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Integrating the Safety Management of Tailings Facilities to the ISO Model and to the Global Industry Standard on Tailings Management

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Abstract

This text seeks to demonstrate how mining companies that adopt the ISO management standards could, at the same time, integrate them into the tailings management model represented by the Tailings Guide by Mining Association of Canada and demonstrate adherence to the Global Standard developed by the Global Tailings Review, while adopting the quality management approach advocated by the authors, aimed at the design and construction of tailings dams.

Keywords: Tailings Facilities, Management Systems, Design and Development of Tailings Facilities, Quality Plans for Tailings Facilities, Global Industry Standard on Tailings Management

1. Introduction

Mining companies (notably large ones) have structured management according to the ISO model. It is a fact that the tailings management in these companies usually has a 'life of its own' and is not part of the ISO model. In an article recently published in the journal *Mine Water and Environment* entitled 'Integrated Risk Management in Mine Tailings Facility' "see [1]", the authors presented a way to integrate the two aspects of management above.

The management of Quality, Environment, Safety and Occupational Health of mining companies already follows, for the most part, the ISO model. Tailings management, on the other hand, does not follow (in principle and in a general assessment) a pre-established model. In the article, the authors sought the best (and most consolidated) technical reference in tailings management, represented by Mining Association of Canada (MAC), in order to facilitate this integration. MAC itself recognizes that its model, expressed in the so-called Tailings Guide "in [2] A Guide to the Management of Tailings Facilities", is based on the ISO 14001 standard "in [3] ISO 14001:2015 Environmental Management Systems — Requirements with Guidance for Use". The ISO 14001 standard "see [3]" (as well as all the ISO management systems standards), in turn, as of 2015, started to follow a unique structure defined by ISO, represented by the so-called Annex SL. Add to this the fact that,

in the article mentioned above, a specific approach was developed in terms of Quality management, aimed at design and construction.

In August 2020, the Global Industry Standard on Tailings Management “see [4]” was published, developed through an independent process (Global Tailings Review), jointly organized by the United Nations Environment Program (UNEP), the Principles for Responsible Investment (PRI), and the International Council on Mining and Metals (ICMM). This became a benchmark for the mineral sector. The so-called Global Standard is comparable to Towards Sustainable Mining® (TSM®), an externally verified performance system for sustainable mining, adopted by MAC, in which tailings management is inserted. TSM® is composed of several protocols, one of which is represented by MAC’s Tailings Guide “see [2]” (and, subsidiarily, by Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities - OMS Guide “in [5] Developing an Operation, Maintenance, and Surveillance Manual for Tailings and Water Management Facilities”). The Tailings Guide “see [2]” guides how the company should organize a Tailings Management System (TMS) which, according to the Global Standard itself, represents its central element.

The Global Standard “see [4]” also says that the TMS and its various elements need to interact with other systems, such as the Environmental and Social Management System (ESMS), the operations management system as a whole and the regulatory system, and that this interaction between systems is essential for the Standard to be effectively implemented.

2. Differences between the MAC guides and ISO standards

In the text of the article entitled ‘Integrated Risk Management in Mine Tailings Facility’ “see [1]”, can be found the most notable differences and main points of attention between the guides published by MAC (Tailings Guide, Third Edition, released in February 2019 “see [6]”; OMS Guide, Second Edition, released in February 2019 “see [7]”) and the ISO 9001 “in [8] ISO 9001:2015 Quality Management Systems, Requirements”, ISO 14001 “see [3]” and ISO 45001 “in [9] ISO 45001:2018 Occupational Health and Safety Management Systems, Requirements with Guidance for Use” management system standards.

In March 2021, MAC published version 3.2, which is an update to the third edition of the Tailings Guide, dated February 2019. Changes were made due to the launch in August 2020, of the Global Industry Standard in Tailings Management (the Standard), thus aiming to improve the alignment between the tailings management component of MAC’s TSM® program and the Standard. For the same reason, also in March 2021, MAC published version 2.1, which is an update of the second edition of the OMS Guide, dated February 2019.

In sequence, an analysis is made of the possible impacts of these changes on the differences and points of attention mentioned above, between the two guides published by MAC and the three ISO standards for management systems considered.

2.1 Accountability and responsibility

In Version 3.2 of the Tailings Guide “see [2]”, the level of detail in the descriptions of the roles and responsibilities of the Accountable Executive Director has been increased over the previous version.

This greater detail, seeking to clarify the roles and responsibilities of this executive, and greater alignment with the Standard’s requirements, in no way impacts the analysis carried out previously and the perspective of integration of the management mechanisms.

2.2 Critical controls

As part of a redistribution of requirements that made up the “Plan” element of the Plan-Do-Verify-Act (PDCA) cycle in Version 3.1 of the Tailings Guide “see [6]”, the Critical Controls requirement was repositioned in Version 3.2 “see [2]”, becoming part of the Risk Management process.

In terms of content, just highlighting the addition made to the text, incorporating two stakeholders (regulatory bodies and COI) into the process of defining high-consequence events. This in no way impacts the analysis made previously and the perspective of integrating management mechanisms.

2.3 Quality management

As part of a redistribution of requirements that made up the “Plan” element of the Plan-Perform-Verify-Act (PDCA) cycle in Version 3.1 of the Tailings Guide “see [6]”, the Quality Management requirement, which was subordinated to Controls, which in turn was included in the Management Process, it was repositioned in Version 3.2 “see [2]”, moving up the hierarchy to becoming one of the components of the “Plan” element of the PDCA cycle.

In terms of content, the text of Version 3.2 of the Tailings Guide “see [2]” incorporated the assertion that quality management must address a wide range of aspects related to tailings facilities, considering the initial and ongoing construction, including specifications for materials and construction procedures (e.g. material compaction), OMS activities such as calibration of surveillance instruments, and Quality Assurance and Quality Control related to the closure plan implementation.

2.4 Emergency preparedness

The text added in Version 3.2 of the Tailings Guide “see [2]”, over the previous one, reinforced this document’s alignment with ISO standards by including what is apparently obvious in terms of what it means to be prepared for an emergency: assessing the range of potential emergency scenarios that could occur, and potential impacts; maintaining the necessary capacity (e.g., personnel, equipment, supplies) to respond; maintaining a state of readiness to respond, in collaboration with external parties (e.g., local first responders) that would be involved in responding to an emergency; developing plans for emergency preparedness; and conducting training and exercises/tests of the plans for emergency preparedness.

3. Additional differences between MAC guides and ISO standards

We will now analyze other changes promoted in Version 3.2 of the Tailings Guide “see [2]”, and also in Version 2.1 of the OMS Guide “see [5]”, and their potential impact on the ease of integration between management models advocated in the article ‘Integrated Risk Management in Mining Waste Facility’ “see [1]”, mentioned earlier in this text.

3.1 Policy and commitment

To highlight, in the text added in Version 3.2 of the Tailings Guide “see [2]”, in relation to the previous one, the emphasis given to the need for the Owner of the tailings facility to demonstrate commitment to a culture that promotes the early recognition of problems, and also with the response to emergencies and participation

in post-incident recovery, in collaboration with authorities and communities of interest (COI).

This in no way impacts the analysis made previously and the perspective of integrating management mechanisms.

3.2 Managing change

To highlight, in the text added in Version 3.2 of the Tailings Guide “see [2]”, in relation to the previous one, the emphasis given to the Engineer of Record (EoR) succession plan.

This in no way impacts the analysis made previously and the perspective of integrating management mechanisms.

3.3 Control of documented information

The most significant change promoted in version 2.1 of the OMS Guide “see [5]” was precisely the transfer of the text existing in the second edition of this guide, then called ‘Control of Documented Information’, to the Tailings Guide. The text, in addition, was enriched in content, renamed ‘Information Management’, in turn subdivided into two requirements: ‘Information to be Documented’ and ‘Control of Documented Information’. The text has been transferred from the OMS Guide to the Tailings Guide because the latter is applicable to documented information that goes beyond that contained in OMS manuals.

The text of the new ‘Information to be Documented’ requirement even spells out what information must be documented and updated throughout the tailings facility life-cycle, and references to the new Appendix 6 (Information to be Documented to Support Responsible Tailings Management) and Appendix 8 (Technical Considerations) of the Tailings Guide “see [2]”, specifically with regard to the closure plan.

In terms of correspondence with the text of the ISO standards, the new text of the Tailings Guide presents itself as more aligned in the richness of details, containing specific characteristics of a specific management system for mining tailings facilities.

3.4 Training and competence

To highlight, in the text added in Version 3.2 of the Tailings Guide “see [2]”, in relation to the previous one, the importance given to the traceability of evidence of competence, in order to ensure that all relevant personnel receive the appropriate training.

This in no way impacts the analysis made previously and the perspective of integrating management mechanisms.

3.5 Communications

Section 3.1.2 of the OMS Guide - second edition “see [7]”, discussing Communications, was deleted and incorporated into Version 3.2 of the Tailings Guide “see [2]”. The associated appendix (Appendix 7: Factors in Effective Communications, Governance, and the “Human Element” of Tailings Management) was also moved to the Tailings Guide, even with the same numbering.

The three ISO standards do not go as deep as the Tailings Guide on Communications aspects and, in a common way, define the need for the organization to establish, implement and maintain the necessary processes for internal and external communications, including: a) about what to communicate; b) when to communicate; c) with whom to communicate; d) how to communicate; e) who should communicate. The ISO 14001 “see [3]” and ISO 45001 “see [9]” standards

also emphasize the need to take into account legal obligations and ensure that the information communicated is consistent with that generated within the scope of the management system, and that it is reliable.

The Tailings Guide “see [2]”, for its part, emphasizes the fact that timely communication of potential problems can be essential to achieving the goal of minimizing harm, and cites two main mechanisms for establishing a corporate culture that encourages people to report problems: establishing a confidential process to promptly receive, investigate and resolve issues; and the development and implementation of whistleblower protection mechanisms to ensure there are no retaliations.

It is also important to cite the content of the aforementioned Appendix 7, which presents a summary of 14 lessons learned on governance and communications, applicable to tailings management and dam safety, extracted, according to the Tailings Guide “see [6]”, from the publication Martin, T. (2001) - Pearl Harbor: Lessons for the Dam Safety Community (presented at the annual conference of the Canadian Dam Association).

3.6 Management review for continual improvement

The Tailings Guide text “see [2]” incorporated, as one of the inputs to periodic management reviews, the integration of tailings management activities with site-wide systems, such as, where applicable, a site-wide environmental and social management system.

This requirement meets the idea of integration of management mechanisms advocated by the authors.

Another addition made in version 3.2 of the Tailings Guide “see [2]” was the requirement that management review describe the current conditions related to the tailings facility, including a summary of construction activities since the last review, as well as any significant changes that have taken place since the last management review, including: an assessment of whether the tailings facility is continuing to meet the design intent; and a summary of any deviations from the design or expected conditions since the last management review, including an assessment of the cumulative impacts of those deviations.

Finally, to highlight an item added in version 3.2 of the Tailings Guide “see [2]”, the list of changes that should be considered for the continuous improvement of the tailings management system: relevant new or emerging technologies, practices or knowledge related to tailings management.

Such particularities found in the Tailings Guide text in no way compromise the analysis made before and the perspective of integration of management mechanisms.

From the “Do” element of the Plan-Do-Check-Act (PDCA) cycle in version 3.1 of the Tailings Guide “see [6]”, Section 5.3 was deleted, which described a checklist that could assist in the implementation of the tailings management framework throughout the life cycle. Appendix A.5.1 - Considerations for Managing Throughout the Life Cycle of a Tailings Facility, which included, in version 3.1 of the Tailings Guide “[6]”, an illustrative sample of a master checklist, to be used as a tool for Owners in implementing the tailings management framework, has been deleted in version 3.2 “see [2]”. The checklist has been replaced by MAC in the Tailings Guide by a Table of Conformance, as a reference for Gap Analysis in relation to the TSM® Tailings Management Protocol.

As part of the effort to bring TSM® into line with the standard, MAC has added a new supporting appendix (Appendix 6: Information to be Documented to Support Responsible Tailings Management) on information requirements related to: site characterization; design information; documentation on construction and as-built conditions; and closure plan.

4. Comparative analysis between the Standard and the ISO management systems

The Standard developed by the Global Reporting Initiative has 77 requirements for tailings management, covering six thematic areas, which in turn are subdivided into 15 principles. MAC conducted a detailed analysis “in [10] Equivalency Between Requirements for Sustainable Mining and the Global Industry Standard on Tailings Management” of the TSM requirements against the Standard. Considering the form and content of this gap analysis, the authors of this text carried out a comparative analysis of each of the 77 requirements of the Standard with those of the ISO 9001, ISO 14001 and ISO 45001 standards, indicating how the management system(s) of mining companies could be used to implement the requirements of the Standard. The analysis was complemented by the indication of the sections of the Tailings Guide that would support the structuring of this integrated management system. The result of this analysis is embodied in **Table 1**.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
TOPIC I: Affected Communities	
PRINCIPLE 1: Respect the rights of project-affected people and meaningfully engage them at all phases of the tailings facility lifecycle, including closure.	
Requirement 1.1	Recognize the applicability of the UNGP when determining external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended results of its environmental and OH&S management system (4.1/ISO 14001 + ISO 45001), and also by seeking to understand the needs and expectations of its stakeholders (4.2/ISO 14001 + ISO 45001). Explicitly make this commitment in its policy (5.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 3 - Policy and Commitment), include the UNGP in its compliance obligations (6.1.3/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.4 - Conformance Management) and periodically assess compliance (9.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 6 - Performance Evaluation).
Requirement 1.2	Recognize the applicability of the FPIC when determining external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended results of its environmental, OH&S management system (4.1/ISO 14001 + ISO 45001), and also by seeking to understand the needs and expectations of its stakeholders (4.2/ISO 14001 + ISO 45001). Explicitly make this commitment in its policy (5.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 3 - Policy and Commitment), include the FPIC in its compliance obligations (6.1.3/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.4 - Conformance Management) and periodically assess compliance (9.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 6 - Performance Evaluation).
Requirement 1.3	When implementing the process of understanding stakeholders needs and expectations (4.2/ISO 14001 + ISO 45001), include the involvement of those affected by the project among the compliance obligations (6.1.3/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.4 - Conformance Management). From there, periodically assess this compliance (9.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 6 - Performance Evaluation). From the perspective of ISO 9001, clause 4.2 determines that the needs and expectations of interested parties must be understood in terms of their effect or potential effect on the organization's ability to provide products and services that meet customer requirements, regulatory requirements and applicable bylaws. These needs and expectations must be monitored and reviewed periodically.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 1.4	Emphasize the participation of non-managerial level workers in hazard identification (5.4/ISO 45001), and establish the necessary process(es) to receive and respond (in accordance with the UNGP) to relevant communications from stakeholders (7.4/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.11 Communications, with emphasis on key mechanisms required to ensure confidentiality and protection of whistleblowers), protecting workers from retaliation when reporting incidents, hazards and risks (5.1/ISO 45001).
TOPIC II: Integrated Knowledge Base	
PRINCIPLE 2: Develop and maintain an interdisciplinary knowledge base to support safe tailings management throughout the tailings facility lifecycle, including closure.	
Requirement 2.1	By establishing the process to determine the external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended results of the environmental and OH&S management system (4.1/ISO 14001 + ISO 45001), ensure that the knowledge is updated at least every 5 years and whenever there is any relevant change in the tailings disposal structure or in the local social, environmental and economic context. Incorporate into this process of analyzing the context and when making commitments in the environmental policy (5.2/ISO 14001) the uncertainties related to climate change (corresponding section in Tailings Guide: 3 - Policy and Commitment).
Requirement 2.2	When implementing requirements 8.3.2 of ISO 9001 (Design and development planning) and 8.3.3 (Design and development input), relevant topics such as climatic, seismological, geomorphological, geological, geochemical, hydrological and hydrogeological conditions can be considered as important information for elaboration of the tailings dam project. Tailings Guide - Appendix 6: Information to be Documented to Support Responsible Tailings Management
Requirement 2.3	Ensure that the methodology(ies) established to identify and assess environmental and occupational hazards/risks contemplates plausible failure modes, site conditions and the properties of the slurry (6.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.1 Risk Management). Ensure that, when flowable materials are present in tailings disposal structures with a consequence classification of “High”, “Very High” or “Extreme”, according to criteria in Annex 2 of the Standard), the results include estimates of the physical area impacted by a possible failure, flow arrival times, depth and velocities, and material deposition depth. When establishing the planning for response to potential emergency situations, consider the results of the above analysis (8.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 5.2 Emergency Preparedness). Update the risk assessment and response planning whenever there is any relevant change in the tailings disposal structure or in the impacted physical area (8.1/ISO 14001 – 8.1.3/ISO 45001; corresponding section in Tailings Guide: 4.5 Managing Change).
Requirement 2.4	Update the risk assessment and response planning contemplated in R 2.3 whenever there is any relevant change in the tailings disposal structure, in the impacted physical area or in the knowledge base.
PRINCIPLE 3: Use all elements of the knowledge base - social, environmental, local economic and technical - to inform decisions throughout the tailings facility lifecycle, including closure.	
Requirement 3.1	Keep the identification and assessment of environmental and occupational hazards/risks updated (6.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.1 Risk Management), as well as the operational control planning (8.1/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 5.1 Operation, Maintenance, and Surveillance Manual), in view of knowledge about climate change and using the principles of Adaptive Management. Make appropriate adjustments in emergency planning (8.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 5.2 Emergency Preparedness). The knowledge base attributed to climate can be verified both in the planning phase (8.3.2/ISO 9001) and in the requirement regarding changes in projects and development (8.3.6/ISO 9001), applicable throughout the life cycle of tailings facilities.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 3.2	<p>For new tailings facilities, ensure that in the process of identification and assessment of environmental and occupational hazards/risks (6.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.1 Risk Management), a multi-criteria analysis of location alternatives, technological and viable strategies for the management of tailings is made in order to minimize risks to people and the environment. The assignment of responsibilities and authorities must ensure the need for approval by the ITRB or an independent senior technical reviewer (5.3/ISO 9001 + ISO 14001 + ISO 45001, corresponding section in Tailings Guide: 4.3 Accountability and Responsibility).</p> <p>For existing facilities, ensure that the identification and assessment of environmental and occupational hazards/risks (6.1.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.1 Risk Management) is kept up to date in terms of technologies, of the design of the disposal structures and tailings management strategies to minimize risks and improve environmental performance.</p> <p>When considering the requirements of ISO 9001 that can be applied to both new tailings facilities and existing facilities, it is possible to consider the need for risk assessment in 6.1 (Action to address risks and opportunities) which makes reference to item 4.2 (Understanding the needs and expectations of interested parties), in addition to item 8.3.3 (Design and development input), especially with regard to the assessment of potential consequences of failures (paragraph “e”).</p>
Requirement 3.3	<p>Implement the process of identification and assessment of environmental and occupational hazards/risks from the stage of conceptual and feasibility studies (6.1.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.1 Risk Management), including the impacts of social and economic nature, and ensuring that, in the case of identification of potential acute or chronic impacts at a relevant level, mitigation measures are established and implemented according to a hierarchy of controls (8.1/ISO 14001 + ISO 45001; corresponding sections in the Tailings Guide: 4.1 Risk Management + 4.8 Operation, Maintenance, and Surveillance Manuals + 5.1 Operation, Maintenance, and Surveillance Manual).</p> <p>Item 8.3.3 of ISO 9001 (Design and development inputs) provides for the need to assess the potential consequences of failures, in addition to the need to retain documented information, which may consider the uncertainties regarding climate change and its social, environmental consequences and economic, in the scope of tailings facilities.</p>
Requirement 3.4	<p>Ensure that the identification and assessment of environmental and occupational hazards/risks (6.1.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.1 Risk Management) is kept up to date, including as a result of knowledge about climate change or about long-term impacts (8.1/ISO 14001 – 8.1.3/ISO 45001; corresponding section in Tailings Guide: 4.5 Managing Change).</p>
TOPIC III: Design, construction, operation and monitoring of the tailings facility	
PRINCIPLE 4: Develop plans and design criteria for the tailings facility to minimize risk for all phases of its lifecycle, including closure and post-closure.	
Requirement 4.1	<p>In the environmental and occupational risk assessment process (6.1.2/ISO 14001 + ISO 45001; corresponding section in the Waste Guide: 4.1 Risk Management) consider, for all categories of impacts, the classification of consequences of the highest indicated level in Annex 2, Table 1 of the Standard.</p>
Requirement 4.2	<p>The application of clause 8.3 of ISO 9001 (Design and development of products and services) makes clear the need to evaluate, in the planning phase (8.3.2/ISO 9001), the items referring to the nature, duration and complexity of the project; stages of required processes, including necessary revisions; project verification and validation requirements; definition of responsibilities and necessary authorities; assessment of required resources; interface control; expected level of control, considering the interested parties.</p>

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 4.3	By applying item 8.3.2 of ISO 9001, paragraph “d”, it is possible to verify the establishment of responsibilities and authorities involved in the design and development process and, in addition, paragraph “j” determines the need to establish these responsibilities and authorities as documented information for the project.
Requirement 4.4	Item 8.3.3 of ISO 9001 (Design and development input) establishes the need to consider issues associated with: functional and performance requirements of the project; verification of similar projects; verification of the need to comply with statutory, regulatory, standards and applicable codes requirements; potential consequences of failures. And, also, to ensure that all information evaluated is considered as controlled.
Requirement 4.5	According to item 8.3.4 of ISO 9001 (Design and development controls), the following control measures must be considered: ensure that the results to be achieved are defined; that reviews are conducted to assess the ability of the results to meet the project’s purposes; verification to ensure that the outputs meet the conditions established at the entrance of the projects; determination of the results validation process; guarantee of the solution of the problems identified during the reviews. There is also a need to document all information obtained and decisions made.
Requirement 4.6	In item 8.3.5 of ISO 9001 (Design and development output), measures are defined to: ensure that the project input requirements have been met; that the project is fit for purpose; that monitoring and measurement requirements are defined and that acceptance criteria have been defined; guarantee of project safety.
Requirement 4.7	For existing tailings facilities, item 8.3.6 of ISO 9001 (Design and development changes) can contribute to their adequacy, as it considers: the possibility of revisions, including their documentation; establishing responsibilities and authorities for making necessary changes; and taking actions to prevent adverse impacts.
Requirement 4.8	With regard to the Design Basis Report (DBR), full compliance with clause 8.3 of ISO 9001 (Design and development of products and services) provides that all stages are properly documented, including with the approval of those responsible.
PRINCIPLE 5: Develop a robust design that integrates the knowledge base and minimizes the risk of failure to people and the environment for all phases of the tailings facility lifecycle, including closure and post-closure.	
Requirement 5.1	Clause 8.3 of ISO 9001 (Design and development of products and services) makes clear the need to evaluate, in the planning phase (8.3.2/ISO 9001), the items referring to: nature, duration and complexity of the project; stages of required processes, including necessary revisions; project verification and validation requirements; definition of responsibilities and necessary authorities; assessment of required resources; interface control; expected level of control, considering the interested parties.
Requirement 5.2	The same comment made for R 5.1 applies.
Requirement 5.3	By integrating items 8.3.2 (Design and development planning) and 8.3.3 (Design and development input) of ISO 9001, relevant topics such as climatic, seismological, geomorphological, geological, geochemical, hydrological and hydrogeological conditions can be considered as important information for the elaboration of the tailings dam project.
Requirement 5.4	The same comment made for R 5.1 applies.
Requirement 5.5	The same comment made for R 4.4 applies. For existing tailings facilities, the same comment made for R 4.7 applies.
Requirement 5.6	The same comment made for R 4.6 applies. It is important that, in implementing the planning and entry requirements (8.3.2 + 8.3.3/ISO 9001), the requirements for closing the tailings facility have been considered.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 5.7	Clause 8.3 of ISO 9001 (Design and development of products and services) establishes the need to define responsibilities and authorities at the various stages of the process. In addition, paragraph “e” (8.3.3/ISO 9001) establishes the need to assess the potential consequences of failures.
Requirement 5.8	Item 8.3.3 of ISO 9001 (Design and development input) establishes the need to consider statutory, regulatory, standards and codes requirements, thus taking into account the possibility of including international standards.
PRINCIPLE 6: Plan, build and operate the tailings facility to manage risk at all phases of the tailings facility lifecycle, including closure and post-closure.	
Requirement 6.1	For the stages of planning, construction and operation of tailings disposal structures, the application of a methodology based on the requirements of ISO 10005 “in [11] ISO 10005:2018 Quality management systems - Guidelines for quality plans” can be considered, which in turn considers the means for process requirements, product, project or contract.
Requirement 6.2	The same comment made for R 6.1 applies.
Requirement 6.3	The same comment made for R 6.1 applies.
Requirement 6.4	The same comment made for R 6.1 applies.
Requirement 6.5	The same comment made for R 4.7 applies.
Requirement 6.6	The same comment made for R 4.4 applies.
PRINCIPLE 7: Design, implement and operate monitoring systems to manage risk at all phases of the facility lifecycle, including closure.	
Requirement 7.1	The same comment made for R 4.4 applies.
Requirement 7.2	The same comment made for R 4.6 applies.
Requirement 7.3	Clause 8.3 of ISO 9001 (Design and development of products and services) establishes the need to define responsibilities and authorities at the various stages of the process. In addition, item “e” of item 8.3.3 (Design and development input) establishes the need to assess the potential consequences of failures. In item 8.3.5 (Design and development output) measures are defined to: guarantee that the project input requirements have been met; that the project is fit for purpose; that monitoring and measurement requirements are defined and that acceptance criteria have been defined; guarantee of project safety.
Requirement 7.4	The same comment made for R 4.4 applies.
Requirement 7.5	The same comment made for R 6.1 applies.
TOPIC IV: Management and Governance	
PRINCIPLE 8: Establish policies, systems and accountabilities to support the safety and integrity of the tailings facility.	
Requirement 8.1	Ensure the inclusion, in the Environmental and OH&S policies (5.2/ISO 14001 + ISO 45001), of the commitments with the safe management of tailings facilities, with emergency preparedness and recovery from failures. Alternatively, establish a specific tailings management policy in which these commitments are made explicit (Tailings Guide: 3 Policy and Commitment).
Requirement 8.2	Establish and implement a tailings management system based on the MAC Tailings Guide, integrated with the management system(s) in the ISO model (4.4/ISO 9001 + ISO 14001 + ISO 45001) that include social aspects, possibly using as references the guidelines of ISO 26000 and the requirements of the SA8000 standard in [12] Social Accountability International. 2014. International Standard SA8000.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 8.3	Individual performance evaluations linked to compensation mechanisms are beyond the scope of this text. Nevertheless, it is recommended that the determinations of R 8.3 be considered as compensation criteria that are part of the organization's human resources policy.
Requirement 8.4	Ensure that responsibilities and authorities for relevant functions in the management system are assigned, formally communicated and understood at all levels (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility).
Requirement 8.5	The same comment made for R 8.4 applies.
Requirement 8.6	Determine the necessary competence of professionals whose performance affects the results of tailings management, ensure that these people are competent, based on appropriate education, training and experience and, where applicable, take actions to acquire the necessary competence and assess effectiveness of the actions taken (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence).
Requirement 8.7	Ensure that responsibilities and authorities for relevant functions in the management system are assigned, formally communicated and understood at all levels (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility - 2.2.3 Independent Review).
PRINCIPLE 9: Appoint and empower an Engineer of Record.	
Requirement 9.1	<p>Determine the necessary competence of professionals whose performance affects the results of tailings management, ensure that these people are competent, based on appropriate education, training and experience and, where applicable, take actions to acquire the necessary competence and assess effectiveness of the actions taken (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence).</p> <p>When considering clause 8.4 of ISO 9001 (Control of externally provided processes, products and services), it is possible to identify three important steps in the acquisition of these specialized services in tailings facilities: the first step is that regarding the approval of possible suppliers, considering the necessary competency criteria; the second step refers to the selection of the supplier; and the third stage refers to the performance evaluation, considering the possibility or not of continuity of service provision.</p>
Requirement 9.2	Ensure that responsibilities and authorities for relevant functions in the management system are assigned, formally communicated and understood at all levels (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility).
Requirement 9.3	<p>It is possible to consider that the establishment of quality management to ensure the proper operation of a tailings disposal structure can be done through Quality Plans, provided for in ISO 10005 “in [13] ISO 10005:2018 Quality management systems - Guidelines for quality plans”, which considers the means to process, product, project, or contract requirements.</p> <p>Tailings Guide: 4.7 Quality Management</p>
Requirement 9.4	<p>The same comment made for R 9.2 applies.</p> <p>When considering clause 8.4 of ISO 9001 (Control of externally provided processes, products and services), it is possible to identify three important steps in the acquisition of these specialized services in tailings facilities: the first step is that regarding the approval of possible suppliers, considering the necessary competency criteria; the second step refers to the selection of the supplier; and the third stage refers to the performance evaluation, considering the possibility or not of continuity of service provision.</p>

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 9.5	When considering clause 8.4 of ISO 9001 (Control of externally provided processes, products and services), it is possible to identify three important steps in the acquisition of these specialized services in tailings facilities: the first step is that regarding the approval of possible suppliers, considering the necessary competency criteria; the second step refers to the selection of the supplier; and the third stage refers to the performance evaluation, considering the possibility or not of continuity of service provision.
PRINCIPLE 10: Establish and implement levels of review as part of a strong quality and risk management system for all phases of the tailings facility lifecycle, including closure.	
Requirement 10.1	When establishing the process of identification and assessment of environmental and occupational hazards/risks (6.1.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.1 Risk Management), specify the use of methodologies based on best practices, and establish responsibilities and authorities related to this process (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility), ensuring that it is carried out by a qualified multidisciplinary team (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence), at the minimum defined frequency. Cover the aspects and impacts of a social and economic nature in the process. Submit the assessment result for scrutiny by the ITRB or an independent senior technical reviewer (Tailings Guide/2.2.3 Independent Review), establishing and implementing a plan to mitigate the risks considered unacceptable (8.1/ISO 14001 + ISO 45001).
Requirement 10.2	Implement the process of periodic critical analysis of tailings safety management (Tailings Guide: 7 Management Review for Continuous Improvement), integrated with quality, environmental and OH&S management (9.3/ISO 9001 + ISO 14001 + ISO 45001), at intervals settled down. Define responsibilities and authorities related to this process (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility), ensuring that the analyzes are carried out by senior technical reviewers with the appropriate qualifications and knowledge (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence) and resources (7.1/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.9 Resources).
Requirement 10.3	Conduct internal audits at planned intervals to provide information on the performance of the tailings system integrated with quality, environmental and OH&S management (9.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 8 Assurance).
Requirement 10.4	Define responsibilities and authorities related to this process (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility), ensuring that the analyzes are carried out by the EoR or by a senior independent technical reviewer, with the appropriate qualifications and knowledge (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence), at intervals settled down.
Requirement 10.5	When establishing a process to monitor, measure, analyze and evaluate the performance of tailings management, integrated with quality, environmental and OH&S management, define the need to conduct DSRs at the defined frequency and according to best practices, imposing the restriction on the carrying out consecutive works by the same contracted technical manager (9.1/ISO 9001 + ISO 14001 + ISO 45001; corresponding sections in the Tailings Guide: 6 Performance Evaluation - 8 Assurance).

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 10.6	When establishing a process to monitor, measure, analyze and evaluate the performance of tailings management, integrated with quality, environmental and OH&S management, define the need to conduct DSRs at the defined frequency (9.1/ISO 9001 + ISO 14001 + ISO 45001; corresponding sections in the Tailings Guide: 6 Performance Evaluation - 8 Assurance), allocating responsibilities and authorities as required (5.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility), and ensuring that DSRs are conducted by competent professionals (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence).
Requirement 10.7	Ensure the provision of the necessary financial resources for the planned closure, early closure, rehabilitation, and post-closure of tailings disposal structures (7.1/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.9 Resources). When establishing the process(es) of external communication (7.4.3/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.11 Communications), define the obligation of public disclosure with due frequency, in addition to, limited by the provisions of local or national regulations on the matter, seek to influence prospective acquirers to comply with the requirements of the Standard.
PRINCIPLE 11: Develop an organizational culture that promotes learning, communication and early problem recognition.	
Requirement 11.1	Making people who carry out work under the organization's control aware of their role in preventing failures (5.1 + 7.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding sections in the Tailings Guide: 3 Policy and Commitment + 4.11 Communications + Appendix 7).
Requirement 11.2	When establishing the process that aims to ensure the necessary competence of people whose actions may affect the performance of tailings management, integrated with the management of quality, environmental and OH&S (7.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.10 Training and Competence), build a database that integrates workers' experience in planning, design, and operations at all stages of the tailings disposal structure lifecycle.
Requirement 11.3	Make people who perform work under the organization's control aware of the importance of sharing data and knowledge, effective communication, and the proper implementation of management measures (5.1 + 7.3/ISO 9001 + ISO 14001 + ISO 45001; corresponding sections in the Guide Tailings: 3 Policy and Commitment + 4.11 Communications + Appendix 7).
Requirement 11.4	When establishing the process(es), including reporting, investigations and taking action, to determine and manage incidents and non-compliances (10.2/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 6 Performance Evaluation), emphasize human and organizational factors.
Requirement 11.5	Making people who carry out work under the organization's control aware of their role in reporting problems or identifying opportunities to improve the management of tailings disposal structures (5.1 + 7.3/ISO 9001 + ISO 14001 + ISO 45001; 5.4/ISO 45001; corresponding sections in the Tailings Guide: 3 Policy and Commitment + 4.11 Communications + Appendix 7), protecting them from retaliation (5.4/ISO 45001; corresponding section in the Tailings Guide: 4.11 Communications), in addition to establishing deadlines for response and communication of measures taken and their results.

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
PRINCIPLE 12: Establish a process for reporting and addressing concerns and implement whistleblower protections.	
Requirement 12.1	When establishing the internal communication process of relevant information on tailings management, integrated with quality, environmental and OH&S management, between the various levels and functions of the organization, define a formal and confidential process to receive, investigate and respond promptly to the concerns raised by employees and contractors (7.4/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.11 Communications).
Requirement 12.2	When establishing the internal communication process of relevant information on tailings management, integrated with quality, environmental and OH&S management, between the various levels and functions of the organization, define a formal and confidential process to receive, investigate and promptly respond to concerns raised by employees and contractors (7.4/ISO 9001 + ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.11 Communications), safeguarding the whistleblower from dismissal, discrimination or any retaliation.
TOPIC V: Emergency Response and Long-Term Recovery	
PRINCIPLE 13: Prepare for emergency response to tailings facility failures.	
Requirement 13.1	Establish, implement and maintain the process(es) necessary to prepare and respond to potential emergency situations, taking actions to prevent or mitigate the consequences arising from these situations, including the case of a catastrophic tailings facility failure, testing the planned response actions at the established frequency, when feasible, and periodically review the process(es) and planned response actions, in particular, after the occurrence of emergency situations or tests (8.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 5.2 Emergency Preparedness). Provide relevant information and training related to emergency preparedness and response to relevant stakeholders, including emergency response services, government authorities and, as appropriate, the local community.
Requirement 13.2	The same comment made for R 13.1 applies.
Requirement 13.3	The same comment made for R 13.1 applies.
Requirement 13.4	The same comment made for R 13.1 applies.
PRINCIPLE 14: Prepare for long-term recovery in the event of catastrophic failure.	
Requirement 14.1	When establishing external communications processes (7.4.3/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.11 Communications), including what to communicate, when to communicate, to whom to communicate, how to communicate, insert in the process(s) public sector agencies and other organizations, including the actions defined in emergency response planning, to mitigate the consequences arising from these situations (8.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 5.2 Emergency Preparedness).
Requirement 14.2	When critically analyzing, as timely as possible, after the occurrence of a catastrophic failure, the planned response to the previously identified scenario(s), consider the social, economic and environmental impacts caused by the emergency situation (8.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 5.2 Emergency Preparedness).
Requirement 14.3	When planning and implementing actions to mitigate the consequences arising from emergency situations (8.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 5.2 Emergency Preparedness) arising from catastrophic failure, involve public agencies and other interested parties in the development and implementation of reconstruction, rehabilitation and recovery plans.
Requirement 14.4	When planning and implementing actions to mitigate the consequences arising from emergency situations (8.2/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 5.2 Emergency Preparedness) arising from catastrophic failure, consider, when establishing responsibilities and authorities, the participation of persons affected in the ongoing reconstruction, rehabilitation and rehabilitation works and monitoring activities (5.3/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.3 Accountability and Responsibility).

Global Industry Standard on Tailings Management X ISO Standards	
G. I. Standard	ISO Standards
Requirement 14.5	When establishing the process(es) for external communications, including who to communicate, what to communicate, when to communicate, to whom to communicate and how to communicate, encompass the public disclosure of post-failure results and adapt these activities according to the results and with feedback received from the parties involved (7.4/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.11 Communications).
TOPIC VI: Public Disclosure and Access to Information	
PRINCIPLE 15: Publicly disclose and provide access to information about the tailings facility to support public accountability.	
Requirement 15.1	Recognize the applicability of the UNGP (and particularly of Principle 21) when determining external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended results of its environmental and OH&S management system (4.1/ISO 14001 + ISO 45001), and also by seeking to understand the needs and expectations of its stakeholders (4.2/ISO 14001 + ISO 45001). Explicitly make this commitment in its policy (5.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 3 - Policy and Commitment), include the UNGP (and particularly of Principle 21) in its compliance obligations (6.1.3/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 4.4 - Conformance Management) and periodically assess compliance (9.1.2/ISO 14001 + ISO 45001; corresponding section in Tailings Guide: 6 - Performance Evaluation). When establishing the process(es) for external communications, including who to communicate, what to communicate, when to communicate, to whom to communicate and how to communicate, cover the public disclosure of the content established by Requirement 15.1 of the Standard and the obligation to provide local authorities and emergency services with information from the analysis of breach formation (7.4/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.11 Communications).
Requirement 15.2	When establishing the process(es) for external communications, including who to communicate, what to communicate, when to communicate, to whom to communicate and how to communicate, define how and when to respond to stakeholder demands (7.4/ISO 14001 + ISO 45001; corresponding section in the Tailings Guide: 4.11 Communications).
Requirement 15.3	By determining external and internal issues that are relevant to its purpose and that affect its ability to achieve the intended results of its environmental and OH&S management system (4.1/ISO 14001 + ISO 45001), and also seeking to understand needs and expectations of its stakeholders (4.2/ISO 14001 + ISO 45001), assume as one of the compliance obligations the commitment to cooperate with plausible global transparency initiatives aimed at creating databases, inventories or other information repositories (5.3 + 6.1.3/ISO 14001 + ISO 45001; corresponding sections in the Tailings Guide: 3 Policy and Commitment + 4.4 Conformance Management).

Table 1.
Comparative analysis between the requirements of the Standard and ISO standards.

5. Conclusion

The recent publication of the Global Industry Standard for Tailings Management prompted some modifications or adjustments to the main MAC reference documents, such as the Tailings Guide “see [2]”, but these changes did not have a major impact on the model originally proposed in the article published by authors in the journal Mine Water and Environment entitled ‘Integrated Risk Management in Mine Tailings Facility’ “see [1]”. In a way, however, the Standard induced a different view on the applicability of ISO standards to tailings management, in particular the ISO 9001 standard.

In our previous article, we considered as a differential the use of requirement 8.3 of the ISO 9001:2015 standard, as one of the tools for integrating MAC guides to ISO standards, although the focus was on the design and development of products and services. In line with our purposes, by identifying some works edited by TC 176, the committee responsible for the work on ISO 9001 at ISO, we identified recommendations for using this requirement for process design, as can be seen in the document ISO 9001 Auditing Practices Group - Guidance on: Design and Development Process, “see [13]”.

In addition, through the Standard, it was possible to increase the scope of the applicability of ISO 9001, including, in this text, issues associated with the context of the organization, risk mentality and quality plans, which were not previously considered.

Finally, the interpretation of the Standard led us to conclude that its design did not take into account the current models of management systems, making it repetitive in some of the established requirements, and we believe it is appropriate that, in a future revision, the Standard becomes be organized according to the superior structure of Annex SL, used in the ISO standards of management systems and based on the PDCA cycle.

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