

A New Incident Reporting System for UK Dams

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SYNOPSIS. This paper describes the development of a system of incident reporting for UK dams, to be administered by the Environment Agency. Drawing from recent research for Defra by KBR Consultants, and building on an existing database developed by the BRE, the paper describes the development of the system specification for the particular requirements of the Environment Agency and the reservoir industry. The main aim of the new specification is to provide an effective system for the reporting, storage and analysis of information on incidents at dams and related structures, and related remedial measures. This information will then be used to inform the industry on vulnerabilities and trends in incidents and to improve reservoir safety through the lessons learnt. It may also inform future research priorities. Some of the key issues addressed in the paper are: what constitutes an incident; who reports an incident; confidentiality and liability. The paper also discusses proposals for the investigation of major incidents by suitably-qualified engineers.

INTRODUCTION

The concern of society in responding to incidents or accidents is often influenced by the character of the incidents. The general public appears to take great interest in serious incidents at establishments capable of causing significant number of deaths and destruction and where victims have no influence or control over the accident or its outcome, especially where the number of people at risk is large, even if no one was hurt. In this respect, dams can be likened to the nuclear industry, which also has a very good safety record but one that still captures the public's imagination. The UK dam safety record since the introduction of legislation in 1930 can be considered as good. However, major incidents continue to occur and the industry should learn, and be seen to learn, from such events to minimize the likelihood of dam failures.

Incident reporting and investigation in several UK industries has recently been studied by the Royal Academy of Engineering (RAE, 2005). Of the conclusions reached by this study, three are of particular relevance to the general aims of the incident reporting and investigation specification development:

- Incidents that by chance fall short of developing into major

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accidents should attract an equal intensity of investigation if they are to serve as sources of insight into causes and allow future accidents to be prevented that may not benefit from the same fortuitous chance.

- The primary aim of any post accident investigation into cause should be to allow accidents having similar causes to be prevented for the future.
- A powerful contributor, possibly the most important one, to preventing accidents is by companies and individuals learning from those that do happen, digesting their causes and consistently applying them throughout their own organisation wherever it is relevant to do so.

The potential benefits of incident reporting to the UK reservoir industry have recently been explored by Charles (2005).

The development of a database for recording and analyzing incidents at UK dams can draw from the experience gained from the development and administration of the Building Research Establishment (BRE) database (Tedd, 1992). This BRE database was primarily developed with the following objectives:

- To provide a register of dams that come within the ambit of the Reservoirs Act 1975;
- To identify research needs and provide background information for the government's reservoir safety research programme;
- To assemble data on dam failures and incidents and remedial works to allow some form of risk assessment to be carried out.

Prior to the development of the new system, there has been no formal request to supply information to a central agency and the information has been acquired from a number of sources including responses to questionnaires, published information and private communications. It is likely that the majority of all serious incidents in recent times are contained in the BRE database as they will be in the public domain. Analysis of incident data has been reported by Tedd *et al* (2000), Charles *et al* (2000), Skinner (2000) and Brown *et al* (2003). The BRE database has also been used in the preparation of a number of UK engineering guides.

Defra funds the great majority of the Environment Agency's expenditure on flood risk management and gives financial support to improvement projects undertaken by local authorities and internal drainage boards. Defra has a number of Service Delivery Agreement (SDA) targets relating to flood defence. One of these targets (SDA 26) aims, by the encouragement of sustainable defence measures (including timely and effective flood warning

systems), to have no loss of life through flooding. Clearly, investment in reservoir safety is relevant to this aim.

In 2002, Defra commissioned a research contract for KBR Consultants to develop a specification for incident reporting and investigation, under the direction of a steering group. The need for such a system is underlined by the recent RAE report. This included a questionnaire to the dam industry and progress on this work was reported by Gosden and Brown (2004) and, in the context of other developments in reservoir safety research contracts, by Brown and Gosden (2004¹). Access to the completed Defra specifications is available through the Defra website.

The incident reporting and investigation system will be administered by the Environment Agency. The database will be developed through 2006 and shall be available to the industry from early 2007. A current contract between the Environment Agency and Halcrow Group Ltd aims to develop the Defra specifications through:

- Consideration of the Environment Agency's particular requirements for interfacing the database with its Reservoir Enforcement and Surveillance System (RESS) (Hope and Hughes, 2004);
- Further consultations with the reservoir industry through 2006;
- Development of the database through trials using data on hundreds of incidents from the BRE database and major incidents as they arise through 2006;
- Consideration of how the system will be administered and managed.

The formalization of incident reporting for dams in the UK conforms with international best practice. ICOLD Bulletin 59 states:

The operator should be obliged to immediately inform the government agency of any occurrence, distress or deficiency that affects or may affect the safety of the dam or reservoir.

It can be argued that the underlying need for this provision is not only to render the reservoir safe, as provided for by the Reservoirs Act 1975, but to allow others to learn from the experiences gained.

INCIDENT REPORTING

Incident Definition

Various categories of incident were considered in developing the Defra specifications and similar definitions will be used by the Environment Agency for incident management and reporting purposes. These include dam failures and 'near-miss' incidents that would have had a high probability of leading to dam failure had not prompt corrective action been

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taken. Reportable incidents will generally be instigated by:

- external threats (e.g. a flood);
- internal threats (e.g. progressive internal erosion); or
- human error (adverse changes to operating, maintenance or surveillance provisions or procedures).

Routine reservoir safety measures, as may be carried out following statutory reservoir inspections, would not normally be considered as reportable incidents.

Use of panel engineers and Undertakers in reporting incidents

There is currently no legislation to enforce incident reporting. It is highly likely that future reservoir safety legislation will provide for this if the reservoir industry does not support the new system by providing information voluntarily. Defra has made it clear in a recent communication to panel engineers and reservoir undertakers that panel engineers and Undertakers should support the incident reporting system. Supervising Engineers are usually ideally placed to report on incidents through their technical training, familiarity with the dam and its history, and (in many cases) good knowledge of how an incident arose and the measures taken. In some cases, the responsibility could reasonably be passed to an Inspecting Engineer involved in dealing with the incident.

In many cases, especially where incidents arise at dams owned by major Undertakers, it is anticipated that the dam owner will wish to take a lead role in the reporting process.

It is proposed to provide an internet site dedicated to reservoir incident reporting to provide appropriate contact details of the Environment Agency team who will guide and support them through the reporting process.

Scope for prosecution

The Environment Agency intend to operate the database using staff drawn from its Reservoir Safety team. Relevant information held on RESS in relation to panel engineers and dam characteristics will be transferred onto the incident database. However, there is no intention of using the incident database for the purposes of prosecution as non-compliances will already have been detected by RESS. However, where significant damage and/or loss of life arises due to gross negligence, there may be reasonable grounds for prosecution by, for example, the Health and Safety Executive. In such cases, contributing to the incident database is highly unlikely to increase the risk of prosecution from third parties. Furthermore, in any prosecution it

may be in the operator's interests to demonstrate compliance with industry initiatives on safety management.

Confidentiality

The system will make provision, as far as practicable, to ensure that data is only released for the purposes of analysis. In most cases, analysis will not require the identity of the reservoirs to be released. The Environment Agency is aware that some dam owners are sensitive about information being released which may, for example, affect their share price. It is proposed that information that identifies reservoirs should only be released to third parties with the consent of the dam owner.

Coverage

The database shall be used for incidents arising at reservoirs within and outside the ambit of Reservoirs Act 1975 (the Act). It is expected that only a small number of serious incidents arising at reservoirs outside of the Act is likely to be captured, but the database should not be developed to exclude the possibility of learning from incidents at small reservoirs on these grounds.

The intention is that the database should capture information from the whole of the UK. Northern Ireland (NI) is not covered by the Act, but the Act is often applied in spirit, with Supervising Engineers appointed accordingly. We therefore propose that incidents at NI reservoirs should be captured by the system.

Information on Scottish reservoirs is not held on RESS. The Scottish Executive is currently considering proposals to follow England and Wales in forming a single enforcement authority for Scottish reservoirs under the Act. In this eventuality, it should become possible to populate the database with the same basic information on dam characteristics currently available from RESS for English and Welsh reservoirs.

THE DATABASE

Incident Details

The database development draws on some concepts developed for the *Interim guide to quantitative risk assessment for UK reservoirs* (Brown and Gosden, 2004²). It is appropriate that the database clearly distinguishes between:

- the external and internal threats acting on the dam structure; and
- the mechanism(s) of deterioration.

For some incidents, there may be more than one threat that contributes to an incident being declared. The database will need to clearly identify the

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primary and secondary threats (external or internal) leading to the incident, as well as documenting:

- the indicators that led to the incident being declared;
- the immediate measures taken to deal with the situation;
- the lessons learned, including any implications for surveillance frequency, reservoir operation, instrumentation requirements, etc;
- details of any longer-term remedial measures carried out in response to the incident.

Dam Characteristics

To make full use of the incident data, it is desirable to record dam characteristics to a greater level of detail than that held on statutory records or those held on RESS or the BRE database. The Defra Specification includes fields for dam characteristics which have been reviewed and developed as part of the current work. The intention is to complete these fields for reservoirs at which incidents arise with the assistance of the contributor and/or the dam owner or designate. The aim is to ensure that the details of the incident are recorded within the context of the dam details which will assist when evaluating trends or apparent vulnerabilities.

The long term aim is to complete the dam characteristics fields for all 2,600 reservoirs under the Act in the UK, and for any reservoirs not under the Act at which incidents are recorded. This represents a significant challenge for the industry. Dam owners and Supervising Engineers represent the two groups most capable of providing this information. The benefits of achieving this goal are:

- an improvement in the level of incident analysis and an associated improvement in the effectiveness of the reporting.
- a step-change in the industry's ability to access detailed information on UK dams for research and development activities (beyond the capabilities of the existing BRE database);
- the ability in the long term to provide estimates of the annual probability of various mechanisms of deterioration arising at certain dam/structure types. This should prove useful for the purposes of quantitative risk assessments.
- to enable well-informed debate on the safety of the UK dams industry thereby instilling confidence in it.

INCIDENT INVESTIGATION

In the event of a dam failure, it is likely that an independent investigation will be instigated either by the owner or an independent panel of engineers. In some cases there may be a public inquiry. Incident investigation, as detailed in the specification under development, is concerned with the full

capture of information regarding the incident for the sole purpose of ensuring complete capture of relevant information. It will therefore aim to ensure that the root causes of accidents are correctly identified in sufficient detail for the purposes of the database. It will have no remit to apportion blame for the incident or to criticize reservoir operation, surveillance and monitoring regimes.

When serious incidents arise, the Environment Agency (in the case of England and Wales) will appoint a suitably qualified engineer (normally a Panel AR engineer) to investigate such incidents. It is important that the investigation is, and is seen to be, as thorough, objective and impartial as possible.

Incident investigations will usually need to consider:

- any previous history of incidents at the dam;
- any recent works or change in regime leading to, or contributing to, the incident;
- the root cause(s) of the incident and any contributing factors;
- the main lessons to be learned;
- the nature of any remedial works or changes in regime arising from the incident;
- the possible implications for other dams/structures of the same type or configuration.

Investigations should not only contribute to our understanding of how incidents arise and how they are managed, but should also raise the profile of the dams industry through demonstration of a professional response from the industry as a whole as well as from those immediately involved with the incident.

The RAE concluded that incidents that by chance fall short of causing death and destruction should, depending on the circumstances, be regarded equal to those that do.

It is axiomatic that incident investigations should be as independent as feasibly possible. Under any new legislation this is likely to be made mandatory.

In some cases the reporting will need to capture the human side to the incident. Individuals involved in incidents may experience an array of emotions ranging from guilt to denial. Incidents may arise where the proper behaviour is either known to the individual but not practiced, or is not known by those concerned. The reporting should seek to capture and address such weaknesses.

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Investigators may find it difficult to correctly pitch the level of investigation, especially where it becomes evident that there were several different types of deficiency each contributing to the incident. In such cases it may be difficult to be specific about the lessons to be learned and the benefits to be gained from investigation may be closely linked to the time taken in unravelling the full causal chain of events.

The investigation should aim to commence as soon as possible following an incident to prevent deterioration in the quality of the information made available to the investigator.

The investigation of serious incidents should aim to separate the factors that could have prevented the accident (design, operation, training, etc) from the measures that would have reduced the severity of the accident (evacuation procedures, etc).

REPORTING

By taking lessons learned from one incident and checking whether these lessons apply in other situations, similar incidents can be avoided by making suitable changes in dam design and management.

There is no intention to report on incidents in a manner that would disadvantage any potential contributor or associated business interests. It is widely understood that the number of incidents associated with a particular region or owner is likely to reflect the intrinsic condition or age of dams more than the procedures and policies in place for dam monitoring, surveillance and remedial work.

It is currently proposed to make annual reports available to major dam owners and panel engineers. These would not provide detailed information on any particular incidents recorded or provide information that would allow the identification of the dam, or persons or organizations linked to them. The aim would be to provide information on the lessons learnt and the number and nature of incidents recorded.

The database will be subjected to a detailed statistical analysis at intervals of a few years. The value of such work will partly depend on the implementation of suitable measures to populate the dam characteristics database fields.

CONCLUDING REMARKS

It is important to acknowledge that our past and future performance in dam safety is only the product of learning through incidents and a determination to improve methods and procedures. The development of the new incident reporting and investigation procedures aims to provide a robust, formalized

framework which can contribute to our further understanding of how incidents arise at UK reservoirs.

Voluntary reporting of incidents in the UK through learned society meetings and publications has probably captured a significant proportion of the most serious dam incidents to date. The British reservoir industry has long shared its experiences openly. However, it can be argued that a formalized system of incident reporting and investigation for the UK dams industry forms a natural partner to the provisions of the Act. The performance of the UK dams industry, especially over the last twenty years or so, can be regarded as good in terms of the number and severity of incidents. The industry should not make the mistake of viewing this situation as a stable one. The average age of the UK stock of dams exceeds 110 years. Incidents still arise regularly, and almost invariably from causes that have been experienced in the past at other dams. Dams, especially embankment dams, are very complex structures and it is possible that incidents may arise due to new, unexplained causes. Such incidents are likely to be very rare but very valuable as they can contribute much to our understanding and learning. Remedial and upgrading works following incidents or design reassessment have the potential to not only improve the structural integrity of the dam population but to also reduce the probability of incidents occurring.

One of the difficulties faced with voluntary reporting is an entrenched belief in modern society that when incidents arise, somebody must be to blame. Even when incidents are reported, there may be suspicions that not all of the facts have been disclosed.

The value of incident reporting to any one individual can be difficult to grasp. The RAE report states that:

“It is not easy to inculcate a desire to learn from others’ misfortunes. The human default position seems to be resistant to this. Many reasons are advanced for not looking at the experience of others – it is perceived to reflect poorly on what has already been done, it hints at lack of knowledge on the part of individuals, it takes time that often does not exist. Most managers would readily agree that if the extra work of learning from accidents would definitely allow an accident to be prevented it would certainly be worthwhile. But the implicit belief is often that taking on this extra work will not prevent anything because nothing was going to happen.”

Great care is needed in how incident data is managed to protect the interests of the contributors and to ensure that the time and effort spent in reporting incidents, and the trust placed in the system managers, is repaid through careful and effective use of the incident information.

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REFERENCES

Brown, A.J. and Gosden, J.D., 2004¹. *Developments in management of reservoir safety in UK*. Risk Assessment and reservoir management. Proceedings of the 13th Conference of the BDS held at the University of Kent, Canterbury. Thomas Telford.

Brown, A.J. and Gosden, J.D. (KBR), 2004². *Interim Guide to quantitative risk assessment for UK reservoirs*. Thomas Telford.

Brown, A.J. and Tedd P., 2003 “*The annual probability of a dam safety incident at an embankment dam, based on historical data*” *Hydropower & Dams*. Issue 10, Vol. 2, pp122-126.

Charles, J.A., 2005. *Use of incident reporting and data collection in enhancing reservoir safety*. *Journal of the British Dams Society, Dams and Reservoirs*, Vol.15, No.3.

Charles J.A., Tedd P. and Skinner H.D. (1998). *The role of risk analysis in the safety management of embankment dams*. The prospect for reservoirs in the 21st century. Proceedings of 10th British Dam Society Conference, Bangor. Thomas Telford, London.

Defra, SDA 26: www.defra.gov.uk/environ/fcd/policy/sda2627/default.htm

Gosden, J.D, and Brown, A.J., 2004. *An incident reporting and investigation system for UK dams*. *Journal of the British Dams Society, Dams and Reservoirs*, Vol.14, No.1.

Hope, I.M. and Hughes, A.K., *Reservoirs Act 1975 – Progress on the implementation of the Environment Agency as Enforcement Authority*. Proceedings of the 13th conference of the BDS held at the University of Kent, Canterbury. Thomas Telford, London.

The Royal Academy of Engineering, 2005 . “*Accidents and Agenda*”.

Skinner, H.D., 2000. *The use of historical data in assessing the risks posed by embankment dams*. Dams & Reservoirs, Vol. 10, No. 1.

Tedd, P., Holton, I.R. and Charles, J.A., 1992. *The BRE dams database. Water resources and reservoir engineering*. Proceedings of the 7th conference of the British Dams Society, Stirling. Thomas Telford, London.

Tedd P., Skinner H.D. and Charles J.A. (2000). *Developments in the British national dams database*. Dams 2000. Proceedings of 11th British Dam Society Conference. Thomas Telford, London.