The application of the Mines and Quarries (Tips) and the Reservoirs Acts

M. CAMBRIDGE, Cantab Consulting Ltd, Ashford, Kent, UK

SYNOPSIS. Correspondence in the technical press over the last thirty years has shown repeated concerns on the part of the reservoir engineering community that tailings dams do not comply with appropriate design and construction standards. This has been accompanied by repeated calls for mine waste disposal facilities to be included in the Register of Large Raised Reservoirs, and thus be covered by the Reservoirs Act rather than fall under the remit of the Mines and Quarries (Tips) Act. However, these concerns have been accompanied by a certain amount of confusion amongst academics and Panel Engineers alike as to the application of the UK legislation for tailings management facilities.

This paper presents a personal interpretation of the application of the UK legislation based on more than thirty years' experience of the inspection of reservoirs and tailings dams under both Reservoirs and Mines and Quarries (Tips) legislation. The paper concludes that much of the implied criticism of the Mines and Quarries (Tips) legislation, and of the perceived lower engineering standards applied to mine tips, is ill-founded. It is further evident that any criticism stems both from a lack of knowledge of, and from poor interpretation of, the legislation and that any recent failings in design standards relate more to the approach adopted by individual experts than to any significant deficiencies in the Acts themselves.

INTRODUCTION

In the year in which the Reservoirs Act 1975 came into force there was a major and catastrophic failure of the Stava tailings dam in Italy which resulted in the death of 269 people. In the aftermath of this failure, numerous articles appeared in the technical press, particularly the NCE, calling for an immediate revision of the Reservoirs Act and for mine tailings dams to be included under the definition of large raised reservoirs. The justification for the proposed revision was the perceived lack of appropriate design standards for tailings dams and the belief that, in the case of the Stava failure, this had been a contributory factor. Various correspondents

Ensuring reservoir safety into the future. Thomas Telford, London, 2008

implied that there was a similar risk within the UK and concluded that, by incorporating mine waste facilities under the Reservoirs Act, the design and construction of these would automatically be improved and failures prevented. In subsequent years there has remained an undercurrent of criticism at BDS meetings, and in the technical press, of the design standards for mine waste sites. This included an authoritative prediction, post the Baia Mare event in Romania, that without major changes in legislation there would be a year-on-year increase in the failure rate of tailings disposal facilities. This assessment has proved to be wholly unfounded.

There is no dispute that the untoward occurrences at Stava and Baia Mare were preventable, and it is clear that there was a lack of appropriate engineering design in both cases. However, the assumptions made in the published post-event articles were unfounded, appearing to be based not on any knowledge of tailings management facilities currently under construction in the UK but showing, rather, an inadequate understanding of the application of the Mines and Quarries (Tips) Act and of the design and construction standards applied to UK mine waste facilities since 1970. Rational analysis of both water dam and tailings management facility failures shows that reservoir legislation is not a universal panacea for resolving the design and operational problems of tailings lagoons.

The confusion concerning UK legislation applicable to mine and quarry lagoons continues to the present day. This is demonstrated by an abstract from an EU-funded report recently prepared by academic teams from around Europe, including one from a leading UK university minerals department. The report reviewed current EU legislation for mine waste facilities and included the erroneous statement that: “In the United Kingdom tailings dam safety laws fall under the Reservoirs Act 1975 (chapter 23 which enters into force on December 1 1991). UK Legislation provides a mandatory safety regime for all reservoirs which are capable of holding 25,000m^3 of water above natural ground level.” It is evident, therefore, that there is confusion in academic circles, amongst reservoir engineers and even in major mining consultancies, as witnessed by a recent due diligence study which incorrectly reported on the statutory inspection procedures for a current UK tailings management facility. This clearly demonstrates the poor understanding of the legislation by the industry in general.

Rather than confirming the worst expectations of the critics, a practitioner's review of the similarities and differences between the two Acts in the context of industry practice indicates that tailings management facilities in the UK constructed since 1970 have generally been designed to the highest standards.

UK LEGISLATION

Chapter 23, Section 1 of the Reservoirs Act 1975 includes the following definition:

"For purposes of this Act "reservoir" means a reservoir for water as such (and accordingly does not include a mine or quarry lagoon which is a tip within the meaning of the Mines and Quarries (Tips) Act 1969); and -
(a) a reservoir is a "raised reservoir" if it is designed to hold, or capable of holding, water above the natural level of any part of the land adjoining the reservoir; and
(b) a raised reservoir is a "large raised reservoir" if it is designed to hold, or capable of holding, more than 25,000 cubic metres of water above that level."

Even those advocating incorporation of tailings management facilities under the aegis of this Act acknowledge that Section 1 specifically excludes mine tips, and a major revision of reservoir legislation would be required to bring these within its remit. It is therefore worth examining the existing mine waste tips' legislation to assess whether such a revision would be justified.

The Mines and Quarries (Tips) Act 1969, Part I, Section 2 defines a tip as "an accumulation or deposit of refuse from a mine or quarry (whether in a solid state or in solution or suspension) other than an accumulation or deposit situated underground, and where any wall or other structure retains or confines a tip then, whether or not that wall or structure is itself composed of refuse, it shall be deemed to form part of the tip for the purposes of this Act". The Act addresses, in addition, both operating and closed tips, defining these as "active classified tips" and "closed classified tips" respectively. The subsequent Mines and Quarries (Tips) Regulations 1971, Part I, Regulation 2 further defines the physical nature of tips registered under the Act as follows:

"*Interpretation*
2. – (1) In these regulations…"classified tip" means a tip to which Part I of the 1969 Act applies, being a tip of any of the following classes-

(b) the tip consists of refuse accumulated or deposited wholly or mainly in solution or suspension and-
  (i) any part of the tip (other than any wall or other structure retaining or confining it but including any liquid in it) is more than 4 metres above the level of any part of the neighbouring land within 50 metres of the perimeter of the tip; or
  (ii) the volume of the tip (other than any wall or other structure retaining or confining it but including any liquid in it) exceeds 10,000 cubic metres:"

These regulations also impose a duty on the Owner and on the Manager of every mine to ensure that the provisions of the Act are strictly applied and that the nature and scope of the responsibilities of all statutory appointments are written and fully understood. It is also a requirement that tipping rules are prepared and that written records of all activities pertaining to the tip are kept at the site, are up to date, are regularly reviewed by the Mine Manager and made available to the Mines Inspectorate.

The Quarries Regulations 1999 endorsed the 1969 legislation, and further strengthened it by ensuring that the, generally smaller, quarry silt lagoons were also included. These Regulations detail the approach to be taken in the design and execution of tips, and define the nature of geotechnical hazards which require a specified level of competence in assessment, design, operation and monitoring. The definition of a significant geotechnical hazard is as follows:

"Clause 300 The hazard should be treated as significant and the tip subject to a geotechnical assessment if it is, or will be:

(b) a lagoon containing any liquid or material wholly or mainly in solution or suspension (i.e. likely to flow if not contained); and
  (i) the contents of the lagoon are more than 4m above the level of any land which is within 50m of its perimeter; or
  (ii) the contents of the lagoon exceed 10 000 cubic metres; or
(c) irrespective of the size of the tip, other factors, for example the geology, location or proximity to an excavation, mean that there is a significant hazard….".

Any facility containing a volume of more than 10,000m^3 of material in liquid or potentially liquid form therefore needs to meet certain standards of design and operation under tips legislation. This compares with a volume of 25,000m^3 of such material under the Reservoirs Act. The Quarry Regulations extend the definition to include any at-risk facility, acknowledging that a simple volumetric definition does not necessarily address the problems posed by high-risk structures, i.e. a 500m^3 lagoon above a village could pose greater risk to life than a 50,000m^3 facility on remote moorland. Thus sub-clause (c) above requires the employment of a competent geotechnical specialist to assess the risk, regardless of the size of the facility, and to define suitable mitigation methods in design, construction and monitoring. The statutory appointments under the relevant legislation are shown in Table 1 and illustrate the often more prescriptive monitoring and recording requirements for mine waste tips.

Table 1: Summary of Statutory Appointments under UK Legislation

	Reservoirs Act	Mines & Quarries (Tips) Regulations (i)
Regular supervision	Supervising Engineer at minimum of annual inspection	Regulation 5 Appointee – weekly inspections
Independent inspection	10-yearly reporting	2-yearly reporting (ii) 5-yearly for closed classified tips
Statutory records	Prescribed form of record	Weekly record of waste tipped Recording of all defects and remedial actions

Notes

(i) The frequency of inspections and record keeping under the Mines and Quarries (Tips) Regulations are endorsed and strengthened by the Quarries Regulations 1999.

(ii) The Mines and Quarries(Tips) Regulations 1971, Part III, Regulation 11 states that "it shall not be lawful for tipping operations to be carried out at that tip unless a report has been obtained in the last two preceding years…."

Even the hydrological concerns that have been raised by the proponents of an all-embracing Reservoirs Act do not necessarily withstand scrutiny. Mine and quarry lagoons (tailings management facilities) are, as indicated above, specifically excluded from the ambit of the UK Reservoirs Act 1975. However, those in the industry recognise that good practice requires tailings storage facilities to be designed, constructed and operated to the same standards and in accordance with similar risk categories as UK reservoirs. The Reservoirs Act requires that the flood design standards to be adopted for each reservoir accord with the risk categories defined in the ICE publication "Floods and Reservoir Safety". In the UK, most tailings dams would be placed in the highest risk category, i.e. Category A, due to the implications of an untoward release for both life and the environment in the downstream catchment. Any tailings storage facility defined as a "classified tip" within the meaning of the Mines and Quarries (Tips) Act 1969 which has the ability to store more than 25,000m^3 of water, and thus otherwise defined as a "large raised reservoir" under the Reservoirs Act 1975, would therefore require special consideration for flood provision. By applying equivalent standards, therefore, a Mine Owner would be required to ensure that a suitably qualified civil engineer be engaged to undertake any necessary hydrological assessment for such tips and be responsible for defining the necessary flood standards to be applied. Further, the definitions under the Mines and Quarries (Tips) Act and the subsequent Quarries Regulations require that similar risk assessments be undertaken for smaller facilities, i.e. for those with storage volumes of between 10,000m^3 and 25,000m^3 or where specific hazards have been identified. It could therefore be inferred that the hydrological standards required for a mine or quarry

facility are higher and more rational than those which apply to a large raised reservoir.

There are other lagoons which are either not, or not directly, associated with a mine, and for which it is evident that the requisite standards of design and construction may not be fully appreciated. The Health and Safety Executive is unequivocal concerning the definition of ash lagoons, for example, which, though not directly associated with a mine, are defined as tips and fall under the Mines and Quarries (Tips) Act. Other tips and lagoons which fall outside both the Mines and Quarries (Tips) and the Reservoirs Acts, and which hold liquid/fluid waste or "waste with the potential to flow" from manufacturing industry, are covered by the Health and Safety at Work Act. In both cases the HSE has a responsibility for enforcement and applies the nearest equivalent standards principle, i.e. application of the Mines and Quarries (Tips) Regulations as described above.

PERFORMANCE OF UK TAILINGS MANAGEMENT FACILITIES

In 1970 the UK had in excess of 2 billion tonnes of mine waste on surface and, prior to 1969, was regulated only by the Town and Country Planning Act and by specific mine-related Health and Safety Legislation. Following the Aberfan disaster, and the Mines and Quarries (Tips) Act 1969 receiving royal assent, tailings management facilities within the UK became subject not only to general planning, environmental and health and safety legislation but, more importantly, to strict control by the subsequent Mines and Quarries (Tips) Regulations (1971) issued pursuant to the 1969 Act. Design, construction, operation and closure of facilities classified under the Act became strictly regulated by these Regulations. These Regulations impose a strict duty on the Owner of the mine or quarry to ensure that all necessary engineering studies and plans, including tipping plans, be prepared in advance of commencement of tipping and that these documents be continually updated during the development of the facility.

Though no detailed guidance is provided, the Health and Safety Executive requires that the design, construction, operation and closure of the confining structures be undertaken in accordance with current UK design standards and, as appropriate, with ICOLD guidelines. Further, the Regulations require the Owner to make a number of statutory appointments for the day-to-day management of the tip and to appoint a Competent Person to undertake independent inspection and to report on "every matter which might affect the security of each tip". Without such reporting "it shall not be lawful for tipping operations to be carried out at that tip". The 1971 Regulations were further strengthened by the Quarries Regulations 1999. In addition to requiring an operator to ensure that excavations and tips are designed, constructed, operated and monitored to ensure safety and stability, and that suitable and sufficient rules are made, they also require the Owner

to make suitable written appointments within the context of an overall health and safety plan for the site. Documentation and recording are also strengthened, requiring the preparation and regular updating of tips rules governing the operation of a lagoon or tailings dam, with inter alia, respect to maximum storage levels, freeboard, inspection, monitoring and instrumentation.

Though the majority of coal slurry tips in 1970 were non-impounding, with small storage capacity, a significant number of larger, and often impounding, metalliferous and industrial mineral waste facilities were either designed and constructed or permitted in the immediate aftermath of Aberfan. A list of UK facilities is shown in Table 2 and, though not considered to be fully comprehensive, is a reflection of the author's direct experience over the last thirty years or so. It is noted that all the facilities listed involved a suitably qualified civil engineer at relevant stages of design, construction and operation.

The application of both Acts is exemplified by the design and construction standards adopted for the Clemows Valley Tailings Dam, one of the first facilities to be influenced by changes in legislation following the Aberfan disaster. The facility was permitted on a "greenfield site" in 1969 whilst the Regulations were still in draft. The basis for the design was influenced by both international practice and by current and impending UK legislation, including the Reservoirs (Safety Provisions) Act 1930. The design and construction responsibilities were clearly separated into hydrological and geotechnical disciplines, the project being coordinated by a senior geotechnical partner with independent overview and statutory inspection responsibility under the direction of an All Reservoirs Panel Engineer. This was undertaken in accordance with the then extant 1930 Act, and thus the flood design and spillway capacity met with best UK practice for reservoirs. The hydrological design was based on the PMF, spillway design being updated on a regular basis to meet the constraint of a stage-raised facility. Annual inspection was carried out by a Panel Engineer, and Certificates issued permitting the reservoir and tailings storage levels to be raised commensurate with the new spillway and embankment crest level. Once mining operations commenced in 1970 and the 1971 Regulations were in force, modifications were instigated to meet the demands of the Mines and Quarries (Tips) Act. Statutory appointments under the Regulations were made by the Owner, and the inspection routines modified to meet the more stringent inspection and monitoring routines imposed by this Act. In addition, the reservoir continued to receive inspections under the 1930 Reservoirs Act, and Certificates were issued for each spillway raise until the final upstream wall was commissioned in 1977 and the facility became non-impounding. With the change in flood design criteria, the

spillway design became reliant upon PMP, process water balance and groundwater control. Continued supervision by a reservoir engineer has, however, continued since this date. The current Competent Person for the facility under the Mines and Quarries (Tips) Act is also a suitably qualified civil engineer. Through its life the Clemows Valley Tailings Dam has met the highest standards set by both the Mines and Quarries (Tips) and the Reservoirs Acts.

EU LEGISLATION

A review of the details of the operational or permitted mine sites in Europe indicates that most tailings management facilities are covered by some form of legislation. The majority of EU countries have national regulatory bodies for water dams which require designs to be in full accordance with internationally accepted criteria for embankment dams, both for stability and hydrological control. These dams comply with international criteria such as those produced by ICOLD, and are subject to ongoing national embankment inspection routines. Many tailings-confining embankments, whether designed and constructed in the recent past, i.e. during the last twenty years or earlier, have been governed by local legislation – historically that which relates to water dams. This legislation, though not entirely appropriate, results at least in an ongoing programme of controls at design and construction and, in some instances, during the operational phase.

Specific regulations exist in a number of countries for regular monitoring of tailings management facilities. In some countries such as Spain and Portugal the guidance remains within the water sector, which can unfortunately lead to anomalies, particularly with the legal requirement for an emergency outlet, essential for water dams but totally inappropriate for tailings management facilities. The result across the EU as a whole is a large number of tailings management facilities which meet international standards of design and construction despite the varied legislative provisions, and an almost similarly sized group whose day-to-day operations receive at least some level of independent scrutiny. Moreover, an increasing number of tailings management facilities are regularly monitored. However, the type of monitoring regime adopted at many sites remains less than ideal, and the inspection routines would benefit from better regulation. Though most confining embankments are considered to be robust at the initial design stage, neither operational nor closure phases have to date met the same standards.

Table 2: Examples of recent UK Mines and Quarries Tips

Facility	Location	Mine	Mineral	Type of Facility	Height (m)	Storage Volume ($x10^6 m^3$)	Involvement of suitably qualified civil engineer
Clemows Valley	Cornwall	Wheal Jane	Tin/copper zinc	Valley dam	50	6	(iii)
Middleton Moor	Derbyshire	Glebe Mines	Fluorspar/barytes	Paddock dam	22	1.25	(iii)
Blakedon Hollow	Derbyshire	Glebe Mines	Fluorspar/barytes	Paddock dam	29	3.5	(iii)
Wheal Maid	Cornwall	Wheal Maid	Tin/copper zinc	Valley dam	30	4	(iii)
TD 1&2	Derbyshire	Glebe Mines	Fluorspar/barytes	Paddock dam	15	0.9	(iii)
Carnon Valley	Cornwall	Wheal Maid	Tin	5 Paddock dams	7	1	(iii)
Cononish (i)	Perthshire	Cononish Mine	Gold	Valley dam	40	0.9	(iv)
Cavanacaw (i)	Tyrone	Omagh Mine	Gold	Valley dam	12	1	(iv)
Warren North	Norfolk	Kings Lynn Quarry	Industrial sand	Paddock dam	16	1	(iv)
Mintlyn Wood	Norfolk	Kings Lynn Quarry	Industrial sand	Paddock dam	4	1	(iv)
Redmoor (ii)	Cornwall	Redmoor	Tin	Valley dam	54	2.7	(iv)
Acre Nook	Cheshire	Chelford	Industrial sand	Paddock dam	17	1.3	(iv)
Bent Farm	Cheshire	Congleton	Industrial sand	Paddock dam	7	0.5	(iv)
Portworthy	Devon	Lee Moor	Kaolin	Valley dam	55	(v)	(iv)
Kernick	Cornwall	St Austell	Kaolin	Valley dam	90	17	(iv)
Norton Bog	Staffordshire	Cannock Chase	Coal	Paddock dam	6	0.09	(iii)

Notes

i) Permitted but not constructed
ii) Feasibility study completed
iii) Certification under Reservoirs Act
iv) Involvement of suitably qualified civil engineer during design
v) Not known

ENSURING RESERVOIR SAFETY

In May 2008 the Directive on waste from the extractive industries will come into force and will affect the legislative approach across the EU. This legislation is intended to ensure that suitable regulations exist in all member states to prevent a repeat of untoward events such as that which occurred at Baia Mare, and to ensure that these relate specifically to mine waste and NOT to water dams. Though increasing the scope of UK legislation relating to tailings dams, the Directive recognises that the current regulations under the Mines and Quarries (Tips) Act are both appropriate and in accordance with its central tenets. There will not, therefore, be a need for the UK to modify current legislation, which is considered to be competent and has indeed been used as a model for some of the Annexes currently in draft. The Directive will not affect current design and operation practice, though it is likely to reinforce aspects of closure and financial guarantees.

CONCLUSIONS

Correspondence in the technical press over the last thirty years has repeatedly expressed concerns that tailings dams do not comply with appropriate design and construction standards. These concerns have been accompanied by repeated calls for such mine waste disposal facilities to be included in the Register of Large Raised Reservoirs, and thus be covered by the Reservoirs Act rather than fall under the remit of the Mines and Quarries (Tips) Act. However, the proponents of this approach appear to have limited experience of the content and application of this post-Aberfan legislation, demonstrated most recently by a number of misleading papers and reports.

Though mine and quarry lagoons are specifically excluded from the ambit of the UK Reservoirs Act 1975, it is accepted that good practice requires tailings storage facilities to be designed, constructed and operated to the same standards and in accordance with the same risk categories as UK reservoirs. In the UK, most tailings dams would be placed in the highest risk category, i.e. Category A, due to the implications of an untoward release for both life and the environment in the downstream catchment. Any tailings storage facility defined as a “classified tip” within the meaning of the Mines and Quarries (Tips) Act 1969 which has the ability to store more than 25,000m^3 of water would therefore require special consideration for flood provision. By applying equivalent standards, therefore, a Mine Owner would be required to ensure that a suitably qualified civil engineer be engaged to undertake any necessary hydrological assessment for such tips and to be responsible for defining the necessary flood standards to be applied. However, both the Mines and Quarries (Tips) and the Quarries Regulations require that any lagoon intended for the storage of solids in liquid or suspended form which has a capacity in excess of 10,000m^3, or

indeed which poses a significant risk regardless of size, would need to meet the same design standard. This implies that a tailings management facility requires higher rather than lesser standards, not only of design and construction but also of operation, since the Regulations clearly prescribe statutory appointments for the day-to-day management and supervision of the facility. The UK legislation for tailings management facilities is likely to be further strengthened with the implementation of the "extractive waste Directive" on 1st May 2008.

Evidence from more than thirty years' personal experience of the inspection of reservoirs and tailings dams under both Reservoirs and Mines and Quarries (Tips) legislation concludes that much of the implied criticism and the perceived lower engineering standards applied to mine tips is ill-founded. It is evident that this stems both from a lack of knowledge and from poor interpretation of the legislation. The evidence shows that a significant number of mine and industrial mineral tips have been designed to a standard which UK reservoir engineers would recognise as being consistent with good practice. Any failings there may have been in these tips arise from the approach adopted by individuals rather than to any significant deficiencies in the Acts themselves. As with any comparable legislation, its ultimate effectiveness relies not only on the integrity of the independent inspections and audits but also on the degree of enforcement applied by the Regulator which is, of course, a function of political will.

Acknowledgements
The author would like to thank Donald Lamont of the HSE for his helpful comments on the final draft.

BIBLIOGRAPHY

Cambridge, M., The *importance of failure in the design process;* International Workshop in Geoenvironment and Geotechnics, September 2005

Cambridge, M., *Instrumentation and Monitoring to Prevent Failure;* International Workshop in Geoenvironment and Geotechnics, September 2005

Cambridge, M., *Tailings Disposal in Cornwall – Past and Present;* Professor Kontopoulos Memorial Volume, April 2004

Cambridge, M., The Future of Tailings Disposal in Europe, *Minerals and Energy,* Vol 18, No. 4, 2003

Cambridge, M., A Review of Tailings Dam Failures; *International Water Power & Dam Construction,* May 2001

Cyanide Spill at Baia Mare, Romania; UNEP/OCHA Mission, March 2000

Directive 2006/21/EC of the European Parliament and of the Council of 15th March 2006 on the management of waste from the extractive industries.

Health & Safety Commission, *Health and safety at quarries,* Quarries Regulations 1999, Approved Code of Practice, 1999
HMSO Mines and Quarries (Tips), Regulations 1971
HMSO Mines and Quarries (Tips) Act 1969
ICE, *A Guide to the Reservoirs Act 1975,* Thomas Telford, 2000
ICE, *Floods and reservoir safety,* Thomas Telford 1996
ICOLD *Tailings Dams, Risks of Dangerous Occurrences;* Bulletin 121, 2001
ICOLD *Dam Failures; Statistical Analysis;* Bulletin 99, 1995