

Portfolio Risk Assessment in the UK: a perspective

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SYNOPSIS. This paper discusses the merits of Portfolio Risk Assessment (PRA) from the point of view of a practitioner and a dam owner.

INTRODUCTION

The management of reservoir safety in the UK is generally subject to the requirements of the Reservoirs Act 1975 and the assessment methodology applied by Panels of Engineers appointed under that Act. The Health and Safety Executive (HSE) claims jurisdiction over the safety of reservoirs where a business is involved under the powers of the Health and Safety at Work Act 1974, although they defer to Panel Engineers and the inspection system at present. The HSE also claims jurisdiction over non-statutory reservoirs.

Under the Panel Engineer system, the reservoir inspection is generally based on observational techniques supplemented with historical information such as instrumentation data, previous reports and studies, drawings etc. The Panel Engineer tends to focus on technical matters with the intention of maintaining the safety of the public by preventing a dam failure. The system has a good track record with no failure in the UK causing loss of life since 1925. However, the system only considers the safety of individual dams and does not address the justification and prioritisation of recommended works for owners of multiple dams. In addition, it does not consider the tolerability of risk and business drivers for identifying and evaluating options for even higher levels of safety.

WHY WOULD YOU CARRY OUT PORTFOLIO RISK ASSESSMENT?

Portfolio risk assessment is a process which can assist owners to manage reservoir safety in the overall context of their business.

The importance of this approach was recognised in OFWAT document MD 161, 'Maintaining Serviceability to Customers' dated 12 April 2000

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addressed to ‘The Managing Directors of all Water and Sewerage Companies and Water Only Companies’ which stated;

‘Each company needs to demonstrate how the flow of services to customers can be maintained at least cost in terms of both capital maintenance and operating expenditure, recognising the trade off between cost and risk, whilst ensuring compliance with statutory duties.’

‘The Government considers an economic framework related to current and likely future asset performance (serviceability) is likely to provide the best way forward. As the (Environmental Audit) Committee recommends , it will be important for this work to investigate the practicability of approaches that are forward looking, taking account of the risk of asset failure (probability and consequences) as well as past historical trends.’

The PRA process specifically addresses the trade off between cost and risk and the compliance with statutory duties through an approach that takes account of the risk of asset failure accounting for both probability of failure and consequences of failure. The PRA approach does not replace or supplant the role of the Panel Engineers, but builds on the Panel Engineers’ technical assessments and other information available to an owner. The approach seeks to use estimates of the likelihood of various failure modes, estimates of life and economic losses, and preliminary evaluations against tolerable risk guidelines (HSE 2001) and the owner’s business criticality considerations, to identify opportunities for improved dam safety through investigations, and risk reduction brought about by carrying out works at the dam and improved reservoir safety management. Improvements in the effectiveness of detection and response to dam safety incidents by owners and the effectiveness of emergency response by local authorities can also be considered.

THE PORTFOLIO RISK ASSESSMENT PROCESS

PRA is a logical, auditable method of systematically assessing a stock of dams in its current condition and assessing and prioritising the works required to be done and other measures that would improve reservoir safety, but may not be required under current practice. Some water companies have used this technique, and the prioritised lists and resulting spend profile that comes from it, as the basis of their submission to OFWAT (the regulatory body for the privatized UK water industry). OFWAT had asked that risk assessment be used in the companies funding submissions and therefore the submissions that used these techniques were generally well received.

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A risk assessment carried out for a portfolio of dams typically uses data from historic incidents, accidents and failures, together with estimates of the probability of occurrence of extreme floods and earthquakes, to obtain estimates of the probabilities of failures for the failure modes considered. In addition, information from dam break analyses is used to estimate life loss and economic consequences for each failure mode. Remedial measures are defined for each mode of failure to meet UK Reservoir Safety practice and to reduce the probability of failure. Additional measures can be considered to exceed current UK Reservoir Safety practice. An evaluation may then be carried out, including cost benefit analysis, to provide information on the strength of justification for each remedial measure relative to tolerable risk guidelines such as those by the HSE (2001). This also provides data for the prioritisation of these remedial works based on alternative approaches discussed in the next section of this paper. The dam owner must then decide how this information will be used for the reduction of risk.

A number of PRA studies carried out for owners have shown that the process promotes a strengthening of the management of reservoir safety and its integration into all areas of the owner's business such as, the licence to operate, asset management, asset operation and maintenance, risk management, legal and insurance areas.

ISSUES IN USING THE RESULTS FROM A PORTFOLIO RISK ASSESSMENT

Once a Portfolio Risk Assessment has been carried out, many questions arise that can only be answered by the owner. These questions have implications that go far beyond the technical issues that a reservoir safety group typically deals with and therefore representatives from a wide range of departments in the owner's organisation should be involved. The discussion of these questions and some of the suggested answers form the major part of the rest of this paper.

1. **How should the PRA be used to prioritise the remedial works that have been determined should be carried out?**
 - **By probability of failure?** – should the owner take the view that any failure is unacceptable and therefore the dams most likely to fail should be dealt with first?
 - **By consequence of failure?** – some dams, should they fail, might only frighten a few sheep, whereas others might threaten large numbers of people or major elements of infrastructure. It might therefore be prudent to spend money on the dams which have the highest consequence of failure first.

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- **By maximising the cost effectiveness of risk reduction?** – the estimated risk (considering by probability and consequences of failure) reduction and cost for all remedial measures can be estimated and the most cost effective remedial works given the highest priority.
- **Using an evaluation against HSE (2001) Tolerability of Risk Guidelines?** - The Health and Safety Executive (HSE 2001) have published guidelines for assessing in the tolerability of risks to individuals and to groups. A risk is sometimes said to be ‘broadly acceptable’ if it is lower than one in a million per annum. However, the key to evaluating the tolerability of risks is whether the risks have been reduced to be ALARP, or ‘as low as reasonably practicable’. The ALARP Principle is an expression of the undertaker’s duty of care under common law. The HSE (2001) refers to the satisfaction of the ALARP Principle as requiring a “gross disproportion” test applied to individual risks and societal concerns, including societal risks. The gross disproportion, which should be sought in deciding how far to pursue risk reduction, is between the cost of an additional risk reduction measure and the estimated risk reduction benefit for that measure. HSE (2002) refers to this disproportion as “the bias on the side of safety”, “erring on the side of safety”, and “compensating to some extent for imprecision in the comparison of costs and the benefits”
- **By some hybrid of the above?** – A suggested hybrid method is shown in Figure 1.

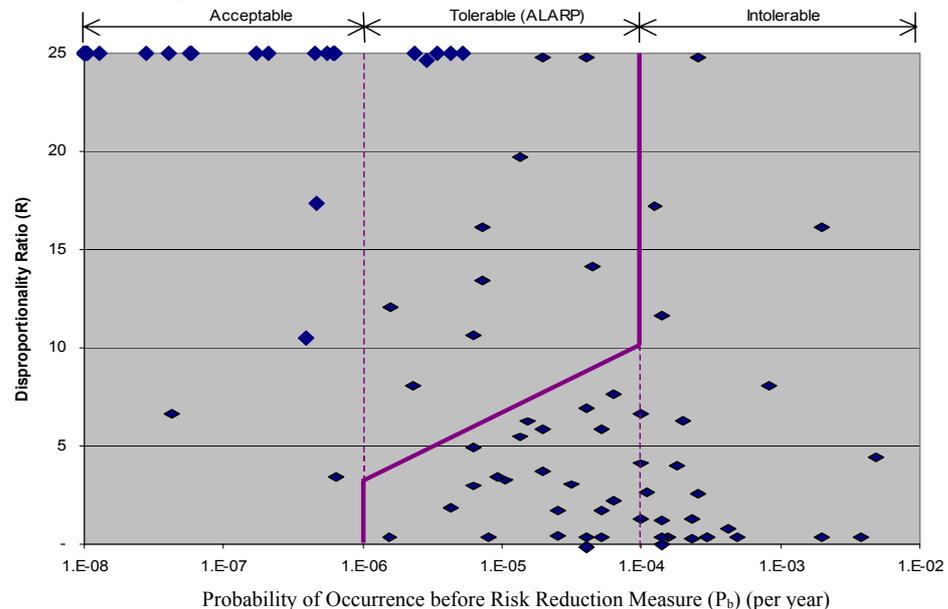


Figure 1. Risk Reduction Measures plotted against HSE Tolerable Risk Guidelines

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This sets limits of tolerability based on HSE guidelines and uses a disproportionality (cost/benefit) ratio and the risk of occurrence before the remedial measure is carried out to prioritise those measures.

- **By doing works recommended “in the interests of safety” at each dam first** – works recommended “in the interests of safety” have to be carried out “as soon as practicable” under the Reservoirs Act 1975 or by the time stipulated by the Inspecting Engineer. The remaining remedial works could then be prioritised by the methods above.

Each approach to prioritisation results in a different rate of risk reduction verses cost relationship. The fastest rate of risk reduction for the investment of funds is achieved by using the cost effectiveness approach, where risk is expressed in average annual terms. However, other factors may be important to consider in establishing a prioritisation. In addition to factors mentioned above, business criticality, or the timing of a capacity expansion construction project, are examples of such factors.

2. **What are the factors that limit the size of the capital programme that can be managed, thus directly influencing the rate of implementation of risk reducing remedial works for a dam owner with a large number of dams?**

- **Limited resources** - Even if the owner had unlimited funds, all works cannot be started at once. Work would be slowed by such things a limited number of site investigation contractors, rigs and engineers, and a limited number of contractors with the relevant experience.
- **Need to maintain water supplies** - Many remedial work projects will require at least a partial drawdown of the reservoir. With the recent history of dry summers many owners would not be prepared to allow work on a number of reservoirs to proceed simultaneously. Equally, if a reservoir is a ‘sole source’ reservoir, in as much as an area can only be supplied from one reservoir, the owner will wish to wait until the water supply network is reinforced or the risk of losing supply can be minimised in some other way before allowing work to start. It is also often necessary to coordinate works at the reservoir with works at the treatment works.
- **Environmental factors** - Planning approvals, rights of way diversions, the migratory and nesting habits of birds, the presence of toads, newts, badgers, etc., SBA’s, SSSI’s, Heritage sites, opposition from local inhabitants and landowners and the need and ability to

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supply compensation to the river downstream can all affect commencement date and duration of construction works, and thus the priority of the scheme.

- 3. Once the prioritised list of works has been agreed upon, how should the Recommendations of the Inspecting Engineer contained in his Report under the Reservoirs Act 1975 be accommodated?**

When the Inspecting Engineer carries out his inspection he is usually unaware of the condition of other reservoirs in the next valley or even in the same valley. Some would say that, traditionally, the Inspecting Engineer has taken the view that his duty is to ensure the safety of the dam that he has been asked to inspect, irrespective of the problems or shortcomings that may exist at other dams in the ownership of the undertaker.

The problem that may arise, following a Portfolio Risk Assessment, is that particular recommendations made “in the interests of safety” by the Inspecting Engineer may not achieve a ‘high ranking’ and therefore may not be scheduled for a number of years. This may occur because the remedial measure that is responsive to the recommendation “in the interests of safety” may result in only a small reduction in risk relative to its cost, or other words it is not as cost effective as other remedial measures that have been identified for the owner’s portfolio of dams. If the undertaker waits too long to act on the Inspecting Engineer’s recommendation, this may cause intervention from the Enforcement Authority because the Act states ‘as soon as practicable’. The actual ‘meaning’ of this phrase has not been defined, except that it has been said by some, that money is not a factor to be considered; but it may take a court ruling before it is defined. Certainly, as discussed above, there are other factors that can affect the timing of works from the owner’s point of view.

In addition, the recent Water Bill gives powers to the Enforcement Authority to determine what “as soon as practicable” means in certain circumstances. It would seem sensible that owners, and particularly those using a PRA approach, should work with an Inspecting Engineer to determine a time for completion rather than have it imposed on them by the Enforcement Authority.

Thus, the PRA process could produce some conflict or difficulties with the current reporting system unless the Inspecting Engineer ‘signs on’ to the process. One mechanism to create an understanding is to have a annual briefing of all Inspecting Engineers involved with the owner’s

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portfolio of dams so they understand how the PRA prioritisation lead to the timescales that the owner is proposing for works that are responsive to their recommendations. Inspecting Engineers could then consider this information when setting their timescales or the date of the next inspection. Owing to the way in which the PRA is carried out, it is highly likely that ‘recommendations in the interests of safety’ will have been identified in advance of the inspection and therefore a risk reduction measure will already have been identified. Any new recommendations by the Inspecting Engineer will themselves have to be assessed and prioritised during an update of the PRA.

Clearly, if there is conflict of any kind, then under the terms of the Reservoirs Act 1975, the owner will be bound to carry out the recommendations “in the interests of safety” irrespective of the fact that the money could be more effectively spent elsewhere to reduce risk to the community based on the PRA.

For example, provision of additional spillway capacity could be recommended “in the interests of safety” for a spillway that will already pass 95% of the design flood without overtopping. The flood that will exceed this capacity could have an annual exceedance probability approaching 1×10^{-6} . At the same dam, the PRA may have identified that seepage failure has a 1×10^{-3} per annum probability of occurring, even though there is no recommendation to improve protection against seepage failure in the Inspecting Engineer’s report. This raises several questions, including the following:

- Where should the owner spend his limited available funds?
- Would a referee, as defined by the Reservoirs Act 1975, take account of the PRA if an owner appealed against a timescale set by the Inspecting Engineer?
- If a failure occurred, what might the judgment of the enquiry be if the owner had enlarged the spillway and severe seepage had caused the dam to be washed away?

4. Is PRA worth the dilemmas that it spawns? Do the advantages outweigh the disadvantages?

Is the owner’s business at greater risk with or without the information provided by the PRA? Should the owner rely solely on the Report and Recommendations of the Inspecting Engineer? Can you hear a barrister

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in cross examination in court saying would you have carried out work on this dam earlier if you had used a technique called Portfolio Risk Assessment?

Some of the advantages and disadvantages of the PRA methodology are summarised below:

Advantages

1. In the event of a major incident, evidence that the owner had assessed the risks and was carrying out safety measures in a logical sequence may reduce any penalties imposed by the courts when funds had been spent on other dams rather than the dam concerned in the incident.
2. A PRA will allow the risks to the Company and the Community associated with dams to be reduced as quickly as possible.
3. A PRA can provide a persuasive argument to the shareholders and the regulator that increased spending on reservoir safety is justified.

Disadvantages

1. In the event of a major incident, evidence that the owner had assessed the risks at considerable cost, and was carrying out safety measures in a logical sequence, may not be taken into account by the courts, when funds had been spent on other dams rather than the dam concerned in the incident – especially when one considers how the ‘expert witness’ system works at times.
2. A prioritisation based on a PRA can conflict with recommendations “in the interests of safety” by Inspecting Engineers. Impecunious owners might be put in a position where they have the funds to carry out works that they are obliged to do under the Reservoirs Act 1975 or the high priority items from the PRA but not both.
3. The PRA may reveal unacceptable risks to the owner that they do not have the funds to reduce. Perhaps “ignorance is bliss”, but then “ignorance is no excuse” when it comes to the law!

CONCLUSIONS

Despite the issues highlighted in this paper, and the vagaries of the English legal system notwithstanding, the authors conclude that the use of Portfolio Risk Assessment can be strongly recommended as a tool to assist owners to manage reservoir safety in the overall context of their business. The approach follows a logical well thought out process involving evaluation against engineering guidelines and accepted practice, risk analysis, evaluation against tolerable risk guidelines, prioritisation of risk reduction measures, and sometimes prioritisation of investigations to reduce the uncertainties associated with engineering and risk assessments. The process will cause the organisation to think about the relationship of reservoir safety to the business as a whole. Effectively using the information derived from a PRA can result in a corporate reservoir safety management system that is much more effective and efficient, is auditable and more defensible, and is better integrated with other parts of the business, including finance, capital projects, legal and insurance sections.

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