The British Dam Society

Quality and the safety of reservoirs

CW Scott, Independent

SYNOPSIS Arising the Independent Reservoir Safety Review Report written by Professor David Balmforth and published in March 2021, work is being done to identify approaches to assess the quality and consistency of inspection reports and annual statements.

This paper will take a step back to consider what "quality" could mean in the context of reservoir safety legislation, the factors that influence the delivery of "quality" in safety interventions and what actions could be taken to promote "quality".

This will be done by considering the various definitions of quality in the literature. The purpose of reservoir safety legislation will be reviewed and possible definitions of quality appropriate for reservoir safety activities discussed. The paper will move on to consider the factors that influence the quality of reservoir safety and finally suggested actions or interventions to deliver improvements will be proposed.

INTRODUCTION

The Independent Reservoir Safety Review Report (Balmforth, 2021) raised concerns about the variability and consistency of the reports produced by engineers appointed to the various panels under the Reservoirs Act. Arising from these concerns activities have been initiated to review the "quality" of Inspection Reports and Annual Statements although what constitutes "quality" in this area has not been defined.

This paper seeks to open a conversation on what constitutes quality and what actions or adjustments in practice would be beneficial to improve "quality".

DEFINITIONS OF QUALITY

The Oxford English Dictionary gives several definitions of the noun quality. The one that seems most relevant in the context of reservoir safety is the first: "the standard of something when it is compared to other things like it".

If quality is to be assessed, a framework is needed to allow such an assessment to be done in a meaningful way. Garvin (1984) investigated this issue in the context of product quality. He identified five approaches to defining quality as set out in Table 1.

Table 1. Five approaches to the definition of quality

Approach	Definition	Example
Transcendent	Intrinsic and based on innate excellence	"Quality is a simple, unanalysed property that we learn to recognise by experience"
Product-based	Quality based on a measurable variable	e.g. The quantity of knots per unit area in a rug
User-based	Meets the needs of the end user	The degree to which a specific product meets the needs of a specific user
Manufacturing-based	Conformance to requirements	i.e. a well-made Mercedes has the same "quality" as a well-made Skoda
Value-based	Degree of excellence at an acceptable price	i.e quality is considered in conjunction with price

From these varying approaches, Garvin proposed a framework of eight dimensions of product quality.

Table 2. Garvin's dimensions of the definition of product quality

Dimension	Definition
Performance	Primary operating properties of a product
Features	Secondary properties that supplement the basic function
Reliability	Probability of the product ceasing to function
Conformance	Extent to which properties meet predefined standards
Durability	Product life
Serviceability	Speed, competence and courtesy of repair
Aesthetics	How something looks, feels, etc.
Perceived quality	Intangible aspects such a brand, etc

Not all these dimensions of quality will have salience for reservoir safety but models such as this provide a framework within which to define quality in the context of the purpose of reservoir safety legislation.

PURPOSE OF RESERVOIR SAFETY LEGISLATION

When considering what constitutes quality in the context of reservoir safety legislation, the express purpose of the legislation that defines the statutory regime needs to be considered.

Every Act of Parliament has a preamble. Erskine May defines the purpose of the preamble to an Act of Parliament as follows:

> "The purpose of a preamble, which appears immediately after the long title, is to state the reasons for and the intended effects of the proposed legislation."

Thus, the preamble to the various Acts that define the statutory framework for reservoir safety in England and Wales provide an obvious starting point for considering the purpose of reservoir safety legislation.

The Preamble to the Reservoirs (Safety Provisions) Act 1930 is: "An Act to impose, in the interests of safety, precautions to be observed in the construction, alteration, and use of reservoirs, and to amend the law with respect to liability for damage and injury caused by the escape of water from reservoirs."

That for the Reservoir Act 1975 is: "An Act to make further provision against escapes of water from large reservoirs or from lakes or lochs artificially created or enlarged."

The preambles to the Water Act 2003 and the Floods and Water Management Act 2010 both involved amendment to a variety of Acts including the Reservoirs Act and their preambles essentially identify their purpose as such amendment, particularly focused on the risk of flooding in the case of the 2010 Act.

As can be seen the Reservoirs Act 1975 was expressly a refinement and addition to the approach taken in the 1930 Act, continuing the purpose of the original legislation.

As a corollary, the preamble to the Reservoirs (Scotland) Act 2011 is: "An Act of the Scottish Parliament to make provision about the regulation of the construction, alteration and management of certain reservoirs, in particular in relation to the risk of flooding from such reservoirs …." That for the Reservoirs Act (Northern Ireland) 2015 is similar: "An Act to make provision about the regulation of the management, construction and alteration of certain reservoirs, in particular in relation to their safety to collect and store water; and for connected purposes."

With some adjustments, refinements, and changes of terminology, the Scottish and Northern Ireland Acts apply the approach defined in the 1930 Act, augmented to be the 1975 Act and adjusted by the amendments in the Water Act 2003 and the Floods and Water Management Act 2010.

The preambles to these various Acts make clear that the purpose of reservoir safety legislation is to introduce precautions to protect the public against uncontrolled releases of water from reservoirs that fall within the ambit of the legislation.

POSSIBLE DEFINITIONS OF QUALITY FOR RESERVOIR SAFETY

Considering the dimensions of quality in Table 2, and the purpose of reservoir safety legislation as defined by the Acts of Parliament, the three dimensions with the greatest salience to reservoir safety appear to be:

- Performance – the extent to which interventions and activities enhance or maintain the safety of the public from uncontrolled releases of water.
- Reliability – the consistency with which the interventions and activities deliver the safety of the public from uncontrolled releases of water.
- Conformance – the extent to which interventions and activities conform with predetermined standards or guidance.

Given the clear purpose of reservoir safety legislation, the list above is in rank order of criticality.

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WHAT CONTROLS THE QUALITY OF RESERVOIR SAFETY INTERVENTIONS?

Reservoir safety interventions are primarily:

(i) the inspections, examinations, reports and statements produced by qualified civil engineers fulfilling the various roles defined by legislation: construction engineer, inspecting engineer, qualified civil engineer and supervising engineer; and

(ii) the works or activities that follow from the recommendations in those reports and statements.

The Enforcement Authority role, which was introduced by the 1975 Act, is twofold:

(i) what the Guide to the Act refers to as "routine activities" including establishing and maintaining a register of reservoirs to which the Act applies, risk designation of those reservoirs, maintaining a post incident reporting database, producing a biennial report, receiving notices of appointments and subsequent reports and certificates

(ii) what the Guide to the Act refers to as "enforcement activities" related to enforcement of appointment of engineers or enforcement of measures in the interests of safety of maintenance.

Quality is largely controlled by how the key roles defined in legislation are discharged. In essence the behaviour of panel engineers in discharging their duties under the Act is the key quality driver.

COM-B model

The COM-B model, developed by a team at University College London, provides a way to consider the factors that influence the behaviour of panel engineers in fulfilling those roles.[1]

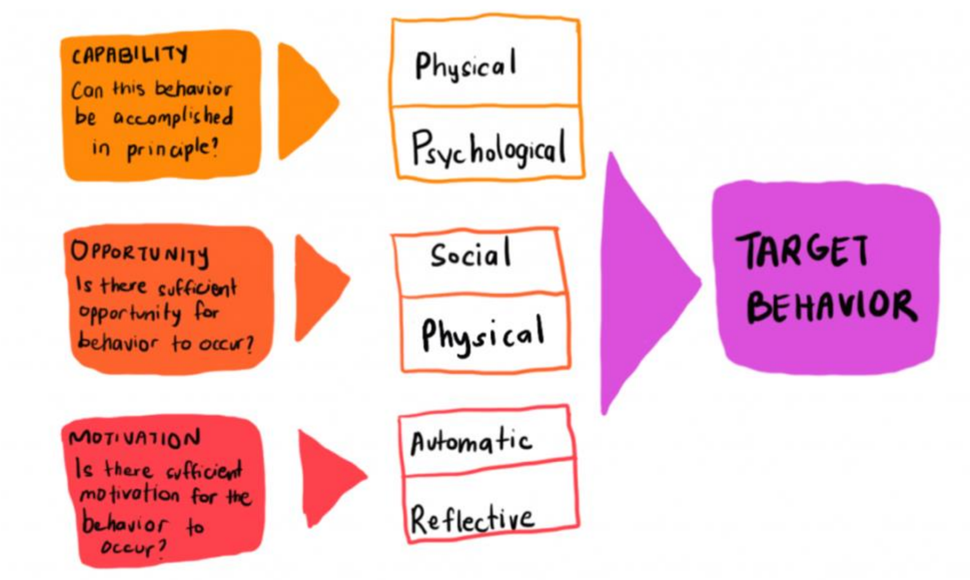

Figure 1 COM-B Model (https://thedecisionlab.com/reference-guide/organizational-behavior/the-com-b-model-for-behavior-change)

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[1] The COM-Be model was devised as a behaviour change tool and thus, the application here is a little tangential. However, it is used as a framework to structure a discussion of the factors driving quality in reservoir safety.

In the COM-B model:

- Capability refers to whether the individual has the necessary knowledge, skills and abilities. Capability comprises knowledge and skills, and physical strength.
- Opportunity refers to external factors that make execution of a behaviour possible. Physical opportunity, opportunities provided by the environment, and social opportunity are all valid components.
- Motivation refers to the internal processes that influence decision making. Reflective motivation - the reflective process involved in making plans - and automatic motivation - the automatic processes such as impulses and inhibition - are the two main components.

The COM-B model suggests that successful outcomes require the combination of these three factors.

The COM-B Model and Reservoir Safety

Capability
For reservoir safety activities Capability is range of mental attributes, predominantly technical capabilities. These are mostly assessed by the application process for appointment to a panel. The attributes used to make the assessment provide the dimensions of capability that are important: a mix of knowledge (e.g. dam engineering, legislation), experience and skills (e.g. observation, judgment, communication). Physical capacity is not directly assessed and is a factor left to the individual.

Opportunity
Opportunity constitutes factors that are less readily measured in an application process but are a fundamental consideration.

For example, a key external factor is having the time for both the physical inspection and the post inspection reflection prior to drafting reports and recommendations. The time available could be constrained by the volume of work to be done or limits posed by fee bids.

Motivation
Motivation is both internal and external. Internal factors are driven by one’s values and beliefs.

An example of an internal factor that could impact performance would be possible sub-conscious complacency with a structure with which one is familiar; either from acting in dual roles or from having conducted previous inspections of the site. The converse would be the heightened attention from visiting a new site.

External factors such as the opinion of one’s peers, a review by a third party or checklist checking of a report or statement content also influence motivation.

POSSIBLE ACTIONS AND INTERVENTIONS TO IMPROVE QUALITY

Within existing legislative context
The existing legislative framework is a process-based approach to delivering the desired outcome. As noted earlier the effectiveness of panel engineers in fulfilling their roles under the legislation is the key driver of the quality of outputs.

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Capacity

The assessment process for appointment and reappointment to a panel is a key check on the capability of engineers fulfilling reservoir safety roles. Currently applicants are interviewed for first time appointment but thereafter are only called for interview if the written reapplication document raises concerns or is considered inadequate.

The current process is dependent on assessment by peers in a structured format. The assessors are all volunteers working on a *pro bono* basis. This latter point combined with the relatively small pool of peers from which assessors can be drawn makes increasing the frequency of formal assessment problematic.

For example, the Reservoirs Committee conducts roughly 20 interviews per year at present, predominantly of new applicants. If all existing panel members were to be reinterviewed every 10 years the number of interviews would be roughly double that number and if engineers were to be interviewed every 5 years the number would triple.

An alternative approach would be that a random percentage of reapplicants are interviewed in addition to those where concerns are identified. This would limit workload and would provide a means of verifying that appointed panel engineers maintain the standards required.

Opportunity

The factors influencing the time available for an inspection or supervision examination are twofold: the volume of work being done by the individual and the amount of time which is funded via the fee. It is recognised that many panel members have other aspects to their organisational roles which will also influence the amount of time available.

There are currently no limits to the number of appointments that a panel member can take on. Setting a maximum is problematic due to the wide variability in the reservoirs covered by the Act in terms of size, height, age, proximity, and myriad other factors that impact on the amount of time required to conduct and report on an inspection – it is easy to say that such and such a number is too many but harder to define an upper limit.

Some Undertakers select their providers by some form of fee competition, be that through a framework or on an individual commission basis. In fee competition for something like inspection or supervision, particularly when lump sums are sought, there are essentially two variables: the rate charged, and the time spent. The rate is linked to the salary of the individual and the overhead structure of the organisation and is generally set within a tight range leaving the time as the easier variable to adjust.

Motivation

The obvious area of action which is underway is around measurement of conformance with standards. In the opinion of the author, this needs to be done in a way that is based on the purpose of legislation, focusing on the recommendations that are the drivers of public safety rather than a list of all statutory requirements and guidance suggestions, equally weighted.

It is important to recognise that checklist reviewing reports is not a means of assessing the quality of an inspection or an inspection report. For example, a checklist-based review can confirm that comment on, say, adequacy of spillway has been made and is logically argued. It cannot assess whether the assessment is correct.

The results of checklist-based reviews should perhaps be referred to as “guidance conformance assessments” rather than “quality assessments” to make the distinction clear.

The only clear way to assess the quality of an inspection in terms of the “performance” and “reliability” dimensions of quality defined earlier is to repeat the inspection in some form.

An option would be a peer review process for a random selection of inspections, including a site visit. The purpose of such a process would need be clearly defined and should be focused on public safety issues: the conclusions regarding the condition of key components and resulting recommendations, rather than the minutiae of guidance.

It is also suggested that, in the same way that the post construction inspection must be done by a panel member independent of the Construction Engineer, the same engineer should not conduct two sequential periodic inspections of a reservoir. It is understood that some Undertakers have implemented this practice.

Recently issued guidance has already suggested that a person acting as Supervising Engineer for a reservoir should not undertake the periodic inspection.

Possible additional role

A significant factor in the monitoring and surveillance of reservoirs is the frequency of visits. Large Undertakers have qualified and experienced staff in addition to Supervising Engineers who visit reservoirs frequently, are familiar with the structures and understand expected conditions. Often, they have checklists relevant to the structure to guide their visits. Smaller owners and those without many staff often do not have this facility and where Supervising Engineer services are provided externally, visits are often annual leaving a gap in regular, knowledgeable surveillance. Proposed changes in the Supervising Engineer role are moving that role from the originally envisaged civil engineer responsible for the oversight of a reservoir to a more quasi-audit role of conformance with plans also leaves a potential gap.

This sort of regular surveillance activity could be formalised by adding an additional role, what might be termed “Reservoir Keeper”, to safety legislation for reservoirs that fall within the higher risk designations. This would be an individual given some training in reservoir safety and provided with a site-specific checklist, prepared in conjunction with the Supervising Engineer or Inspecting Engineer, who visits the reservoir at least monthly. The purpose would be to identify changes in behaviour or condition and maintenance requirements. As noted, for many undertakers this would be a formalisation of existing practice rather than a new requirement. It would be a new requirement for some owners of high-risk designation reservoirs and would provide an additional level of precaution against an uncontrolled release of water in those cases.

CONCLUSIONS

This paper has sought to initiate a discussion on what constitutes quality in reservoir safety and the factors that influence the delivery of “quality” reservoir safety. The paper has used some external models to structure that discussion.

In considering quality is is vital to frame consideration based on the outcomes being sought rather than the set of activities being undertaken to achieve those outcomes.

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