Dam Safety Program

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April 2003
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Appendix A: BC Hydro Dams

Appendix B: Advisory Boards

Appendix C: Capital Projects
Introduction

BC Hydro's dams

BC Hydro owns, operates and maintains 42 dam facilities throughout British Columbia, as a major part of its generating system. The dam facilities are listed in Appendix A and the dam locations are shown on the back cover of this report.

Organizational Changes

Following BC Hydro organization changes in early 2002 to the Generation Line of Business, the staffing in the Office of Dam Safety is now twenty-one. Overall the dam safety program staffing has not changed - this represents only a change in reporting lines to the Director of Dam Safety, for due diligence.

The oversight of the important surveillance program is provided by five dam safety area engineers now resident in each of the five generating regions. Similarly oversight of the regulatory requirements, risk management, and the dam safety investigations and capital upgrade program now report directly to the Director of Dam Safety. The following figure shows the new organizational structure.
The Director of Dam Safety met quarterly with Mr. K. Finch, the assigned Board of Directors representative for dam safety, prior to tabling the quarterly report to the full Board of Directors. An annual report presentation is made to the Board of Directors.

The governance and implementation of the dam safety program is shown on the chart below.
Advisory Boards

The Director of Dam Safety convenes Advisory Boards (see Appendix B) to provide independent interpretation of the engineering and scientific information used to inform decision-making, or to provide guidance on decision-making concerning complex or unique matters of societal risk. A separate Advisory Board is selected for each dam. The individual members are selected depending on the type of issue to be resolved.

The use of Advisory Boards provides the Director of Dam Safety and the Board of Directors with independent assurance of the robustness of the dam safety decisions. Advisory Boards comprise up to three or four independent subject-matter experts of international repute, each with complementary expertise.
**Dam Risk Management**

*Management System*

The dam safety management system is described in detail in the Dam Safety Management Manual. This manual is a living document. The latest official version is resident on the BC Hydro Intranet at the Dam Safety site, [http://w3.bchydro.bc.ca/powersupply/dam_safety/index.shtml](http://w3.bchydro.bc.ca/powersupply/dam_safety/index.shtml).

Dam risks are generally identified through surveillance activities or the periodic comprehensive dam safety reviews for each dam. Once a potential or actual deficiency is identified, it is entered in the dam safety database, and then it is tracked through to resolution.

A key aspect of the risk management process is prioritization of the deficiencies.

*Dam Risk Matrix*

The BC Hydro dam deficiency prioritization system develops a deficiency rating for each dam which is a surrogate for probability of future poor dam performance. This rating is founded on modern understanding of dam performance and statistics of previous dam incidents and failures worldwide.

When the deficiency rating is plotted against the estimated consequences of failure, a measure or index of risk results.

The figure below represents the current risk matrix for all the dams with identified actual deficiencies and potential (as yet unconfirmed) deficiencies. This matrix is updated as new information becomes available, and is plotted quarterly. The matrix at 31 March 2003 is shown below.
Risk Profile

The following figure shows the current risk measure and estimated future changes in risk at each dam that has an identified active or future dam safety improvement project. The portfolio risk is the aggregate total of all the individual dams.

The term “risk” is used here in a general sense; it is not a measure of the probability of failure multiplied by the consequences. Although describable, dam risks cannot be reliably quantified at this time. The risk shown is a measure of non-conformance to current practices, multiplied by a weighting factor which increases with consequence category for the dam.

The risk profile cannot account for any future deficiencies that may be uncovered during routine surveillance, during the periodic dam safety reviews, or during other dam safety activities. As new deficiencies are identified, and as existing deficiencies are addressed, the risk profile is adjusted and reported quarterly.

The risk estimates are heavily weighted by the consequence of dam failure; that is consistent with the use of the “precautionary principle” in catastrophic loss risk management. Therefore the dams with very large consequences dominate the risk profile. Reference to the risk matrix (previous page) provides a separate measure of likelihood of a dam’s future poor performance (aggregate deficiency rating).

PORTFOLIO RISK INDEX OVER TIME
The planned projects that are estimated to exceed $2 million are listed in the table below, along with the expected completion dates. A total of about $330 million is estimated for these projects over the next 5 years to F2008. This includes costs-to-date on active projects, but does not include the costs of deficiency investigations (DI) which are required to confirm the deficiencies and identify risk control options. These DI costs are expected to be about $20 million over the same period to F2008.

An examination of ongoing and future deficiency investigations provides some insight into potential issues which may have to be addressed in the future if they are confirmed as deficiencies.

Possible issues include those listed below

<table>
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<tr>
<th>Dam</th>
<th>Possible Issues</th>
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<tr>
<td>Mica</td>
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<td>Revelstoke</td>
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<td>Gate reliability, aging</td>
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<td>System wide</td>
<td>Emergency notification methods</td>
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* Costs and schedules are uncertain due to lack of technology, constructability or uncertain scope of project.
Regulatory Activities

The key requirements of the BC Dam Safety Regulation include the following activities.

**Site Surveillance**
A total of 1,564 inspections were completed for the 42 damsites. This represents 98.6 percent of the specified inspections, compared to the regulatory target of 90 percent.

**Formal Dam Inspections**
Annual surveillance inspections and reports have been completed for all 42 dams for Fiscal 2003.

**Instrumentation**
Dam instruments have been read and recorded throughout the year in accordance with the schedule submitted to the regulator.

**Gate Testing**
Gates required for dam safety have been inspected and tested, and any exceptions are noted in the annual report for each dam.

**Emergency Preparedness Plans**
Communication directory updates have been completed as required by the regulation.

**Operation, Maintenance and Surveillance (OMS) Manuals**
The OMS manuals (42) have been reviewed and updated during the year.

**Dam Safety Reviews**
Four dam safety reviews were completed within the schedule required by the regulation. These are discussed in more detail following.

*Dam Safety Reviews*
These periodic (5 to 10 year) comprehensive and detailed reviews of dam performance and assessment against current standards were completed for four dams:

- Alouette
- La Joie
- Ladore
- Walter Hardman

The reviews were contracted directly to individual Dam Safety Review engineers who are very senior dam safety professionals from four separate consulting companies from across Canada.

The four dam safety reviews have been completed and the reports received from the reviewers. The reports are submitted to the dam safety Regulator.
Surveillance Highlights

- **WAC Bennett Dam**

  During July 2002, the WAC Bennett Dam reservoir reached full pool level for the first time since 1984. The spillway gates were operated to control the maximum reservoir level during the freshet and periodic rainfall events that occurred in July.

  The second annual performance review of the WAC Bennett Dam by an independent expert was completed in mid-December 2002, as required by the regulator. The reviewer concluded that BC Hydro’s approach to monitoring the dam is sound and that performance of the dam is satisfactory.

- **Reservoir Restrictions and Increased Surveillance**

  With the completion of dam safety improvements at Sugar Lake Dam in 2002, reservoir restrictions related to stoplog procedures are no longer required at Sugar Lake. Restrictions remained in effect at Coquitlam Dam pending a seismic upgrade of the dam and at Coursier Dam pending decommissioning of the dam. In November 2002, the Coquitlam reservoir level approached, but did not exceed, the restricted maximum elevation. This resulted from an extended period of heavy rainfall and constrained discharge capacity due to maintenance at Buntzen Dam. Twenty-four-hour surveillance was briefly implemented in accordance with the enhanced surveillance plan.

  During the same time period, the heavy rainfall also resulted in high reservoir levels and spilling at Jordan Diversion Dam. Increased surveillance was temporarily implemented in accordance with the requirements of the OMS manual.

- **Dam Safety Instrumentation Enhancements**

  Many of BC Hydro’s dams include instruments that provide data that is important for monitoring dam performance and for detecting any changes in performance. At some dams, key instruments are monitored on a real-time or near-real time basis using Automatic Data Acquisition (ADA) systems. During 2002, ADA was implemented or improved for key instruments at Ruskin, Elsie, Strathcona and Seton Dams, and in the mountainside slope above the Wahleach powerhouse.

- **Dam Security**

  In the last two years, increased attention has been paid to security at BC Hydro’s critical major dams. With the commencement of hostilities in Iraq in March 2003, additional security measures were put in place at those dams.