

**Invited Contribution to Q 76: The Use of Risk Analysis to Support Dam Safety
Decisions and Management**

DRAFT FOR REVIEW ONLY

**Portfolio Risk Assessment: A Tool for Managing Dam
Safety in the Context of the Owner's Business**

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1. Introduction

Most dam owners and regulatory agencies need to prioritise remedial measures (fixes) at multiple dams to meet safety requirements. This is not just a technical matter, but should be seen in the context of the owner's business (or agency mission) with manifold considerations, such as, customer service and business criticality, contractual obligations, capital budgeting, improving business value, legal implications, emergency and contingency planning, loss financing and insurance, and public perception (Bowles 1999b). Through the systematic approach of portfolio¹ risk assessment (PRA), technical and business understanding of dam safety issues can be improved and strategies for cost effective risk reduction can be formulated.

PRA provides a risk profile for existing dams and the basis for a dam safety improvement program, including supporting investigations. Other outcomes can be used to strengthen the owner's on-going dam safety program, and to provide inputs to various business processes, with the goal of better integrating dam safety into the owner's business. The process typically establishes the case for funding dam safety improvements, and leads to more rapid risk reduction. The PRA should be a "living document", which is periodically updated to incorporate new or improved inputs and revised evaluation or prioritisation criteria.

Since first introduced in Australia (Bowles 1996), initial PRAs have been completed or are on-going for most major Australian portfolios of dams. PRA is also being used in North America. The PRA process builds on standards-based evaluations and does not commit an owner to using risk assessment for selecting the extent of remedial measures. Variations in the PRA process have been developed for large portfolios using screening or sampling procedures.

2. Overall PRA Process

PRAs should be conducted through a close partnership between engineers (including a PRA expert) and the owner's dam safety manager and decision-makers. The process comprises the following major parts (Figure 1): 1) identification of business framework, including decision context, 2) engineering assessment, 3) risk assessment, and 4) prioritisation of fixes (formulated as "separable construction upgrade packages" or SCUPs, but may include non-structural

¹ A portfolio is a group of dams, which are the responsibility of a single owner or regulator.

measures), and remaining investigations. Typically, SCUPs are formulated at a reconnaissance level to meet engineering standards in one or more stages.

Identification of the business framework is important for identifying PRA outcome “targets” that will benefit the owner’s dam safety program and related business processes (right side of Figure 2), and other stakeholders.

Engineering and risk assessments for initial PRAs are based primarily on available information and engineering judgement. Supporting studies are usually performed at a reconnaissance level and should be based on consistent best estimates. By utilising available information (left side of Figure 2), initial PRAs and PRA updates can be efficiently conducted with a minimum of supporting studies.

Engineering assessments indicate whether portfolio dams are expected to meet current engineering practice and hence the need for fixes. A rating system is used to minimise conservative biases associated with the limited information that is typically available for initial PRAs (Bowles et al 1998). “Pass” and “No Pass” ratings are given when sufficient information is available to make assessments with the normal high level of confidence. When insufficient information is available, “Apparent Pass” and “Apparent No Pass” ratings are given, based on engineering judgment, to indicate the most likely outcome expected after sufficient investigations are completed, and to indicate the need for investigations.

Risk assessment includes the following steps for each dam: a) failure modes identification, b) risk analysis of existing dam (and possible identification of the need for additional fixes or investigations), c) risk evaluation of existing dam, d) risk analysis of fixes, and e) risk evaluation of fixes. Failure modes identification is the foundation upon which the risk assessment is built, and therefore should be carefully performed and documented. In the evaluation steps, life safety and financial/economic criteria (or guidelines) should be considered and the ALARP (as-low-as-reasonably-practicable) principle.

Fixes are typically prioritised to maximise the rate of life safety risk reduction until a point of diminishing returns. From that point, the remaining fixes are prioritised, often by maximising the rate of reduction of financial/economic risks. The resulting prioritisation is sometimes adjusted to account for factors, such as, very high-risks, or the timing of capacity upgrades. Investigations are prioritised to precede related fixes, and based on the sensitivity of the prioritisation of fixes to the uncertainty in investigation outcomes.

3. PRA Outcomes and their Integration into the Owner’s Business

PRA outcomes can be grouped into the following types (“Outcomes” box in Figure 1): 1) current risk profile, 2) improvements in on-going dam safety activities, 3) short-term risk reduction measures, 4) Dam Safety Improvement Program, and 5) inputs to business processes.

One of the most significant challenges in the PRA process is to get the generated information to the appropriate department, where its benefits can be realised. When potentially high risks are identified during the PRA process, it is important that they are promptly investigated and that timely short- and long-term mitigation is implemented.

4. Benefits

The PRA process is generally considered to be robust and defensible for corporate governance, and to justify its cost. It relies primarily on the engineering understanding of dam safety issues, and provides a systematic means for identifying risks and prioritising investigations and fixes. For budgeting and management purposes, it is useful to group fixes and investigations into phases, often with distinct risk reduction characteristics.

The PRA process typically provides many useful insights, which are useful for strengthening dam safety management and for better integrating dam safety considerations into the owner's business (right side of Figure 2).

As illustrated in Figure 3, the PRA approach typically leads to more rapid risk reduction than traditional prioritisation approaches, including index and FMECA methods, which do not preserve the risk metric. Thus, although risk assessment has sometimes been considered to be a tool for justifying less safety, the opposite should be true if PRA is properly applied. Bowles et al (1999b) state that the proper motivation for dam safety risk management should be to achieve:

- More safety
- More rapidly
- More cost effectively, with
- More understanding by all stakeholders, and
- More integration across all aspects of the dam safety program.

5. Limitations

PRA outcomes should be used with full consideration given to their intended purposes and associated limitations. Engineering and risk-based evaluations should be considered to be only indicative, unless they are based on more detailed work performed outside the PRA process. Decisions on the selection of long-term risk reduction measures should not be based solely on information from a PRA. Detailed engineering investigations, including the risk assessment of alternative risk reduction measures, are needed to provide adequate confidence and defensibility for these decisions.

6. References

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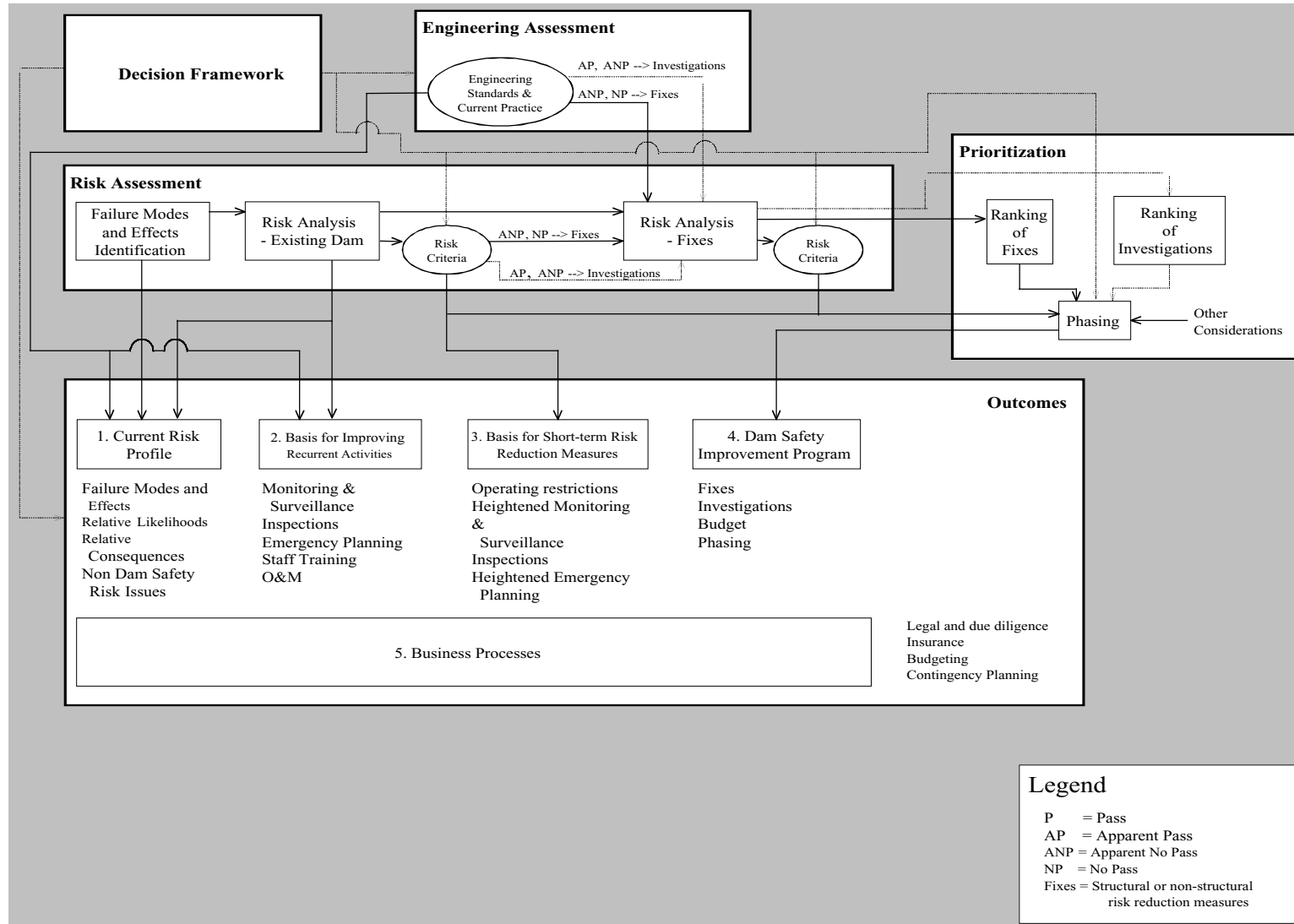


Figure 1. Portfolio risk assessment process and outcomes.

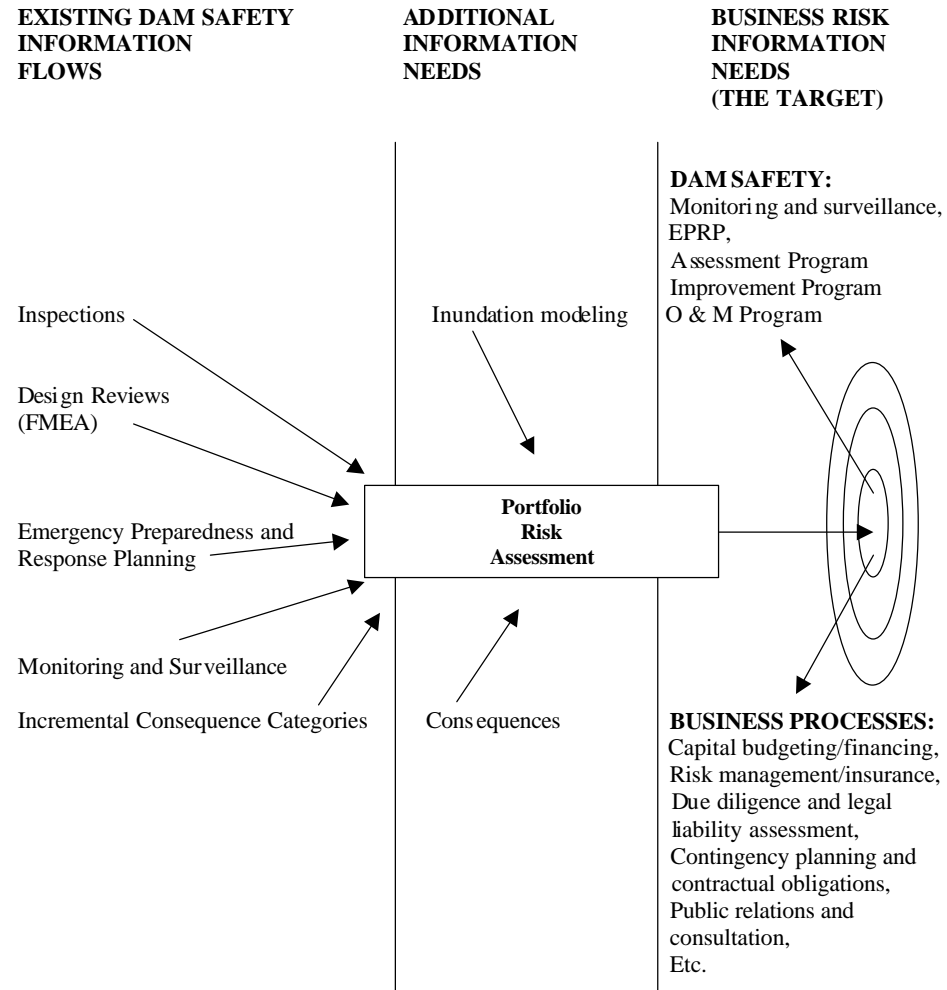


Figure 2. Capturing PRA inputs and targeting and integrating PRA outcomes into the owner's dam safety program and business processes.

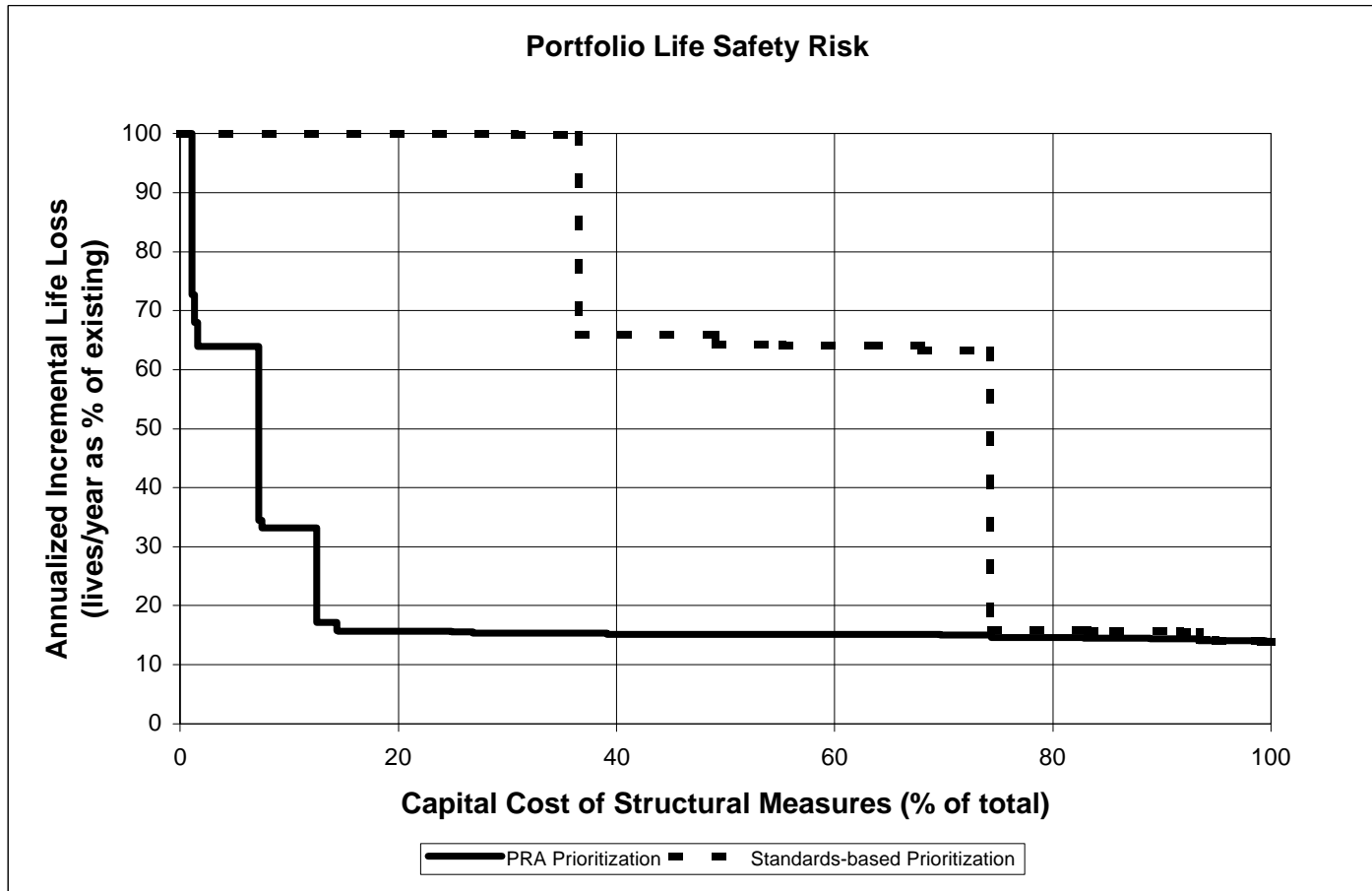


Figure 3. More rapid estimated life safety risk reduction for the PRA approach than for the traditional prioritisation approach for SA Water’s large dams (Bowles et al 1999a).

Reference Card Information

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Summary: A portfolio is a group of dams, which are the responsibility of a single owner or regulator. Portfolio risk assessment (PRA) is a tool for improving the technical and business understanding of dam safety issues and for prioritising remedial measures. PRA builds on engineering standards evaluations and does not require the use of risk assessment for selecting remedial works. It is widely used in Australia. This Contribution summarises the PRA process, outcomes, benefits, and limitations.

Key Words: Portfolio Risk Assessment, Risk Assessment, Dam Safety, Dam Safety Management, Remedial Measures,