Addressing the Risk of Major TSF Failures

Richard Jewell
Australian Centre for Geomechanics (ACG), Australia

ABSTRACT

Major tailings storage facilities continue to fail, often with dreadful loss of life and with significant adverse local environmental outcomes and financial impact on the operators as well as loss of trust and credibility for the mining industry as a whole. Investigations undertaken to determine the cause of these failures indicate that some result when embankments are overtopped - for example due to adverse weather conditions or poor operating procedures and that others are caused by embankment foundation failures resulting from conditions that were not (and probably could not have been) identified from investigations undertaken for the design process. In the event that embankment integrity cannot be ensured, the need will be to find some means of limiting the potential consequences of failures. Low density tailings are likely to be mobilised through liquefaction should a breach occur, in which state they can flow considerable distances. One means of limiting the damaging outflow of tailings is to modify the properties of the tailings deposited in storages such that they are less likely to liquefy.

Thickening tailings by the removal of water from the low density underflow of a process plant to a consistency in which the solid particles pack together to generate a shear strength in the tailings is already a well proven technique for stabilising stored tailings and inhibiting liquefaction. This is achievable naturally in low throughput operations and favourable climatic conditions in which layer thicknesses are limited to depths which dry out by evaporative processes and consolidate after disposal. However, large throughput operations generally require that thickening by removing water from the tailings by some means is undertaken prior to disposal. The consistency of the thickened tailings can vary from medium density slurry through to filter cake, depending upon how the tailings are thickened. The resulting consistency then dictates the appropriate mode of transport and disposition into the tailings storage facility (TSF) and the shear strength of the stacked tailings.

Prompted by the recent TSF failure at Samarco in Brazil, the author has prepared this paper with the objective of examining past failures and suggesting that the risk to the environment could be reduced if the tailings were to be suitably thickened prior to deposition into TSFs. Furthermore, it is postulated that particularly for large operations relying on discharging into above ground level TSFs, the cost of implementing the thickening technology would be far less than the costs currently being incurred when embankments fail in terms of fines, reparations and reputation. The technology involved is currently utilised successfully on operations ranging up to throughputs of around a hundred thousand tonnes of tailings per day and hence should have already proven to be feasible for operations at all scales. To be universally adopted however the concept of adopting thickening technology has to be embraced by the major mining houses in the world and supported by the regulatory authorities as the means to limit the consequences of this ongoing sequence of failures.

INTRODUCTION

The failure of two embankments confining low density tailings at the Germano tailings impoundment belonging to Samarco Mineracao S.A. in the Minas Gerais region in Brazil on November 5th 2015 resulted in the uncontrolled release of a large volume of liquefied tailings. This slurry flow resulted in a number of deaths of mine personnel working on the embankments and residents of the town of Bento Rodriques downstream of the TSF; major environmental pollution of the region overrun by the slurry; and pollution of the downstream river system for hundreds of kilometres right down to the ocean outfall. Furthermore, the loss of the storage facility resulted in the immediate closure of the operation and exposure of the owners and operators to costs including fines imposed by the regulators, reparations for deaths, damage and pollution clean-up and to reputation. This is just the latest of an ongoing sequence of major TSF failures and should again provide the catalyst to mining companies to assess why these are occurring and to put into effect procedures which will ensure that the detrimental outcomes of these incidents will be minimised in future.

There are two major aspects in virtually every above ground TSF failure. First there is the loss of integrity of the confining embankment and then the release of liquefied tailings. Observations and/or investigations after the event indicate that the confining embankment was either undermined by seepage or overtopped, or first displaced laterally due to the load imposed on underlying strata by the embankment and lateral forces of the confined solids. Then, once the embankment had been breached, the stored tailings liquefied and flowed out through the breach as a low density slurry that with favourable topography was able to flow for many kilometres.

For this paper, the history of major TSF failures over the past 50 years or so has been reviewed to determine whether it is likely that anyone will be able to virtually guarantee the integrity of TSF embankments – for example by improved investigation and design practices or improvements in operational management. The potential for minimising the outflow of tailings once an embankment has been breached - in particular using thickening technology is then addressed. The performance of thickened tailings storages will then be examined by means of an assessment of a number of such storages through case studies published in the proceedings of the annual seminars on Paste and Thickened Tailings (P&TT) held under the auspices of the Australian Centre for Geomechanics (ACG) and the various editions of the guidance and advice manual entitled "Paste and Thickened Tailings – A Guide" published by the ACG (Jewell and Fourie, 2015).

TSF FAILURES

On the website (www.wise-uranium.org/mdaf.html) there is a listing of some 103 incidents between 1961 and the 2015 Samarco failure listed as "major dam failures", with a caution to the effect that "*this compilation is in no way complete*". Thirty two of these events have occurred since January 2000 and the two most recently listed have been iron ore mines in Brazil, in both of which there have been fatalities.

1.1 Seepage and overtopping failures

An examination of these records suggests that a great majority of embankment failures have been attributed to free water ponding close to the embankment which resulted in seepage through or overtopping of the structure. Two significant failures in particular are to be considered here because they occurred at large and well managed operations that illustrate particular issues. The basic information outlined below has been taken directly from the website listed above.

Bafokeng, South Africa 11th November 1974

This failure has been attributed to an "*embankment failure by concentrated seepage and piping through cracks*" that had developed, but there are some who still believe that the crest of the embankment may have been overtopped. The flow of tailings released through the breach in the embankment inundated a mine shaft – killing 12 miners and flowed 45 km downstream. The incident was thoroughly investigated and resulted in recommendations for operating and monitoring TSF operations to prevent similar failures in the future. These were widely circulated through the South African mining industry.

Merriespruit, South Africa 22nd February 1994

This failure has been attributed to a "*dam wall breach following heavy rainfall*". The flow of tailings released travelled 4 km downstream which caused extensive damage to a residential township located just below the TSF and resulted in 17 deaths. This incident was noteworthy in that the lessons learned from the Bafokeng incident appear to have been forgotten in the 20 years leading up to the failure at Merriespruit and suggested that time had contributed to a form of "industry memory loss".

It appears that for both Bafokeng and Merriespruit the practice was for low density tailings from the process plant underflow to be deposited into paddock style TSFs by means of spigots on the perimeter embankments operated to channel the excess supernatant water formed on the tailings beaches toward a central decant pond and away from the perimeter embankments. However, in both of these failures it appears that surface water had been allowed to pond close to the crest of the confining embankment at the point of failure and that the improved management practices implemented after Bafokeng were not sufficient to avoid a repetition of this type of failure.

1.2 Embankment foundation failures

To illustrate the potential for catastrophic failures initiated by lateral displacement of embankment foundations, two significant failures of this type that have occurred in the last twenty years are outlined here. Many such failures can only be identified by very careful investigations and it may well be that this form of failure is more prevalent than generally thought. However, these two examples suggest that regardless of the quality of foundation investigation carried out for the design, the potential to fail to recognise the continuity (for example) of thin clay layers – or for the loading on the structure and its foundations to be increased as the life of the mine and storage capacity of the TSF is extended beyond that originally envisioned can lead to failures unimagined in the initial design.

The two operations chosen to illustrate this form of failure are the Los Frailes base metal mine at Aznalcollar in Spain and The Mount Polley copper/gold mine near Likely in British Columbia. The

TSFs for both are major facilities that had been in use for considerable periods prior to failure and had been subject to design modification. For the purpose of this paper, the entries presented for these operations on the website (www.wise-uranium.org/mdaf.html) and the details that can be accessed through those entries have been considered sufficient to illustrate the relevant issues.

Los Frailes, Spain 25th April 1998

The embankment that failed in the "paddock" TSF at this mine was constructed on material variously described as Marl or blue clay. Although the reason for this foundation failure was the subject of much discussion it appears to be generally agreed that the strength of the clay had deteriorated over time from the values used in the initial design and a section of the embankment had displaced outward along a failure plane that developed at a depth of about 14 m. As a result, some 4 – 5 million m^3 of toxic water and slurry was released through the fractured embankment and thousands of hectares of farmland were covered with slurry.

Mount Polley mine, British Columbia, Canada 4th August 2014

A breach in an embankment of a 4 km^2 "paddock" TSF at this mine resulted in a huge volume of water and tailings flowing into an adjacent lake and considerable environmental damage. The initial TSF had been commissioned in 1997 and from that time the confining embankments had been raised almost every year to keep ahead of the level of tailings being deposited. In addition, the entire surface of the TSF had been covered with water for some time before failure. A review carried out by an independent expert engineering and review panel in 2015 concluded that "*evidence indicated that the breach was the result of failure in the foundation of the embankment, a failure that occurred in a glaciolacustrine (GLU) layer of the embankment's foundation*". According to the report from the independent reviewers: "*The Panel concluded that the dominant contribution to the failure resides in the design. The design did not take into the account the complexity of the sub-glacial and pre-glacial geological environment associated with the perimeter embankment foundation. As a result, foundation investigations and associated site characterization failed to identify a continuous GLU layer in the vicinity of the breach and to recognize that it was susceptible to undrained failure when subject to the stresses associated with the embankment.*"

1.3 Assessment

The records indicate that many failures related to overtopping of or seepage through an embankment have occurred worldwide over the years and are still occurring despite improvements in operating practice, such as for example assigning responsibility for the safety of these operations to specific personnel. An inability to interpret the warning signs or to implement the necessary action prior to failure (i.e. stopping the flow of tailings into a TSF if that became necessary) or any other form of human frailty, would suggest that eliminating such failures by means of improved operating and management practices that depend upon human intervention will be challenging.

Embankment failures positively identified as having resulted from foundation movement are not nearly as numerous. The two operations outlined here indicate that even on well-designed major structures; underlying strata may be inadequately identified; strength parameters overestimated or embankment loadings later increased without ensuring that the foundation strata are capable of supporting the increased loadings.

This is not intended to provide a comprehensive coverage of all causes of failure of tailings storages but in the opinion of the author is sufficient to make the point that it is unlikely that the integrity of TSF embankments can be guaranteed. If we then accept that some embankments will fail, minimising the damaging consequences of such events will involve ensuring that the stored tailings will not flow freely once liberated.

THICKENING TAILINGS TO LIMIT FLOW LIQUEFACTION

A comprehensive coverage of thickened tailings technology is presented in the guidance and advice manual entitled "Paste and Thickened Tailings – A Guide" (Jewell and Fourie, 2015). This publication covers the technology in detail including the principal reasons for thickening tailings and the means of thickening, transporting and storing the tailings and the reader is referred to the manual for further information on those issues. One chapter of the guide includes a number of case studies.

The low density slurry deposited into conventional storages is normally discharged from the vicinity of the embankments. The larger solid particles segregate out from the slurry nearer the embankments and the fines are carried by the supernatant water flowing down the resulting shallow beach toward the decant pond at the end of the beach slope. The tailings are loosely packed and saturated and the particle sizes in the vicinity of the embankments are such that they render the tailings susceptible to liquefying if released. Providing water is not allowed to pond on the surface of the tailings and the phreatic surface is kept low, the mass of tailings can dry out naturally with time due to evaporation and pack closer under self-weight consolidation to increase density and reduce liquefaction potential. However, thickening tailings prior to discharge will expedite this process.

The records suggest that there have been no reports of failure entailing an uncontrolled discharge from any TSF containing tailings thickened prior to discharge. There have however been instances of localised slumping within TSFs when individual lifts of thickened tailings exceed some critical thickness. In such cases, each lift needs to be allowed to consolidate and stabilise before commencing the placement of the next lift.

The extent to which tailings are thickened is nearly always a compromise between the reason for thickening and the cost of thickening and disposing of the tailings. The main drivers are water retention (principally in arid areas) and improving storage capacity (increased density and beach slopes) as well as the potential for improving environmental outcomes. The desired consistency of tailings to minimise the potential for flow liquefaction (Chapter 4; Jewell & Fourie 2015) will depend upon the depth of the TSF and the relevant density and strength parameters of the contained tailings.

The effort and cost involved in thickening tailings increases exponentially with solids content as water is removed (Figure 2.2; Jewell & Fourie 2015). Conventional sedimentation thickening techniques produce medium to high density slurries that can be pumped to the TSF. Regardless of the extent of thickening involved, where the tailings can be pumped to storage, the TSF would need to be managed to ensure that free water was not stored on the tailings in the vicinity of any embankment and base drainage provided to ensure that the phreatic surface was kept low to maintain the condition providing maximum resistance to flow liquefaction should the embankment be breached.

Filtering is the most expensive form of thickening and for above ground storages is mostly used where maximising water recovery is the driver. Filter cake contains no excess pore water and conventional earthmoving techniques are utilised for transporting and disposing the material in a very stable form often referred to as "dry stacking". Filter cake would be very unlikely to be susceptible to liquefaction and there are operations at which filtered tailings have been stacked and stored to considerable depths without any confining embankment. This would eliminate the problem of embankment stability and liquefaction of stored tailings but would not be practicable at all sites. Furthermore, the cost of setting up and operating the facility would be considerable and could most likely not be justified except under extreme conditions. However, to illustrate the concept, Figure 1 below has been taken from a case study presented to the ACG Paste 2001 seminar in Santiago by Luis Pizarro, the Plant Superintendent on the Manto de Oro gold mine in Chile.

Figure 1 Dry stacking at the Compañía Minera Mantos de Oro mine in Chile. The plant at this Placer Dome operation had a nominal capacity of 15,000 tpd

1.4 Practicality and cost implications

Most facilities storing thickened tailings have to date been configured such that the maximum depth of tailings has been small compared to the four operations presented above that failed. Thickened tailings have generally been discharged from within the TSF and towards the perimeter embankments such that the deepest part of the storage is in the vicinity of the discharge points and the height of any perimeter embankments minimised.

Large throughput operations depositing thickened tailings exist and the concept should not be dismissed as "yet to be proved". For example, it has been reported (Javadi et al, 2015) that at the Sarcheshmeh copper mine in Iran, 95,000 tpd of tailings thickened by high rate thickeners at the concentrator plant to around 40 % solids are transported by open channel to a "paste" plant located at the main disposal area. The tailings are there thickened to approximately 60 % solids content in twelve 24 m diameter deep cone "paste" thickeners before disposal into the TSF. In the arid climate relevant to the area, the objective of the second stage thickening was the additional water recovery.

According to Gaete et al, (2014) the Esperanza copper and gold mine in Chile commissioned in 2011 was initially depositing 86,000 tpd of tailings daily (to be increased to 105,000 tpd in 2015). Initially designed to thicken tailings to 67 % solids, the thickeners installed were only able to thicken to concentrations of 62 to 64 % and the predicted beach slopes of 4 % were not achieved. After various unsuccessful modifications to the thickeners the owners decided to increase the thickener capacity to accommodate the planned increase in throughput and to increase the average solids content to 67 % as initially envisaged. The paper indicates that two new 45 m diameter deep cone thickeners were to be commissioned in 2014 for this purpose.

The Chuquicamata copper mine in Chile owned and operated by Codelco was by 2014 depositing some 182,000 tpd in the Talabre TSF (Verdugo et al, 2014). These were conventional copper concentrator tailings thickened by the equivalent of high rate thickeners at the plant to an average solids content of around 57 %. Codelco initiated studies to convert this operation to thickened tailings in order to "*allow the mines to use less water, with a positive impact on the environment and on operational costs*" which involves retrofitting Talabre to stack thickened tailings directly over the previously deposited conventional tailings. This further thickening has yet to be implemented.

BHP has for some time been investigating the concept of further thickening the tailings for their Escondida operation in Chile also located in the Atacama Desert and in 2008 commissioned a review of the concept of using deep cone thickeners at their Laguna Seca TSF. The water supply situation was alleviated at that time with the installation of a water desalination plant at the coast and a pipeline to take the water to the mine nearly 200 km inland and to an elevation of around 3,000 m ASL. It is believed that BHP is currently examining the potential for the use of high throughput new generation colossal filter presses from FLSmidth (Figure 8.13; Jewell & Fourie 2015) for the 200,000 plus tpd operation at Escondida where the major drivers are maximising the reclamation of water from the process and hugely increasing the storage capacity of the Laguna Seca TSF.

Regardless of the means, the cost of thickening is not insignificant either in terms of CAPEX or OPEX, but will vary considerably with the location of the mine and degree of thickening desired to the extent that a true indication of these costs must be obtained for each individual operation.

Filtering the tailings prior to discharge is the thickening technology that will provide the greatest level of safety against the tailings liquefying in the event of an embankment failure and would be recommended for high risk storage facilities involving high confining embankments and those where the consequences of failure are severe. The equipment required to filter large throughputs of tailings already exists although it is expected that maintenance requirements and the OPEX costs will be high. Filtering is the most expensive form of thickening, but the cost of the filter cake produced would be counterbalanced by the elimination of the costs related to damage and remedial measures shown to result from the failure of conventional tailings facilities.

ECONOMIC JUSTIFICATION FOR THICKENING

In this paper, the author is postulating that on the operations where major TSF failures occur the cost of implementing the thickening technology would have been significantly less than the costs currently being incurred through fines, reparations and reputation. The November 2015 Samarco TSF failure in Brazil is a very recent and high profile event and will be used here to illustrate the costs to the mine owners that can arise from a major failure. The projected cost of implementing thickening technology in the first place to avoid the failure (or minimise the impact) is not available but would clearly be significantly less than the costs currently being incurred as a result of the failure.

The full cost to BHP of the Samarco failure will probably only ever be known by BHP, but if early indications derived from the BHP group's accounts and associated lawsuits reported in the press after the event are anywhere near the mark the financial implications are significant. The relevant issues include:

1.5 Direct costs in Brazil

- The mine ceased operations immediately after the failure occurred. This can be attributed to the outrage arising from the environmental disaster and death toll from the released slurry and the lack of storage for the waste associated with the beneficiation processes involved in producing the iron ore. Samarco was reputed to be the lowest unit cost mine for BHP and the immediate loss of cash flow could have been significant (but not included here).
- It has been reported (The Australian newspaper, 24 Feb 2016) that BHP took an exceptional charge in its interim accounts of $US1.2 billion before tax for Samarco. This included a $525 m impairment to reduce the value of BHP's involvement in the operation to zero. In addition there was a $US655 m loss covering BHP's 50% share of Samarco's $US1.3 billion provision for costs relating to the dam failure. Against this, there was an offsetting $US330 m write-off of deferred tax liabilities to reflect the reduction in undistributed earnings, now earmarked for the humanitarian and environmental clean-up efforts.
- On March 3 2016 it was reported that the Samarco joint venture had agreed to pay the Brazillian Government $US2.3 billion over the next 6 years as part of a 15 year agreement for restoration and to provide compensation for damages caused by the tailings spill and to repair the environment and meet humanitarian needs. The payments are to be self-funded by Samarco, but Vale and BHP would be responsible for the costs if Samarco is unable to pay. This agreement was subsequently ratified by the Federal Court of Brasilia on May 5.

In other words, BHP has already made a considerable commitment to meet the reparation and fines arising from the failure. BHP has written down the value of its half of the operation to zero and will be relying on the operation to reopen to enable Samarco to meet its share of the cost of the fund for ongoing restoration and compensation as agreed with the government – as otherwise those costs would revert to be a liability for BHP.

On May 4 BHP reported that Brazil's federal prosecutor had launched proceedings for $US43 billion in social, environmental and economic compensation for the disaster. This claim represents a huge increase in the original $US2.3 billion agreement. Apparently the decision as to whether the new lawsuit proceeds or not will reportedly be made by the same court that ratified the $US2.3 billion agreement and would appear to weaken the case for the $US43 billion case to proceed.

1.6 Indirect costs

Another newspaper article (The Australian newspaper, 26 Feb 2016) reported that the chairman, managing director and two other officers of BHP were being sued in the US by investors "*who allege regular mission statements about safety being a top priority were shown to be false and misleading by the Samarco dam disaster in Brazil that killed 19 people*".

The class action indicates that the investors are asking for unspecified compensation for price falls between November 5 when the failure occurred and November 30, during which time BHP Billiton Depository Receipts fell more than 20 %. Regardless of the merits of the class action or the possibility of it being successful, the drop in value of the BHP Billiton Depository Receipts which entitle US investors to BHP shares listed in the UK and Australia could be considered to be a loss of reputation. How this loss in share value can be divided between the impact of the failure and the decline in commodity prices cannot be determined, but certainly the failure created a significant short term loss for investors.

Similar share price reductions occurred for the companies who owned Los Frailes and Mount Polley at the time of the incidents at those operations outlined earlier.

WHERE TO FROM HERE?

The failure of the TSF at Samarco and the resulting impact on people and the environment has been hugely expensive for the joint venture owners BHP and Vale. Not only has a very profitable operation been shut down, but even if it is re-started the profits will be absorbed for years to come by the remedial measures. Quite clearly, while this has been a disaster for Brazil; for the local residents and the mine owners, it has also been another very large TSF failure in an ongoing series around the world that needs to be halted if only to ensure that the "right to mine" is retained by the industry as a whole.

The report of the detailed investigation underway into the cause of the failure at Samarco has yet to be finalised and until that is made available any speculation on the cause of failure is premature. Nevertheless, the paper on the tailings storage at Samarco (Oliveira-Filho, W.L. et al 2013) indicates that the tailings were deposited as a low density slurry into a basin formed behind embankments constructed from the tailings themselves. Being placed at rates considerably faster than could dry out and consolidate under evaporation would have made it inevitable that the stored tailings were in a state that was prone to liquefaction once the embankment failed.

Mining has been underway at Samarco for nearly 40 years and the initial stage of the TSF that failed was very likely designed and commissioned prior to the emergence of the desirability of thickening tailings prior to discharge (and most certainly before filtering became viable). However, we understand that the major embankment involved in the failure was constructed in the mid to late 2000's to increase the size and capacity of the TSF and that the rate of filling of low density tailings behind that embankment was high – and increasingly so in the year or so prior to failure due to the increased rate of mining.

This was well after the concept of thickening was being adopted by the mining industry around the world and also after the CEO's of essentially all of the major mining houses in the world led in particular by Rio Tinto and BHP had agreed that the industry needed to rethink the way in which it presented its case for sustainable development. A study was initiated in the early 2000's that resulted in the publication of the report entitled "Mining, Minerals and Sustainable Development" (MMSD), (IIED, 2002) and UNEP's APELL program (UNEP, 2001) entitled "Guidance for the mining industry in raising awareness and preparedness for emergencies at local level". These reports are particularly relevant to the Samarco failure which suggests that the resolve of the CEO's to improve the image and performance of the industry with regard to safety and environmental protection was not transmitted down to those charged with designing, constructing and operating this facility (in particular) apparently within a year or two of the reports being published.

Samarco is reported to be planning to reopen this operation later in 2016 by depositing tailings into existing open pits and this should not introduce embankment safety issues. Should alternative above ground storages be required in future, the options would probably include cleaning up and retrofitting the TSF that has just failed or establishing a new facility elsewhere. In either case, this would provide the opportunity for thickening technology to be adopted should that be the most appropriate technique selected in the design process.

SUMMARY

An analysis of large TSF embankment failures over the years has demonstrated that there can be no assurance that embankments will not continue to fail into the future. This may for example be due to an inadequate assessment of the foundation conditions; subsequent extensions to an embankment that exceed the bearing capacity of the foundation; or poor operating procedures that lead to seepage through an embankment or overtopping. It would appear that mandating responsibilities to specific individuals cannot be relied upon to prevent embankment failures from occurring in the future. If the industry then is to minimise the consequences of such failures some means needs to be implemented when necessary that will limit the potential for the contained tailings to liquefy and flow from the storage facility.

Thickening the tailings prior to deposition into the TSF has already been shown to minimise the potential to liquefy and a major factor in establishing the degree of thickening necessary should be the potential consequences of an embankment failure. It is proposed that a risk based design approach is required that more readily accepts the need to condition/thicken tailings when necessary to mitigate the impact of a failure. The history of major TSF failures suggests that in the design process there may either be a higher acceptance of risk than is right or that the maximum foreseeable loss has been underestimated (sometimes grossly) and hence the process of assessing risk needs to be far more rigorous. In order to ensure that changes to a TSF from the initial design do not increase the risk of failure, it would appear highly desirable for detailed risk assessments to be undertaken regularly throughout the life of all operations and quite possibly that these should be independently verified.

The level of risk and the consequences of failure will influence the degree of thickening of the tailings required prior to discharge into the TSF and the higher the risk, the greater the required investment. Filtering the tailings prior to discharge is the thickening technology that will provide the greatest level of safety against the tailings liquefying in the event of an embankment failure and would be recommended for high risk storage facilities involving high confining embankments and those where the consequences of failure are severe.

The lead of major mining companies is essential if the industry is to reduce the risk of catastrophic TSF failures by adopting best practice – fail safe designs regardless of the local state of the art and practices. Tailings operations do not make money for any operation, but failures can be hugely expensive and in the long term can tarnish the reputation of individual mining companies and the industry as a whole. If the major mining companies were to set the example in acceptable practice the rest of the industry would hopefully be encouraged to follow their lead, but more importantly governments and regulatory bodies would find it easier to legislate for good practice.

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