

Safety Management of Dams The Australian Practice

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Seminar Outline

How Australian dams are managed and the role to be played by the dams engineer in the dam safety management process

- Introduction
- Dam Safety Legislation and Regulations
- ANCOLD Guidelines
- The Need for Dam Safety Programs
- Johnstown Dam Video
- Dam Safety Management: Approach and Processes
- Case Study
- Summary and Conclusion



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Dam Safety Legislation & Regulations

- Varies across the world
- Regulatory frameworks are dependent on the country's legal and administration systems as well as economic circumstances
- Variations exist in legislative basis, organizational structure of the regulating body, administration arrangements and method of financing regulatory requirements



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Dam Safety Legislation in Australia

- Varies across Australia
- Four States (Victoria, NSW, Queensland, Tasmania) and one Territory (ACT) have enacted dam safety legislation and have developed regulatory systems
- Two States (South Australia, Western Australia) and one Territory (Northern Territory) have not yet enacted dam safety legislation
- National Guidelines on dam safety serve as technical standards for the dams community



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ANCOLD

- Australian National Committee on Large Dams
- A voluntary association of organizations and individuals with an interest in dams in Australia
- Formed in 1937
- The Australian National Committee of ICOLD
- Current membership: 42 organizations, 160 individuals



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ANCOLD'S Objective

To encourage improvement in the planning, design, construction and operation of dams in Australia, and to ensure that dam owners have access to world best practice through the skills of Australian professionals.



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ANCOLD Guidelines

Guidelines in print:

- Dam Safety Management (2003)
 - Risk Assessment (2003)
 - Environmental Management of Dams (2001)
 - Design Floods for Dams (2000)
 - Assessment of the Consequences of Dam Failure (2000)
 - Tailings Dams Design, Construction and Operation (1999)
 - Design of Dams for Earthquake (1998)
 - Concrete Faced Rockfill Dams (1991)
 - Guideline Supplement on Roller Compacted Concrete for Gravity Dams (1991)
 - Design Criteria for Concrete Gravity Dams (1992, under revision)
 - Strengthening and Raising of Concrete Gravity Dams (1992)
- Guidelines under consideration
- Business Management of Dams



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Small Dams Guidelines

- Prepared by regulatory bodies in some States for the benefit of the small dam owners
- Covers non prescribed dams, including farm dams
- Presented in non-technical language
- Common dam safety problems are illustrated
- Complements the technically more comprehensive Dam Safety Management Guidelines prepared by ANCOLD



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Why Have a Dam Safety Program?

- Dam failures continue to occur worldwide
- Dam failures have catastrophic consequences
- Dam owners are legally and morally responsible for losses arising from dam failures
- Assists in reducing the risk of dam failure



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What Should a Dam Safety Program Do?

- Ensure prevailing standards have been used
- Ensure preventative maintenance as programmed
- Manage incidents with a clear plan
- Ensure the dam's risk profile remains within tolerable limits
- Set out an inspection and monitoring program



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What Should a Dam Safety Program Do?

- Provide clearly defined and promulgated responsibilities for dam safety
- Provide a validation system to ensure systems are operative and updated
- Provide training programs to operators and equip them with incident management
- Ensure appropriate personnel and funds are available to conduct the program



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Dam Owner's Information

- Reports on Investigation, Design, Construction, Safety Review
- As Constructed Drawings
- Dam Monitoring & Operational Data
- Dam Safety Inspection Reports
- Operation & Maintenance Manual
- Dam Safety Emergency Plan



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Issues to be Addressed by Dams Engineers

- Regional and site geology
- Soundness of the foundations
- Reservoir basin (and rim) stability and water tightness
- Minimal adverse impact on the environment
- Availability of construction materials
- Capacity of the spillway
- Design for all loading conditions and the materials selected
- Outlet provisions to meet release requirements
- Provisions for monitoring of structural performance
- Satisfactory construction methods & operating procedures



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Johnstown Dam Video



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What Dam Safety Issues Did You Spot?

- Dam once abandoned
- Poor maintenance practices
- Inadequate spillway capacity
- Blocked spillway entry
- Inadequate freeboard
- Crest settlement at the maximum section
- No outlet provisions
- No downstream face protection
- Trees on the dam embankment
- No filters



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Dam Management Process

Process includes:

- Safety Surveillance
- Safety Review
- Emergency Planning
- Appropriate O & M Practices
- Risk Assessment
- Remedial Action (Fixes & Upgrades)
- Maintenance of Performance Records
- Training



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Dam Safety Surveillance

The continuing examination of the conditions of a dam and its appurtenant structures and the review of operation, maintenance, monitoring procedures and results in order to determine whether a deficient trend is developing or appears likely to develop.



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Dam Surveillance

- Inspections
- Monitoring
- Collection of other information relating to dam performance
- Evaluation and interpretation of observed data
- Surveillance reports
- Independent review of the surveillance program



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Dam Safety Inspections

- Comprehensive
- Intermediate
- Routine Visual
- Special/Emergency
- Inspection frequencies in accordance with the dam's risk profile (Hazard Category)
- Instrumentation and monitoring frequencies in accordance with the risk profile (Hazard Category)



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Contents of a Dam Safety (Dam Surveillance) Report

- Physical details of the dam
- Review of the dam's risk profile (Hazard Category)
- Observations during the inspection
- What has occurred since the previous inspection (deterioration as well as upgrades)
- A review of monitored data and other information
- Comment on O&M
- Comment on emergency plans
- A review of performance as indicated by the operational and surveillance data since the previous inspection



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Contents of a Dam Safety (Dam Surveillance) Report

Additional requirements for a comprehensive report

- Flood handling capability
- A statement about the assessed safety of the asset against current standards
- The need for further action, remedial action
- A statement on the adequacy of the dam safety program



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Dam Safety Review

The assessment of dam safety by methodical examination of all records and reports, and by investigation and analysis of matters not addressed previously or of items subject to new design criteria or possible deterioration.



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Dam Safety Review

Process Includes:

- Technical Audits (Design Review)
- Solution Development
- Options Appraisal
- Recommendation to Client
- Approval
- Detailed Design
- Remedial Works



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Technical Audit

Considerations:

- Literature/Data Review
- Field Inspections
- Past and Current Issues
- Site Investigation (Geotechnical)
- Seismological Investigation
- Hydrological Investigation
- Environmental Issues
- State and Life of Materials
- Dam, Foundation, Outlet and Spillway Assessments (including stability, seepage and deformation analyses and evaluation of liquefaction potential) with respect to current standards and practices



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Dam Safety Emergency Plans (DSEP)

A continually updated set of instructions and maps that deal with possible emergency situations or unusual occurrences at or related to a dam or reservoir.



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Dam Safety Emergency Plans (DSEP)

Features Include:

- Roles and Responsibilities
- Emergency Identification, Evaluation and Classification
- Notification and Communication Procedures
- State Emergency Response Plan (DISPLAN)
- Inundation Maps
- Preventive Actions
- DSEP Training and Review Aspects



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Operation & Maintenance (O&M) Practices

- Efficient and effective management of a dam is enhanced by adopting appropriate O&M practices.
- O&M Manual is the best means of documenting this.



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Contents of an O&M Manual

- Data on the dam, drawings
- Structural O&M Instructions and Procedures
- Reservoir and Spillway Operations
- Procedural Flow Charts
- Safety Surveillance Aspects
- Maintenance Schedules (Annual and Cyclic) and Logs
- Dam Safety Emergency Plan (DSEP)
- Communications Directory



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Risk Assessment

The process of deciding whether existing risks are tolerable and present risk control measures are adequate and if not, whether alternative risk control measures are justified or will be implemented. Risk assessment incorporates the risk analysis and risk evaluation phases.



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Risk Assessment

■ Risk

The likelihood or probability of adverse consequences

■ Acceptable Risk

That level of risk that is sufficiently low that everyone who is impacted is comfortable with it. Stakeholders do not generally consider expenditure in further reducing such risks justifiable.



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Risk Assessment Process

- Option Formulation
 - Failure Modes
 - Probability of Adverse Events
 - Dambreak Simulation
 - Damage Analysis
 - Loss of Life Assessment
 - Damages and Loss of Life as a Function of Probability
 - Economic Analysis
 - Sensitivity Analysis
 - Conclusions and Recommendations
- Permits the decisions on remedial action to be made based on acceptable risks.



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Risk Assessment Outcomes

- Identifies the assets which are critical to the business
- Identifies risks from asset management, operational and physical condition perspectives
- Provides a planning tool to enable high risk components to be addressed with the priority they deserve
- Provides a basis for optimising investments
- Provides a basis for justifying works to stakeholders



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Remedial Action

- Action required to rectify a deficiency to an adequate safety standard and acceptable risk profile.
- Does not imply zero risk
- There is residual risk in any decision



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Remedial Action

- Engineering Solutions
- Non-Engineering Solutions



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Remedial Action

Steps Involved in Engineering Solutions:

- Detailed Design
- Environmental Approvals, EIS
- Temporary Works, Site Establishment, Cofferdams
- Construction Phase
- First Filling
- Commissioning of Equipment
- Inspection of Works
- Safety Surveillance Program
- Construction Report




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Remedial Action

Non-Engineering Solutions Involve:

- Decisions to alter operating rules (eg: lowering of reservoir level)
- Installation of public warning/alarm systems etc.

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Remedial Action (Upgrades & Fixes)

Common Drivers

- Our understanding of the behaviour of dams improve over time
- Design standards evolve
- Inadequate flood capacity
- Internal erosion & piping protection
- Seismic retrofitting


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Case Study

- Slope stability and liquefaction remediation at Yan Yean Dam




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Yan Yean Dam

- 150 year old puddle clay core embankment dam supplying Melbourne – Australia's oldest embankment dam
- 10m high, 1km long
- Safety review revealed slope stability, piping and liquefaction issues within the embankment and foundation




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Yan Yean Dam



A black and white photograph of the Yan Yean Dam. The dam is a long, low structure made of earth and stone, stretching across the middle ground. The reservoir is visible behind the dam, reflecting the sky. In the foreground, there are several trees, including a prominent one on the right and some smaller ones on the left. The ground in the foreground appears to be a mix of dirt and grass.

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Yan Yean Dam - Typical Cross Section

Yan Yean Dam - Typical Cross Section

UPPER CRUISE DETAILS AFTER 25% DOWNCUTTED EL. 30.10

STOP LOG AND GATE HOUSING

TOPSOIL AND GRASS 150mm THICK

EXISTING EMBANKMENT PROFILE

FILTERS

EXCAVATE TO BOTTOM OF EXISTING BULLESTONE CHANNEL

20cm FROM THE REFERENCE LINE

NEW DRAINAGE PIT

EXISTING DRAINAGE PIT

EXISTING BULLESTONE CHANNEL BY EXISTING

EXISTING DRAINAGE PIPE 150mm I.D. 175mm O.D.

EXISTING GROUND PROFILE

SECTION AT RD 150m


SCALE 1:100

Yan Yan Dam - Filter Grading




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Yan Yean Dam



A black and white photograph of the Yan Yean Dam. The image shows a large concrete dam structure with a spillway. A road runs alongside the dam, and there are some trees and vegetation in the background. The dam appears to be in good condition.

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Yan Yean Dam



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Summary

- Dam Safety Legislation and Regulations
- ANCOLD Guidelines
- Need for Dam Safety Programs
- Johnstown Dam Video
- Dam Safety Management: Approach and Processes
- Case Study



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Concluding Remark

The risk of failure of a dam is an ever present one, and in no other field of engineering is the responsibility to the community more exacting. The role of the dams engineer is to assist the dam owner with a (management) process that reduces the risk to a level acceptable to the dam owner and the community.



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