that experts with "sound engineering judgment" undertake all inspections. The inspector should also be independent of the dam owner. The dam safety engineer who is appointed by the dam owner must report to the authorities after each annual inspection in the case of dams subject to the jurisdiction of the FMAF. In the case of FMAF dams, the dam supervisory officer conducts an annual review on behalf of the relevant provincial governor. This is in addition to the 10-year inspection described above.

The relevant information on the design, construction, and operation of a dam must be collected systematically. The dam safety engineer must be informed of all extraordinary events. Most large dams have emergency plans to deal with dam failures.

### **Brazil**

Although there have been several attempts in the past to develop legislation on dam safety, Brazil currently has no such legislation at either the federal or the state level.<sup>8</sup> However, in 1999, the São Paulo branch of the Brazilian Committee on Dams published a *Basic Guide on Dam Safety* based on the *Dam Safety Guidelines* published by the Canadian Dam Association. These guidelines have become a general reference for dam owners and engineers in Brazil.

Recently, there have been some movements that may result in a Brazilian dam safety statute. The Energy Regulatory Agency (ANEEL) has requested all public and private utilities to provide it with updated and basic information on the status and operations of dams associated with hydropower plants. In addition, the new National Water Agency (ANA) has asked the Brazilian Committee on Dams to work with it on a project that is expected to result in a draft national dam safety law.

### **Canada**

In Canada water resources management is a provincial responsibility. In the absence of specific provincial legislation on dam safety, the *Dam Safety*

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8. This section is based on information provided in a communication from G. V. Canali to the authors.

*Guidelines*, issued by the Canadian Dam Association (CDA) in January 1999, are treated as evidence of best practice. The guidelines suggest that the responsibility for all aspects of dam safety must be clearly defined and the delegation of authority must be documented. They state that normally the dam owner has responsibility for dam safety, which means that the owner is responsible for ensuring that dam safety reviews and all required safety improvements are carried out by knowledgeable and qualified people. This means that the review should be carried out under the direction of a professional engineer who is qualified in the design, construction, performance evaluation, and operation of dams. This person is responsible for providing the results of the dam safety review in a dam safety report.

The owner is also responsible for preparing an emergency preparedness plan. The CDA suggests that the dam owner should also inform the public about safety and involve the public in resolving dam safety issues.

The CDA recommends that the safety review should identify reference points against which comparisons can be made so that it is possible to test if the dam's actual performance complies with internal policies, CDA guidelines, and best practices.

The CDA proposes that the responsibilities of the regulatory agencies should be clearly defined. These responsibilities can include maintaining an inventory of dams, requiring dam owners to provide periodic dam safety reports, adopting substantive standards for dam safety, requiring remedial action based on the recommendations of the engineer who conducts the dam safety review, establishing the timing of dam safety reviews, and inspecting dams. The regulatory authority should also have the power to accept or reject dam safety reports in written and reasoned statements.

The CDA also suggests that dams should be classified according to the consequences of their failure, the physical characteristics of the dam, and the perceived probability of their failure. This classification should provide the basis for determining the level of surveillance activity.

The CDA also discusses the content of dam safety reviews. It argues that these reviews should include the design, operation, maintenance, surveillance, and emergency plans and should be intended to determine if they are safe in all respects. If not, the review should seek to determine what safety improvements are required. The first inspection should be made before the initial filling of the dam in order to establish baseline data. There should be

regular inspections thereafter. These include weekly or monthly inspections conducted by the dam's staff and annual or semiannual intermediate inspections performed by appropriate representatives of the owner. In addition, there should be more comprehensive dam safety reviews, the first of which should be completed within three years of filling. This review should include an inspection of the dam structures, an assessment of its performance, and a review of the original design and construction records to ensure they meet current standards. A qualified engineer who was not involved in the design or construction of the dam and is not involved in the normal inspections of the dam should conduct this review. The level of detail of the review should be consistent with the importance, design conservatism, and complexity of the dam, as well as with the consequences of failure.

After this first review, comprehensive dam safety reviews should occur every 5 to 10 years, depending on the consequences of dam failure. These reviews should include site inspections, a review of the dam's design and construction to see if they meet current standards, a review of operations and maintenance procedures, testing instrumentation for data collection, surveillance and monitoring of the dam's emergency preparedness, and checking for compliance with the recommendations of previous reviews. At the conclusion of the review, the reviewing engineer should produce a report that addresses all aspects of the review and identifies any additional actions required for safe operation, maintenance, and surveillance of the dam.

The guidelines also propose that each dam should have an Operations, Maintenance, and Surveillance Manual (OMS Manual) that spells out the procedures for OMS.<sup>9</sup> This manual should provide adequate information to allow safe operation and to define the chain of operational responsibilities. The OMS Manual should be reviewed annually. It should also ensure that adequate records are kept on matters such as operations and operating conditions.

Finally, dams need emergency preparedness plans that include notification processes. The plans, which should be in writing, should identify the procedures and processes that dam operators should follow in case of emergency. Normally, provincial or local governments would have the responsibility to warn residents of hazardous situations based on information provided by the dam owner or operator. The dam owner is responsible for linking

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9. This OMS Manual is included as appendix VI to this study.

dam surveillance with emergency response procedures. These can include direct warnings from the owner or operator to downstream communities. It is important to note that the absence of government regulation or regulators does not negate the owner's responsibility for dam safety and emergency preparedness. The level of detail in the emergency plan should be determined by the degree of potential impact of the emergency. There should be periodic testing of the emergency preparedness plans.

Alberta, British Columbia, Ontario, and Quebec are the only Canadian provinces with specific dam safety legislation.

### *Alberta*

The applicable laws for dam safety in Alberta are the Dam and Canal Safety Regulations of 1978, as revised in 1998; the Dam Safety Guidelines of 1975; and the 1995 Dams Safety Guidelines of the CDA. There is a dam safety branch in the Alberta Environmental Protection Agency that is responsible for the regulation of dam safety. This branch reviews applications for new dam licenses. It also compiles and updates the Inventory of Dams. The director of this branch can require dam owners to prepare emergency preparedness plans and OMS Manuals. The dam safety branch carries out audit inspections accompanied by the dam owner and related consultants. The director of the branch can require that the dam owner have an independent professional engineer carry out regular safety reviews. The owner conducts its own routine inspections and data collection activities. In the case of major dams and depending on the size of the dam, the dam safety branch, the owner, and their consultants prepare a comprehensive independent dam safety report. In the case of government-owned dams, the five-year review is carried out by an external consultant. The Dam and Canal Safety Regulations contain provisions that specify whom the owner must notify and the steps that must be taken in the case of hazardous conditions.

### *British Columbia*

In February 2000, the government of British Columbia issued its Dam Safety Regulations.<sup>10</sup> The regulations are applicable to all dams that are more than

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10. Regulations B. C. 44/00 (Feb. 11, 2000). These regulations are included as appendix V to this study.

one meter in height and have an impounding capacity of more than 1,000,000 cubic meters, or more than 2.5 meters in height, and have an impounding capacity greater than 30,000 cubic meters, or are more than 7.5 meters in height. It also contains provisions applicable to low-capacity dams. In the case of dams classified as high or very high consequence, the dam owner must prepare and submit to the dam safety officer for approval both an emergency preparedness plan and an OMS Manual. Low-hazard dams only need to submit the OMS Manual.

The dam owner is responsible for carrying out regular inspections of the dam and for installing the required equipment. The frequency of the inspections varies according to the classification of the dam. They can vary from weekly site surveillance to reviews of the OMS plans every 7 to 10 years. The owner must record the results of these inspections and submit them to the dam safety officer, together with documentation relating to the design, construction, or alteration of the dam. The dam safety officer can also request information needed to evaluate the condition or hazard potential of a dam.

Professional engineers must conduct all dam safety reviews. The regulations are silent about whether a professional engineer must be responsible for other inspections. The regulations specify whom the dam owner must contact in case of hazardous conditions and what actions the owner must take.

### *Ontario*

Dam safety in Ontario is governed by the Lakes and Rivers Improvement Act and the guidelines issued pursuant thereto. In 1977, the Ministry of Natural Resources, which is responsible for administering this act, issued the Lakes and Rivers Improvement Act Guidelines, which are applicable to dams in Ontario. These guidelines address construction of dams, as well as operational and safety issues. In January 2000, the relevant branch of the ministry appointed a task force to help it develop dam safety guidelines. In August 2000, the task force issued its report, which included a number of conclusions.<sup>11</sup> First, it concluded that there should be one standard for public safety policy that is applicable to all dams. In the case of dams that cannot meet this standard, the dam owners should be offered an opportunity

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11. Ontario Dam Safety Guidelines Task Force, Ontario Ministry of Natural Resources, *Summary Report* (Aug. 23, 2000) <[www.cda.ca/ontario/summary\\_report.html](http://www.cda.ca/ontario/summary_report.html)>.

to develop acceptable risk management plans to demonstrate how they will manage the increased risk to dam safety. Second, there should be one set of safety standards for both new and existing dams. If existing dams cannot meet these standards, they need to develop risk management plans to demonstrate how they will manage the increased risk. Third, environmental criteria should be considered in determining the hazard classification of the dam. Fourth, the risk management plans of dams that do not meet the safety standards should be subjected to independent review. Dams that do meet the safety standards should be subjected to independent review only if the regulator so requires. Fifth, the inflow design flood should be based on a simple approach that is linked to the hazard classification of the dam and its height and storage capacity. Sixth, government oversight of dam safety should be required in the case of dams that do not meet the current safety requirements, and there should be a selective audit of only those that do meet the current safety standards.

### *Quebec*

Dam safety in Quebec is governed by the Dam Safety Act, which was adopted by Parliament on May 23, 2000. The act is applicable to all “high-capacity” dams, which are those that are more than one meter in height and have an impounding capacity of more than 1,000,000 cubic meters, are more than 2.5 meters in height and have an impounding capacity greater than 30,000 cubic meters, or are more than 7.5 meters in height. It also contains provisions applicable to low-capacity dams. The construction, alteration, or removal of a high-capacity dam requires the approval of the minister of the environment. The minister’s approval is based on a submitted application that must contain the plans for the dam and be prepared by an engineer. The engineer must certify that the plans conform with the government’s safety standards. The minister classifies all high-capacity dams according to the risk that they present to persons and property. Each high-capacity dam must undergo a safety inspection by an engineer at regular intervals that cannot exceed five years. The report on the safety review must be forwarded to the minister. If the owner fails to conduct these periodic reviews, the minister can have the review carried out at the owner’s expense. The owner must maintain a register for the dam that contains the information from the safety reports. The register must be available for inspection by the minister. The minister has the

power to set application fees for people seeking approval to construct or modify dams, as well as annual fees for dam owners. The annual fees should cover the cost of administering the act and regulations. The minister can also impose fines that cannot exceed Can\$500,000 for violators of these regulations.

### **China**

China has a number of laws and regulations dealing with dam safety.<sup>12</sup> The Flood Control Law (August 29, 1997) appears to impose on all units and individuals the duty to prevent floods. The Water Law (January 21, 1988) provides for inspections and administrative rules about water issues. The State Council issued the Reservoir Dam Safety Regulations (July 2, 1991) and the Flood Fighting Regulations (July 2, 1991). The Ministry of Water Resources issued the Reservoir Dam Safety Certification Regulations (March 20, 1995). The Ministry of Power Industries issued the Hydropower Station Dam Safety Management Regulations (January 1997), while the Ministry of Energy has issued the Detailed Rules on Hydropower Station Dam Safety Inspection (August 1988).<sup>13</sup>

According to Gong Zhenghua and others, dams in China are divided into those for water resources, which are under the jurisdiction of the Ministry of Water Resources, and those for power generation, which are under the jurisdiction of the State Power Corporation. Both of these were previously under the Ministry of Water Resources and Electric Power. In the provinces, the electric power bureaus are responsible for the management of dams associated with their hydropower stations, while the power plants themselves are responsible for dam operation. This means that there are three levels for dam safety management: ministry, province, and power plant.

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12. The information in this section is drawn from a secondary source, Gong Zhenghua and others, *Chinese Dam Safety: Philosophy and Practice in International Water Power and Dam Construction* 14–17 (Dec. 1999).

13. Other applicable laws and regulations include: Reservoir Dam Registration Regulations (Ministry of Water Resources, December 28, 1995, and revised on December 26, 1997); General Dispatching Guidelines on Multipurpose Reservoirs (Ministry of Water Resources, December 1, 1993); Care and Maintenance Specifications of Embankment Dam (SL210-98, December 23, 1998); Regulations of Data Compilation for Embankment Dam Safety Monitoring (SL169-96, January 1, 1997); Technical Criteria on Embankment Dam Safety Monitoring (SL 60-94, August 27, 1994). These laws and regulations are available only in Chinese. This information was provided by Xiaokai Li of the World Bank office in Beijing.

In addition, there are two committees with responsibility for dam safety. These are the Large Dam Safety Supervision Center (LDSSC), which was set up by the State Power Corporation in 1985, and the Dam Safety Management Center, which was established by the Ministry of Water Resources. The LDSSC has conducted two rounds of general inspections of dams constructed before 1980, and some remedial action was taken. In 1997, the Guidelines for a Register of Hydropower Stations were issued, and pursuant to them LDSSC has classified about 110 dams, of which 100 are class A. In 1992, the Ministry of Energy published the Dam Safety Monitoring Modification Program for Hydropower Stations. The various regulatory efforts in dam safety have resulted in standard criteria for monitoring technology for concrete dams, embankment dams, national standards for monitoring instruments, and the types of monitoring instruments to be used on concrete and embankment dams.

The primary responsibility for dam safety lies with the owner of the dam. The government has a supervisory function, which in 1999 it assigned to the LDSSC for hydropower stations. LDSSC fulfills this function by providing advice on dam safety management to hydropower stations and by carrying out its supervisory function for all dams within its jurisdiction.

## **Finland**

Dam safety in Finland is governed by a number of laws, including the 1984 Dam Safety Act (DSA); the Dam Safety Decree 27.7.1984/574 (DSD); the 1985 Dam Safety Code of Practice (DSCP), which was last revised in 1997; and the Water Act of 19.5.1961/1264. The DSA is supervised by the Regional Environmental Centers (RECs) under the guidance of the Ministry of Agriculture and Forestry. Rescue services fall under the Ministry of the Interior.

The Finnish regulatory framework applies to all dams that are no less than three meters in height. Pursuant to article 2, the DSA also applies to dams of less than three meters if the “volume of the substance in the basin impounded by the dam is so large or if the substance in the basin is of such a type that in the event of an accident it manifestly endangers human life, or health or manifestly seriously endangers the environment or property.” All dams covered by the DSA are classified on the basis of size and hazard risk assessment. Dams are classified at the planning stage and checked at the commissioning stage. The classifications are P dams (dangerous), N dams

(smaller risk), O dams (minor hazard risk), and T dams (temporary dams). The DSA does not apply to dams covered by the Mining Act, but the safety requirements for dams covered by the Mining Act correspond to those in the DSA. These mining dams are subject to supervision by the Safety Engineering Center of the Ministry of Trade and Industry, which uses the DSCP.

Before a dam is classified as a P dam, a hazard risk assessment must be done. RECs can require that this assessment be done for other dams. The main issues considered in this assessment are the facilities for organizing rescues and the measures needed to prevent or contain an accident. The results of this assessment must be delivered to the REC, the provincial government, and the regional and municipal fire centers. The REC classifies the dam on the basis of this report, after consulting with the Finnish Environmental Institute.

The emphasis of the DSA is on accident prevention and effective reduction of hazards if accidents do occur. The basis for evaluating dam safety is monitoring and inspection and, if necessary, investigations by the owner. If the REC considers the person who assesses dam safety to be incompetent or inexperienced, it can require the owner to do a new inspection.

Pursuant to the DSA, the dam owner, in the case of P dams, is responsible for drawing up a dam safety monitoring program which must be approved by the appropriate REC. The REC can only give its approval after obtaining an expert opinion from the Finnish Environmental Institute. The monitoring program can include both monitoring and inspections. The dam owner must maintain documents related to dam safety in a special safety file that must be kept in a readily available location. The contents of the dam safety file are specified in section 5 of the DSA and section 2 of the DSD. In sum, the DSCP indicates that the owner must keep the documents that a competent person considers essential for the preliminary assessment of dam safety. The document should also include all the information drawn from the annual inspections and monitoring that are required by the safety monitoring program. These inspection reports should also be submitted in triplicate to the REC and in the case of P dams to the provincial government. The owner also has the responsibility to familiarize itself with the current dam safety requirements. It can consult the REC and the Finnish Environmental Institute about these requirements. The REC will also inform dam owners about relevant changes in the law and regulations.

The dam safety plan must be drafted by someone who has the same competence as the designer of the corresponding structure. It may include guidelines for monitoring and regular inspections. It must be approved by the REC. There should be annual inspections whose records are kept in the safety file. In addition a more comprehensive inspection should take place at least every five years. The relevant authorities (i.e., the REC and the provincial government) must be informed about this inspection and can, if they so choose, participate in it.

The Water Act provides in chapter 21 that the supervisory authority is obliged to take measures to ensure dam safety, and that it has the right to inspect dams and to undertake investigations. It can seek the assistance of the Water Court and can recover costs for the state. The Water Act is also applicable in cases of noncompliance with safety requirements. Pursuant to this act, if the dam poses an immediate danger to public safety, then the provincial government, the police authority, and the REC are empowered to take the necessary measures to eliminate the danger.

Dam design, which must include dam safety monitoring devices, must be directed by a competent and experienced person. The REC can evaluate the person to see if he or she meets this standard. The ultimate decision to approve the design rests with the Water Court. However, the REC must be informed of dam construction in sufficient time that it has time to study the design documents before construction begins. Similarly, any dam modifications must take dam safety into account, and if dam safety is affected, the modifications must be reviewed. This review is initiated with a written notification to the REC. It includes a review of the dam plans, a monitoring program, and a field inspection. The REC can participate in the field inspection. In the case of P dams, the provincial government, the fire authorities, and the Finnish Environmental Institute also may participate. The owner organizes the inspection.

### **France**

The current French law dealing with dams dates back to the early 1960s, when it was amended following a dam accident in 1959. It was revised in the law of July 22, 1987, dealing with the prevention of major risks. Furthermore a general law on water was adopted on January 3, 1992. In addition there is a circular, No. 70/15 of August 14, 1983, issued by the Ministries of Industrial and

Scientific Development, Agriculture, and Public Works that deals with the “Inspection and Surveillance of Dams Relevant to Public Safety.” While there may be other decrees and circulars related to dams, this circular appears to be the most relevant for dam safety. One of the additional decrees is the circular of July 13, 1999, issued jointly by the Ministry of the Interior; the Director of Defense and Civilian Security in the Ministry of Defense; the Director of Gas, Electricity, and Coal in the Secretary of State for Industry in the Ministry of Economy, Finance, and Industry; and the Director of Water in the Ministry for Management of Land and the Environment (1999 Circular). There is another applicable circular, which was issued by the Secretary of State for Industry in the Ministry of Economy, Finance, and Industry on May 23, 1997, that gives additional rules for medium-size hydroelectric dams. A decree of June 13, 1966, creates a Permanent Technical Committee on Dams. This committee supervises all dam projects with a height greater than 20 meters.

Circular 70/15 stipulates that the Chef des Services du Control (SERCON) is involved in the regulation of dam safety. SERCON is responsible for maintaining an inventory of dams that can affect public safety. For each of the dams in this inventory, SERCON maintains a dossier with all relevant documents, descriptions of the actual work, and monitoring and inspection reports. In addition, the owner or operator is expected to maintain a dossier with all the relevant documents relating to the dam.

The circular offers general instructions on supervision that can then be adapted to the specifics of each dam. It stipulates that the owners and operators of dams are responsible for maintaining the dam and for any accidents that may happen. The circular requires that the first inspection occur in the course of the first filling of the dam. Diverse methods for monitoring the dam can be used in this inspection. However, the person who is in charge of the dam’s construction must also supervise the execution and monitoring of the first filling of the dam. The procedures to be followed must be approved by SERCON. The frequency of the surveillance during the filling of the dam is a function of the height of the dam. The owner of the dam must provide SERCON with a copy of the report on the first filling within six months of the filling of the dam.

After the filling of the dam, surveillance of the dam should include periodic visual inspections, and measurements done by a qualified person. The frequency of the visits and the measurements should vary according to the

importance of the dam and should be increased if there are any abnormal situations. The visits should be at least once every two weeks. Measurements should be taken at least once a month in the case of simple measurements and once a year in the case of more complex measurements. A specialized engineer should interpret the results of these inspections. In addition, a report must be submitted annually to SERCON on the surveillance and monitoring of the dam. SERCON agents will visit each dam at least once a year to conduct their own examination of the dam. SERCON requires a more detailed report every two years. Finally, SERCON will make a more comprehensive inspection of the dam every 10 years, normally after a total emptying of the dam.

Pursuant to Decree 399/997 of September 15, 1992, which deals with “Intervention Plans for Hydraulic Installations,” dams that are more than 12 meters in height above ground level and have a storage capacity greater than 15 million cubic meters need to maintain an emergency plan.

The 1999 circular is designed to establish secure zones in the vicinity of and downstream from dams and other hydraulic installations. To this end, it establishes a system of concessions to which these installations are subjected. The circular establishes an interagency working group to evaluate and implement actions intended to achieve this objective. It also provides for consultations with local authorities. Under the circular, any dam operator may be required to sign an agreement with other users or local authorities that establishes the means for sharing information and warnings of problems. An annex to the circular specifies that the dam operator must conform with any rules relating to protection against floods and interventions in dam operations to avoid damage and risks to public health.

## **India**

The information on India is derived from the draft Dam Safety Act of 2000 (DSA), which offers an interesting example of a dam safety statute.<sup>14</sup> This draft has not yet become law, so its provisions are not yet applicable in India at either federal or state level. In addition to the draft act, the Dam Safety Organization of the Central Water Commission (CWC) issued in June 1987 the *Guidelines for Safety Inspection of Dams*, for adoption by the states of India.<sup>15</sup>

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14. Discussion of and reference to this draft act should not be seen as an endorsement of the draft act.

15. For a general discussion of those guidelines, see World Bank, *Staff Appraisal Report for the Dam Safety Project* (Report No. 9391—IN, Apr. 19, 1991).

The DSA requires inspection of all large dams. A large dam is defined in the DSA as any artificial barrier capable of impounding or diverting water and which is above 15 meters in height, or which is between 10 and 15 meters in height and satisfies at least one of the following conditions: the length of the crest is no less than 500 meters, or the reservoir has a capacity of no less than one million cubic meters, or the maximum discharge of the dam is not less than 2,000 cubic meters per second, or the dam has special foundation problems.

The DSA provides that each state or organization with responsibility over dams should have a Dam Safety Organization (DSO) headed by an officer with the rank of at least superintendent engineer. The DSO should have jurisdiction over the dams in the state or organization. Dam owners have to file all technical reports with the DSO. The DSO reports to the highest engineering or technical authority for irrigation or water resources in the state. It must file reports on all inspections with this authority. It also liaises with the DSO of the CWC, which gives advice on safety. In addition, dam owners must file all their technical documents with the relevant DSO. The DSO has the power to conduct investigations, which must be carried out by someone with the rank of executive engineer or higher. The timing of these inspections is specified in the DSA. Primarily they should occur both pre- and post-monsoon as well as at other times. The DSO must also evaluate or arrange for an independent panel of engineers to evaluate all existing large dams at least every 10 years. The DSO has the responsibility to pursue with the relevant project authorities any remedial action arising from these periodic inspections.

The DSO has other responsibilities. It advises states and organizations on the regulations for dam safety. It is responsible for pursuing any remedial action arising from periodic inspections with project authorities. It provides an annual report on dam safety to the state government or head of the organization and to the Central Water Commission. It must also provide the DSO of the CWC with information on the status of dams and reports on any inquiries made by the DSO of the CWC. The DSO of the CWC prepares a consolidated annual report on dam safety for the Ministry of Water Resources. The DSA also requires dam owners to file technical documents with the DSO.

Under the *Guidelines for Safety Inspection of Dams*<sup>16</sup> the key responsibility for dam safety is with the owner. Dam safety is not part of the current dam

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16. See *id.* at 24.

approval process for locally funded projects.<sup>17</sup> In the case of internationally funded dams or dam safety programs, dam safety assurances are usually required by the relevant international funding source. This was the case with the dam safety project that was funded by the World Bank in India in 1991.<sup>18</sup> The objective of the project was to improve the safety of selected dams in certain states in India (project states) through remedial works, installation of basic safety facilities, and strengthening of the DSO of the CWC and the Dam Safety Committee (DSC). One assurance in this regard required each project state to maintain the Dam Safety Review Panel during the implementation of the project, with composition, functions, and terms of reference satisfactory to the World Bank.<sup>19</sup>

In addition, India has the Indian Standards and a Code of Practice for all waterworks, including dams. These documents address safety considerations. They suggest that a dam safety review panel should review the safety of each large dam each year. The documents establish a process according to which all dams are subject to preliminary reviews and those with serious problems to a secondary review. It should be noted that dam safety guidelines may exist within each organization responsible for operating dams, such as DSO, but such guidelines are hard to obtain.<sup>20</sup>

It should be noted that currently the CWC encourages state governments to conduct dam break analyses and to prepare inundation plans, emergency action plans, and remedial plans to deal with safety-related deficiencies in dams. In addition, India has a National Dam Safety Committee (NDSC) that has advisory and recommendatory powers. The NDSC enables an exchange of information on dam safety among experts, state governments, and bodies that own large dams or significant numbers of dams. The NDSC is chaired by

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17. It is worth adding that dam safety may be a factor that is considered in the issuing of permits for new dams.

18. See Loan Agreement between India and International Bank for Reconstruction and Development (Loan Number 3325 IN), and Development Credit Agreement between India and International Development Association (Credit Number 2100 IN) both dated January 10, 1991, for the Dam Safety Project. See also the Staff Appraisal Report for this project, *supra* n. 15.

19. See Project Agreement among International Development Association, International Bank for Reconstruction and Development, and State of Madhya Pradesh, State of Orissa, State of Rajasthan, and State of Tamil Nadu, dated June 10, 1991, for the Dam Safety Project.

20. Currently, the central government has issued guidelines on dam safety that are followed in some states.

the chair of the CWC and has 12 other members, drawn from state governments and bodies that own large dams or large numbers of dams. The chief engineer of the CWC is also a member of the NDSC and serves as its secretary. The NDSC meets twice a year to exchange views and to discuss and monitor whether dam owners are following the CWC's dam safety guidelines.

### **Ireland**

According to the 1994 World Bank study on the supervision of dams,<sup>21</sup> the chief engineer in Ireland is responsible for water regulations that deal with the safe operation of dams. In addition, the chief civil engineer of the Electricity Supply Board (ESB) is designated as the person responsible for dam safety issues relating to hydroelectric dams. The ESB conducts annual inspections through a subsidiary corporation. The chief engineer of ESB carries out an inspection of ESB dams every five years. The ESB is also audited by an independent External Dam Safety Committee (EDSC) that carries out inspections, at varying levels of comprehensiveness, every year, 5 years, and 10 years. The 10-year report is formally presented to the ESB Board. The EDSC consists of internationally recognized dam experts. The chief executive of the ESB appoints the chair of the EDSC. The chief engineer of the hydro group of ESB is responsible for issuing regulations and guidelines in the form of a Structural Safety Surveillance Manual.

### **Latvia**

In December 2000, Latvia adopted the Hydropower Plant Dam Safety Act. The purpose of the act is to establish the legal grounds for determining the responsibilities of hydropower dam owners. Paragraph 12 of the draft law stipulates that the State Civil Engineering Inspection Board is responsible for overseeing compliance with the law.<sup>22</sup>

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21. Guy Le Moigne, *Supervision of Dams By Governmental Authorities World-Wide: A Survey of Countries Where Regulations Exist in the Interest of Dam Safety* (Agricultural and Natural Resources Department, World Bank, 1994).

22. It should be noted that the act entered into force quite recently, and as such it is too early to know with certainty how its different aspects will be implemented. It appears, however, that the State Construction Inspectorate, which is a unit within the Ministry of Environmental Protection and Regional Development, will also play a role in overseeing compliance with the act. This observation is based on communication from John Irving to the authors.

Paragraph 3 of the act classifies dams into three categories. Class A dams are those that in the event of an accident would “manifestly” endanger human life and health or “seriously damage” legal or natural persons or the environment. Class B dams are those that, in the event of an accident, would not create any danger for human life or health but would damage property and the environment. Class C dams are those that, in the event of an accident, would not create any danger for human life or health but could cause minor damage to property or the environment. The classification is made at the design stage of the dam.

The owner or legal titleholder of the dam is responsible for the safety of the dam. Pursuant to paragraph 4 of the act, the owner is required to take all necessary steps to ensure that the dam is not a danger to human life, health, property, or the environment. The owners of class A and B dams must insure the dam against civil liability due to the potential damage caused by a dam accident. The amount of the insurance is set by the cabinet of ministers.

Paragraph 5 of the act requires the dam owner to draft a dam safety monitoring program that it must submit for approval to the State Civil Engineering Inspection Board. Paragraph 6 stipulates that owners of class A dams must submit this program during construction of the dam. Owners of class B and C dams must do so after the commissioning of the dam. In both cases, according to paragraph 5, the program must conform to the standards established by the Cabinet of Ministers, which also determines the procedures for submission and approval of the program. The Cabinet of Ministers, according to paragraph 7 of the act, also decides which measuring devices should be used in the safety program.

Pursuant to paragraph 8, dams can only be operated when they have received a certificate of safety from the State Civil Engineering Inspection Board. The board has the authority to annul the certificate according to procedures established by the Cabinet of Ministers. According to the transitional regulations issued in conjunction with the act, the owners of dams that were commissioned before the act entered into force were required to submit their safety programs to the authorities by December 31, 2001. They must receive their certificates by March 31, 2003. The procedures to be followed and the criteria that the State Construction Inspectorate should apply in deciding whether to issue safety certificates are spelled out in Cabinet Regulation No. 351.

According to paragraph 9, dam owners are required to submit reports detailing the steps they have taken to comply with the safety program. The contents of this report and the procedures governing their submissions are established by the Cabinet of Ministers. These requirements are spelled out in Cabinet Regulation No. 257.

Paragraphs 10 and 11 deal with dam failures and accidents. Paragraph 10 provides that when observations, monitoring data, and inspections indicate that the continued operation of the dam is likely to lead to dam failure, the owner of the hydropower dam has the right to lower the reservoir level after giving notice to the operator of the transmission and distribution system and to the state fire and rescue services in the potentially affected areas. The owner must also give notice to owners of downstream hydraulic structures. Paragraph 11 of the act deals with the situation in which a dam fails. It provides that the owners of the dam must give notice to the operator of the transmission and distribution system and to the state fire and rescue services in the potentially affected areas. In addition, the owner must initiate the regional alarm system in accordance with the Civil Defense Act.

## **Mexico**

Dam safety in Mexico falls under the jurisdiction of the National Water Commission (NWC), which is an administrative unit of the Secretariat for the Environment and Natural Resources. The National Water Law, its implementing regulations, and the internal regulations of the Secretariat establish the powers and responsibilities of the NWC. It is responsible for studying, creating, and promulgating standards; monitoring; administering; operating; and rehabilitating the dams that belong to the federal government or that are operated pursuant to concessions granted by the federal government.

Article 29 IV of the National Water Law stipulates that the owners and operators of dams are responsible for operating, maintaining, and preserving the works necessary for the stability and security of the dam, and other works required in accordance with the hydraulic safety standards.

The NWC has a number of powers that are relevant to dam safety. Pursuant to article 29 IV of the National Water Law, it can require dam owners and operators to provide the NWC with whatever information and documentation it requests. Pursuant to article 29 V, the owner and operator of the dam must allow NWC personnel to inspect the hydraulic works, take

measurements, verify the functioning of the measuring equipment, and conduct other activities necessary to comply with the law. If the owner or operator does not allow the NWC to inspect, take measurements, or monitor the dam, article 26 of the law gives the NWC the authority to suspend that owner's or operator's dam concession until the situation is corrected. The corrections must be made within 15 days. In accordance with article 83 of the law, the NWC is also responsible for issuing standards and making recommendations relating to flood control. Finally, chapter IV of the law requires the NWC to maintain a public registry of water rights.

### **New Zealand**

Dam safety in New Zealand is governed by the Resource Management Act of 1991 (RMA). Other relevant laws are the Building Act of 1991 and the Civil Defense Act of 1983.

The RMA is premised on the principle of subsidiarity, according to which decisionmaking is best left to those who are directly affected by the results of the decision. Therefore it devolves authority to the most appropriate level, and as a result, local authorities are responsible for the day-to-day implementation of the RMA. District and city councils have jurisdiction over the effects of land use and the effects of activities on the surface of lakes and rivers. They are also expected to prepare district plans, issue resource consents, take enforcement actions, and monitor actions in this regard. The regional councils are responsible for controlling the taking, damming, and diversion of water, and the discharge of contaminants into the environment. This means that they are responsible for issuing consents for dams in their area of jurisdiction. In issuing these consents they are required implicitly to consider the potential effects of a dam failure, even though the RMA imposes no explicit obligation on them with regard to dam safety.<sup>23</sup> They are also expected to prepare regional plans and policy statements, issue resource consents, take enforcement actions, and monitor actions related thereto. The powers of the central and local governments are spelled out in part IV of the RMA. The minister of the environment can issue national statements and national environmental standards, and maintains an oversight role over the

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23. See *Guidelines for Resource Consents for Dams and Associated Activities* secs. 6-4, 6-5 (Ministry of the Environment 2000).

implementation of the RMA. The Ministry of Conservation is responsible for coastal marine areas, in partnership with regional councils.

Although the Building Act of 1991 does not have any specific provisions dealing with dam safety, dams fall within the definition of a “building” contained in the act. This means that a building consent is required for all dams higher than three meters and capable of storing more than 20,000 cubic meters of water. Building permits will only be issued if the dam complies with the Building Code. It is interesting to note that the Building Code’s requirements are given in general terms and they do not have any specific provisions dealing with dam safety. International methods and codes and the New Zealand Society of Large Dams (NZSOLD) Dam Safety Guidelines are often used in the absence of a specific New Zealand standard.<sup>24</sup>

District councils are responsible for the day-to-day administration of the Building Act, and the Department of Internal Affairs is responsible for overall administration. The Building Act is currently being reviewed. Two of the issues under review are the safety of large dam structures and the monitoring of dam safety. Pursuant to section 36 of the RMA, local authorities can charge applicants for the actual and reasonable costs of processing and monitoring resource consents. The charges should be set to recover the authority’s actual and reasonable costs for these activities.

Article 330 of the RMA deals with emergencies. In cases of emergencies relating to public works that can have an adverse effect on the environment or that may lead to loss of life, injury, or serious damage to property, the RMA provides that the local or consent authority can, without notice, enter the place and take such action as is “immediately necessary and sufficient” to remove the cause of the emergency. Article 331 allows the responsible authority to obtain reimbursement for expenses from the consent holder when it incurs these expenses in dealing with emergencies that occur because of the failure of any resource consent holder to comply with the applicable laws and regulations. The law also allows any person who suffers damage because of the authority’s action to seek compensation from the authority, provided the authority’s action did not arise from any failure of the complaining party. The Civil Defense Act of 1983 may also be applicable to the case of dam

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24. *Id.* at sec. 2.3, 2–7.

failures. It provides for the declaration of local, regional, and national civil emergencies by authorized personnel. Once an emergency is declared under this act, the authorities can carry out or order the dam owners to carry out work to deal with the emergency.<sup>25</sup>

Article 332 of the RMA allows an enforcement officer:

- to obtain written permission from the responsible authority to enter, at all reasonable times, any place or structure (except a dwelling house);
- to inspect the place or structure;
- to conduct surveys;
- to carry out tests and measurements; and
- to prepare, change, or review a policy statement investigation.

Article 333 allows any enforcement officer to carry out surveys, investigations, and tests, or to take measurements and samples of air, water, soil, or vegetation.

### **Norway**

Norway recently revised its regulatory framework for dams. Its new Water Resources Act entered into force on January 1, 2001. The act, which covers a broader range of issues than dams, empowers the Norwegian Water Resources and Energy Directorate (NVE) to oversee dams in Norway. It also grants the NVE the power to issue regulations pertaining to dam safety. With regard to dam safety, the new act places a greater emphasis on the operations phase of the dam's life cycle than did the previous regulatory regime.

The NVE, which had similar powers under the previous water law, issued *Regulations Governing the Safety and Supervision of Watercourse Structures* (the Regulations) on December 15, 2000. These regulations deal with safety considerations at the planning, construction, operation, and decommissioning phases of the dam's life cycle. The NVE is also planning to issue detailed guidelines that set out the specifications and technical requirements for issues related to dam safety. It is anticipated that the NVE will have issued 25 such guidelines by the end of 2002. The NVE has also issued regulations

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25. *Id.* at sec. 2.3.1, 2–9.

detailing the qualifications required of those who plan, construct, and operate dams. In brief, they are required to be well-trained engineers.

The Regulations classify dams into three categories based on the consequences of the failure of the dam. Category 3 dams have the highest hazard potential. The basis for the classification is the number of dwelling units that could be affected by a dam failure. There is a special regulation that explains how the numbers of dwelling units are determined, with the relevant criteria being the number of people who live in a normal dwelling in Norway and the period of occupancy. The Regulations are applicable to all category 2 and 3 dams, which are those dams that are at least four meters high, or have a storage capacity of least 500,000 cubic meters, and all category 1 dams, which are those dams that are more than six meters high, or have a storage capacity of at least 500,000 cubic meters.

The Regulations specify that the dam owners must prepare an emergency plan for the dam and must have internal quality controls to ensure that the dam complies with the requirements of the Regulations. The Regulations stipulate that the NVE must approve all plans for dams. They contain detailed provisions on the technical requirements that the plans for dams must satisfy. Section 8-1 of the Regulations stipulates that the watercourse authority can compel the dam owner to take action in the case of “a special and an unusual” hazardous situation.<sup>26</sup>

The regulations require each dam to have a program of inspection. The program, which should indicate the frequency of the inspection, the scope of the inspection, and the qualifications required for the inspectors, must be approved by the NVE. It appears that these regular inspections should be conducted annually.<sup>27</sup> Section 7-3 of the Regulations states that a “reassessment,” which is “a thorough examination and review . . . intended to clarify whether the structure meets the safety requirements” set out in the Water Resources Act and subsidiary regulations, should take place on a “regular basis.”<sup>28</sup> It appears that these reassessments, which must be conducted by an independent

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26. Under the new regulatory regime, the owner is required to report all incidents that have an actual or potential impact on safety.

27. K. Molkersrod and T. Konow, *Requirements for Operation of Dams in the Revised Norwegian Legislation in Dams in a European Context* (A.A. Balkema 2001) (proceedings of the ICOLD European Symposium, Norway, June 25–27, 2001).

28. Guidelines issued by the regulatory authority contain recommendations on the frequency of dam safety inspections, but these are not legally binding.

but approved company, take place every five years.<sup>29</sup> In addition, it appears that there should be a total reassessment of each dam every 15 years. This reassessment should include a new design analysis in light of the then current state-of-the-art safety criteria, updated estimates of hydrological conditions, and changed conditions upstream and downstream from the dam.

The Regulations provide that the NVE can charge fees to cover the costs of the inspection and license approvals. It appears, in fact, that the fees cover approximately 80 percent of the NVE's actual costs.<sup>30</sup> The Regulations also give the NVE the authority to levy fines on those who fail to comply with the Regulations and other applicable regulations.

The Pollution Control Act (PCA) also seems to be applicable to dam safety. Section 6 of the PCA defines pollution as "the introduction to air, water, or ground of solid matter, fluid or gas . . . which causes or may cause damage . . . to the environment." Thus, the consequences of a dam failure could qualify as "pollution" under the terms of the PCA. The PCA is administered by the "pollution control authority," which is defined in section 83 to include the Ministry of the Environment, the Pollution Control Council, and State Pollution Control Authority, and their county and municipal equivalents.

Section 38 of the PCA stipulates that the owner of a facility that can cause "acute pollution," which is defined as "significant pollution which occurs suddenly," must have contingency plans. The pollution authorities must approve these plans, pursuant to sections 40 and 41 of the PCA. Section 39 of the PCA requires owners to notify police authorities if acute pollution occurs. However, it also gives the pollution control authority the power to impose a more rigorous notification requirement. Sections 49–51 stipulate that the pollution control authorities have the power of inspection and can require the owner to carry out inspections at its own expenses. They also impose on owners an obligation to provide the pollution control authority, if so requested, with information necessary for the authority to perform its duties. The PCA also makes the owner liable for damages caused by pollution from its facility (sections 53–64).

The PCA requires municipal and state governments to have their own contingency systems to deal with acute pollution (sections 42–44). Section 45 of the PCA establishes a Governmental Action Command Group (GACG),

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29. *Id.*

30. *Id.*

whose members include representatives of concerned authorities and other appointed persons, to deal with large-scale accidents. This group has the authority to take over the operation of the facility from the owner in cases of acute pollution (section 45).

Section 48 of the PCA stipulates that the pollution control authority must monitor the pollution situation. The PCA grants the authority certain enforcement powers in this regard. Pursuant to section 52a, the authority can require applicants to pay fees for any permits it issues and inspections it undertakes. Section 73 empowers the pollution control authority to levy fines on any licensee or permit holder who violates the PCA or the terms of the license. It can also arrange for remedial action at the violator's expense. The pollution control authority can also levy fines and seek imprisonment in cases of willful or negligent pollution.

## **Portugal**

The regulations dealing with dam safety in Portugal were adopted by a decree of law in 1990.<sup>31</sup> The regulations are complemented by four codes that define all the requirements and standards relating to the design, construction, operation, observation, and inspection of dams. One of these codes, *The Portuguese Code of Practice for Observation and Inspection of Dams*, provides methodologies for evaluating the safety of existing dams.

Dams in Portugal are classified into two categories. There are "high dams," which are higher than 15 meters, have a storage volume greater than 1,000,000 cubic meters, or pose an important risk to human life and economic concerns. The second category consists of small dams and includes all dams that do not meet the above criteria. In the four codes that complement the regulation, dams are classified into three groups on the basis of a Global Risk Index. This index takes into account three factors: external and environmental conditions, dam condition and reliability, and human-economic hazards. Each of these factors contains a number of components, which are evaluated by dam inspection. Based on this index, dams are classified into three classes according to their hazard and performance characteristics. The index values are used to determine priorities in comprehensively evaluating and dealing with dam safety.

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31. The information on Portugal is taken from *Dam Legislation*, *supra* n. 7.

Three government departments are involved in dam safety regulation. They are the National Institute of Water (NIW) in the Ministry of Environment and Natural Resources, the National Department of Civil Defense (NDCD), and the Commission for Safety of Dams (CSD). The NIW is responsible for approving and supervising the construction and operation of dams. However, it does not need to approve the engineers in charge of dam projects. When necessary, it will consult with the National Laboratory of Civil Engineering (NLEC). The NLEC also carries out studies for the owners of dams. The NDCD is in charge of emergency plans. The CSD prepares standards and gives opinions on issues presented to it by the NIW.

The regulatory framework in Portugal sets out general standards dealing with specific aspects of dam structures, such as the foundation and spillways. However, it does not include precise standards on these issues. The regulations do stipulate what information needs to be included in the studies submitted to the NIW when seeking approval for the project.

Pursuant to the regulation, the NIW must approve the final design of the dam and any modifications during construction. It is also empowered to respect the project site. The NIW must also accept the dam at the end of the construction phase and must approve the plan for the first filling of the dam. At the end of the filling, the NIW carries out a detailed inspection of the dam. During this period, the NLEC will also publish a final report about the behavior of the dam.

During operation of the dam, the NIW, acting on the advice of the NLEC, must approve the project monitoring system. The monitoring system must be in accordance with the regulations in the *Standards for Monitoring and Surveillance of Dams*. The regulations provide for three levels of surveillance: continuous, special, and exceptional. The NIW in collaboration with the NLEC, and in the presence of the owner, carries out periodic inspections of the dam.

Each dam is required to have an emergency plan that is subject to periodic testing. The regulations require all important dams to have a permanent communications system that connects the dam, the powerhouse building, and the operation center of the dam. The dam must also have an alarm system, paid for by the owner. In case of an emergency, the dam owner must immediately contact the civil defense center.

## Romania

The National Commission for the Safety of Dams in Romania is responsible for the regulation of dams.<sup>32</sup> The National Commission is part of the Ministry of Water, Forest, and Protection of the Environment. All large dams are owned by either the Romanian Electricity Authority or the Romanian Water Authority. Each of these companies has its own dam safety commission, which develops internal standards for the design, construction, operation, and monitoring of dams.

All dam projects require formal approval. The State Standards stipulate the technical criteria—for example, spillway capacity and earthquake resistance—that dam projects must meet. During construction, the Ministry of Public Works carries out inspections. During this stage the owner is expected to keep an up-to-date description of the progress of the operations. This description is required for the final acceptance of the dam. The Commission of Acceptance must give its approval before filling of the dam can commence.

The dam owner and operator is expected to keep a file with all the documentation about the construction of the dam and about its operation. The two primary owners of dams each have their own inspection departments. These departments establish the methods of surveillance and monitoring of dams owned by each entity. The National Committee for the Safety of Dams and Hydraulic Structures carries out periodic inspections of dams. There can also be special inspections after exceptional events. There are regulations dealing with the monitoring of dams.

All dams higher than 10 meters, with a reservoir capacity greater than 10,000,000 cubic meters and with inhabited areas closer than 10 kilometers downstream must have an emergency plan. Furthermore, a 1992 regulation requires all dam owners to install an alarm system that will alert the authorities and the potentially affected population about any emergencies.

## The Russian Federation

The relevant statute for dam safety in Russia is Federal Law 21.07.97, N117-OC, adopted by the State Duma on June 23, 1997. This statute deals with the safety of state-owned hydraulic structures. Pursuant to articles 5 and 6 of this

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32. The information on Romania is taken from *Dam Legislation*, *supra* n. 7.

law, the government of the Russian Federation designates a part of the federal executive as responsible for the safety of all hydraulic structures, except those that are owned by municipalities. Article 7 requires that the government of the Russian Federation establish a register of hydraulic structures.

Article 8 of the law sets out the requirements for ensuring the safety of hydraulic structures. It requires the authorities to establish permissible levels of risk for the failure of dams; to take actions to ensure the safety of hydraulic structures, including specifying the criteria for dam safety and the technical equipment for monitoring safety; to maintain local alarm systems for emergencies; and to finance activities related to the construction, operation, and decommissioning of hydraulic structures. Pursuant to article 10, the owner or operating agency of the hydraulic structure must file a declaration of safety with the relevant authorities. This declaration must contain information relating to the compliance of the hydraulic structure with the applicable dam safety criteria. The declaration must be made four months prior to the commencement of dam operations. Thereafter it must be repeated every five years.

Article 16 provides that natural and legal persons are entitled to compensation for harm caused by violations of dam safety legislation. Furthermore, article 17 provides that the owner or the relevant operating agency is liable for any damage caused by the failure of the hydraulic structure. However, pursuant to article 18, the state may be liable for some damage if the amount of the actual damage exceeds the amount specified as the amount of civil damage due under article 17 of the law.

### **Republic of South Africa**

The regulatory framework for dam safety in South Africa is spelled out in the 1998 National Water Act<sup>33</sup> as well as the 1986 Regulations.<sup>34</sup> Although these regulations were issued prior to the National Water Act, they must be interpreted in a manner that conforms to the act, which includes a separate chapter on dam safety.<sup>35</sup> Pursuant to section 2 of the act, dam safety and the management of floods and droughts are among the goals of the act. It should be noted that the Department of Water Affairs and Forestry (DWAf)

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33. South Africa, Act No. 36 (1998).

34. The Regulations are published in the *Government Gazette*, Vol. 253, No. 10366 (Jul. 25, 1986).

35. Chapter 12, sections 117–123. This chapter on dam safety is included as appendix IV to this study.

has drafted dam safety regulations that would replace the 1986 Regulations.<sup>36</sup> DWAF will invite public comment on these draft regulations before they enter into effect.

Pursuant to regulation 2.1 of the 1986 Regulations, all dams are classified on the basis of size (based on wall height) and hazard potential (based on potential loss of life and economic loss) into three categories. The higher the classification, the greater the size and hazard potential of the dam and the more extensive is the regulatory oversight of the dam. The classification is made by the director general of the DWAF upon the completion of the dam feasibility studies. The classification, which can be changed, affects requirements relating to the design, construction, putting into operation, operation, maintenance, alteration, and decommissioning of the dam. The considerations in making licensing decisions relating to dams include the operations and maintenance manual, which must be developed by an approved engineer, and the plans to communicate with local authorities and communities about dam safety warnings.

In the case of the higher-category dams, the regulations require the dam owner/operator to secure the services of a professional engineer. In addition, before issuing a permit to proceed with the dam, the director general may require the owner to appoint an independent panel of experts—approved by the director general—to review the dam’s proposed design, plans, or specifications. This typically will only occur in cases of unusual dams.

In general, the owner has the duty to regularly inspect its dam. This means that the owner must conduct the first inspection within three years of the dam becoming operational, and then every five years thereafter for higher-category dams. In the case of Class II dams, the inspections must be carried out by an approved professional engineer, and in the case of Class III dams, by an approved team of professional engineers. The owners may be able to obtain some government subsidies to cover the costs of these inspections. In addition, the owner must conduct an inspection as soon as a condition affecting the safety of the dam arises. The owner has an obligation to report the results of the inspection to the director general within 60 days.

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36. In general, although the draft regulations are more detailed than the current regulations, they are not substantially different in basic design. The most interesting difference is that the draft regulations take a more holistic approach to dam safety and require much more information on the social and environmental impacts of the dam than is the case under the current regulations.

In addition to these regular inspections, the director general may inspect any dam with a safety risk or require the owner to provide information on any matter affecting dam safety. The director general can also order modifications to the dam to correct problems. When so instructed, the owner must also make additional reports to the director general. The owner is also required to report emergencies to the director general.

Another obligation of the owner is to keep comprehensive records on the dam. These records and other relevant information must be provided to the minister. An approved professional engineer is required to make the reports about these dams and to see that any actions necessary to maintain the dam and ensure its safety are taken. Violators of these regulations are subject to fines or imprisonment.

The director general keeps a register of all dams with a safety risk. These are defined as dams with wall height greater than five meters and storage capacity greater than 50,000 cubic meters or dams that in the opinion of the Minister of Water Affairs and Forestry (MWF) pose a risk to health and property. Owners of dams with a safety risk require a permit from the MWF in order to begin construction, make alterations, or abandon the dams. The MWF can demand an inspection of dams with a safety risk. The owners of such dams must keep comprehensive records and must conduct inspections. There is a Dam Safety Advisory Committee, appointed by the MWF, to advise the MWF on dam safety issues.

## **Spain**

The key regulations dealing with dam safety in Spain include the 1996 Technical Regulation about Reservoir and Dam Safety (TR); the Order of the Ministry of Public Works of March 31, 1967, approving "Instruction for the Project, Construction, and Operation of Large Dams" (MPW)<sup>37</sup>; and the 1994 Basic Directive for Civil Protection Planning Against Flood Risk. There is also a national committee, the Commission on Norms for Large Dams, that is responsible for developing technical regulations related to dam safety.

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37. This was apparently supplemented in 2000 by a new regulation titled "Standard on the Safety of Dams and Reservoirs" that is applicable to dams under the jurisdiction of the Ministries of Public Works, Transportation, and the Environment. It is important to note that the 1967 Regulation is still applicable to all dams that are higher than 15 meters, or that are higher than 10 meters and have a storage capacity greater than 100,000 cubic meters. See *Dam Legislation*, *supra* n.7.

The TR is applicable to all publicly owned dams and to all private dams built after 1996, including those that store industrial waste. Article 3 establishes classifications for dams based on their size, potential risk (hazard), and their form of construction. It classifies all dams that are higher than 15 meters, or that are 10 to 15 meters in height and have a crest greater than 500 meters, a storage capacity greater than 1 million cubic meters, or a discharge capacity greater than 200 meters per second, as large dams covered by the regulatory framework. Smaller dams that have special features can be subjected to the regulatory framework. Its hazard classification divides dams into A dams, which can cause serious material and environmental damage and loss of life; B dams, which can cause “important” material and environmental damage and loss of life; and C dams, which can cause “moderate” material and environmental damage and “incidental” loss of life.

The TR also addresses all stages of a dam project. Article 7 stipulates that the approval process for any new dam whose failure can affect people, property, or the environment includes obtaining approval for its dam safety plan. In addition, the project proposal must include an emergency safety plan that deals with the negative social and environmental impacts of dam failure, and contains information and warning systems. The emergency plan must be approved by the General Directorate for Hydraulic Works (which is an administrative unit in the Ministry of the Environment) in the case of dams situated in interregional basins<sup>38</sup> after a preliminary report has been submitted by the National Commission for Civil Protection. The dam owner must also coordinate with the General Directorate on Civil Protection, which is a unit in the Ministry of Internal Affairs. The licensing application must also include technical solutions for all safety issues and a justification for the proposed solution.

Pursuant to these regulations, the dam owner has the primary responsibility for dam safety. The regulations, however, set out the standards that the owner must take into account in developing the dam’s safety program, and in dealing with the potential social and environmental risks associated with the dam.

Article 5 of the TR specifies the dam owner’s responsibility at all stages of the dam’s life cycle. With regard to safety, this means that during the design and construction phases the owner must conduct inspections and monitor

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38. Interregional basins are water basins located in the territories of two or more autonomous communities in Spain.

activities to ensure that dam safety requirements are being met. During operations, the owner must conduct periodic inspections, provide information to the regulatory authorities and communicate with them about exceptional or abnormal events, and take steps to study and repair problems. Article 34 of the TR requires that in cases of high-hazard dams (categories A and B) the safety plans must be subjected to periodic testing. The TR also contains technical standards that the dam must meet.

Article 33 of the TR states that in addition to the owner's inspections there must be a compulsory inspection after extraordinary events such as earthquakes and large spills from the dam. If the owner fails to conduct this inspection, the Administration can do it. Article 33 also empowers the Administration to ask the owner for a report on the safety of the dam at any time. This report is separate from the regular reports submitted by the owner.

Pursuant to article 5.5, the owner must maintain a technical archive for the dam that includes information on the dam's classification, studies done for the dam, the results of tests and analyses done on the dam, and changes in the dam project's operation and maintenance activities. Article 25 stipulates that the dam owner/operator has an obligation to arrange a technical team for the project that is competent to develop and implement the dam safety plan. The technical team is also responsible for developing the technical archive for the dam. This team must be in existence at all stages of the project.

The dam owner is responsible for observing all dam safety regulations, monitoring the dam, and conducting inspections. Article 30 of the TR states that the owner is responsible for drawing up standards of operation that must include dam safety provisions. These standards of operation must be included in the technical archives. Pursuant to article 33 of the TR, these standards of operation must include a plan for inspection and monitoring of the dam, including timing of inspections, scope of data to be collected, and specifications relating to the means of collecting and processing data. The manager of the dam must prepare an annual report on the results of the inspections, detailing problems observed and proposed corrective action. This becomes part of the technical archive. In the case of the most hazardous dams (category A), a copy of this report must be sent to the Administration, which can make observations and recommendations based on the report.

The administrative agency that grants the dam license is responsible for ensuring that the dam is used for its intended purpose. The agency has the power

to monitor compliance with dam safety regulations, conduct inspections, and require modifications to the dam's design and safety plans. The regulations require the regulatory authorities to maintain an inventory of all dams.

### **Switzerland**

The applicable law for dam safety in Switzerland is the federal law regarding supervision of hydraulic structures of 1877 (*Bundesgesetz über die Wasserpolizei*, June 22, 1877) as amended. Article 3 of this act (introduced in 1953) provides that the Federal Council must take steps to ensure dam safety with regard to questions of dam maintenance and the effects of war. An executive decree of December 7, 1998 (*Verordnung über die Sicherheit von Stauanlagen, Stauanlagenverordnung, StAV*), which became effective on January 1, 1999, superseded a 1957 Statutory Rule Concerning Dams, which addressed dam safety. The 1998 Decree redistributes supervisory authority between the federal and cantonal authorities. It is applicable to all dams that are higher than 10 meters or dams with a height of at least 5 meters and a minimum storage capacity of 50,000 cubic meters. Other dams that present specific safety concerns can also be subjected to this decree and thereby made subject to its jurisdiction.

Pursuant to articles 21 and 22 of the 1998 Decree, all dams that have an impounding head of at least 25 meters, or which have an impounding head of more than 15 meters and minimum storage capacity of 50,000 cubic meters, or which have an impounding head of more than 10 meters and a minimum storage capacity of 1,000,000 cubic meters or which have a storage capacity of more than 500,000 cubic meters are under the supervision of the Swiss Federal Office for Water Management and Geology, which is the federal supervisory authority. Dams that are smaller than these specifications and are not explicitly subject to federal supervision are under the supervision of the cantons.

The 1998 Decree relies on the following three principles with regard to dam safety: structural safety, monitoring, and emergency planning. Articles 3–6 of the 1998 Decree deal with structural safety. These provisions provide that the construction of new dams and the alteration of existing dams must be approved by the authority in charge in each canton, the *Aufsichtsbehörde* (supervising authority). There is also extensive opportunity for public comment in the permit process. The licenses are only granted for a limited period and renewals depend on a new analysis of the operating and environmental

conditions. At the end of construction, the owners draw up a final report detailing all aspects of the construction, including information on the geological and geotechnical tests carried out on the dams.

Articles 7–11 deal with the operations of the dam. They provide that the supervisory authority must approve the first filling of the dam. In addition, the supervisory authority must approve the maintenance of the dam and any modifications thereto.

Articles 12–16 of the 1998 Decree deal with dam monitoring. These articles provide that monitoring of dam safety must involve regular checks, measurements, and operational tests of gates and valves. The dam owner, experienced engineers, and the supervising authority are all involved in surveillance of the dam. The owner is responsible for controlling and measuring the condition and behavior of the dam. The owner must also ensure that the measurements (which are collected automatically) are manually checked once a month by hand measurements. Article 13 states that the owner must use experienced civil engineers to continuously monitor the dam and prepare the annual report. These engineers must supplement their use of mechanical measurements with an annual visual inspection. Article 14 states that dams with an impoundment head greater than 40 meters or a storage capacity greater than 1,000,000 cubic meters must be monitored/inspected at least every five years by special experts, who must be civil engineers and geologists. Article 15 states that the dam owner must inform the authorities of the identity of the persons chosen to do this five-year inspection. The authorities can reject the engineers chosen by the owner. The owner must also report all results of the five-year inspection to the authorities. Article 16 requires the owner to maintain records and files on the dam. The authorities have the right to inspect these records.

Article 17 of the 1998 Decree requires the owner to have plans for dealing with emergencies. Pursuant to article 18, the owner must inform the supervisory authority, the cantons, and the local government of these plans. The state, the canton, and the local government can provide help to the owner in developing and implementing these plans. Article 19 requires owners of dams with a storage capacity greater than 2,000,000 cubic meters to maintain an alarm system near the dam. Article 20 requires the owner to sound the alarm in any cases of abnormal behavior, natural disaster, or sabotage.

## **United Kingdom**

The most important statute with regard to dam safety in the United Kingdom is chapter 23 of the 1975 Reservoirs Act (RA), which entered into force on December 1, 1991. The RA only applies to raised reservoirs for water. Within the meaning of the RA, this refers to dams that have a holding capacity greater than 25,000 cubic meters and do not fall within the scope of the Mines and Quarries (Tip) Act of 1969.

Article 2 of the RA requires each local authority to keep a register of all raised reservoirs in the area. Pursuant to article 3 of the RA, the local authorities must submit regular reports to the secretary of state detailing the steps they have taken to ensure that undertakers (i.e., owners and operators) observe and comply with the requirements for all reservoirs in their area. If the secretary of state is concerned that the local authority is not meeting its obligations, he or she can order an inquiry into the matter.

Article 4 of the RA creates a panel of civil engineers that are deemed “qualified engineers” within the meaning of the RA. Any engineer can apply to be included in the panel. Appointments are for five years and are open to anyone who meets the qualification standards set by the secretary of state. The secretary of state consults with the Institution for Civil Engineers in setting these standards. Article 6 of the RA stipulates that a reservoir cannot be constructed or modified unless a qualified engineer is employed to design and supervise its construction.

The act spells out clear procedures for issuing the certificate to fill and operate the dam. Pursuant to article 7 of the RA, when a qualified engineer believes a dam under construction is ready for filling, the engineer issues a preliminary certificate specifying the level to which the dam can be filled. A final certificate is issued after three years if the engineer is satisfied that the dam is sound and satisfactory and may safely be used for storing water. An annex to the final certificate should detail the issues that the supervising engineer believes need to be watched in any inspection of the dam. If a final certificate is not issued after five years, the engineer must provide a written explanation. A qualified engineer must approve the abandonment of reservoirs, according to articles 13 and 14 of the RA.

According to article 8 of the RA, if the enforcing authority believes that there is no qualified engineer responsible for the reservoir, it may serve

notice on the dam undertakers, requiring them to appoint a qualified engineer within 28 days. This engineer must inspect the dam and supervise it until a final certificate can be issued.

Pursuant to Article 10 of the RA, the undertakers of a dam must have an independent qualified engineer conduct periodic inspections on the dam and obtain from him or her a report on the results of the inspection. In the case of large reservoirs, if they are not under the supervision of a construction engineer, they must be under the supervision of a qualified civil engineer who is employed to supervise the reservoir and advise the undertakers on safety-related issues. Unless the dam is under the supervision of a construction engineer, an inspection must be conducted within two years of the final certificate being issued, as soon as practicable after alterations, whenever the supervising engineer recommends an inspection, and within 10 years of the last inspection. The inspection report should include any recommendations for improving safety. These recommendations must be carried out. If the owner fails to appoint such an engineer, the enforcing authority can order the dam undertaker to appoint an inspecting engineer within 28 days. Article 15 empowers the enforcement authority to appoint qualified engineers if the undertakers fail to do this when so ordered.

Undertakers of dams are required to keep records on critical issues relating to the dam, such as its water level and leakages. They must also install instruments to measure these aspects of the dam's functioning.

Pursuant to article 16 of the RA, if the enforcement authority decides that a dam is unsafe and that immediate action is required to protect life and property, the authorities can take such measures as they feel are necessary to prevent harm. They must appoint a qualified engineer to make recommendations in these situations. An engineer must also supervise the actions. The costs of these actions are to be paid by the undertakers. Article 17 empowers the person appointed by the enforcement authorities, at a reasonable time and after giving seven days' notice, to enter into the land of the dam to carry out surveys or other operations, to see that the dam is being constructed or altered as represented by the undertaker, and to see if the applicable recommendations related to safety are being carried out. This right to enter can be enforced by a justice of the peace. Article 18 provides that if third parties' enjoyment of their land is impaired or they suffer an injury because of the enforcement authority's exercise of its powers under article 17, the third party

can seek compensation from the enforcement authority. The authority, in turn, can recover these costs from the dam undertaker.

The RA provides the undertaker with an opportunity to challenge the recommendations of the inspecting engineer. Pursuant to article 19, any undertaker who disputes the recommendations of an inspecting engineer can refer its complaint to a referee, who is an independent qualified engineer appointed by agreement between the undertaker and the inspecting engineer. The undertaker must pay the costs for this process.

## **United States**

There are both federal and state laws in the United States that deal with dam safety. For the sake of clarity, these will be discussed separately.

### *Federal Law*

The basic federal law is the National Dam Safety Program Act (NDSPA), passed in 1972, revised in 1984, and incorporated as section 215 of the Water Resources Development Act of 1996, PL104-303, October 12, 1996. This act establishes a National Dam Safety Review Board. It also establishes an interagency Committee on Dam Safety, which includes representatives from the Departments of Agriculture, Defense, Energy, Interior, and Labor; the Federal Emergency Management Agency (FEMA), which chairs the committee; the Federal Energy Regulatory Commission (FERC); the Nuclear Regulatory Commission; the Tennessee Valley Authority (TVA); and the U.S. section of the International Border Commission. The mandate of this committee is to encourage the establishment and maintenance of effective federal and state safety programs, policies, and guidelines through the coordination of information exchange among federal and state dam safety agencies, and among federal agencies regarding the *Federal Guidelines for Dam Safety* (issued by FEMA).

The NDSPA authorizes the secretary of the army, through its chief of engineers, to maintain an inventory of dams in the United States. In addition, the NDSPA requires FEMA to establish, maintain, and administer a coordinated national dam safety program. For these purposes, it should be noted that the NDSPA defines a dam as any barrier capable of impounding water, wastewater, or any liquidborne material that is greater than 25 feet in height or has an impoundment capacity for maximum storage elevation of at least 50 acre-feet.

The objectives of the program are to ensure that new and existing dams are maintained in a safe condition through the development of technologically and economically feasible programs and procedures, encourage the establishment of state dam safety programs, enhance public awareness so that there is increased support for state safety programs, and develop mechanisms to provide technical assistance on dam safety to the non-federal dam sector. The program must include both a federal and a non-federal component. The federal component incorporates all the activities carried out by federal agencies to implement the *Federal Guidelines for Dam Safety*. The non-federal element includes the activities of states, local governments, and the private sector to safely build, regulate, operate, and maintain dams. It also includes all federal activities designed to encourage states to develop dam safety programs.

The NDSPA requires FEMA to develop an implementation plan that will set yearly targets (up to FY2002) to demonstrate dam safety improvements and for providing assistance to dam safety programs. The NDSPA establishes some requirements that states must meet before their dam safety programs are eligible for assistance. The state programs must have the authority to review and approve plans to construct or alter dams, and to undertake inspections at least every five years. In addition, state programs must require that qualified and experienced professional engineers undertake dam inspections. A state program must also require that the owner obtain state approval before operationalizing any constructed dam. Additional requirements are that the state program have the authority to require the owner to make repairs to the dam and to take remedial action if the owner is non-compliant, that there be an emergency system for dealing with situations in which dam failure is either imminent or has actually occurred, and that the state has made a budgetary allocation for dam safety. Finally, FEMA must have approved the state plan. FEMA reviews each state program periodically and can revoke its approval of a state program. Every two years, the director of FEMA is required to submit a report on dam safety to Congress.

Federal law also requires the secretary of the army to carry out inspections of all dams in the United States, except those under the jurisdiction of the Bureau of Reclamation, the TVA, and the International Boundary Commission, that are constructed pursuant to a permit issued under the Federal Power Act or that are not deemed a threat to life and property. The secretary must share the results of these inspections with the states.

It is important to note that there is separate legislation dealing with the safety of dams located on Indian reservations. These dams are under the jurisdiction of the Bureau of Indian Affairs in the Department of the Interior.

### *State Law*

Each of the states has its own laws on dam safety. These laws are summarized in the Association of State Dam Safety Officials (ASDSO) Summary of State Laws and Regulations on Dam Safety (2000). Since many of the programs are similar to each other, this brief discussion of the state laws will merely attempt to highlight certain features of the state programs without providing a summary of each program.

The basic pattern of state regulatory schemes contains the following elements:

- A state regulatory agency, often the agency dealing with water or natural resources, has jurisdiction over dams, including dam safety. Any person interested in constructing and operating dams is required to obtain the permission of this agency before beginning construction of a dam.
- The state regulatory scheme establishes a classification scheme for dams. This scheme classifies dams according to one or more of the following factors: the dam's hazard potential, size, or condition. Most states have three categories of dams. The classification scheme determines the frequency of dam inspections, with dams having greater potential to cause harm having a higher frequency of inspections and more intensive scrutiny of dam safety. The frequency of inspections usually will vary between about 1 and 10 years.
- The primary responsibility for dam safety rests with the dam owner. This means that the owner must undertake dam safety inspections and is responsible for monitoring dam operations. Many states require that the inspections and dam design, construction, and operation be overseen by a suitably qualified person. The owner will usually be required to report on dam inspections to the relevant supervisory authority.
- The regulatory agency has the power to enforce dam safety regulations and to undertake its own inspections. The agency usually has the power to force the dam owner to undertake remedial action or to undertake the actions itself and recoup the costs from the dam owner. As part of

its enforcement powers, the regulatory agency can usually impose fines on the dam owner. These fines can vary from a few hundred dollars a day to a few thousand dollars a day. In addition, in some cases the agency can arrange for the non-compliant owner's imprisonment.

- In many states, the state authorities have immunity from liability for any damages caused by the failure of the dams subject to their jurisdiction or for which they issued the permits.

The following are some aspects of some individual state's regulatory frameworks that are noteworthy:

- In Arizona, there is limited state liability for damage arising from a state's inspection of a dam. Arizona also has created a dam repair fund that is funded through state appropriations and the fees paid by dam owners.
- The applicable California law establishes guidelines for the design and construction of dams. In California, the state conducts annual inspections of certain dams at its own expense, but charges fees for applications for a new dam or an enlargement of an existing dam. Dam owners must also pay an annual fee. The state has established a dam review board with limited numbers of members. In addition, there is an independent review board for state-owned dams.
- In Idaho, each dam is inspected by the state every two years at the state's expense. The owner is required to keep data, which it must provide to the state, but is not required to conduct its own inspections. There is state immunity for damage caused by a dam failure. The owner is responsible for liabilities incident to the ownership and operation of the dam.
- Iowa requires the dam owner to post a performance bond as a condition for obtaining the permit/approval order to construct or operate the dam.
- Kentucky requires permit applications to be drawn up by a licensed professional engineer. The applications must bear his or her signature and seal. The state carries out dam inspections. The law only requires the owner to conduct inspections in case of renovations.
- Maine's Department of Defense, Veterans, and Emergency Management has jurisdiction over dam safety. The Maine Emergency Management Agency actually exercises this authority. It inspects dams to determine their hazard potential every six years. In addition it can conduct safety

inspections, take control of dams in case of emergencies, set regulatory standards for dam safety, appoint safety inspectors, and honor petitions for inspection from third parties. It is also responsible for ensuring the competent operations of dams and for giving approval for dam construction and alteration permits. It should be noted that the Maine Department of Environmental Protection has jurisdiction over water and navigation matters.

- Michigan's Natural Resources and Environmental Protection Act has a section on dam safety. The Department of Natural Resources is responsible for dam safety. It regulates all aspects of construction and alteration of dams, provides for inspections and the protection of natural resources, and safeguarding the public trust. It is authorized to impose remedies and penalties in cases of non-compliance and to take actions to protect public safety. Owners cannot begin constructing dams without permits from the department, and the statute establishes a fee structure for permit applications. They may also be required to post a performance bond to ensure completion of the project. Plans for dams must be prepared by a licensed professional engineer. Dam owners are required to submit inspection reports prepared by a licensed professional engineer to the department every three to five years, depending on the hazard potential of the dam (this means that each year one-fifth of all low hazard potential dams and one-third of all high hazard potential dams are required to submit an inspection report). Owners of all high and significant hazard potential dams must have emergency plans that must be submitted to the department and the local emergency services coordinator.
- Missouri's Dam and Reservoir Safety Council is responsible for dam safety. It has the authority to provide adequate protection for public safety, life, and property; to make policy, rules, regulations, standards, and guidelines; and to issue permits. The Department of Natural Resources has the authority to administer and enforce the council's policies and rules and regulations. In addition, the chief engineer of the council is responsible for administering the laws for the council, including carrying out inspections. Dam owners are required to obtain three permits: one each for registration, construction, and safety. Dams must be inspected by an experienced professional engineer before the registration or safety permit will be issued or renewed (after five years).

- Montana only requires the state to conduct inspections during dam construction. The state is also required to resolve complaints and determine a dam's hazard classification. The law requires owners to have a private-sector professional engineer conduct an inspection at the owner's expense at least every five years, but the state sets the frequency of the inspection. The owner is not liable for damage arising from dam failures caused by floods that exceed the 100-year floodplain if there is no evidence of negligence.
- New Hampshire requires all dams to pay an annual registration fee.
- Ohio requires the owner to pay an annual fee to the state with the fee based on the classification and size of the dam. Each dam must have an inspection manual that includes a program for periodic inspections by the owner that are undertaken by a licensed professional engineer.
- Pennsylvania charges fees for permit applications. The state also requires the owner to notify the state and the responsible authorities of downstream communities of any condition that threatens the safety of the dam and to take corrective action.
- In Puerto Rico, dam safety is overseen by the Dam Safety Unit of the Puerto Rico Electric Power Authority. This unit is supervised by a seven-member committee composed of the executive director of the Puerto Rico Electric Power Authority, the secretary of Natural and Environmental Resources, the president of the Puerto Rico Planning Board, the chief of operations of the Puerto Rico Water Company, and three members of the public sector named by the governor.
- Utah requires intensive inspections during construction and thereafter once every five years for dams with significant hazard potential. The inspections are conducted jointly by the dam owner and the state. The state also sets minimum maintenance and operating standards. The state waives immunity for all state employees except those who are involved in "intervening during dam emergencies."
- Washington State's Department of Ecology has jurisdiction over dams and is responsible for conducting inspections. It has issued seven volumes of dam safety guidelines. The state inspections are conducted at least every six years in the case of high and significant hazard dams. In addition the owner is responsible for conducting its own regular inspections. The state charges the owner for the regular state inspections.

The fees for the inspections are based on the actual cost to the state for doing the inspection. In addition, the state charges for the permits it issues. These fees can range up to \$20,000.

- West Virginia's Dam Control and Safety Act spells out in detail the requirements for applying for dam permits. These requirements include design requirements, geotechnical evaluation and stability requirements, special considerations for gravity structures and instrumentation, parameters for site development and construction, and rules for the operation and maintenance of dams. The act requires the state to conduct inspections during construction at the owner's expense. It also requires the owner to have a registered engineer conduct inspections at regular intervals that vary according to the stage in the life cycle of the dam and its hazard classification. The owner must submit the reports from these inspections to the state.
- Wisconsin requires the owner to post a performance bond with the state equal to the estimated cost of restoring a reconstructed dam to a safe condition when seeking a permit to construct or alter a dam. The owner must also file proof of financial ability to operate and maintain a dam in good condition. In addition, the state charges a fee for permit applications.



## **PART TWO**

### **Comparative Analysis of Dam Safety Regulatory Frameworks**

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The survey of the regulatory frameworks for dam safety in the first part of the study identified a number of common issues addressed by those frameworks. Such issues can be classified into four considerations. These considerations are the legal form of the regulation, the institutional arrangements for regulating dam safety, the powers of the regulating entity, and the contents of the regulatory scheme. The legal form of the regulation deals with issues such as whether the regulatory framework consists only of a primary legal instrument, like a statute, or also involves subsidiary instruments, such as regulations, decrees, or guidelines. The institutional arrangement addresses such issues as the location of the regulatory authority within the governmental structure, the relative independence of the regulators from the policymakers and those whom they regulate, and their relationships with other governmental bodies. The powers of the regulating entity refer to such issues as whether the functions of the entity are purely advisory or its decisions are binding on the regulated entity, the rule and policymaking powers of the agency, the ability of the regulators to monitor and inspect the operations of the regulated entity, and the enforcement powers of the regulators. The contents of the regulations relate to factors like the obligations of the regulated entities, the scope of the regulations, and the consequences of non-compliance with the stipulated obligations.

In this part of the study, the dam safety regulatory frameworks described in part one are compared on the basis of these four considerations. Each consideration is dealt with separately in this part of the study. It should be noted that not all the regulatory schemes described in part one address all aspects of these issues.

### **The Form of the Regulation**

Fourteen of the regulatory schemes studied relied on specific dam safety legislation. These are the schemes in the following jurisdictions:<sup>39</sup> Argentina, Australia (New South Wales), Canada (Alberta, British Columbia, Quebec), Finland, France, India,<sup>40</sup> Latvia, Portugal, South Africa (regulations), Russia, and the United States (both federal and some state regulatory schemes).

Twelve jurisdictions deal with dam safety as one aspect in more general legislation. The applicable legislation may deal more generally with water, dams, energy, or natural resources. The jurisdictions in this group are Australia (Queensland, Victoria), Austria, Canada (Ontario), China (general statute), Mexico, New Zealand, Norway, Spain, Switzerland, the United Kingdom, and the United States (some state regulatory schemes).

### **The Institutional Arrangements**

Eleven jurisdictions have designated a regulatory authority that is exclusively dedicated to dam safety. These jurisdictions are Argentina, Austria, Australia (New South Wales), Canada (Alberta), China, France, India, Portugal, Romania, and the United States (federal and some states). In some of these countries the specifically designated regulatory authority may share jurisdiction over certain aspects of dam safety with other regulatory bodies.

In 15 jurisdictions, the regulatory authority deals with dam safety as part of broader regulatory responsibilities. These jurisdictions are Canada (Ontario), China, Finland, Ireland, Latvia, Mexico, New Zealand, Norway, Russia, Portugal, South Africa, Spain, Switzerland, the United Kingdom, and the United States (some states).

In Australia (Queensland), the regulatory framework identifies a specific individual as being responsible for dam safety issues. Interestingly, the Canadian Dam Association recommends that the regulatory framework identify a specific officer as being responsible for dam safety.

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39. For the purposes of this comparative analysis, each regulatory scheme that was specifically described in part one of this study has been counted separately in this section of the study. This means that the regulatory scheme of each state/province within a country has been counted as a separate regulatory scheme except for the United States, which in some cases is dealt with as one scheme.

40. All references to India in part two of this study are to the draft Dam Safety Act, 2000.

In three jurisdictions, the regulatory framework creates a specific commission with oversight or advisory responsibility for dam safety. These jurisdictions are Australia (New South Wales), Ireland, and South Africa.

### **The Powers of the Regulating Authority**

#### *Power to Develop Norms and Standards*

In 20 jurisdictions, the regulatory authority has the power, either explicitly or implicitly, to develop norms and standards applicable to dam safety. These jurisdictions are Argentina, Australia (New South Wales, Queensland, Victoria), Austria, Canada (Alberta, Ontario), China, Finland, France, Latvia, Mexico, Norway, New Zealand, Portugal, Romania, Russia, Spain, and the United States (federal and some states). In three other cases, South Africa, the United Kingdom, and Michigan, these standards are established in the legislation itself.

#### *Power to Issue Licenses/Permits*

In 17 jurisdictions the authority responsible for dam safety also plays some role in the issuance of permits or licenses for the construction and operation of dams. Usually this means that the dam safety regulator must approve the applicant's plans for dealing with dam safety. These jurisdictions are Argentina, Australia (Queensland, Victoria), Austria, Canada (Alberta, British Columbia, Quebec), Latvia, New Zealand, Norway, Portugal, Romania, South Africa, Spain, Switzerland, the United Kingdom, and the United States (some states). In the case of the United Kingdom, the regulatory authorities base their decisions on the recommendations of a qualified engineer who is involved in the dam project.

#### *Power to Monitor Inspections*

In 15 jurisdictions, the regulatory authority has the power to monitor inspections by the dam owner and to accept or reject the owner's reports on dam safety. These jurisdictions are Argentina, Austria, Canada (Alberta, Ontario), China, Finland, France, India, Mexico, Norway, Portugal, South Africa, Spain, the United Kingdom, and the United States (some states). The Australian Committee on Large Dams and the Canadian Dam Association, in their respective guidelines on dam safety, recommend that the regulatory authority should have this power.

### *Power to Conduct Inspections*

In 14 jurisdictions, the regulatory authorities have the power to conduct their own inspections. These jurisdictions are Australia (New South Wales, Queensland), Austria, China, Finland, France, India, Norway, Portugal, Romania, South Africa, Spain, and the United States (federal and some states). In most of these cases, it is the dam owner or operator, and not the regulatory authority, that is the party primarily responsible for conducting safety inspections. However, in a small number of cases, for example, the states of Kentucky and Washington in the United States, the regulatory authority has the primary responsibility for conducting safety inspections.

### *Power to Approve Inspectors*

In three jurisdictions, the regulatory authority has the explicit power to approve or reject the party selected by the dam owner or operator to conduct the safety inspection. These jurisdictions are Mexico, Switzerland, and the United Kingdom. In other cases, the regulatory authorities implicitly have similar powers because of their ability to accept or reject the owners' inspection reports and to conduct their own inspections.

### *Maintain Register/Inventory of Dams*

Six jurisdictions require the regulatory authority to maintain a register or inventory of all dams covered by the dam safety regulatory scheme. These jurisdictions are France, Russia, South Africa, Spain, the United Kingdom, and the United States (federal). The ANCOLD and the CDA both recommend that states maintain a registry of dams.

### *Advisory Responsibilities*

China, Finland, and India all explicitly give the regulatory authorities some role in advising dam owners on dam safety issues. They also require the regulatory authority to inform dam owners and other interested parties about developments in dam safety issues and the applicable regulatory scheme.

### *Reporting Responsibilities*

Five jurisdictions—Argentina, India, Portugal, the United Kingdom, and the United States (federal)—require the dam safety authorities to issue periodic

reports on dam safety. These reports are public, although they may be issued in the first instance to a higher regulatory authority.

#### *Central Government—State/Local Government*

A number of the countries studied have decentralized governmental structures in which relations between the central government and state or local governments become an important issue. In these countries, the regulatory scheme usually addresses the relationships between the different levels of government. This is important both in order to accommodate the requirements of the governmental structure in the country and to avoid duplication or ambiguity in the regulatory framework applicable to any particular dam.

In the case of Argentina, the regulatory authority, ORSEP, has four regional offices that have independent technical and institutional authority. If the regional offices have jurisdiction over more than one province, the office will have both a regional and a provincial director. Argentina's goal, as part of its attempt to privatize energy facilities, is to develop a uniform dam safety regulatory framework for the whole country. In this regard it is important to note that ORSEP only has jurisdiction over privatized dams.

In India, the draft legislation would require dam safety offices to report to the Central DSO, which then prepares a report on national dam safety. This report is based on the various state reports plus the Central DSO's evaluation of safety at the dams for which it is responsible.

The Russian statute stipulates that all dams except those owned by municipalities are subject to the jurisdiction of the federal government.

The Swiss regulatory framework stipulates that all dams larger than a specified size are subject to federal jurisdiction.<sup>41</sup> All other dams are subject to regulation by cantons.

In the United States, the federal government has its own dam safety regulatory scheme. As part of this scheme it sets standards for state dam safety regulatory schemes. It seeks to enforce these standards by withholding assistance from any state that does not meet its basic requirements for dam safety.

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41. All dams that are higher than 25 meters, higher than 15 meters, and with a reservoir capacity greater than 50,000 cubic meters, or with a reservoir capacity greater than 500,000 cubic meters and which are under the supervision of the Swiss Office of Water Management and Geology are subject to the federal regulatory framework. A second federal decree is applicable to all dams higher than five meters and that have a storage capacity greater than 50,000 cubic meters, and all other dams that present particular safety concerns.

It should also be noted that in many countries, issues related to emergency preparedness involve some regulatory action at the municipal level. This means that dam safety in these countries will always involve some central government–state/local government interaction.

New Zealand, which is a unitary state, has attempted to address the potential problems that can arise from inadequate coordination between different governmental levels in a regulatory scheme by stating in the applicable law that the principle of subsidiarity is applicable to dam and resource management issues.

### **The Contents of the Regulatory Scheme**

#### *Dams Covered by Regulatory Scheme*

The regulatory schemes in 18 jurisdictions include a specific definition of the dams that are covered by the scheme. This definition will clarify such issues as whether the regulations are applicable to all dams or only those that involve water storage and the size and hazard characteristics of the dams covered by the regulatory scheme. These jurisdictions are Argentina (only privatized dams), Australia (New South Wales, Queensland), Canada (British Columbia, Ontario, Quebec), Finland, France, India, Latvia, Norway, Portugal, South Africa, Spain, Switzerland, the United Kingdom, and the United States (federal and states). ANCOLD, CDA, and ICOLD all recommend that the regulatory scheme should define which dams are covered by the scheme.

Some states take an innovative approach to defining which dams are covered by the regulatory scheme. For example, Portugal uses two classification systems. The first is based on size. The second is based on a global risk index that develops a global risk profile for each dam based on three criteria: external and environmental factors, the condition of the dam, and the human and economic hazard potential of the dam. The global risk index is used to rank dams according to the urgency of their need for remedial action and to establish a priority list of dams needing attention. Apparently, Brazil is considering developing a dam classification system that would classify dams according to their hazard potential based on numerical weights and parameters that produce a hazard potential value for each dam. This would allow similar prioritization for remedial action to what is possible under the Portuguese system.<sup>42</sup>

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42. Communication from G. V. Canali to the authors.

Norway focuses on the consequences of dam failure in classifying the dams that are included in its regulatory scheme. It bases its classification scheme on the number of dwelling units<sup>43</sup> that could be affected by a dam failure. Queensland in Australia utilizes a similar concept. It decides which dams to include in its regulatory scheme on the basis of the population at risk in the case of a dam failure.<sup>44</sup> All dams whose failure places more than two people at risk are covered by the regulatory scheme.

### *Scope of Regulatory Scheme*

Finland's regulatory scheme is limited to the issue of dam safety. In the case of Australia (New South Wales, Victoria), France, and South Africa, the regulatory scheme explicitly addresses issues relating to dam construction, and operation, maintenance, and surveillance, as part of the dam safety regulatory framework. The CDA recommends that the dam safety regulatory framework should cover construction, operations, maintenance, and surveillance.

It should be noted that South Africa is currently considering a revised set of dam safety regulations. The new regulations are expected to pay more attention to the social and environmental aspects of dam safety than the current regulations do.

Another recent development is that a number of dam owners are utilizing ISO 14000 as the basis for developing procedures for dealing with the environmental aspects of dam operations.<sup>45</sup> While this is currently occurring on a voluntary basis, it is conceivable that these dam owners and South Africa are indicators of a developing trend in dam safety regulation.

### *Primary Responsibility for Safety*

In 13 jurisdictions, the regulatory framework explicitly imposes on the dam owner the primary responsibility for dam safety and for conducting safety inspections. These jurisdictions are Canada (British Columbia), China, Finland, France, India, Ireland, Mexico, Norway, South Africa, Spain, Switzerland, the

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43. "Dwelling units" are defined in the Norwegian Water Act. See the section on Norway in part one of this study.

44. See the section on Queensland, Australia, in part one of this study.

45. Communications from G. V. Canali and David Watson to the authors. Canali cites the examples of HydroQuebec and dam owners in Brazil who are using ISO 14000 in their dam operations. ISO 14000 is a series of standards for environmental management issued under the auspices of the International Organization for Standardization. For more details on ISO 14000, see United Nations Development Programme, *ISO 14000—Environmental Management Standards and Implications for Exporters to Developed Markets* (UNDP 1996).

United Kingdom, and the United States (some states). ANCOLD and CDA both recommend making the owner responsible for dam safety, including conducting inspections. In another eight jurisdictions, the regulatory framework makes clear, through the obligations that it imposes on the owner, that the dam owner bears the primary responsibility for dam safety. These jurisdictions are Austria, Canada (Quebec), Finland, Latvia, Norway, Romania, Russia, and the United States (some states).

One issue that is not directly addressed in any of the regulatory frameworks, except for that of Argentina, is how responsibility for dam safety is handled in cases in which there is a transfer of dam ownership, such as in the case of privatized dams. In Argentina, the issue of dam safety is addressed in the contractual arrangements that exist between the state and the private dam owner. This issue is of particular importance in the case of older dams that may require some work to bring them into compliance with the most current dam safety standards. In these cases, it is important that the respective dam safety responsibilities of the old and new dam owners for bringing the dam into compliance with current safety standards be clarified.

#### *Standards and Specifications for Inspections*

In most cases, the regulatory schemes do not contain explicit standards that must be met in the inspections and surveillance activity related to dam safety. Instead the legislation leaves it to the regulatory authority to develop such standards. For example, Washington State in the United States has published seven volumes of guidelines on dam safety and operations. Even where these guidelines are not legally binding, they will provide important evidence of best practice and of the standards that dam owners should meet with regard to dam safety.

In a few jurisdictions the regulations do contain certain standards or requirements for dam safety activity. These jurisdictions are Switzerland and the following states in the United States: Michigan (addresses all stages of the dam's life cycle), California, Utah (establishes minimum standards for operations, maintenance, and surveillance), and West Virginia (establishes requirements for design, construction, and issuance of permits). Another jurisdiction that has taken this approach is Italy.

It is interesting to note that some other countries, for example, the Netherlands, Norway, and Portugal, allow for risk assessment approaches in their regulations. It should also be noted that most of the regulatory schemes that

contain standards relating to dam safety do not contain standards applicable to the operation and maintenance of the dam.

### *Qualifications of Inspectors*

The legislation in 17 jurisdictions requires that suitably qualified engineers conduct the safety inspections. The jurisdictions are Australia (Queensland), Austria, Canada (Alberta, British Columbia), Finland, France, India, Norway, South Africa, Spain, Switzerland, the United Kingdom, and the United States (Ohio, Kentucky, Michigan, Missouri, and West Virginia). In the case of Norway, the legislation stipulates that the dam licensee shall establish the qualifications of the inspector.

The legislation in the United Kingdom requires the creation of a panel of qualified engineers. Any engineer with the requisite qualifications (which are set by the regulatory authority in conjunction with the engineering profession) can apply to be included in this panel. The legislation in the United Kingdom allows any engineer included in the panel to conduct the inspections. Portugal is an example of a country that does not explicitly require that a suitably qualified engineer conduct the inspections undertaken by the dam owner.

### *Reporting Requirements*

Eighteen jurisdictions require that dam owners or operators or those whom they hire to conduct safety inspections file reports with the dam safety regulators. These jurisdictions are Argentina, Australia (Queensland), Austria, Canada (British Columbia, Quebec), Finland, France, India, Ireland, Latvia, Mexico, Norway, Romania, South Africa, Spain, Switzerland, the United Kingdom, and the United States (states). ANCOLD and the CDA both recommend that dam safety regulations include a reporting requirement.

### *Timing of Inspections*

The legislation in 18 jurisdictions specifies that inspections should take place at regular intervals. These jurisdictions are Australia (Queensland), Austria, Canada (Alberta, British Columbia, Quebec), Finland, France, India, Ireland, Norway, Portugal, Romania, Russia, South Africa, Spain, Switzerland, the United Kingdom, and the United States (states). The CDA recommends that the regulatory scheme specify how often inspections should take place.

The intervals specified for inspections in these different regulatory schemes vary. In almost all cases, the frequency of the inspections varies

proportionately to the hazard classification of the dam, with more hazardous dams having more frequent inspections. The one exception is the United Kingdom, which does not categorize dams according to their hazard potential.

Many of the regulatory schemes require close inspections of the dams around the time of their first fillings or soon thereafter. Some also require relatively close monitoring of the dam during construction. After the dam becomes operational, the frequency of the inspections can vary from 1 to 10 years, depending on the regulatory scheme and the hazard classification of the dam. The dams with the greatest potential to cause harm tend to be inspected about once every 1 to 3 years.

In addition, some countries establish different inspection cycles for inspections by the owner and inspections by the regulators. For example, in Washington State the owners are required to do annual inspections, while the regulators inspect the dam every 6 years. In the case of Alberta, the regulatory framework establishes one schedule for dams that are privately owned and another for dams that are owned by the state. In the former case, dams are inspected every 1 to 10 years, depending on their classification. In the latter case the inspections are carried out by an independent consultant every 5 years.

The regulatory schemes may also require different levels of inspections. For example, the Swiss authorities require the owner to check the measurements on equipment monitoring dam safety monthly, to conduct an annual visual inspection of the dam and (for certain dams) to organize a more comprehensive inspection, conducted by qualified engineers and geologists, every 5 years. Similarly France requires the owner to visit the dam every two weeks and to take simple measurements every month and more complex measurements once a year. The owner is also required to submit a detailed report on the dam to the regulatory authority every 2 years. The French regulatory authority supplements the owner's safety investigation with its own annual examination of the dam and a comprehensive examination of the dam every 10 years. Portugal also establishes different levels of inspections, which must be conducted with different frequencies.

#### *Technical Archives/Records*

Ten jurisdictions explicitly require that the dam owner maintain a complete set of records on the dam. These records should include the dam's design,

construction records, operating records, maintenance records, records of all inspections, and measurements taken from any monitoring equipment. These jurisdictions are Australia (New South Wales), Canada (Quebec), Finland, France, India, Romania, South Africa, Spain, Switzerland, and the United Kingdom. There is some country variation regarding where the records must be kept. Some countries require the owner to keep the records both at the head office and at the dam site. Others require the owner to submit all these records to the regulator.

In Austria, while the regulatory framework does not explicitly require that the dam owner keep an archive, it does require the dam owner/operator to “systematically” collect information on the design, construction, and operation of the dam.

#### *Fees for Inspections and Permits*

Ten jurisdictions require licensees to contribute some financing toward the cost of the license. These jurisdictions are Argentina, Australia (Queensland), Canada (Quebec), New Zealand, Norway, and the United States (Arizona, California, Michigan, New Hampshire, and Pennsylvania). In some cases the regulations require the licensee to pay an application fee. In other cases, for example, California and New Hampshire, the dam owner is required to pay an annual fee for the dam license. In the case of Arizona, the legislation provides that the state will allocate the application fee and some other public funds to a dam repair fund. Three states in the United States (Iowa, Michigan, and Wisconsin) require the dam owner or operator to post a performance bond as a condition for obtaining permission to construct or operate a dam. The bond should be sufficient to cover the cost of any potential damage caused by the failure of the dam.

The legislation in four jurisdictions provides that the state can charge for any inspections that it conducts and for any remedial actions that it undertakes. These jurisdictions are Australia (Queensland), New Zealand, the United Kingdom, and the United States (Washington). South Africa adopts a different approach. Its legislation provides that the state can subsidize the cost of inspections for the owners of certain dams.

It is important to note that these provisions are the only discussion of the budgetary implications of dam safety legislation. While it is not surprising that dam safety legislation does not explicitly discuss the financing of the

regulation of dam safety, it does expose a potential weakness in the regulatory scheme. It suggests that in some cases the regulatory authority might not have sufficient resources to adequately fulfill its responsibilities.

### *Emergency Plans*

Fourteen jurisdictions require dam owners to prepare a plan for dealing with dam emergencies. These jurisdictions are Argentina, Australia (New South Wales, Queensland), Canada (Alberta, British Columbia), France, Latvia, New Zealand, Norway, Portugal, Romania, Spain, Switzerland, and the United States (Michigan). ANCOLD and CDA both recommend that dam owners be required to prepare an emergency plan. It is important to note that in some jurisdictions, emergency plans are only required for some dams—usually those with higher hazard potentials.

Some jurisdictions require that the emergency plan be reviewed periodically and that the affected communities and other interested parties be informed of the emergency plan. In some cases, it is suggested that the affected communities and other interested parties should be consulted about the contents of the emergency plan.

It should be noted that, in some cases, the agency with primary responsibility for handling emergencies is not the agency with primary responsibility for dam safety. In these cases, the relevant agency, in addition to the dam safety regulatory authority, must be informed about the emergency plans.

The regulatory framework in some of the jurisdictions that require emergency plans do not provide extensive detail on what the plan should contain. However, approval of the plan is usually a condition for obtaining approval to operate the dam. It is widely believed that the South African regulatory framework is a good example in this regard. It provides useful and cost-effective guidelines to dam owners on what information should be included in the emergency plan.

### *Enforcement of the Dam Safety Regulations*

Seven jurisdictions allow the regulators to impose fines on dam owners that fail to meet their obligations under the regulatory framework. These jurisdictions are Australia (New South Wales, Queensland), Canada (Quebec), New Zealand, Norway, South Africa, and the United States (states). These fines can vary from a few hundred dollars to several thousand dollars. The most severe fine can be imposed by Quebec, where the fine can be up to Can\$500,000.

In some cases, the regulations treat each day that the owner remains out of compliance as a separate infraction that is subject to a separate fine.

Eight jurisdictions empower the regulators to take action to deal with the problems caused by owners who fail to meet their obligations under the dam safety regulatory scheme. These regulators may be empowered to take remedial action and then charge the owner for the cost of these actions. Alternatively, the regulators may be empowered to seek judicial assistance to force the owner to take remedial action or to seek criminal sanctions against a non-complying owner. These jurisdictions are Argentina, Australia (New South Wales, Queensland, Victoria), Finland, Latvia, New Zealand, and the United States (some states).

### *Liability for Dam Failures*

In general, it can be assumed that dam owners and operators are liable for the consequences of dam failures. There is some variation in their legal liability. The common law rule is that dam owners may be strictly liable for injuries to downstream communities and property caused by water escaping from the dam. However, this rule has so many exceptions that it cannot safely be assumed that dam owners will be liable in the absence of negligence on their part. Australian case law, *Burnie Port Authority v. General Jones Pty. Ltd.*,<sup>46</sup> holds that there is a negligence standard applicable to the dam owner's liability for dam failures. In Montana the regulatory framework specifically provides that dam owners will not be liable in the absence of negligence in the case of dam failures caused by floods that exceed the 100-year flood plain.

Civil law systems appear to treat dam owners more strictly. Norway's legislation stipulates that dam owners are liable for the damage resulting from the pollution they cause. The definition of pollution used in the legislation appears to include water that escapes because of a dam failure. Sweden,

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46. 68 ALJR 331 (High Court of Australia, 1994). The case dealt with an owner/occupier's liability for damage caused by the escape from its property of materials that were being maintained on the property in a dangerous or non-natural way. It held that the traditional common law rule, which was close to strict liability, had been absorbed into the general principles of ordinary negligence. As such, the owner/occupier only was liable if the owner/occupier was negligent in allowing the material to escape. It should be noted that a dam is viewed as a non-natural use of water. It is worth noting that the traditional rule of strict liability spelled out in the English case of *Rylands v. Fletcher*, 1866 LR 1 EX 265; affd (1868) LR 3 HL 330, is still applicable in England, although subsequent cases have qualified the rule.

according to Hjorth,<sup>47</sup> has introduced a strict liability standard. He claims that this has had a positive effect on dam safety.

There is another issue related to liability. This is the question of the state's responsibility for the harm that may result from its failure to adequately implement its dam safety responsibilities. In the United States, some states have explicitly claimed immunity from such responsibility. The United Kingdom has explicitly recognized that the state may be liable to third parties for the injuries caused by the consequences of the state entering into the property of the dam owner. The state can seek compensation for these expenses from the dam owner. New Zealand has taken another approach. Under its regulatory scheme, the state may be held liable for any harm caused by the acts of its regulatory authorities. Russia also appears to allow for some state liability in certain circumstances—where the state may have some responsibilities if the total damages exceed a certain amount.

An interesting issue that is not directly addressed in the regulatory frameworks examined is the issue of liability for dam failure in the case of privatized dams. It has been pointed out that problems can arise if the state was previously responsible for the maintenance and safety of the now privatized dam.<sup>48</sup> This is particularly a concern in cases involving dams that require updating to bring them into compliance with the latest safety standards. It also raises a question of whether there may not be certain situations in which the owner may be able to claim a liability waiver on the grounds of state negligence.

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47. P. Hjorth, *Operating, Monitoring and Decommissioning of Dams* 64 (paper prepared for Thematic Review IV.5: Operation, Monitoring and Decommissioning of Dams [World Commission on Dams]). Available at <[www.dams.org](http://www.dams.org)>.

48. Communication from G. V. Canali to the authors.

## **PART THREE**

### **Essential Elements, Desirable Elements, and Emerging Trends for Dam Safety**

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Based on the lessons learned from the survey and comparative analysis of the regulatory frameworks for dam safety discussed in the first two parts of this study, this part will offer some recommendations on the elements that should be addressed in any dam safety regulatory framework. Such recommendations will be related to the same four groups identified in part two of the study, namely the form of the regulation, the institutional arrangements of the regulating entity, the powers of the regulating entity, and the contents of the regulatory scheme. The recommendations are divided into three sections. These sections are the essential elements in a dam safety regulatory scheme, elements that would be desirable to include in a regulatory scheme, and emerging trends in dam safety regulation. The last section is designed to highlight elements that could become important dam safety issues in the future.

The recommendations contained in this section have purposefully been stated at a relatively general level. This is intended to facilitate the adaptation of these suggestions to the legal and administrative situation in each country. This is necessary because each country has its own legal and administrative traditions and will have to design a dam safety regulatory framework that is consistent with these traditions.

There are three issues that the drafters of any dam safety regulatory scheme must consider in designing their regulatory scheme.

First, the regulatory scheme must address two closely related but different aspects of dam safety:

1. the safety of the dam and the appurtenant structures; and
2. public safety, particularly the safety of the population living in the vicinity of or downstream from the dam.

Both aspects involve technical and “non-technical” issues. The technical issues include which instruments to use in measuring the performance of the dam, or in determining the adequacy of the dam structure and spillway system. While these technical issues are not without controversy, they are best decided by those with the technical expertise required to make such decisions. The “non-technical” issues are those that depend more on the judgment of the decisionmakers than on objective criteria. They include determining the acceptable level of risk that should be associated with a particular dam or category of dams, determining the appropriate safety-cost tradeoffs for each dam or category of dams, and determining how to address the environmental and social aspects of dam safety.

The second issue is whether the regulatory scheme should set different safety requirements for different categories of dam owners. This is particularly relevant in cases where the government is considering privatizing dams. It is also relevant in cases where the government itself is the owner or operator of the dam. Government ownership of the dam can affect questions of liability for dam failure and the independence of the dam safety activities of the regulatory authority with regard to the government-owned dam.

Third, the drafters of the regulatory scheme must decide if they want their regulatory scheme to cover all dams or only those that exceed certain size or hazard criteria. They will also need to decide if they want to have one set of requirements that is applicable to all dams or to establish different requirements for different categories of dams.

As explained above, these recommendations are divided into three parts: those that relate to the essential elements in a regulatory framework, those that would be desirable to include in a regulatory scheme, and the emerging trends in dam safety regulations.

### **The Essential Elements of a Regulatory Scheme**

The essential elements of a regulatory scheme refer to those elements that any regulatory scheme needs if it is to be capable of performing the most essential functions with regard to dam safety. In this regard it is important to note that the general principle underlying dam safety is that the owner is responsible for making the dam safe and for operating and maintaining it in a safe condition. The regulator is responsible for protecting the safety of the public by establishing the dam safety standards with which the dam owner

must comply and by monitoring compliance with these standards. This suggests that the essential elements of the regulatory framework are intended to achieve three basic objectives. The first is to clarify that the dam owner is responsible for dam safety and the regulators are responsible for monitoring the owner's performance in this regard. The second is to specify the owner's responsibilities with regard to the operation and maintenance of the dam and how the owner should review the safety of the dam. The third is to explain the ways in which the regulatory authority can perform its monitoring functions, which can include conducting its own inspections, and what powers it has to deal with non-complying dam owners and dams.

The following constitute the essential elements of any dam safety regulatory scheme:

### **1) The Form of the Regulation**

The regulatory framework should be clearly spelled out in publicly available documents. The precise form of the legal instruments used in the regulatory framework will vary depending on the specific characteristics of the legal and administrative traditions in each country. Such variations can be summarized in the following:

- In many cases the regulatory framework will consist of more than one legal instrument.
- The first of these instruments will be a statute or law that is passed by the legislative branch of government. Since changing such an instrument requires legislative approval, it should be kept relatively simple and should contain only the objectives of and the general principles governing the regulatory framework. In some jurisdictions, such as Argentina, Australia (New South Wales), Canada (Quebec), Finland, France, Latvia, Portugal, Switzerland, and the United States (federal and some states), the statute deals exclusively with dam safety. In other cases—such as Australia (Queensland, Victoria), Canada (Alberta, British Columbia, Ontario), Mexico, New Zealand, Norway, South Africa, Spain, and the United Kingdom, for example—dam safety is only one of the topics addressed in a more general statute. Usually the more general statute deals with dams, energy, or the management of water or natural resources. If dam safety is dealt with in a more general statute, it is helpful for the statute

- to contain a specific section that deals exclusively with dam safety.
- The statute should stipulate in clear terms the responsibilities of all parties involved with dams, the identity of the regulatory authority responsible for dam safety, and the authority responsible for handling any emergencies that are caused by dam failure.
  - The details of the regulatory scheme should be contained in legal instruments, such as regulations and decrees, that are relatively easy to change. In some cases, for example, Canada (Alberta, British Columbia), China, France, Portugal, Spain, and South Africa, these regulations deal only with dam safety. In other cases, such as some states in the United States, dam safety is one aspect of more general regulations dealing with such issues as water and environmental management.
  - The regulations may also be supplemented by non-binding guidelines. This is the case, for example, in New Zealand, Norway, and Washington State in the United States.

## **2) The Institutional Arrangements**

The institutional arrangements of the regulating entity should address the following:

- a) The regulatory authority that is responsible for dam safety should be identified, and its powers and responsibilities should be clearly spelled out in the regulatory framework. Since this is an aspect of the regulatory framework that should not be easily changed, it should be addressed in the primary statute or legislation. The authority must be independent from all those who make decisions about whether to build dams and all those who are involved in the ownership and operation of dams.
  - In some cases, for example, Argentina, Australia (New South Wales), Canada (Alberta), and France, the regulatory authority is exclusively dedicated to dam safety.
  - In other cases, for example, Canada (Ontario), Finland, France, Norway, Portugal, Spain, Switzerland, and South Africa, the regulatory authority deals with dam safety as part of broader regulatory responsibilities. These broader responsibilities usually include

dams, water, or environmental management more generally. In some of these cases, for example, Canada (Ontario) and South Africa, the regulatory authority may be assisted by a specific dam safety advisory body.

- b) The regulatory authority must be provided with adequate human and financial resources to perform its functions.
- In some countries it may be possible to achieve this objective by having the authority raise a significant portion of its financing through charging fees for issuing licenses, permits, or annual fees that are paid by dam owners. This is the case, for example, in Argentina, Canada (Quebec), New Zealand, Norway, and some states in the United States.
  - In other cases, for example, South Africa, the budgetary rules in the country may mean that the regulatory authority cannot retain the funds it obtains from charging fees. In these cases, the government will have to fund the regulatory authority through its normal budgetary allocation procedures.

### **3) The Powers of the Regulating Entity**

The powers of the regulatory authority should include:

- a) The power to identify and develop norms, standards, and guidelines dealing with dam safety.
- In many countries, for example, Argentina, Austria, Canada (Alberta, Ontario), Latvia, France, Mexico, Norway, Portugal, Spain, and the United States (Washington State), the regulatory authorities are granted explicit powers to create such norms and standards. Normally, these norms and standards supplement the general standards relating to dam safety stipulated in the applicable legislation.
- b) A voice in decisions to issue permits or grant licenses for the construction and operation of dams.

- This means that the regulatory agency should be able to review the dam safety plans of the dam owner/operator and ensure that they comply with all applicable dam safety requirements. While the dam safety regulatory authority does not need to have the final decision on granting the license or permit, it should have sufficient authority to ensure that licenses or permits are not issued to applicants who fail to meet the applicable dam safety standards.
  - Countries where the regulatory authority plays some role in decisions relating to permission to construct and operate dams include Argentina, Canada (Alberta, British Columbia, Quebec), Latvia, Norway, Portugal, South Africa, Spain, and Switzerland.
  - One way of dealing with this issue is to require, as a precondition to obtaining the relevant dam permits, that the dam safety regulator approve the applicant's dam safety plans.
- c) The power to monitor inspections conducted by others and the power to reject the findings of the inspection either because the inspector is not qualified to conduct the inspection or because the report of the inspection is inadequate.
- This power is particularly important because the regulators rely on it to ensure that dam owners are complying with their responsibilities.
  - Examples of jurisdictions where the regulatory authorities have such monitoring powers include Argentina, Austria, Canada (Alberta, Ontario, Quebec), Finland, France, Mexico, and Portugal.
- d) The power to conduct its own inspections when it deems it necessary to do so.
- The regulatory authority needs this power both to monitor the owner's compliance with its safety responsibilities and to deal with the consequences of non-complying owners.
  - Examples of jurisdictions where the regulatory authorities have the power to conduct their own inspections include Australia (New South Wales), Canada (Alberta), Finland, France, Mexico, Portugal, South Africa, Spain, and the United States (federal and some states).

- e) The power to approve the party selected by the dam owner or operator to conduct the required safety inspections.
- The regulatory authority needs this power in order to ensure that the dam owner is fulfilling its responsibilities in a competent manner.
  - Examples of jurisdictions where the regulatory authority has this power are Argentina, Mexico, Spain, Switzerland, and the United Kingdom.
  - In some cases the regulatory authority, in effect, can monitor the qualifications and competence of the person conducting the inspection through its power to accept or reject the report of the inspector. This approach, however, requires the regulatory authority to have a greater level of technical capability than if it has the power to approve the inspector. The reason is that in the former case it must have the capacity to evaluate the performance of the inspector rather than just his or her qualifications.
- f) The responsibility to maintain an inventory/register of all dams in the country that are covered by the regulatory scheme.
- The inventory/register will assist the regulators and the public in monitoring the safety of the country's stock of dams and in understanding the scope of the regulatory authority's responsibilities.
  - Examples of jurisdictions that require such inventories are Finland, France, South Africa, Spain, the United Kingdom, and the United States (federal level).
- g) The responsibility to advise dam owners and other interested parties, such as affected communities and industry, about dam safety issues and developments in the regulatory framework.
- In order to ensure that dam owners and these other interested parties know about the latest developments relating to dam safety and the regulatory framework, it may be helpful for the authority to conduct seminars and issue publications about dam safety issues.

- In fulfilling this responsibility, the regulatory authority may need to pay careful attention to the multilingual nature and level of literacy of its target audiences.
  - Examples of jurisdictions where the regulators have this responsibility are China and Finland.
- h) The responsibility to make periodic and publicly available reports on dam safety issues to both higher authorities in the executive branch of government and the legislature and to advise government on dam safety issues.
- The purpose of this requirement is to ensure that policymakers know about the level of safety of the dams within their jurisdiction. This helps promote safe dams and regulatory frameworks that are up-to-date and responsive to the needs of the country, and that have adequate resources. In addition, it is a mechanism for holding the regulatory authority accountable for its performance of its responsibilities.
  - Such reporting is required in jurisdictions like Argentina, Portugal, the United Kingdom, and at the federal level in the United States.
- i) The power to enforce the dam safety regulatory framework.
- This includes the power to undertake all necessary actions relating to dam safety in the event of the owner's failure to fulfill its responsibilities, to impose significant fines on non-compliant dam owners, and to suspend or annul the dam owner/operator's permit to operate the dam.
  - In order to avoid the possibility of the regulator abusing its powers, its decisions should be subject to appeal to a higher authority or the courts. For example, in the United Kingdom, a dam owner who disputes the recommendations of an inspecting engineer can appeal to a referee at its own expense.
  - Another way to make regulators accountable is to hold them liable for the adverse consequences of their actions and decisions. For example, in the United Kingdom, a third party can seek damages for injuries caused by state inspectors to the third party's land. The danger

of relying on this means of accountability is that it creates a disincentive for the regulators, who feel that they will be punished for being creative and too diligent in the performance of their responsibilities. For this reason, the regulators should only be liable for damage that results from their negligent supervision (or lack of supervision), and for their grossly negligent acts and omissions. The liability of the regulators should not be interpreted as meaning any reduction in the owner's responsibility for the consequences of the failure of its dam. New Zealand is another example of a jurisdiction in which the regulatory authority can be held liable for any harm caused by its acts. Russia provides that the state can be held liable if the damage caused by a dam failure exceeds a certain specified amount.

- In a number of other cases, for example, the United States (Arizona, California, Montana, Utah), the state has claimed immunity from such responsibility.
- Examples of jurisdictions in which the regulatory authority has the power to impose fines or take other punitive steps in order to enforce the regulatory framework include Australia (Queensland), Canada (Quebec), Latvia, Mexico, Norway, South Africa, and the United States (some states). Some jurisdictions, for example, Argentina, Australia (Queensland, New South Wales, and Victoria), Finland, and Norway (under the Pollution Control Act) allow for criminal sanction against non-complying owners.

#### **4) The Content of the Regulatory Scheme**

The regulatory scheme should include the following:

- a) Establishment of clear and easily applied criteria for determining which dams are covered by the regulatory scheme. It is not essential that all dams be included in the scheme, but those that are excluded should be easily identified and should be too insignificant to cause harm to anyone other than the owner if they fail.
- The most common criteria used in identifying which dams are covered by the regulatory framework are the size and hazards caused by the dam. Examples of countries that use these bases for classifying

dams are Argentina, Canada (Alberta, British Columbia, Ontario, and Quebec), Finland, France, Latvia, Norway, Portugal (uses both a size and hazard and a risk classification scheme), South Africa, Switzerland, and the United States (some states).

- In these cases, the size criteria relate to the height of the dam and to the size of the reservoir created by the dam.

b) Definition of the scope of the regulatory scheme. It should address dam safety issues at all stages of the dam life cycle. Thus it should address dam safety considerations that arise during the design, construction, first filling, operation, alteration, and decommissioning stages of the dam's life.

- This life-cycle approach to dam safety is important because it makes it more likely that dam safety considerations will be given adequate attention and that, as a result, adequate resources will be allocated to dam safety at all times.
- Examples of jurisdictions that address dam safety at all these stages are Argentina, Australia (New South Wales), France, Spain, South Africa, and the United States (West Virginia).

c) Clarification that it is the owner that has the primary responsibility for dam safety and can be held liable for any damage that results from a dam failure.

- For these purposes it is important to define the "owner" of the dam. World Bank Operational Policy (OP) 4.37, on the safety of dams, states that an "owner" can be "a national or local government, a parastatal, a private company or a consortium of entities."<sup>49</sup> It adds that "If an entity other than the one with legal title to the dam site, dam, and/or reservoir holds a license to operate the dam and responsibility for its safety, the term 'owner' includes such an entity." Under this definition, it is possible that a particular dam

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49. See *supra* n. 3 at footnote 1. This operational policy is included as appendix I of this publication.

can have more than one owner and therefore more than one party responsible for its safety.

- The case of dams owned by the state can be particularly difficult for the regulatory authority. The reason is that in these cases the regulatory authority, in effect, is part of the owner of the dam. Some jurisdictions handle this problem by requiring the state to hire outside independent experts to conduct regular inspections of the dams to evaluate its safety and its compliance with the applicable dam safety standards.
- In some jurisdictions, for example, Sweden, dam owners can be held strictly liable for any harm caused by the failure of the dam. The benefit of this approach is that it gives the owner a strong incentive to pay close attention to safety issues. However, the value of this incentive depends on the credence the owners will give to the threat to hold them strictly liable. If they believe that the relevant judicial system moves very slowly and is easily manipulated, they will not find this threat credible and may fail to respond to the intended incentive.
- It may not be possible in some jurisdictions to adopt a strict liability standard because of the existing constitutional, statutory, and case law applicable to the issue of dam owner liability for the consequences of dam failure.
- Other approaches to liability that may be useful include joint and several liability and proportional liability according to which a number of parties involved in dam safety can be held fully or partially responsible for the harm caused by dam failure.
- Another means for increasing the incentive for the dam owners to pay adequate attention to dam safety is to make the owners responsible in both criminal and civil cases for dam failures. Examples of jurisdictions where the possibility of criminal liability exists are Australia (New South Wales, Victoria), Finland, New Zealand, Norway (under the Pollution Control Act), and the United States (some states).
- An important issue that needs to be addressed, particularly in countries in which privatization of dams is a possibility, is how responsibility for dam safety will move in cases of transfers of title to

the dam. This is particularly relevant in cases of transferring ownership of dams that are currently not complying with applicable dam safety requirements.

d) Stipulation of the dam safety standards and specifications with which the owner is expected to comply.

- The regulatory authority can exercise its powers to develop its own safety norms, standards or guidelines or it can require dams subject to its jurisdiction to comply with the standards issued by a recognized body such as ICOLD, CDA, or ANCOLD.
- Examples of jurisdictions which have issued their own standards or guidelines are Norway and Washington State in the United States.

e) Establishment of the qualifications required of the person who does the safety evaluations for the owner.

- These qualifications should relate to the technical expertise of the person and his or her experience. Usually the person is required to be a suitably qualified engineer.
- In the case of important inspections and events in the life of the dam, the safety evaluator should be able to demonstrate his or her independence from the dam owner/operator and the regulator.
- Examples of jurisdictions that establish qualifications for safety inspectors in their regulatory frameworks are Australia (Queensland), Finland, France, Norway, South Africa, Spain, Switzerland, and the United States (some states). The United Kingdom has established a panel of qualified engineers on which any engineer with the requisite qualifications can be included. Dam owners are free to choose any member of this panel to conduct their inspections.

f) Stipulation that the owners/operators of the dam must make periodic reports to the regulators on the results of their reviews, inspections, and monitoring of the dam's safety.

- These reports should be prepared by a qualified person and should be designed to demonstrate how the dam is complying with all applicable dam safety standards.
  - Examples of jurisdictions that require such reports are Argentina, Austria, Canada (British Columbia), Finland, Latvia, Mexico, Portugal, South Africa, Spain, and the United States (Michigan and West Virginia).
- g) Stipulation of the frequency with which the dam owner/operator should conduct dam safety inspections and reviews.
- The regulatory authority can require inspections of different aspects of dam safety and inspections or reviews of differing levels of intensity at different intervals over the life of the dam. Thus certain relatively superficial inspections may take place with greater frequency than more rigorous inspections.
  - Examples of jurisdictions in which the frequency with which inspections must take place over the life of the dam are specified in the regulatory framework include Australia (Queensland), Finland, France, Norway, Switzerland, the United Kingdom, and the United States (some states).
- h) Stipulation that the owner/operator must maintain complete records on the dam at a convenient location.
- These records should include all information relating to the construction and operation of the dam, as well as to all safety inspections. They should also include information on all unusual events in the life of the dam.
  - These records can be very helpful to the regulators and the dam owners in protecting the safety of the dam and in developing plans for dealing with any dam-related emergencies.
  - Examples of jurisdictions that require dam owners to keep such records include Canada (British Columbia, Quebec), France, South Africa, Spain, and the United Kingdom.

- i) Requirement of all dams to have an operations, maintenance, and supervision manual,<sup>50</sup> and an adequate budget for operation, maintenance, and supervision.
- The regulatory authority should be required to review the dam owner/operator's operations, maintenance, and surveillance manual to ensure that it remains consistent with current dam safety practices and procedures.
  - The regulatory authority should review the sufficiency of the dam's operations, maintenance, and surveillance budget when it reviews the safety reports of the dams subject to its jurisdiction.
  - Examples of jurisdictions in which the dam safety authority requires dam owners to have an operations, maintenance, and surveillance manual are Canada (Alberta, British Columbia) and South Africa.
- j) Imposition of fees that dam owners/operators must pay to the regulatory authority.
- These fees can include both an application fee for any applicable license or permit and an annual fee.
  - The purpose of these fees is to cover the costs related to the dam safety activities of the regulatory authority.
  - The revenues may also be used to ensure that the regulatory authority has the funds to deal with non-complying dams.
  - In cases where it is not feasible for the regulatory authorities to charge fees and allocate those funds to dam safety activities, they may wish to consider requiring the dam owners to post a performance bond as a condition for obtaining permission to construct or operate a dam. This is done in Iowa, Michigan, and Wisconsin in the United States. Other possibilities include creating trust funds and requiring dam owners to maintain certain levels of insurance to deal with dam safety issues. Latvia is an example of a jurisdiction that requires dam owners to maintain a certain level of insurance for their dam.

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50. Appendix VI of this book contains a sample operations, maintenance, and surveillance manual.

- Examples of jurisdictions that charge fees for licenses and permits include Argentina, New Zealand, Norway, and some states in the United States.
- k) Requirement of dams with the greatest hazard potential to have an emergency plan that is provided to the regulatory authority and to all other relevant authorities and downstream communities that could be affected by a dam failure. The regulatory authorities should provide dam owners with guidance on the issues to be addressed in the emergency plan.
- If it is feasible, the regulatory framework should require all dams subject to their regulations to have an emergency action plan. The reason is that dam owners should always be prepared for dam failures, and regulators should be monitoring to ensure that they are prepared.
  - It would be useful for the regulatory framework to explain how the dam safety regulatory authority must interact with the local and national authorities responsible for dealing with emergencies. In the event that dam emergencies fall within the primary jurisdiction of the emergency management authorities rather than the dam safety authorities, the emergency management authorities should have a dam advisory board. The function of this board would be to advise the emergency management authorities about specific issues related to dam emergencies.
  - Examples of jurisdictions that require at least dams with the greatest hazard potential to have emergency action plans are Argentina, Australia (New South Wales, Queensland), Canada (Alberta, British Columbia), Finland, France, Latvia, Portugal, New Zealand, Norway, and the United States (Michigan).

### **Elements That Would Be Desirable to Include in a Regulatory Scheme**

The elements listed in this section are those elements, in addition to the essential elements described above, that would be desirable to include in the regulatory framework.

These desirable elements are:

### **1) Institutional Arrangements**

- a) The dam safety regulatory authority is exclusively devoted to dam safety.
  - An authority exclusively devoted to dam safety will find it easier to develop its expertise in dam safety and to remain informed of new developments in dam safety than one that has responsibilities in addition to dam safety.
- b) Regulatory authorities appoint a dam safety advisory committee. The function of this committee would be to advise the authority on dam safety issues.
  - The committee membership should include technical experts and representatives of affected local authorities and communities. Such a structure can allow for some public consultation on dam safety issues.

### **2) The Powers of the Regulating Entity**

- a) The dam safety regulatory authority is empowered, where appropriate, to coordinate dam safety regulation among all the agencies at the local, regional, and national levels that are involved in or affected by the regulation of dam safety.

### **3) The Content of the Regulatory Scheme**

- a) Stipulation that the regulatory authority may make its own periodic inspections of all dams that have high hazard classifications. These inspections would be in addition to those conducted by the owner/operator of the dam.
  - These inspections can be less frequent than the owner/operator's inspection as their purpose is to verify that the condition of the dam

conforms to the representations made about the dam by its owner/operator rather than to be the primary means of determining the safety of the dam.

- b) Stipulation that the regulatory authority be provided with a copy of the dam's technical archives/records and, for the highest hazard category dams, be required to review these records in its periodic inspections of the dam.
- c) Stipulation that, as part of a process for obtaining a dam license, prospective dam owners are required to conduct a failure impact assessment. This is an effort to determine the likely impacts of a dam failure on the potentially affected communities, property, and environment. The issuance of the license would be contingent on the regulator's approval of the assessment. Once the dam becomes operational, the dam owner would be required periodically to repeat this impact assessment and submit it for reapproval to the regulatory authority.
  - The purpose of this requirement is to ensure that the owner and the regulators have a good understanding of the consequences of the dam failure and of the measures they need to take to avoid this happening.
- d) The dam safety regulatory framework should establish a series of benchmarks that can be used to measure dam safety at all dams.
  - These benchmarks should take into account all structural, environmental, social, health, and economic factors that make up the general concept of dam safety.
  - The purpose of these benchmarks is to determine the dam safety standards and procedures that are applicable to each category of dams.
  - Owners of dams that do not comply with the applicable standard should be required to develop a risk management plan acceptable to the regulatory authority. The plan must indicate how the dam owner/operator will deal with the higher level of risk associated with the dam.

- e) The regulatory authority requires the dam owner to conduct periodic safety reviews of all dams.
- These reviews should be designed to test each dam's compliance with a set of dam safety standards that are based on the regulatory scheme and current best practices.
  - The dam safety regulatory authority should have the ability, when necessary, to conduct these reviews itself.
- f) The regulatory authority is required to issue annual reports on the safety of the dams subject to its jurisdiction.
- These reports should be publicly available and should be submitted both to higher authorities in the executive branch of the government and to the legislature.
  - The reports should discuss, for each dam, whether the owners are meeting all their safety-related obligations; whether dam safety reviews have been completed at all dams, and whether deficiencies have been identified. The report should also detail how any deficiencies will be corrected and the steps that have been taken to deal with non-complying dam owners and dams.
- g) The regulatory authority undertakes activities designed to educate the public about dam safety.

### **Emerging Trends in Dam Safety Regulation**

Dam safety is a dynamic concept. It evolves as our understanding of the safety implications of the technical characteristics of dams evolves and as our understanding of the social, economic, and environmental implications of dam safety develops. In light of this fact, it is useful to identify a number of emerging trends in dam safety. It is important to stress that the identified trends are currently reflected in dam safety regulatory frameworks to varying degrees. However, the trends are sufficiently strong that it is reasonable to expect that they will become more prominent features of dam safety regulatory frameworks in the coming years.

The following are the emerging trends identified in this study:

### **Institutional Arrangements**

- a) There is a general trend toward making the owners responsible for monitoring dam safety and for conducting all the necessary inspections. This is linked to a trend toward limiting the regulatory authority to developing standards and norms and to monitoring the dam owner's performance.
- A consequence of this development is that there is a trend toward reducing the size of the regulatory authority. The reason is that the authority does not need large numbers of people if its responsibilities are limited to monitoring the performance of the dam owner.
  - Another consequence is that it will become more important for the regulators to ensure that they are obtaining full and adequate information from the dam owners. This means that protection for whistleblowers (that is, employees of the dam owner who are willing to provide the regulators with important information about the dam owner's performance of its obligations that the owner itself has failed to reveal to the regulators) will become a more important issue. In some countries, such as the United States, there are specific legal protections given to whistleblowers.
  - This trend is likely to be strengthened if there is more privatization of dams around the world. On the other hand, it may be weakened if dam ownership by the state grows.
  - As the trend discussed becomes stronger, it will highlight the need for the regulators to have effective mechanisms for enforcing the regulatory requirements in cases of non-complying owners and dams. This in turn will increase the need for more effective means for holding the regulators accountable for the manner in which they exercise their authority. Thus, it is likely that over time dam safety regulatory frameworks will include new mechanisms for holding the regulatory authorities accountable and for resolving disputes between the authorities and dam owners.

### **The Contents of the Regulatory Scheme**

- a) There is a trend toward taking a life cycle approach to dam safety. This means that the dam owner is required to incorporate dam safety issues into its plans for the design, construction, operation, maintenance, alteration, and decommissioning of the dam. One consequence of this trend is that more attention is likely to be given to the funding of dam safety monitoring and maintenance during the dam licensing process and during the operational phase of a dam's life.
  
- b) There is a trend toward requiring dam owners to pay more attention to the funding of dam rehabilitation and maintenance. The funding mechanisms that can be used for these purposes include trust funds, bonds, insurance, and sinking funds.
  
- c) There is a clear trend toward paying more attention to the social implications of dam safety, including health and environmental implications. This trend is likely to be strengthened, given the critical importance of social and environmental factors for sustainable development. It is also likely to be strengthened as our understanding of how these factors interact with the efficient operation and sustainability of infrastructure projects like dams develops. One potential consequence of this trend is that there is likely to be a growing role for all stakeholders in dam safety matters.
  
- d) There is a significant trend toward using risk analysis in dam safety. At present this trend is focused on qualitative, as opposed to quantitative, risk analysis. The purpose of this risk analysis is to develop a relative ranking of the priorities that should be attached to specific dam safety-related issues and to identify those dams that are most in need of remedial action. The factors looked at in these risk analyses include the structural aspects of the dam and its appurtenant structures, the strengths and weaknesses in the owner's internal control systems, the priorities attached to specific proposed remedial and rehabilitation measures, and the owner's emergency action plans. They also include populations at risk, risk of loss of life, social and environmental risks,

and economic impacts, including property and community damage. Consistent with the trend toward making the owner responsible for dam safety monitoring, there also appears to be a trend toward having the dam owner conduct the risk analysis, and having the regulator approve the owner's analysis and the conclusions it derives therefrom.



## CONCLUSION

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The world's population has more than tripled in the last century, presenting a major challenge to governments, particularly in the water sector. Urbanization and environmental degradation compound this challenge, pushing the need to rethink water resources management to the top of the global agenda. During the second half of the last century, dams emerged as the single most elaborate mechanism for managing and controlling fresh water resources. Dams have been built to provide water for irrigation; for domestic, municipal, and industrial purposes; for generation of electricity; and for controlling floods. The debate on the costs and benefits of dams has been heightened in recent years, particularly after the release of the report of the World Commission on Dams. This debate has, by necessity, been extended to the issue of dam safety and how best to ensure it.

The purpose of this study is to provide policymakers and technical experts, as well as civil society organizations, with a "tool kit" of the issues related to the regulatory framework for dam safety. Based on the survey and analysis of the regulatory frameworks for dam safety in 22 countries, both industrial and developing, the study has highlighted what it considers the four most important considerations in this field. These considerations are the legal form of the regulation, the institutional arrangements, the powers of the regulatory entity, and the contents of the regulatory scheme. Based on the lessons learned from the survey and analysis of these four considerations in the 22 countries, the study offers some suggestions regarding the elements to be addressed in any regulatory framework for dam safety. Those suggestions are classified in three sections, the first of which contains the elements we consider essential, the second those elements that we consider desirable, and the third section the emerging trends in this field.

One point mentioned earlier that needs to be emphasized is that dam safety is a dynamic, evolving concept, and should be viewed and treated accordingly. Our understanding of the technical characteristics and economic, financial, environmental, and social considerations concerning dams is in a constant state of evolution. This fact in turn would have to be reflected in our thinking and handling of the single most important issue concerning dams—that is, their safety. As such we caution against a “straitjacket” or “one size fits all” approach to regulatory frameworks for dam safety.

Another point needs to be emphasized. Although the regulatory framework for dam safety will not, by itself, resolve the problems associated with dam safety, it is difficult to imagine any effective dam safety program that is not eventually translated into a binding and enforceable framework.

## **Appendices**

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APPENDIX I. World Bank: Operational Policy 4.37 on the Safety of Dams

APPENDIX II. World Bank: Bank Procedure 4.37 on the Safety of Dams

APPENDIX III. World Bank: Bank Procedure 4.37 on the Safety of Dams, Annex A on Dam Safety Reports: Content and Timing

APPENDIX IV. Republic of South Africa, 1998 National Water Act, Chapter 12: Safety of Dams

APPENDIX V. British Columbia, Canada, Dam Safety Regulation

APPENDIX VI. Canadian Dam Association, Sample Operations, Maintenance, and Surveillance Manual

APPENDIX VII. Selected Legislation on Dam Safety and Additional Information Sources



## World Bank: Operational Policy 4.37 on the Safety of Dams

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### III THE WORLD BANK OPERATIONAL MANUAL Operational Policies

OP 4.37  
October 2001

*These policies were prepared for use by World Bank staff and are not necessarily a complete treatment of the subject.*

## Safety of Dams

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**Note:** OP and BP 4.37 replace the versions dated September 1996. Other Bank policies that may apply to projects that involve dams include the following: OP/BP 4.01, *Environmental Assessment*; OP/BP 4.04, *Natural Habitats*; OP 4.11, *Cultural Property*; OD 4.20, *Indigenous Peoples*; OD 4.30, *Involuntary Resettlement*; and OP/BP 7.50, *Projects on International Waterways*. Questions on dam safety should be addressed to the Director, Rural Development Department (RDV).

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1. For the life of any dam, the owner<sup>1</sup> is responsible for ensuring that appropriate measures are taken and sufficient resources provided for the safety of the dam, irrespective of its funding sources or construction status. Because there are serious consequences if a dam does not function properly or fails, the Bank<sup>2</sup> is concerned about the safety of new dams it finances and existing dams on which a Bank-financed project is directly dependent.

### New Dams

2. When the Bank finances a project that includes the construction of a new dam,<sup>3</sup> it requires that the dam be designed and its construction

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1. The owner may be a national or local government, a parastatal, a private company, or a consortium of entities. If an entity other than the one with legal title to the dam site, dam, and/or reservoir holds a license to operate the dam, and has responsibility for its safety, the term “owner” includes such other entity.

2. “Bank” includes the International Development Association (IDA), and “loans” include credits.

3. For example, a water storage dam for a hydropower, water supply, irrigation, flood control, or multipurpose project; a tailings or a slimes dam for a mine project; or an ash impoundment dam for a thermal power plant.

supervised by experienced and competent professionals. It also requires that the borrower<sup>4</sup> adopt and implement certain dam safety measures for the design, bid tendering, construction, operation, and maintenance of the dam and associated works.

3. The Bank distinguishes between small and large dams.
  - a) Small dams are normally less than 15 meters in height. This category includes, for example, farm ponds, local silt retention dams, and low embankment tanks.
  - b) Large dams are 15 meters or more in height. Dams that are between 10 and 15 meters in height are treated as large dams if they present special design complexities—for example, an unusually large flood-handling requirement, location in a zone of high seismicity, foundations that are complex and difficult to prepare, or retention of toxic materials.<sup>5</sup> Dams under 10 meters in height are treated as large dams if they are expected to become large dams during the operation of the facility.
4. For small dams, generic dam safety measures designed by qualified engineers are usually adequate. For large dams, the Bank requires
  - a) reviews by an independent panel of experts (the Panel) of the investigation, design, and construction of the dam and the start of operations;
  - b) preparation and implementation of detailed plans: a plan for construction supervision and quality assurance, an instrumentation plan, an operation and maintenance plan, and an emergency preparedness plan;<sup>6</sup>

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4. When the owner is not the borrower, the borrower ensures that the obligations of the borrower under this OP are properly assumed by the owner under arrangements acceptable to the Bank.

5. The definition of “large dams” is based on the criteria used to compile the list of large dams in the World Register of Dams, published by the International Commission on Large Dams.

6. BP 4.37, Annex A, sets out the content of these plans and the timetable for preparing and finalizing them. In the dam safety practice of several countries, the operation and maintenance plan includes both the instrumentation plan and the emergency preparedness plan as specific sections. This practice is acceptable to the Bank, provided the relevant sections are prepared and finalized according to the timetable set out in BP 4.37, Annex A.

- c) prequalification of bidders during procurement and bid tendering;<sup>7</sup>  
and
  - d) periodic safety inspections of the dam after completion.
5. The Panel consists of three or more experts, appointed by the borrower and acceptable to the Bank, with expertise in the various technical fields relevant to the safety aspects of the particular dam.<sup>8</sup> The primary purpose of the Panel is to review and advise the borrower on matters relative to dam safety and other critical aspects of the dam, its appurtenant structures, the catchment area, the area surrounding the reservoir, and downstream areas. However, the borrower normally extends the Panel's composition and terms of reference beyond dam safety to cover such areas as project formulation; technical design; construction procedures; and, for water storage dams, associated works such as power facilities, river diversion during construction, shiplifts, and fish ladders.
6. The borrower contracts the services of the Panel and provides administrative support for the Panel's activities. Beginning as early in project preparation as possible, the borrower arranges for periodic Panel meetings and reviews, which continue through the investigation, design, construction, and initial filling and start-up phases of the dam.<sup>9</sup> The borrower informs the Bank in advance of the Panel meetings, and the Bank normally sends an observer to these meetings. After each meeting, the Panel provides the borrower a written report of its conclusions and recommendations, signed by each participating member; the borrower provides a copy of that report to the Bank. Following the filling of the reservoir and start-up of the dam, the Bank reviews the Panel's findings and recommendations. If no significant difficulties are encountered in the filling and start-up of the dam, the borrower may disband the Panel.

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7. See *Guidelines: Procurement under IBRD Loans and IDA*.

8. The number, professional breadth, technical expertise, and experience of Panel members are appropriate to the size, complexity, and hazard potential of the dam under consideration. For high-hazard dams, in particular, the Panel members should be internationally known experts in their field.

9. If the Bank's involvement begins at a later stage than project preparation, the Panel is constituted as soon as possible and reviews any aspects of the project that have already been carried out.

### **Existing Dams and Dams under Construction**

7. The Bank may finance the following types of projects that do not include a new dam but will rely on the performance of an existing dam or a dam under construction (DUC): power stations or water supply systems that draw directly from a reservoir controlled by an existing dam or a DUC; diversion dams or hydraulic structures downstream from an existing dam or a DUC, where failure of the upstream dam could cause extensive damage to or failure of the new Bank-funded structure; and irrigation or water supply projects that will depend on the storage and operation of an existing dam or a DUC for their supply of water and could not function if the dam failed. Projects in this category also include operations that require increases in the capacity of an existing dam, or changes in the characteristics of the impounded materials, where failure of the existing dam could cause extensive damage to or failure of the Bank-funded facilities.
8. If such a project, as described in para. 7, involves an existing dam or DUC in the borrower's territory, the Bank requires that the borrower arrange for one or more independent dam specialists to (a) inspect and evaluate the safety status of the existing dam or DUC, its appurtenances, and its performance history; (b) review and evaluate the owner's operation and maintenance procedures; and (c) provide a written report of findings and recommendations for any remedial work or safety-related measures necessary to upgrade the existing dam or DUC to an acceptable standard of safety.
9. The Bank may accept previous assessments of dam safety or recommendations of improvements needed in the existing dam or DUC if the borrower provides evidence that (a) an effective dam safety program is already in operation, and (b) full-level inspections and dam safety assessments of the existing dam or DUC, which are satisfactory to the Bank, have already been conducted and documented.
10. Necessary additional dam safety measures or remedial work may be financed under the proposed project. When substantial remedial work is needed, the Bank requires that (a) the work be designed and supervised

by competent professionals, and (b) the same reports and plans as for a new Bank-financed dam (see para. 4[b]) be prepared and implemented. For high-hazard cases involving significant and complex remedial work, the Bank also requires that a panel of independent experts be employed on the same basis as for a new Bank-financed dam (see paras. 4[a] and 5).

11. When the owner of the existing dam or DUC is an entity other than the borrower, the borrower enters into agreements or arrangements providing for the measures set out in paras. 8–10 to be undertaken by the owner.

### **Policy Dialogue**

12. Where appropriate, as part of policy dialogue with the country, Bank staff discuss any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in the country.



## APPENDIX II

### World Bank: Bank Procedure 4.37 on the Safety of Dams

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# THE WORLD BANK OPERATIONAL MANUAL Bank Procedures

BP 4.37  
October 2001

*These procedures were prepared for use by World Bank staff and are not necessarily a complete treatment of the subject.*

## Safety of Dams

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**Note:** OP and BP 4.37 replace the versions dated September 1996. Other Bank policies that may apply to projects that involve dams include the following: OP/BP 4.01, *Environmental Assessment*; OP/BP 4.04, *Natural Habitats*; OP 4.11, *Cultural Property*; OD 4.20, *Indigenous Peoples*; OD 4.30, *Involuntary Resettlement*; and OP/BP 7.50, *Projects on International Waterways*. Questions on dam safety should be addressed to the Director, Rural Development Department (RDV).

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### Project Processing

1. When the Bank<sup>1</sup> begins processing a project that includes a dam, the processing team includes individuals who have relevant experience in dam engineering and in preparation and supervision of previous Bank-funded projects that have included dams. If such individuals are not available within the Region, the task team (TT) consults the Rural Development Department for referral to appropriate specialists inside or outside the Bank.
2. Bank projects involving dams are processed according to the procedures set forth in BP10.00, *Investment Lending: Identification to Board Presentation*.
3. As soon as a project involving a dam is identified, the TT discusses with the borrower the Bank's policy on dam safety (OP 4.37).

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1. "Bank" includes IDA, and "loans" includes credits.

### **Preparation**

4. The TT ensures that the borrower's terms of reference (TOR) for technical services to investigate the site and design the dam, supervise new or remedial construction, advise on initial reservoir filling and start-up operations, and perform inspections and safety assessments, as well as the qualifications of the professionals (e.g., engineers, geologists, or hydrologists) to be employed by the borrower are adequate to the complexity of the particular dam.
5. If an independent panel of experts (the Panel) is required, the TT advises borrower staff, as necessary, on the preparation of the TOR. The TT reviews and clears the TOR and the Panel members proposed by the borrower. Once the Panel is in place, TT staff normally attend Panel meetings as observers.
6. The TT reviews all reports relating to dam safety prepared by the borrower, the Panel, the independent specialists who assess an existing dam or a dam under construction, and the professionals hired by the borrower to design, construct, fill, and start up the dam.
7. The TT monitors the borrower's preparation of the plans for construction supervision and quality assurance, instrumentation, operation and maintenance, and emergency preparedness (see OP 4.37, para. 4, and BP 4.37, Annex A).

### **Appraisal**

8. The appraisal team reviews all project information relevant to dam safety, including cost estimates; construction schedules; procurement procedures; technical assistance arrangements; environmental assessments; and the plans for construction supervision and quality assurance, instrumentation, operation and maintenance, and emergency preparedness. The team also reviews the project proposal, technical aspects, inspection reports, Panel reports, and all other borrower action plans relating to dam safety. If a Panel has been required, the team verifies that the borrower has taken the Panel's recommendations into

consideration and, if necessary, assists the borrower in identifying sources for dam safety training or technical assistance.

9. The TT and the assigned Bank lawyer ensure that the legal agreements between the Bank and the borrower require the borrower
  - (a) if a Panel has been required, to convene Panel meetings periodically during project implementation and retain the Panel through the start-up of a new dam;
  - (b) to implement the required plans (see Annex A) and raise to the required standard any that have not been adequately developed; and
  - (c) after filling and start-up of a new dam, to have periodic dam safety inspections performed by independent qualified professionals who have not been involved with the investigation, design, construction, or operation of the dam.

### **Supervision**

10. During implementation, the TT monitors all activities relating to the dam safety provisions in the Loan Agreement, using technical staff and, as appropriate, consultants to assess the borrower's performance. If performance in regard to dam safety is found to be unsatisfactory, the TT promptly informs the borrower that the deficiencies must be remedied.
11. During the latter stages of project implementation, the TT discusses post-project operational procedures with the borrower, stressing the importance of ensuring that written instructions for flood operations and emergency preparedness are retained at the dam at all times. The TT also points out that the advent of new technology or new information (e.g., from floods, seismic events, or discovery of new regional or local geologic features) may in the future require the borrower to modify the technical criteria for evaluating dam safety; the TT urges the borrower to make such modifications and then apply the revised criteria to the project dam and, as necessary, to other dams under the borrower's jurisdiction.

12. To ensure that completed dams are inspected and maintained satisfactorily, Regional staff may carry out supervision beyond the closing date of the project, either during work on follow-up projects or during specially scheduled supervision missions.<sup>2</sup>

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2. See OP/BP 13.05, *Project Supervision*.

**World Bank: Bank Procedure 4.37 on the Safety of Dams,  
Annex A on Dam Safety Reports: Content and Timing**

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*These procedures were prepared for use by World Bank staff and are not necessarily a complete treatment of the subject.*

## **Dam Safety Reports: Content and Timing**

1. *Plan for construction supervision and quality assurance.* This plan is provided to the Bank by appraisal. It covers the organization, staffing levels, procedures, equipment, and qualifications for supervision of the construction of a new dam or of remedial work on an existing dam. For a dam other than a water storage dam,<sup>1</sup> this plan takes into account the usual long construction period, covering the supervision requirements as the dam grows in height—with any accompanying changes in construction materials or the characteristics of the impounded material—over a period of years. The task team uses the plan to assess the need to fund components under the loan to ensure that dam-safety-related elements of the design are implemented during construction.
2. *Instrumentation plan.* This is a detailed plan for the installation of instruments to monitor and record dam behavior and the related hydrometeorological, structural, and seismic factors. It is provided to an independent panel of experts (the Panel) and the Bank during the design stage, before bid tendering.
3. *Operation and maintenance (O&M) plan.* This detailed plan covers organizational structure, staffing, technical expertise, and training required;

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1. For example, a mine tailings, ash impoundment, or slag storage dam.

equipment and facilities needed to operate and maintain the dam; O&M procedures; and arrangements for funding O&M, including long-term maintenance and safety inspections. The O&M plan for a dam other than a water storage dam, in particular, reflects changes in the dam's structure or in the nature of the impounded material that may be expected over a period of years. A preliminary plan is provided to the Bank for use at appraisal. The plan is refined and completed during project implementation; the final plan is due not less than six months prior to the initial filling of the reservoir. Elements required to finalize the plan and initiate operations are normally financed under the project.<sup>2</sup>

4. *Emergency preparedness plan.* This plan specifies the roles of responsible parties when dam failure is considered imminent, or when expected operational flow release threatens downstream life, property, or economic operations that depend on river flow levels. It includes the following items: clear statements on the responsibility for dam operations decision making and for the related emergency communications; maps outlining inundation levels for various emergency conditions; flood warning system characteristics; and procedures for evacuating threatened areas and mobilizing emergency forces and equipment. The broad framework plan and an estimate of funds needed to prepare the plan in detail are provided to the Bank prior to appraisal. The plan itself is prepared during implementation and is provided to the Panel and Bank for review not later than one year before the projected date of initial filling of the reservoir.

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2. In the dam safety practice of several countries, the operation and maintenance plan includes both the instrumentation plan and the emergency preparedness plan as specific sections. This practice is acceptable to the Bank, provided the relevant sections are prepared and finalized according to the timetable set out in this Annex.

## APPENDIX IV

### **Republic of South Africa, 1998 National Water Act, Chapter 12: Safety of Dams**

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**NOTE:** This appendix is provided merely as an example of a statute that contains specific provisions on dam safety. There are many other examples of such statutes and the inclusion of this example in this report should not be interpreted as an endorsement of this statutory model over other models.

*(English text signed by the President)*

*(Assented to 20 August 1998)*

#### **REPUBLIC OF SOUTH AFRICA NATIONAL WATER ACT Act No. 36 of 1998**

#### **ACT**

**To provide for fundamental reform of the law relating to water resources; to repeal certain laws; and to provide for matters connected therewith.**

#### **PREAMBLE**

Recognising that water is a scarce and unevenly distributed national resource which occurs in many different forms which are all part of a unitary, inter-dependent cycle;

Recognising that while water is a natural resource that belongs to all people, the discriminatory laws and practices of the past have prevented equal access to water, and use of water resources;

Acknowledging the National Government's overall responsibility for and authority over the nation's water resources and their use, including the equitable allocation of water for beneficial use, the redistribution of water, and international water matters;

Recognising that the ultimate aim of water resource management is to achieve the sustainable use of water for the benefit of all users;

Recognising that the protection of the quality of water resources is necessary to ensure sustainability of the nation's water resources in the interests of all water users; and

Recognising the need for the integrated management of all aspects of water resources and, where appropriate, the delegation of management functions to a regional or catchment level so as to enable everyone to participate;

BE IT ENACTED by the Parliament of the Republic of South Africa, as follows:

## **CHAPTER 1: INTERPRETATION AND FUNDAMENTAL PRINCIPLES**

1. Definitions and interpretation
2. Purpose of Act
3. Public trusteeship of nation's water resources
4. Entitlement to water use

## **CHAPTER 2: WATER MANAGEMENT STRATEGIES**

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5. Establishment of national water resource strategy
6. Contents of national water resource strategy
7. Giving effect to national water resource strategy

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9. Contents of catchment management strategy
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11. Giving effect to catchment management strategies

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### ***Part 1: Classification system for water resources***

12. Prescription of classification system

### ***Part 2: Classification of water resources and resource quality objectives***

13. Determination of class of water resources and resource quality objectives
14. Preliminary determination of class or resource quality objectives

15. Giving effect to determination of class of water resource and resource quality objectives

**Part 3: The Reserve**

16. Determination of Reserve
17. Preliminary determinations of Reserve
18. Giving effect to Reserve

**Part 4: Pollution prevention**

19. Prevention and remedying effects of pollution

**Part 5: Emergency incidents**

20. Control of emergency incidents

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21. Water use
22. Permissible water use
23. Determination of quantity of water which may be allocated by responsible authority
24. Licences for use of water found underground on property of another person
25. Transfer of water use authorisations
26. Regulations on the use of water

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27. Considerations for issue of general authorisations and licences
28. Essential requirements of licences
29. Conditions for issue of general authorisations and licences
30. Security by applicant
31. Issue of licence no guarantee of supply

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32. Definition of existing lawful water use
33. Declaration of water use as existing lawful water use
34. Authority to continue with existing lawful water use
35. Verification of existing water uses

***Part 4: Stream flow reduction activities***

- 36. Declaration of stream flow reduction activities

***Part 5: Controlled activities***

- 37. Controlled activity
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***Part 6: General authorisations***

- 39. General authorisations to use water

***Part 7: Individual applications for licences***

- 40. Application for licence
- 41. Procedure for licence applications
- 42. Reasons for decisions

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- 44. Late applications
- 45. Proposed allocation schedules
- 46. Preliminary allocation schedule
- 47. Final allocation schedules
- 48. Licences replace previous entitlements

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- 50. Formal amendment of licences
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- 52. Procedure for earlier renewal or amendment of licences

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- 54. Suspension or withdrawal of entitlements to use water
- 55. Surrender of licence

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- 59. Liability for water use charges
- 60. Water use charges are charges on land

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- 61. Financial assistance by Minister
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## **CHAPTER 12 SAFETY OF DAMS**

*This Chapter contains measures aimed at improving the safety of new and existing dams with a safety risk so as to reduce the potential for harm to the public, damage to property or to resource quality. To reduce the risk of a dam failure, control measures require an owner to comply with certain directives and regulations, such as to submit a report on the safety of a dam, to repair or alter a dam, or to appoint an approved professional person to undertake these tasks. These measures are in addition to the owners' common law responsibility to ensure the safety of their dams. An approved professional person has a statutory duty of care towards the State and the general public and must fulfil, amongst other things, defined responsibilities when acting under this Chapter. Not all dams are subject to regulation under this Chapter, and the Minister may exempt certain persons from its requirements. Only dams of a defined size, dams which have been declared to be dams with a safety risk, or dams falling into a prescribed category are affected. All dams with a safety risk must be registered. Compliance with any directive or regulation*

*under this Chapter does not exempt an owner from complying with any other provision of this Act, such as the requirement for a licence or other authorisation for water use in respect of the dam.*

**Definitions**

**117.** In this Chapter –

- (a) “approved professional person” means a person registered in terms of the Engineering Profession of South Africa Act, 1990 (Act No. 114 of 1990), and approved by the Minister after consultation with the Engineering Council of South Africa (established by section 2 of that Act);
- (b) “dam” includes any existing or proposed structure which is capable of containing, storing or impounding water (including temporary impoundment or storage), whether that water contains any substance or not;
- (c) “Dam with a safety risk” means any dam –
  - (i) which can contain, store or dam more than 50 000 cubic meters of water;
  - (ii) belonging to a category of dams declared under section 118(2) to be dams with a safety risk; or
  - (iii) declared under section 118(iii)(a) to be a dam with a safety risk;
- (d) “owner of a dam” or “owner of a dam with a safety risk” includes the person in control of that dam; and
- (e) “task” includes a task relating to designing, constructing, altering, repairing, impounding water in, operating, evaluating the safety of, maintaining, monitoring or abandoning a dam with a safety risk.

**Control measures for dam with safety risk**

**118.** (1) The owner of a dam must

- (a) within the period specified, provide the Minister with any information, drawings, specifications, design assumptions, calculations, documents and test results requested by the Minister; or
- (b) give any person authorised by the Minister access to that dam, to enable the Minister to determine whether
  - (i) that dam is a dam with a safety risk;
  - (ii) that dam should be declared to be a dam with a safety risk;

- (iii) a directive should be issued for specific repairs or alterations to that dam; or
  - (iv) the owner has complied with any provisions of this Act applicable to that dam.
- (2) The Minister may by notice in the *Gazette* declare a category of dams to be dams with a safety risk.
  - (3) The Minister may
    - (a) by written notice to the owner of a dam, declare that dam to be a dam with a safety risk;
    - (b) direct the owner of a dam with a safety risk to submit, at the owner's cost, and within a period specified by the Minister, a report by an approved professional person regarding the safety of that dam; or
    - (c) direct the owner of a dam with a safety risk to undertake, at the owner's cost, and within a period specified by the Minister, any specific repairs or alterations to that dam which are necessary to protect the public, property or the resource quality from a risk of failure of the dam.
  - (4) If the owner of the dam fails to comply with the directive contemplated in subsection (3)(c) within the period specified, the Minister may undertake the repairs or alterations and recover the costs from the owner.
  - (5) Before issuing a directive, the Minister must
    - (a) be satisfied that the repairs or alterations directed are necessary, adequate, effective and appropriate to reduce the risk to an acceptable level; and
    - (b) consider the impact on public safety, property, the resource quality and socio-economic aspects if the dam fails.

### **Responsibilities of approved professional persons**

- 119.** (1) When carrying out a task in terms of this Chapter, an approved professional person also has a duty of care towards the State and the general public.
- (2) An approved professional person appointed to carry out a task on a dam must
  - (a) ensure that the task is carried out according to acceptable dam engineering practices;

- (b) keep the prescribed records;
  - (c) compile the prescribed reports; and
  - (d) where the task includes constructing, altering or repairing a dam, issue a completion certificate to the owner of the dam to the effect that the task on that dam has been carried out according to the applicable design, drawings and specifications.
- (3) An approved professional person appointed to carry out a dam safety evaluation must –
- (a) consider whether the safety norms pertaining to the design, construction, monitoring, operation, performance and maintenance of the dam satisfy acceptable dam engineering practices; and
  - (b) compile a report on the matters contemplated in paragraph (a) according to the prescribed requirements and submit the signed and dated report to the owner of the dam within the prescribed period.

#### **Registration of dam with safety risk**

- 120.** (1) The owner of a dam with a safety risk must register that dam.
- (2) An application for registration must be made within 120 days
- (a) after the date on which the dam with a safety risk becomes capable of containing, storing or impounding water;
  - (b) after the date on which an already completed dam is declared to be a dam with a safety risk; or
  - (c) after publication of a notice declaring a category of dams to be dams with a safety risk, as the case may be.
- (3) A successor-in-title to an owner of a dam with a safety risk must promptly inform the Director-General of the succession, for the substitution of the name of the owner.

#### **Factors to be considered in declaring dam or category of dams with safety risk**

- 121.** In declaring a category of dams or a dam to be a category of dams or a dam with a safety risk, the Minister must consider
- (a) the need to protect the public, property and the resource quality against the potential hazard posed by the dam or category of dams;

- (b) the extent of potential loss or harm involved;
- (c) the cost of any prescribed measures and whether they are reasonably achievable;
- (d) the socio-economic impact if such a dam fails; and
- (e) in the case of a particular dam, also
  - (i) the manner in which that dam is designed, constructed, altered, repaired, operated, inspected, maintained or abandoned;
  - (ii) the person by whom that dam is designed, constructed, altered, repaired, operated, inspected, maintained or abandoned; and
  - (iii) the manner in which the water is contained, stored or impounded in that dam.

### **Exemptions**

- 122.** (1) The Minister may exempt owners of dams belonging to certain categories, by notice in the *Gazette*, from compliance with any provision of this Chapter or any regulation made under this Chapter, on conditions determined by the Minister.
- (2) The Minister may in writing exempt an owner of a dam belonging to a certain category from compliance with any provision of this Chapter on conditions determined by the Minister.
- (3) The Minister may withdraw the exemption or impose further or new conditions in respect of the exemption.
- (4) Before deciding on an exemption, the Minister must consider
- (a) the degree of risk or potential risk posed by the dam or category of dams to public safety, property and the resource quality;
  - (b) the manner of design, construction, alteration, repair, impoundment of water in, operation or abandonment of the dam or category of dams;
  - (c) the supervision involved in the dam or category of dams;
  - (d) alternative measures proposed for regulating the design, construction, alteration, repair, operation, maintenance, impoundment of water in, inspection or abandonment of the dam or category of dams and the effectiveness of these measures;
  - (e) the knowledge and expertise of the persons involved in any task relating to the dam or category of dams;

- (f) the costs relating to the dam or category of dams;
- (g) any security provided or intended to be provided for any damage which could be caused by the dam or category of dams; and
- (h) whether the dam or category of dams are permitted in terms of a licence or any other authorisation issued by or under any other Act.

**Regulations regarding dam safety**

**123.** (1) The Minister may make regulations

- (a) for the establishment of a register of approved professional persons for dealing with dams with a safety risk
  - (i) providing for
    - (aa) different classes of approved professional persons;
    - (bb) the tasks or category of tasks which each class of approved professional persons may perform; and
    - (cc) the conditions under which each class of approved professional persons may perform any task or category of tasks;
  - (ii) concerning the requirements for admission to each class;
  - (iii) setting out, in respect of each class, the procedure for
    - (aa) approval;
    - (bb) withdrawal of an approval; and
    - (cc) suspension of an approval;
  - (iv) providing for a processing fee for an approval;
- (b) regulating the approval of a person as an approved professional person for a specific task
  - (i) setting out the procedure for approval;
  - (ii) setting out the procedure for cancelling an approval;
  - (iii) requiring that the approved person be assisted in the task by another person or group of persons with specific experience and qualifications; and
  - (iv) providing for a processing fee for an approval;
- (c) in respect of dams with a safety risk
  - (i) classifying such dams into categories;
  - (ii) requiring the owner of a dam of a specific category to appoint an approved professional person to

- (aa) design that dam or any repair, alteration or abandonment of the dam;
  - (bb) ensure that a task is carried out according to the applicable design, drawings and specifications; and
  - (cc) carry out dam safety evaluations on the dam;
  - (iii) requiring that licences be issued by the Minister before any task relating to a specific category of dams may commence, and the conditions, requirements and procedure to obtain any specific licence;
  - (iv) laying down licence conditions and requirements that must be met when carrying out a task on a specific category of dams;
  - (v) requiring an approved professional person, appointed for a dam of a specific category, to keep records of information and drawings, and to compile reports;
  - (vi) requiring
    - (aa) an owner of a dam belonging to a specific category of dams; and
    - (bb) an approved professional person appointed for a specific task for a specific dam, to submit information, drawings, reports and manuals;
  - (vii) determining the duties of
    - (aa) an owner of a dam belonging to a specific category of dams; and
    - (bb) an approved professional person appointed for a specific task for a specific dam;
  - (d) requiring the owner of a dam with a safety risk to accomplish regular monitoring of the dam, to the extent and manner prescribed;
  - (e) requiring the registration of a specific dam with a safety risk, and setting out the procedure and the processing fee payable for registration; and
  - (f) specifying time periods that must be complied with.
- (2) In making regulations under subsection (1)(a), the Minister must consider

- (a) the expertise required for the effective design, construction, alteration, repair, operation, maintenance and abandonment of a dam in the category concerned; and
  - (b) the qualifications and experience needed to provide the expertise for a particular category of tasks.
- (3) Before making regulations under subsection (1), the Minister must consult the Engineering Council of South Africa, established by section 2 of the Engineering Profession of South Africa Act, 1990 (Act No. 114 of 1990), and any other appropriate statutory professional bodies.

## APPENDIX V

### British Columbia, Canada, Dam Safety Regulation

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**NOTE:** This appendix is provided merely as an example of a regulation that deals exclusively with dam safety. There are many other examples and the inclusion of this example in this report should not be interpreted as an endorsement of this regulatory model over other models.

*B. C. Reg. 44/00*

*Deposited February 11, 2002*

#### BRITISH COLUMBIA DAM SAFETY REGULATION

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  3. Operation and maintenance of dam
  4. Alteration of a dam
  5. Inspection
  6. Reporting
  7. Dam Safety Review
  8. Hazardous conditions at a dam
  9. Suspension of normal operation or removal of a dam
  10. Information and evaluation
  11. Instrumentation
  12. Expert opinion
- 
- Schedule 1
  - Schedule 2

## **Definitions**

1. In this regulation:

**“Act”** means the Water Act

**“dam”** means

- (a) a barrier constructed across a stream, or
- (b) a barrier constructed off stream and supplied by diversion of water from a stream for the purpose of enabling the storage or diversion of water, and includes all works which are incidental to or necessary for the barriers;

**“dam owner”** means with respect to a dam, any or all of the following:

- (a) the person who holds the current license or is required to hold a license for the dam;
- (b) the person who last held a license for the dam including a license that has been suspended, cancelled, abandoned and or terminated;
- (c) if there is no person whom paragraph (a) or (b) applies, the owner of the land on which the dam is located or the person who had the dam constructed;

**“dam safety officer”** means an engineer or officer, designated in writing by the comptroller as a dam safety officer;

**“emergency preparedness plan”** means a plan prepared by a dam owner under section 3 (2) (a) that describes the actions the dam owner proposes to take in the event of an emergency at a dam;

**“height”** means the vertical distance to the top (crest) of a dam measured,

- (a) in the case of a dam across a stream, from the natural bed of the stream at the downstream outside limit of the dam, or
- (b) in the case of a dam that is not across a stream, from the lowest elevation at the outside limit of the dam;

**“Instrumentation”** means, but is not limited to, survey monuments and stations, inclinometers, extensometers, piezometers or measuring weirs;

**“maintain” or “maintenance”** means the performance of those tasks required to keep the dam in a good operating condition;

**“operation, maintenance and surveillance manual”** means a manual prepared by a dam owner under section 3 (2) (b) that describes the dam owner’s operation, maintenance and surveillance procedures for the dam;

**“professional engineer”** means a person registered, and in good standing, as a professional engineer under the Engineers and Geoscientists Act;

**“volume of water”** means the total storage volume of the reservoir at full supply level measured in accordance with one of the following:

- (a) between the natural bed of the stream and the spillway crest;
- (b) between the upstream outside limit of the dam and the spillway crest;
- (c) if a low level outlet is excavated to an elevation lower than the general foundation of the dam, between the bottom of that outlet and the spillway crest.

### **Application**

- 2. (1) This regulation applies to all of the following:
  - (a) a dam 1 meter or more in height that is capable of impounding a volume of water greater than 1,000,000 m<sup>3</sup>;
  - (b) a dam 2.5 meters or more in height that is capable of impounding a volume of water greater than 30,000 m<sup>3</sup>;
  - (c) a dam 7.5 meters or more in height;
  - (d) a dam that does not meet the criteria under paragraph (a), (b) or (c) but has a downstream consequence classification under Schedule 1 of low, high or very high.
- (2) This regulation does not relieve a dam owner from any other requirements that may be imposed under the Act, the Water Regulation or any other applicable enactment.

### **Operation and maintenance of a dam**

- 3. (1) A dam owner must operate and maintain a dam in accordance with all of the following:

- (a) this regulation;
  - (b) any applicable license or approval;
  - (c) any order that is made under the Act;
  - (d) the emergency preparedness plan that has been prepared and accepted in accordance with subsection (2) (a);
  - (e) the operation, maintenance and surveillance manual that has been prepared and accepted in accordance with subsection (2) (b)
- (2) A dam owner must, in the form and manner and within the time period specified by the comptroller or regional water manager, prepare and submit to dam safety officer, for acceptance by the dam safety officer, the following:
- (a) if the downstream consequence classification under Schedule 1 is high or very high, an emergency preparedness plan;
  - (b) if the downstream consequence classification under Schedule 1 is low, high or very high, an operation, maintenance and surveillance manual.
- (3) Subsection (2) applies whether there is a term or condition in an approval granted or license issued that requires the preparation of such a plan or manual for the dam.
- (4) A dam owner must ensure the dam is adequately safeguarded to prevent unauthorized operation of the dam by someone other than the dam owner or an agent of the dam owner.

### **Alteration of dam**

4. (1) Any alteration, improvement or replacement to all or any part of a dam must be authorized by an approval, license or order.
- (2) Subsection (1) does not apply to an alteration, improvement or replacement for the purpose of
- (a) maintaining the dam as authorized under section 3, or
  - (b) addressing a hazardous condition as specified in section 8.
- (3) A dam owner must submit to a dam safety officer, on completion of the alteration, improvement or replacement, a report on the work and the manner in which any such alteration, improvement or replacement to all or any part of the dam was performed.

### **Inspection**

5. A dam owner must do all of the following:

- (a) carry out an inspection of a dam on the frequency applicable to the downstream consequences classification for the dam as set out in Schedule 2 in order to assess the condition of the dam during the construction, operation or alteration of the dam;
- (b) record the results of every inspection performed under paragraph (a);
- (c) repair any safety hazards revealed by an inspection, if authorized to do so by an approval, license or order or as authorized under this regulation.

### **Reporting**

- 6. (1) A dam owner must, when an inspection is carried out under section 5 or when any other inspection is carried out with respect to a dam,
  - (a) submit to a dam safety officer, in the form and manner and within the time period specified by the dam safety officer,
    - (i) the record of inspection required by section 5(b), and
    - (ii) the results and analysis of any test or measurement taken including, but not limited to,
      - a) instrumentation readings and analysis,
      - b) visual records or observations,
      - c) drawings,
      - d) soil, aggregate and concrete test results, and
      - e) any other test results, and
  - (b) promptly submit to a dam safety officer the record of inspection required by section 5 (b) if the inspection reveals a potential safety hazard.
- (2) A dam owner must submit to a dam safety officer, if requested by the dam safety officer, the original or clear copies of the following documentation required for the design, construction or alteration of the dam:
  - (a) all design notes, drawings and specifications;
  - (b) hydraulic, hydrologic, geological and geotechnical data;
  - (c) reports and other similar documentation.

### **Dam safety review**

- 7. (1) If required by Schedule 2, a dam owner must have a professional engineer, experienced in dam safety analysis, do a dam safety

review and prepare, in the form and manner and within the time period specified by the comptroller or regional water manager, a dam safety report.

- (2) The dam owner must submit to a dam safety officer a copy of the dam safety report prepared by the professional engineer who carried out the dam safety review under subsection (1).

### **Hazardous conditions at a dam**

8. If conditions are, or may likely be, hazardous to a dam, or conditions may reasonably be anticipated to cause a dam, or any part of a dam, or any operation or action at or in connection with a dam, to be or become potentially hazardous to public safety, the infrastructure or works, other property or the environment, a dam owner must promptly do all of the following:
  - (a) if an emergency preparedness plan exists, modify the operation of the dam, or any part of the dam, in accordance with the emergency preparedness plan;
  - (b) if an emergency preparedness plan does not exist, operate the dam in a manner, and initiate any remedial actions, that will
    - (i) safeguard the public,
    - (ii) minimize damage to the infrastructure or works or to other property, including that not owned by the dam owner, and
    - (iii) minimize damage to the environment;
  - (c) contact the Provisional Emergency Program contained under the *Emergency Program Act*;
  - (d) notify a dam safety officer, or the comptroller or regional water manager, of
    - (i) the nature of existing or anticipated conditions,
    - (ii) all things done by the dam owner to rectify the conditions, and
    - (iii) the time and exact nature of any information or warning of existing or anticipated conditions issued to any person under this section;
  - (e) inform local authorities, and persons who may be in immediate danger from the potential failure of the dam, of the nature of the existing or anticipated conditions and, if necessary, advise those persons who may be in immediate danger to vacate and remove any property from the endangered area;

- (f) modify the operation of the dam to minimize or prevent damage which may be caused by the failure of the dam, and undertake any other hazard response activity if required by a dam safety officer or engineer or by the comptroller or regional water manager.

### **Suspension of normal operation or removal of dam**

9. (1) A dam owner must give the comptroller or regional water manager at least 60 days written notice before undertaking any of the following activities:
  - (a) removing all or a significant part of a dam;
  - (b) decommissioning or abandoning a dam;
  - (c) stopping the normal operation of a dam for a period of time longer than one year.
- (2) The dam owner must prepare, and submit to a dam safety officer for approval,
  - (a) a plan respecting an activity under subsection (1) (a) or (b), or
  - (b) if required by the dam safety officer, a plan respecting an activity under subsection (1) (c).
- (3) The dam owner must, at least 14 days before the date on which the work is expected to commence, notify a dam safety officer before commencing any work under the approved plan.
- (4) The dam owner must submit to a dam safety officer, on the completion of the work performed under the approved plan, a report on the work and the manner in which it was performed.
- (5) The dam owner must undertake any further actions that the comptroller or regional water manager requires to alleviate any adverse consequences to any person, the infrastructure or works, other property or the environment that may be affected by any work performed on the dam.
- (6) An approval under subsection (2) respecting the decommissioning of a dam is subject to the Environmental Assessment Act and to approvals, if any, required under the Act.

### **Information and evaluation**

10. (1) A dam owner must, if requested by a dam safety officer, provide the following information in order to evaluate the condition or hazard potential of a dam:

- (a) information with respect to the dam including, but not limited to,
    - (i) foundation investigation results,
    - (ii) design details and as-built plans,
    - (iii) construction records,
    - (iv) operation manuals,
    - (v) records of instrumentation,
    - (vi) inspection reports,
    - (vii) safety reports, and
    - (viii) inundation studies and emergency preparedness plans;
  - (b) information with respect to the nature of the land and the stream, and the use of the land and the stream, downstream from or adjacent to the dam or reservoir, including the hydraulic, hydrologic, geological and geotechnical characteristics and the uses of the land and stream;
  - (c) information with respect to the watershed upstream of the dam.
- (2) The information requested under subsection (1) must be submitted to a dam safety officer, in the form and manner and within the time period specified by the comptroller or regional water manager.
- (3) The dam owner must conduct any inspection, investigation, survey or test that is necessary to provide the information required by subsection (1).

### **Instrumentation**

11. A dam owner must do all of the following:
- (a) install any instrumentation necessary to adequately monitor the performance of a dam;
  - (b) monitor, maintain or replace instrumentation installed at a dam to ensure continuity of readings;
  - (c) submit instrumentation readings and evaluations to a dam safety officer, in the form and manner and within the time period specified by the dam safety officer;
  - (d) submit, to a dam safety officer for approval by the dam safety officer,
    - (i) notice of any planned modifications to, changes to or removal of the instrumentation at least 60 days before the proposed modification, change or removal, or

- (ii) an annual plan outlining intended changes to the instrumentation.

**Expert opinion**

- 12. (1) If, based on information submitted in respect of a dam or related works, the comptroller or regional water manager considers that a question has arisen as to what is proper practice for resolving an issue involving a dam or related works, the comptroller or regional water manager may require a dam owner to retain an expert, satisfactory to the comptroller or regional water manager, with qualifications and experience as follows:
  - (a) In the case of a dam, in dam design, construction and analysis;
  - (b) In the case of related works, in hydraulic, hydrological, geological, geotechnical, mechanical or structural engineering or other appropriate disciplines.
- (2) The expert retained under subsection (1) must provide a report to the comptroller or regional water manager on the issue.

**SCHEDULE 1 (Sections 2[1][d] and 3[2])****Downstream Consequence Classification Guide**

<b>Rating</b>	<b>Loss of Life</b>	<b>Economic and Social Loss</b>	<b>Environmental and Cultural Loss</b>
VERY HIGH	Large potential for multiple loss of life involving residents and working, traveling, and/or recreating public. Development within inundation area (the area that could be flooded if the dam fails) typically includes communities, extensive commercial and work areas, main highways, railways, and locations of concentrated recreational activity. Estimated fatalities could exceed 100.	Very high economic losses affecting infrastructure, public and commercial facilities in and beyond inundation area. Typically includes destruction of or extensive damage to large residential areas, concentrated commercial land uses, highways, railways, power lines, pipelines, and other utilities. Estimated direct and indirect (interruption of service) costs could exceed \$100 million.	Loss or significant deterioration of nationally or provincially important fisheries habitat (including water quality), wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance. Feasibility and/or practicality of restoration and/or compensation is low.
HIGH	Some potential for multiple loss of life involving residents, and working, traveling, and/or recreating public. Development within inundation area typically includes highways and railways, commercial and work areas, locations of concentrated recreational activity and scattered residences. Estimated fatalities less than 100.	Substantial economic losses affecting infrastructure, public and commercial facilities in and beyond inundation area. Typically includes destruction of or extensive damage to concentrated commercial land uses, highways, railways, power lines, pipelines, and other utilities. Scattered residences may be destroyed or severely damaged. Estimated direct and indirect (interruption of service) costs could exceed \$1 million.	Loss or significant deterioration of nationally or provincially important fisheries habitat (including water quality), wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance. Feasibility and practicality of restoration and/or compensation is high.
LOW	Low potential for multiple loss of life. Inundation area is typically underdeveloped except for minor roads, temporarily inhabited or non-residential farms and rural activities. There	Low economic losses to limited infrastructure, public and commercial activities. Estimated direct and indirect (interruption of service) costs could exceed \$100,000.	Loss or significant deterioration of regionally important fisheries habitat (including water quality), wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance.

must be a reliable element of natural warning if larger development exists.

Feasibility and practicality of restoration and/or compensation is high. Includes situations where recovery would occur with time without restoration.

VERY LOW

Minimal potential for any loss of life. The inundation area is typically undeveloped.

Minimal economic losses typically limited to owners' property and do not exceed \$100,000. Virtually no potential for future development of other land uses within the foreseeable future.

No significant loss or deterioration of fisheries habitat, wildlife habitat, rare and/or endangered species, unique landscapes or sites of cultural significance.

## SCHEDULE 2 (Sections 5[a] and 7[1])

### Minimum Inspection Frequency and Dam Safety Review Requirements

Item	Very High Consequence	High Consequence	Low Consequence	Very Low Consequence
Site Surveillance <sup>a</sup>	Weekly	Weekly	Monthly	Quarterly
Formal Inspection <sup>b</sup>	Semi-annually	Semi-annually or annually	Annually	Annually
Instrumentation	As per OMS* manual	As per OMS* manual	As per OMS* manual	N/A
Test Operation of Outlet Facilities, Spillway Gates and Other Mechanical Components	Annually	Annually	Annually	Annually
Emergency Preparedness Plan	Update communications directory semi-annually	Update communications directory semi-annually	Update communications directory annually	N/A
Operation Maintenance & Surveillance Plan	Review every 7–10 years	Review every 10 years	Review every 10 years	Review every 10 years
Dam Safety Review <sup>c</sup>	Every 7–10 years <sup>d</sup>	Every 7–10 years <sup>d</sup>	<sup>d</sup>	<sup>d</sup>

\*Operation, Maintenance and Surveillance.

N/A Not available.

<sup>a</sup>Site surveillance may consist of visual inspections and/or monitoring of automated data acquisition systems. Reduced frequencies of visual inspections may be determined by seasonal conditions.

<sup>b</sup>Formal Inspections are intended as more thorough inspection performed by the appropriate representative of the owner responsible for safety surveillance.

<sup>c</sup>A Dam Safety Review involved collection of all available dam records, field inspections, detailed investigation and possibly laboratory testing. It then proceeds with a check of structural stability and operational safety of the beginning with a reappraisal of basic features and assumptions. The level of detail required in a Dam Safety Review should be commensurate with the importance and complexity of the dam, as well as the consequences of failure.

<sup>d</sup>Dam owners must conduct an annual review of conditions downstream of their dam and notify a dam safety officer if the downstream consequence classification level increases. The downstream consequence classification guide is shown in Schedule 1.

## **APPENDIX VI**

### **Canadian Dam Association, Sample Operations, Maintenance, and Surveillance Manual**

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**NOTE:** This appendix is provided merely as an example of the table of contents of an OMS Manual. There are many other examples and the inclusion of this example in this report should not be interpreted as an endorsement of this model of an OMS Manual over other possible models.

#### **NON-STRUCTURAL SAFETY MEASURES DAM SAFETY PLANS**

Based on “Dam Safety Guidelines—Canadian Dam Association—January 1999”

#### **OPERATION & MAINTENANCE PLAN**

- General Information
- Operation
- Reservoir operational rules
- Flood forecasting (if available)
- Flood operating procedures
- Emergency operating procedures
- Maintenance
- Historical document
- Performance indicators
- Preventive measures
- Instrumentation Plan (see detail)
- Surveillance
- Standards
- Regular inspections
- Special inspections
- Tests
- Emergency Preparedness Plan (EPP) (see detail)

### **EMERGENCY PREPAREDNESS PLAN (EPP)**

- Responsibilities
- Emergency Identification, Evaluation and Classification
- Preventive Actions
- Notification Procedures
- Notification Flowchart
- Inundation Maps and Tables
- Testing and Upgrading the EPP
- Training

### **INSTRUMENTATION PLAN**

- Description and location of instruments and monitoring devices
- Initial datum, design limits, calibration requirements, operating ranges
- “Alarm” levels
- Mode and methodology of readings
- Data recording and storing
- Data interpretation

### **OPERATION AND MAINTENANCE (O&M) MANUAL**

#### **B.1. General**

Dam operation, maintenance and surveillance shall be provided so that an acceptable level of dam safety is ensured.

A manual (the “O&M Manual”) shall be prepared, documenting operation, maintenance and surveillance. The O&M manual shall be implemented, followed, and updated at appropriate intervals. The manual shall contain suitable and sufficient information to allow operators to operate the dam in a safe manner, maintain it in a safe condition, and monitor its performance well enough to provide early signs of any distress.

A general description of the dam should be included to indicate such items as type, size, consequence classification, age, location, and access.

Qualified personnel shall be used for the operation, maintenance and surveillance.

The O&M Manual should state the chain of operational responsibilities and requirements for training of staff at the various levels.

As a minimum, the O&M Manual should be reviewed annually to ensure that all appropriate updates of personnel or organization have been made.

The required duties and qualifications of operators in regard to dam safety should be defined, listing the appropriate areas of involvement. The description may include details of suitable training programs.

A permanent log book should be maintained, containing information and records appropriate to the type of dam, such as:

- Weather conditions
- Changes to normal operation, unusual events, conditions or public activity
- Unusual maintenance activities
- Instructions
- Alarms or annunciation
- Inspections

The log book should not detail activities of normal operation nor records routinely being maintained elsewhere. Suitable instructions should be in place for the recording of this operating information, including references to drawings and technical operation and maintenance manuals.

## **B.2. Operation**

### ***B.2.1. Flood Operating Procedures***

During the flood season, a sufficient number or capacity of gates and facilities necessary for discharging flows up to the Inflow Design Flood (IDF) shall be maintained in operable condition, and procedures for state operation shall be specified.

Any restrictions for gate operation shall be documented.

The reservoir shall be operated in such a manner that the Inflow Design Flood can be routed safely. Drawdown or other reservoir operating restrictions shall be documented.

Descriptions of all the various parts of the dam that affect the above requirements should be provided and where appropriate, manufacturers' operating manuals should be readily available.

Concise operating instructions should be provided for use, during normal operation as well as in the case of extreme flood, by qualified dam operators who are not necessarily familiar with the particular facility or project.

Details of normal operating conditions should be provided to indicate such items as: inflows and discharges, normal levels, storage volumes, spillway and tailwater rating curves, spillway operating parameters, power supplies and environmental restrictions. Potential emergency conditions should be identified and listed with related recommended operating parameters and restraints.

The instructions should detail the flow capacities of the structures and related water elevations, list the hazard areas and flows at which they are affected, and provide details about warning systems as well as primary and backup power systems.

### ***B.2.2. Emergency Operating Procedures***

Procedures for reservoir control and discharge in the case of a developing breach or potential breach, and for any emergency drawdown of the reservoir, shall be established.

General procedures and considerations should be outlined, such as any special instructions for spillway operation, and instructions on reservoir drawdown to alleviate the effect of emergencies. These should include any limitations on reservoir surcharge or drawdown, implications of rising flows downstream, list of erosion-prone areas of river banks, and reservoir slopes which should be monitored. Operations during an emergency would follow procedures of the Emergency Preparedness Plan, as described in Section C.

Operation to evacuate the reservoir in the event of damage to the dam, including precautions to avoid damage to facilities and any restrictions on the rate of drawdown should be provided.

### ***B.2.3. Ice and Debris Handling***

Where reservoirs can contain significant quantities of ice or debris, procedures shall be established for safely handling ice and/or debris.

The details, functions and required operating activities of log, trash and ice booms, including trash removal and any ice-growth restrictions on structures

or gates, should be described in the O&M Manual. The operation of any required bubble systems for ice prevention and/or steam lances should be described.

#### **B.2.4. Flood Forecasting**

If available, the source of flood forecasting information shall be identified.

Authorized sources of flood forecasting should be designated, with a list of other available sources of flood forecast. The Inflow Design Flood, the basis of its estimation and the capacity of the facilities should be described.

#### **B.3. Maintenance**

Maintenance policies, procedures, records and responsibilities shall be developed and implemented to ensure that the dam, together with applicable structures and equipment required for flood discharge, is maintained in a safe and fully operable condition.

Equipment shall be inspected and tested at regular intervals to ensure safe and reliable operation.

A description of maintenance policies, procedures, records and responsibilities for dams, appurtenant structures and associated equipment (including instrumentation) essential to dam safety should be available.

Maintenance requirements should also be documented for all miscellaneous structures such as timber cribs and conduits.

All relevant manufacturers' and designers' maintenance manuals should be available.

Changing conditions in the facility must be evaluated and appropriate actions taken both in regard to design reviews and necessary construction changes and/or repairs.

Instrumentation required to verify the continuing safe operation of the dam, together with any data acquisition and transmission systems, must be maintained in good working condition.

Considerations for maintenance of different types of structures and equipment are briefly outlined below.

### *Concrete Structures*

Uplift pressure and water seepage are the main potential causes of instability, under normal loadings, of part or all of the structures, as well as the primary cause of degradation due to leaching of frost action. In addition, the effects of freeze/thaw at the water line and alkali aggregate reaction (AAR) can have serious impacts on the safety of the structures.

Annual or long-term maintenance programs for concrete structures should include, but not be limited to, regular cleaning of drains and drainage systems, maintenance of sealing systems, pumping equipment, monitoring equipment and instrumentation required to assure the safety of the structures.

### *Steel Structures*

Maintenance requirements for the structural steel components of items such as gates, stoplogs, guides, hoist structures, monorails, and conduits, may apply to the following: alignment, anchor bolts, bolted, riveted and welded connections, protective coatings, support details, support grouts.

### *Earthfill Dams*

Earthfill structures require maintenance work directed essentially to controlling seepage and erosion, in order to prevent deterioration of structures and development of seepage paths.

Annual or long-term maintenance programs for earthfill structures may include regular maintenance of instrumentation, rip-rap and crest maintenance and repair, control of vegetation and burrowing animals, slope stabilization, drainage system maintenance, and removal of upstream debris, to assure the safety of the structure.

### *Equipment*

Maintenance requirements may apply to all mechanical and electrical components which are essential to dam safety, including: spillway and conduit gates, hoists, gate and guide heating systems, stoplog hoisting facilities, bubbler systems, relevant instrumentation, normal and emergency lighting and pumps.

A preventative maintenance program should be devised based upon dam consequence classification, industry standard, manufacturer's recommendations and operating history for particular pieces of equipment.

Reference should be made (with supplementary information where necessary) to manufacturers' and designers' operating and maintenance manuals for required maintenance, spare parts, and appropriate regular tests to confirm ongoing functionality.

#### *Communicators and Control*

Operating staff should have a description, including a complete overview with system schematic diagram of all the communication and control equipment. Equipment should be operated continuously and monitored to ensure integrity. The documentation should include all current test and maintenance practices.

### **B.4. Surveillance**

#### ***B.4.1. Standards***

Standards shall be established to cover inspections, monitoring of water-retaining structures, and testing of discharge facilities.

Standards or guidelines should be provided to establish the types of inspections to be carried out, the purpose of each type of inspection, frequency of inspections, type of items to be inspected, required documentation, qualification and training of inspectors and procedures for the correction of deficiencies.

#### ***B.4.2. Regular Inspections***

**Requirements:** Periodic inspections shall be performed to determine the condition of integral portions of water-retaining structures.

Appropriate investigations shall be undertaken of all potential deficiencies disclosed by regular inspection.

Instructions and procedures for the dam should provide the following information:

- Checklists for routine, intermediate and comprehensive inspections for all structures and equipment
- Frequency, responsibility and requirements for recording and reporting
- Description of additional inspections which may be required including

underwater inspections and inspections required during initial reservoir impounding

- Requirement and frequency of alignment and deformation surveys

The program of inspections, including the frequency of inspections, should be devised based upon the dam classification, industry standards, manufacturers’ recommendations, operating history and condition of particular structures and equipment.

As a general guideline, “routine” inspections should be performed by project staff as a regular part of their maintenance activities. Such inspections should be carried out weekly or monthly as appropriate for the item being inspected. Reduced frequencies may be selected to suit seasonal restraints. “Intermediate” inspections are intended as more formal inspections, generally annual or semi-annual, performed by the appropriate representative of the owner responsible for safety surveillance. Comprehensive inspections (Dam Safety Review) should be performed by an independent expert or panel of experts at regular time intervals.<sup>1</sup> The review should include the O&M Plan and the EPP to determine any modifications thereof.

Procedures, including definition of responsibility, should be in place for evaluating data (obtained from visual inspections, instrumentation and design reviews of current operating conditions such as spillway capacity, freeboard, drawdown, maximum water levels) to confirm structural and operational safety and to identify areas requiring deficiency investigations. These procedures should include an “action code” to ensure that appropriate action will be taken, depending on the severity of the observed deficiency.

### ***B.4.3. Special Inspections***

Special inspections shall be performed following potentially damaging events.

Instructions and procedures for the dam should describe special inspections and other surveillance and procedures required after floods, windstorms, earthquakes and unusual observations such as cracks, settlements, sinkholes and slopes failures. The responsibility to undertake these special inspections

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1. Review period depends on the consequence classification of the dam:

Consequence category:	Very High	High	Low
Period between reviews:	5	7	10 (years)

should be assigned to all site staff and the engineer responsible for dam safety. This wide empowerment is intended to ensure timely inspection after all potentially damaging events.

Requirements for documentation and reporting should be specified with inspection checklists and procedures for review by the engineer responsible for dam safety, following the occurrence of the above events.

#### ***B.4.4. Instrumentation***

Instrumentation shall be monitored, evaluated and maintained to assist in the safe operation of the dam.

Included with all descriptions of instruments should be their initial data, design limits, dates of and requirements for calibration, normal operating ranges, and “alarm” levels at which point detailed review of the readings is required. The responsibility should be assigned for routine instrument readings, changes to data, calibration and interpretation of the results.

The mode and methodology of readings should be described, i.e., automated or manual. If automated, the system should be described including modem telephone numbers. If manual, there should be documentation of methodology, maintenance, calibration and storage of instrumentation reading equipment.

Exact locations and details of the instrument installations should be provided, complete with plan views and cross-sectional drawings.

The documentation of instrumentation could be covered in a separate instrumentation report, with reference to it in the O&M Manual.

#### ***B.4.5. Tests***

All operating equipment and facilities necessary to pass extreme floods shall be inspected and tested annually to ensure that they will function as required during an extreme flood.

Intake flow control equipment should undergo a balance pressure test annually before the flood season. Spillway gates should have annual operation tests to ensure correct operation. The frequency and level of inspection and testing should be compatible with the consequence category of the dam.

All test procedures should be specified in the O&M Manual and incorporated with the inspection checklists. Instructions and procedures should provide descriptions of operational and integrity tests for all mechanical and electrical components of water flow control equipment to ensure fully operational condition.

## **EMERGENCY PREPAREDNESS PLAN (EPP)**

### **C.1. General**

Potential emergencies at a dam shall be identified and evaluated, with consideration of the consequences of failure, so that appropriate preventative or remedial actions can be taken.

An Emergency Preparedness Plan (EPP) shall be prepared, tested, issued and maintained for any dam whose failure could be expected to result in loss of life as well as for any dam for which advanced warning would reduce upstream or downstream damage.

A notification process shall be initiated as specified in the EPP, immediately upon finding a hazardous condition that could lead to a dam breach, or upon discovering a potential dam breach or dam breach in progress.

The dam owner<sup>2</sup> or operator shall assess whether dam breach warnings should be issued directly to inhabitants in areas immediately downstream of a dam, due to the short period of time before the anticipated arrival of a flood wave.

Where preventative actions are available, these actions shall be initiated, as appropriate, to prevent failure or to limit damages where failure is inevitable.

An EPP is a formal written plan that identifies the procedures and processes that the dam operators would follow in the event of an emergency at a dam. The emergency could be, for example, failure of essential equipment such as flood gates, slope failure having the potential to cause dam failure, or a complete failure of the dam caused by overtopping, earthquake or piping.

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2. As defined in this document, the term "owner" refers to the person or entity responsible for the safety of the dam.

An EPP allows for planning by municipalities, local police, provincial agencies, telephone and transportation companies and other parties affected in the event of a dam break flood, and the coordination of efforts between provincial and municipal levels of government. In the event of an emergency, an effective, comprehensive, well-tested EPP will save lives and has the potential to reduce property damage.

### **C.2. Development of an EPP**

An EPP shall describe the actions to be taken by the dam owner and operator in an emergency. The EPP shall assign responsibility for each action to be taken to an individual and/or a backup.

Input from other agencies and affected parties shall be included in the EPP, as appropriate.

Copies of the EPP, or summaries of relevant information, shall be provided to those who have responsibilities under the plan.

The steps in developing an EPP are as follows:

1. Identify those situations or events that would require initiation of an emergency action; specify the actions to be taken and by whom.
2. Identify all jurisdictions, agencies, and individuals who will be involved in implementing the EPP.
3. Identify primary and auxiliary communications systems, both internal (between persons at the dam) and external (between dam personnel and outside agencies).
4. Identify all persons and agencies involved in the notification process, and draft a notification flowchart which shows whom should be notified, in what order and what other actions are expected of downstream agencies. Each provincial and local government agency involved may have its own general emergency plan. This would normally require amending to include actions required as a result of dam break flooding.
5. Develop a draft of the EPP.
6. Hold coordination meetings with all parties included in the notification list for review and comment on the draft EPP.
7. Make any revisions, obtain any necessary regulatory approval, finalize and distribute the EPP.

### **C.3. Contents of an EPP**

The EPP shall include the following procedures and information:

- Emergency identification and evaluation
- Preventative actions (where available)
- Notification procedure
- Notification flowchart
- Communication systems
- Access to site
- Response during periods of darkness
- Response during periods of adverse weather
- Sources of equipment
- Stockpiling supplies and materials
- Emergency power sources
- Inundation maps
- Warning systems (if used)

#### *Emergency Identification and Evaluation*

If detected early enough, potential emergencies can be evaluated and preventative or remedial actions taken. The EPP should contain clear procedures for taking action when a potential emergency is identified. Notification of emergency situations requires that a responsible contact person initiate the remedial action and decide if and when an emergency should be declared and the EPP executed. Clear guidance should be provided in the EPP on the conditions which require that an emergency be declared.

The Emergency Preparedness Plan should include a discussion of procedures for timely and reliable identification, evaluation, and classification of existing or potential emergency conditions. Major elements of these procedures are:

- Listing of the conditions or events which could lead to or indicate an existing or potential emergency. Situations involving flood emergencies due to a breach or other structural failure as well as a major flood without a breach should be included. Breach conditions could occur

as a result of such occurrences as piping, floods, earthquake, sabotage or landslide-induced waves.

- Brief description of the means by which potential emergencies will be identified, including the data and information collection system, monitoring arrangements, surveillance, inspection procedures and other provisions for early detection of conditions indicating an existing or potential emergency.
- Procedures, aids, instructions and provisions for interpreting information and data to assess the severity and magnitude of any existing or potential emergency.
- Designation of the person responsible for identifying and evaluating the emergency. This would normally be the owner or his representative: however, if the owner does not have the proper technical expertise, responsibility may need to be assigned to another individual. Appropriate alternatives should be designated to ensure that continuous coverage is provided.

#### *Preventative Action*

Where there are provisions for preventative actions available they should be clearly detailed in the EPP. These could include listings of the availability of machines, equipment, material and labour that are ready available to the dam operator in an emergency situation.

#### *Notification Procedures*

Notification Procedures must be clear and easy to follow. The EPP should contain a list of all persons to be notified in the event that an emergency is declared.

#### *Notification Flowchart*

A notification flowchart is a diagram showing the hierarchy of notification during an emergency. It is a pictorial representation of the notification procedure. The EPP should contain a notification flowchart clearly summarizing the notification procedure for each of the emergency conditions considered.

#### *Communications Systems*

Full details of internal and external communications systems as they apply to the EPP should be included.

*Access to the Site*

The description of access should focus on primary and secondary routes and means for reaching the site under various conditions (e.g., foot, boat, helicopter, snowmobile).

*Response during Periods of Darkness*

The EPP should cover the response to potential or actual emergency conditions during periods of darkness including those caused by power failure.

*Response during Periods of Adverse Weather*

The EPP should address emergency response under adverse weather conditions including extremes of cold, snow or storms.

*Sources of Equipment*

The location and availability of equipment and contractors that could be mobilized in case of an emergency should be included.

*Stockpiling Supplies and Materials*

The location and availability of stockpiled materials and equipment for emergency use should be addressed.

*Emergency Power Sources*

Details on the location and operation of emergency power sources should be included.

*Inundation Maps*

Inundation maps are needed by local authorities to develop an adequate evacuation plan.

*Warning Systems*

Warning systems are sometimes used to provide warnings to residents, campgrounds and parks that are close to the dam. Full details should be contained within the EPP.

*Appendices*

Additional items may be covered in appendices to the EPP. General site plans may be useful. Drawings showing the potential breach location used in the inundation study may be included. Tables showing the variation in flood stage with time at key locations in the flooded area should also be included.

#### **C.4. Maintenance and Testing of an EPP**

The EPP shall be issued to those affected, and all registered copies of the EPP shall be updated.

The EPP shall be tested.

As updates or amendments to the EPP are produced they are forwarded to each holder (as listed in the EPP) and acknowledged by the recipient. Telephone numbers and names of contact persons should be updated on a regular basis, at least annually. It is helpful to place the EPP in a loose-leaf binder so that outdated pages can be easily removed and replaced with updated information, to ensure a complete, current and workable plan. A list of planholders should appear in the EPP.

Testing is an integral part of EPP to ensure that both the document and the training of involved parties are adequate. Tests can range from a limited table-top exercise to a full-scale simulation of an emergency and can include multiple failures.

#### **C.5. Training**

Training shall be provided to ensure that dam personnel involved in the EPP are thoroughly familiar with all elements of the EPP, the availability of equipment, and their responsibilities and duties.

Technically qualified personnel should be trained in problem detection and evaluation and appropriate remedial (emergency and non-emergency) measures. This training is essential for proper evaluation of developing situations at all levels of responsibility which, initially, is usually based on observations on-site. A sufficient number of people should be trained to ensure adequate coverage at all times.

#### **C.6. Inundation Studies**

Requirement: An inundation study shall be carried out based on assumptions that will indicate all areas that could be flooded for the most severe combination of reasonably possible conditions.

Various dam failure scenarios are normally studied: these cover rapid failure times, large breach sizes and conservative antecedent conditions. The

potentially inundated area should be determined and the following conditions considered:

- Design flood failure
- Fair-weather dam failure
  - At full supply level (piping, earthquake)
  - During winter conditions where ice jam formation is possible
- Failure induced by failure of an upstream structure

Inundation maps showing the maximum flooded areas should be prepared.

Inundation maps should also be prepared for the reservoir rim and for areas affected by the backwater effect upstream of the reservoir. Two cases should be analyzed:

- Extreme flood exceeding the discharge capacity
- Reduction of discharge capacity during the passage of a large flood (for example, blockage by debris, or malfunction or non-operation of gates).

## APPENDIX VII

### **Selected Legislation on Dam Safety and Additional Information Sources**

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#### **SELECTED LEGISLATION**

##### **Argentina**

- Decree no. 239/99 (Mar. 17, 1999)

##### **Australia**

###### *New South Wales:*

- Dams Safety Act (1978)

###### *Victoria:*

- Water Act (2000)

###### *Queensland:*

- Water Resources Act (1989)
- Water Act (2000)

##### **Canada**

###### *Alberta:*

- Dam and Canal Safety Regulation (1978, as revised in 1998)
- Dam Safety Guidelines (1975)
- Dams Safety Guidelines of the CDA (1995)

###### *British Columbia:*

- Dam Safety Regulations B.C. Reg 44/00, (deposited Feb. 11, 2000, issued by the Government of British Columbia in Feb. 2000)

###### *Ontario:*

- Lakes and Rivers Improvement Act (issued by the Ministry of Natural Resources in 1977)

###### *Quebec:*

- Dam Safety Act (adopted by the Quebec Parliament on May 23, 2000)

**Finland**

- Dam Safety Act (1.6.1984/413)
- Dam Safety Decree (27.7.1984/574)
- Water Act (19.5.1961/264)
- Dam Safety Code of Practice (1985, last revised in 1997)

**France**

- Law on the Organization of Civil Security, Protection against Forest Fires, and Prevention of Major Risks (Jul. 22, 1987) [*Loi du 22 juillet 1987 relative à l'organisation de la sécurité civile, à la protection de la forêt contre l'incendie et à la prévention des risques majeurs*]
- Water Law (Jan. 3, 1992)
- Circular no. 70/15 on the Inspection and Surveillance of Dams Relevant to Public Safety (Aug. 14, 1983) [*Inspection et Surveillance des barrages intéressant la Sécurité publique*]
- Circular on the Security of Zones in Proximity to and Downstream from Dams (Jul. 13, 1999) [*Circulaire de 13 juillet 1999 relative à la sécurité des zones situées à proximité ainsi qu'à l'aval des barrages et aménagements hydrauliques, face aux risques liés à l'exploitation des ouvrages*]
- Decree Creating the Permanent Technical Committee on Dams (Jun. 13, 1966)
- Intervention Plans for Hydraulic Installations (Decree 399/997, Sept. 15, 1992)

**India**

- Draft Dam Safety Act (2000)

**Latvia**

- Hydropower Plant Dam Safety Act (Dec. 2000)

**Mexico**

- National Water Law

**New Zealand**

- Resource Management Act (1991) (amended)
- Building Act (1991)
- Guidelines for Resource Consents for Dams and Associated Activities (Nov. 2000)

**Norway**

- Water Resources Act (Jan. 1, 2001)
- Regulations Governing the Classification of Watercourse Structures (Dec. 11, 2000)
- Regulations Governing the Safety and Supervision of Watercourse Structures (Dec. 15, 2000)
- Regulations Governing the Qualifications of Those Undertaking the Planning, Construction, and Operation of Watercourse structures (Dec. 11, 2000)

**Portugal**

- Decree Law (1990)
- The Portuguese Code of Practice for Observation and Inspection of Dams
- Standards for Monitoring and Surveillance of Dams

**Russian Federation**

- Federal Law 21.07.97, N117- OC (adopted by the State Duma on June 23, 1997)

**South Africa**

- Regulations, *Government Gazette* Vol. 253 (No. 10366, July 25, 1986)
- National Water Act (no. 36, 1998)

**Spain**

- Technical Regulation about Reservoir and Dam Safety (1996) [*Reglamento Técnico Sobre Seguridad de Presas y Embases*]
- Order of the Ministry of Public Works Approving Instructions for the Project, Construction, and Operation of Large Dams (Mar. 31, 1967)
- Basic Directive on Planning for Civil Protection against the Risk of Flood (1994) [*Directriz Básico de Planificación de Protección Civil Ante el Riesgo de Inundaciones*]

**Switzerland**

- Federal Law Regarding Supervision of Hydraulic Structures (June 22, 1877, as amended) [*Bundesgesetz ueber die Wasserpöizeil*]
- Executive Decree (Dec. 7, 1998, went into effect Jan. 1, 1999) [*Verordnung ueber die Sicherheit von Stauanlagen, Stauanlagenverordnung*]

### **United Kingdom**

- Reservoirs Act (1975, entered into force on Dec. 1, 1991)

### **United States**

- National Dam Safety Program Act, (passed in 1972, revised in 1984, and incorporated as Section 215 of the Water Resources Development Act of 1996, PL104-303, October 12, 1996 [NDSPA])
- ASDO Summary of State Laws and Regulations on Dam Safety (2000)
  1. Arizona—Arizona Revised Statutes, title 45: Waters, chap. 6: Dams and Reservoirs, art. I: Supervision of Dams, Reservoirs and Projects (ARS 45:1201-1223); Arizona Rules and Regulations Pertaining to the Supervision of Dams, chapter 15 (R12-15-151 and 152-15-1201 through 1226)—adopted 1978 and substantially revised in 2000
  2. California—California Water Code, division 3, secs. 6000-6501 (last amended 1995); California Administrative Code, title 23, ch. 2, arts. 1-301 to 5-333 (adopted 1996)
  3. Idaho—Idaho Safety of Dams Rules and Regulations (amended July 1998), implementing provisions of Safety of Dams Statutes, title 42 ch. 17 Idaho Code (as amended)
  4. Iowa—ch. 455B, division III (Water Quality), pt. (Water Allocation and Use), first enacted 1949 and last amended 1986; chs. 70–75 Iowa Administrative Code, title V, Flood Plain Development (1975), amended 1994
  5. Kentucky—Kentucky Revised Statutes, ch. 151, Geology and Water Resources (1996), amended 1990; Kentucky Administrative Code, ch. 4, title 401, Water Resources
  6. Maine—Maine Revised Statutes, title 37-B, Defense, Veterans and Emergency Management, secs. 1051–1070, ch. 21, Dams and Reservoirs and ch. 22, Dam Inspection (1983 and revised 1989 to include safety components separated from title 38 art. 3-A, Dam Registration and Abandonment, secs. 815–843); title 37-B revised in 1997 with inclusion of Section 1065(5), Correction of Unsafe Conditions and 1080, Establishment of Commission); in 1999 Section 1065 updated and added 1071, Notice of Transfer of Ownership; Regulations, ch. 3, Design and Construction Standards for New or Reconstructed Dams (1990)—laws currently under revision;

- Maine Dam Registration, Abandonment, and Water Level Act of 1983, title 38, General Provisions Relating to Rivers and Streams, ch. 5, subchapter 1, Mills and Dams, secs. 611–933 (enacted in 1983 to include safety components, amended in 1987 and changed to separate safety components in 1989)
- 7. Michigan—Natural Resources and Environmental Protection Act, pt. 315, Dam Safety (1994 PA 451 as amended); draft rules promulgated
- 8. Missouri—Revised Statutes of Missouri (RSMo.), secs. 236.400—236.500 (enacted 1989, last amended 1993); Code of State Regulations, 10CSR 22-1.010 to 10 CSR 22-4.020
- 9. Montana—Dam Safety Act, ch. 15 (85-15-101 through 504), last amended 1993; Department of Natural Resources and Conservation, Title 36, ch. 25: Safety of Dams (1988)
- 10. New Hampshire—RSA Chapter 482 (1937), last amended 1998; New Hampshire Code of Administrative Rules, ch. ENV-WR 100-800 (NH Water Division, Dept. of Environmental Services), effective 1980 and 1981, last amended 1997
- 11. Ohio—Ohio Revised Code (ORC), title XV (enacted 1963, last amended 1990); administrative rules enacted by Division of Water of Department of Natural Resources (enacted 1972, revised 1981 and 1999)
- 12. Pennsylvania—Dam Safety Encroachments Act (DSE Act), enacted 1979, last amended 1985; title 25: Rules and Regulations, pt. I: Department of Environmental Resources, subpart C, Protection of Natural Resources, article II: Water Resources, ch. 105: Dam Safety and Waterway Management (the Rules), adopted 1980; rules supplemented by subsequent policy statements incorporated into ch. 105; complete revision adopted in 1991, further revisions planned in 2000 or 2001
- 13. Puerto Rico—Puerto Rico Law Number 133 of July 15, 1986; Administrative Regulations of the Dam Safety Program may be obtained through the Dam Safety Unit of the Puerto Rico Electric Power Authority (PREPA)
- 14. Utah—Utah Code, secs. 73-5a-101 through 702 (enacted 1990 and amended 1993); State of Utah Statutes and Administrative Rules for Dam Safety (1996) contains both statutes and administrative rules

15. Washington—Revised Code of Washington, chs. 90.03, 43.21A and 86.16 (1994); Washington Administrative Code, chs. 173–175 (1992); Dam Safety Guidelines (Department of Ecology)
16. West Virginia—West Virginia Dam Control & Safety Act (1973), Code of West Virginia, chs. 22–14, last amended 1992; Dam Control Regulations, title 47, Series 34 under Division of Environmental Protection (DEP) regulations (1982)
17. Wisconsin—Regulation of Dams and Bridges Affecting Navigable Waters (1971), last amended 1984, Wisconsin Statutes, ch. 31; Dam Design and Construction Standards, Wisconsin Administrative Code, ch. NR 333 (adopted 1985, last amended 1987)

**Additional Information Sources  
Not Appearing in Appendices or Footnotes**

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ANCOLD Guidelines on Dam Safety Management (1994)

Dam Safety Guidelines (Canadian Dam Association, January 1999)

Pisaniello, John D., and Jennifer M. McKay, *Models of “Appropriate” Practice in Private Dam Safety Assurance* 1 Water Policy 525–530 (1998)

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