STATE OF NEW MEXICO
BEFORE THE WATER QUALITY CONTROL COMMISSION

In the Matter of:	)	
PROPOSED AMENDMENT TO 20.6.2 NMAC (Copper Rule)	)	**No. WQCC 12-01(R)**

EXHIBIT SCOTT – D-11

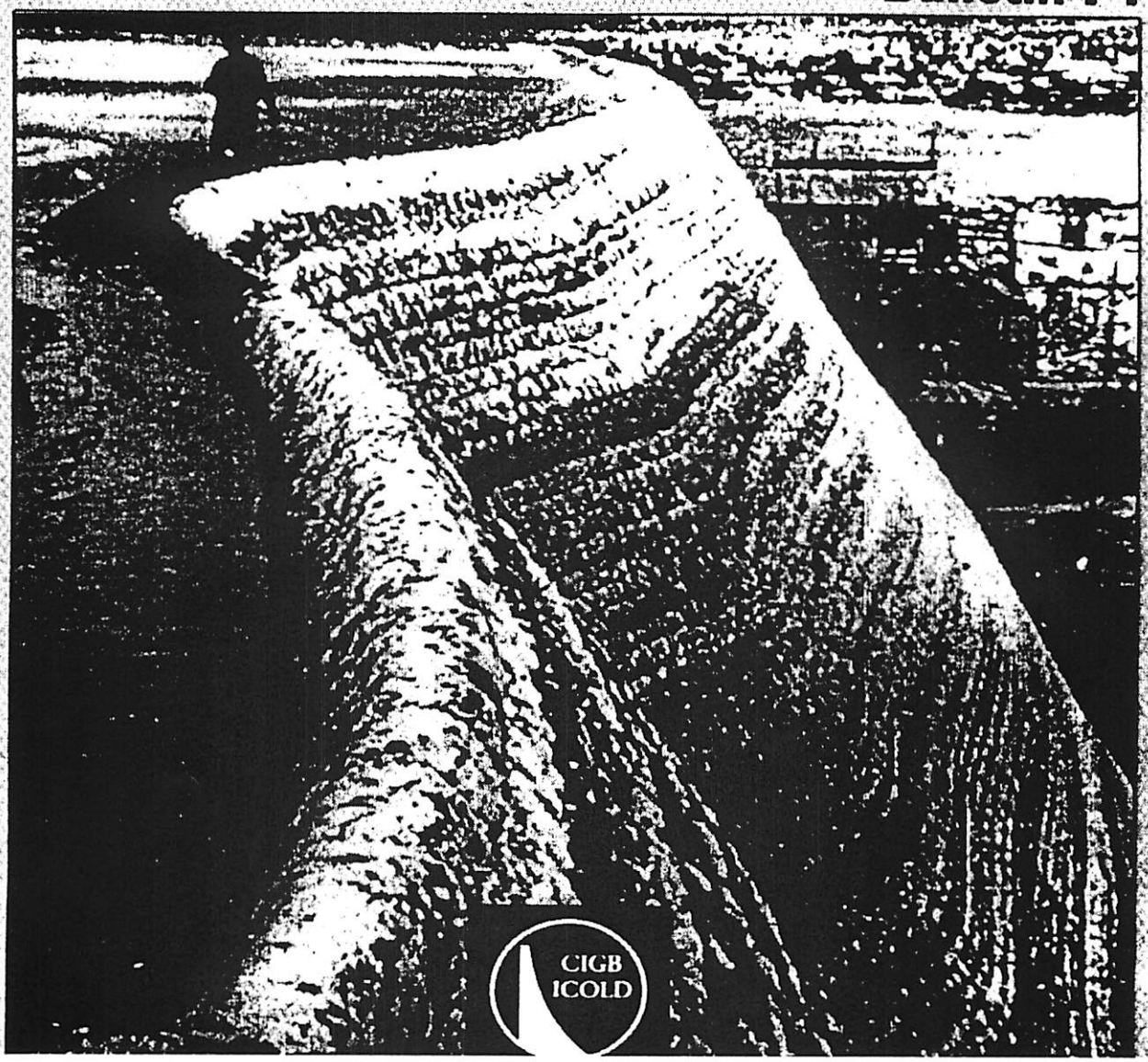
TAILINGS DAM SAFETY.

Guidelines.

BARRAGES DE STÉRILES MINIERS SÉCURITÉ.

Recommandations.

Bulletin 74



4. DESIGN

4.1. HYDROLOGY AND HYDRAULICS

4.1.1. General

The tailings and water stored behind the dam are usually toxic and, in many instances, no discharge of effluent is allowed (closed circuit tailings pond). For this case the pond water balance becomes a critically important factor as all water entering the pond must be stored or treated before release.

Even if the discharge of surplus effluent is allowed during high runoff periods, handling large volumes of water poses many problems and often requires the construction of a series of spillways, each at successively higher elevations, as the tailings dam is raised.

For the above reasons, tailings dams, unlike conventional water storage dams, should be located such that the watershed contributing to the tailings pond is kept to a minimum value. Where this cannot be achieved diversions should be constructed to convey the excess runoff around the tailings pond.

4.1.2. Design Methods and Criteria

Before starting the actual design work, the criteria upon which hydrologic and hydraulic design are to be based should be defined and documented. In the selection and definition of design criteria, account should be taken of such items as : amount and accuracy of available hydrologic and correlated data; availability of processing methods and equipment; degree of precision of computational methods including computer software to be employed; and the possibility of substantial modification in the drainage area by the diversion of surface water around the tailings pond.

Design methods should conform to current state-of-the-art procedures.

Design criteria must satisfy the regulatory requirements applicable to the project.

In those instances where major hydraulic structures are a part of the tailings storage facilities, consideration should be given to the need for and suitability of hydraulic model testing, as a check on hydraulic layout and design derived from theoretical analyses.

The effect of wind and waves should be analyzed when determining the necessary freeboard of the tailings dam above normal operating level, and the slope protection required. (For tailings dams with wide flat beaches, special wave protection is not required.)

4.1.3. Design Flood

Accuracy and reliability of hydrological data derived from historical records should be checked by theoretical computation. To this end, procedures based on

precipitation records, comparison with runoff data from neighbouring drainage areas, etc., may be applied. Conversely, values resulting from purely theoretical computations should be checked by similar comparative techniques against available data records.

If little or no historical record is available, data on which design can be based may be obtained from correlation with hydrologic and meteorologic records from neighbouring drainage areas. However, care must be exercised in determining relationships and conversion factors. The resulting values should be checked in the field by runoff measurements, comparison with marks left from floods, etc.

The design of major tailings dams, where failure could result in loss of life and extensive property damage, should be based on the probable maximum flood (PMF). The latter should be derived from the combination of maximum precipitation with the most unfavourable runoff conditions and is to be used to produce the design flood hydrograph. For tailings dams that allow downstream discharge during high flows, the PMF is usually handled by a combination of storage and spillway discharge. For closed circuit tailings dams, where no discharge is permitted, the tailings dam must provide sufficient freeboard to allow the storage of the PMF as a surcharge on the tailings pond. Suitable emergency spillway capacity should also be provided so that in an emergency (e.g. high pond levels due to a mine shutdown plus a PMF), surplus water could be spilled downstream to prevent overtopping of the tailings dam. Although the discharge of toxic waters is to be avoided if at all possible, controlled discharge is preferable to having the dam overtopped which could result in a catastrophic failure with the release of huge volumes of tailings and water.

4.2. STRUCTURAL DESIGN

4.2.1. Design Methods, Criteria and Strategy

Design methods and criteria should conform with current state-of-the-art knowledge.

Before beginning the actual design work, the criteria upon which the design of the tailings dam and appurtenant works are to be based should be defined and documented.

Design criteria must satisfy the regulatory requirements applicable to the project.

Design strategy should take into consideration the following specific safety related requirements :

— performance of all design work by an organization specialized in the design and construction supervision of tailings dams, under the direct management of a tailings dam engineering " generalist ";

— avoidance of unnecessarily complicated design concepts and details;

— compatibility of design and available construction experience, technology, materials and equipment;

— careful theoretical and experimental investigation of new design concepts and/or unconventional construction methods and materials, if either one should be employed;

— provision for adequate access to all critical areas of the tailings dam in order to facilitate safety surveillance and possible future repair or rehabilitation work;

— provision of adequate ventilation of galleries, shafts, tunnels, instrument houses, water carrying ducts or other enclosed spaces that can be entered for work or inspection or in which inflammable or toxis gases can accrue;

— provision for as simple operation and maintenance conditions as possible;

— provision of flexibility in the design so that adjustments can be made readily should some of the original design criteria change (i.e. fineness of grind, volume of tailings to be stored, etc.).

Design computations, considerations, investigations, testing, conclusions and decisions should be thoroughly documented.

The designer should supply the construction force with complete details of all civil engineering structures. No detailing should be left for the contractor, the owner or the operator.

4.2.2. Loads and Safety Factors

The tailings dam and appurtenant works should be designed to withstand the most severe and unfavourable combination of static and dynamic loads including those that may occur only during construction. Safety factors, however, may vary in accordance with the probability of occurrence of such combinations.

The effect of loading relief devices, such as uplift relief or pressure relief drains, should be taken into account when analyzing the structure's stability, with the application of conventional safety factors. However, the structure's safety should also be ensured by computation under the assumption that those loading relief devices are not functioning. In this case, however, a reduced safety factor would be appropriate.

When determining loads and loading combinations, their possible alteration with aging of the tailings dam should be taken into account.

For economic reasons, it may be desirable to base design on the most probable conditions rather than on the most unfavourable conditions that could prevail. In this case, however, it is absolutely necessary to provide for efficient and reliable monitoring during construction and the early stages of operation.

4.2.3. Geotechnical Investigations

The amount and extent of foundation exploration should be appropriate to the size and importance of the structure and to the complexity of the local tectonic and geologic features. The exploration program, as well as the geotechnical analysis and design, must be guided by the site-specific requirements and conditions and should be capable of revision as required to satisfy actual site conditions as they are revealed.

The main objectives of the detailed geotechnical investigations should include determining the :

— site geology of both superficial deposits and the bedrock. This should include detailed soil and bedrock stratigraphy, giving depth, thickness, continuity and composition of each significant stratum and a history of deposition and erosion;

— site hydrogeology, including : definition of aquifers and aquicludes, determination of the piezometric pressures in all aquifers; determination of hydraulic conductivity; determination of both local and regional groundwater flow systems;

— geotechnical properties of the soil and rock strata that may effect design of the waste impoundment structure;

— availability of suitable construction materials for building dams or dykes and impervious linings.

When interpreting the results of laboratory and/or field tests, it should be kept in mind that results relate to samples. To transform such results into numerical data upon which design can be based, the relationship of the samples to the geological structure as a whole has to be considered.

By taking advantage of appropriate field observations during excavation, design decisions may be based on the most probable foundation conditions that can reasonably be expected, rather than on the most unfavourable conditions which would be deduced from the analysis of a necessarily limited amount of data from foundation exploration. As construction goes on, reliable information on the real subsurface conditions will be obtained and possible shortcomings in the design can be remedied. Thus, unnecessarily conservative solutions determined *a priori*, with corresponding higher costs, can possibly be avoided. If observation during construction indicates the necessity of stronger or more sophisticated foundation works, additional expenditures may be required. Using this approach, however, it would be absolutely necessary to devise in advance, appropriate means for the reliable solution of problems which may develop should observations disclose less favourable conditions than those upon which the design has been based.

4.2.4. Seepage

Seepage control is a critically important aspect in the design, construction, and operation of tailings dams as it directly affects : the stability of the downstream slopes, internal erosion due to piping, and pollution of ground and surface waters downstream of the dam. Seepage losses, which might be entirely acceptable for a conventional water storage dam could be unacceptable for a tailings dam because of the pollutants contained in the seepage water.

Theoretical forecasts and analyses of the permeability of foundations and embankments and of the rate of seepage flow to be expected should be furnished by the designer.

Adequate means of minimizing seepage flows such as cutoffs, grout curtains, impervious blankets, etc., should be incorporated into the tailings dam design as required.

Adequate filters and drains should be provided to allow seepage flows to safely pass through foundations, abutments, and embankments and be collected and measured. For tailings dams the water quality of seepage flows should also be determined.

4.2.5. Seismicity

Determination of the stability of a tailings dam under earthquake loading is a critically important aspect of tailings dam design. Loose, saturated sands of the gradation normally produced from mine tailings are highly susceptible to liquefaction under earthquake loadings, as are the tailings stored behind the dam. Liquefaction of the tailings in the pond places an additional sudden shear force on the dam (the difference between earth pressure at rest and the liquefied tailings) which does not occur for conventional water storage dams. Consequently, all dynamic analyses for tailings dams, including pseudo-static, simplified, and complex state-of-the-art, must be adjusted from the procedures used for the analyses of a conventional water dam to compensate for this extra shear force. The end results are an increase in pore pressures along each failure surface as well as an additional inertial force against the dam.

The consideration of earthquake motion in the design of a tailings dam to be built in a region of natural seismic activity is mandatory. Earthquake engineering is a field of specialization subject to rapid evolution. The analysis of the response of a tailings dam to seismic activity should therefore be based on, and guided by, the latest standards and methods.

To evaluate seismic potentiality, historical earthquake records as well as the influence of faulting or other tectonic features on the estimate of the occurrence, magnitude, and location of possible seismic activity should be carefully examined. If it is determined that no seismic forces should be considered in the design analyses, such determination should be justified and documented.

For major tailings dams, where failure could result in loss of life and extensive property damage, seismic analysis should be based on the maximum credible earthquake (MCE). This analysis should not be limited to structures but extended to all equipment essential for safe operation and should be carried out in accordance with current technology. The maximum credible earthquake is defined as the hypothetical earthquake that could be expected from the regional and local potential sources for seismic events and that would produce the severest vibratory ground motion at the site. Although the tailings dam and appurtenant structures might be badly damaged from the effects of a MCE, the essential criterion is that the dam maintains its integrity and does not allow the release of impounded water and/or tailings.

4.3. INSTRUMENTATION AND MONITORING

4.3.1. General

Instrumentation and monitoring of tailings storage facilities falls into three categories. The first category includes all work carried out prior to design and

construction of the facility. The second category includes all work carried out as part of the performance monitoring of the operating facility. The third category includes all work carried out after the mining operations have ceased and rehabilitation has been instituted. All three phases of monitoring are important and should be considered as part of the design requirements.

Monitoring of a dam for safety reasons should include those observations essential for the evaluation of the structural stability and integrity.

The monitoring system and program must be flexible enough to allow for possible changes from anticipated conditions, during construction and/or operation. It should also be compatible with the degree of education, ability, and customs of the people who will ultimately operate the project.

The monitoring system should be designed with the necessary duplication to prevent failure and provide the facility for checking.

The designer should provide detailed instructions for the installation and reading of the monitoring equipment and for data reduction and evaluation.

Complete records on the design, installation, testing, repair, and performance should be kept for every monitoring device.

4.3.2. Preconstruction Instrumentation and Monitoring

Early in the site investigations, a climate-hydrology package of observations should be formulated. This data is scarce to non-existent at many mining sites and the designers are usually forced to extrapolate from the nearest site having such data when making their preliminary designs. Climate-hydrology observations are therefore needed as soon as possible to provide a check on the extrapolated data and to start an accumulation of climate-hydrology data that applies to the specific site.

Piezometer installations made for the prime purpose of measuring water pressures in both the overburden and bedrock strata are one of the major items of preconstruction instrumentation. All piezometers should be read on a regular basis throughout the entire year. This permits seasonal variations and trends in piezometric pressures to be observed and recorded.

Water quality determinations should also be made on samples taken from the various identified aquifers. These date are important for establishing the base line values for water quality prior to the start of mining operations. The piezometer installations, whenever possible, should be designed in such a manner that they may also be used as water sampling stations and thus reduce or eliminate drill holes required for water sampling programs.

4.3.3. Performance Instrumentation and Monitoring

Performance monitoring of the ongoing, Stage II tailings dam construction is an important procedure required to determine if the structure is behaving as anticipated by the designers. This monitoring also provides the record data usually

required by the Regulatory Agencies for their assessment of the tailings facilities. Performance monitoring normally should include such items as : piezometers, settlement gauges, alignment gauges, inclinometers, and water quality measurements. For major tailings dams in areas of high seismicity, a seismic monitoring system should also be installed.

4.3.4. Rehabilitation Instrumentation and Monitoring

Rehabilitation monitoring is primarily concerned with surface and groundwater quality, and wind and water erosion. For uranium tailings ponds radon gas emissions also require monitoring.

4.4. TAILINGS POND PLANNING AND DESIGN

4.4.1. Site Selection

Tailings ponds containing toxic fluids should be sited at areas where the base and sides of the pond are relatively watertight so that large toxic seepage losses do not occur into ground or surface waters downstream of the pond. Where pervious foundation of abutment conditions exist these should be treated by grouting, impervious cutoffs, impervious blankets or other suitable means.

Wherever possible, tailings ponds should be located at areas where the watershed contributing to the tailings pond is relatively small.

Tailings ponds should not be located on major streams where large flood volumes must be either diverted around the pond, stored in the pond, spilled, or handled by a combination of two or more of these procedures.

4.4.2. Design

The materials stored in the tailings pond comprise water and tailings. The volume of water stored and the location of the free water surface within the tailings pond varies from one mining operation to another. In a few instances tailings dams are designed to have water stored against their upstream face and must perform the same function as a conventional water storage dam. However, most tailings dams operate with a wide slimes beach against their upstream face. This slimes beach acts as the upstream impervious zone for the tailings dam, which in most instances is built of pervious tailings sand.

An accurate water balance must be developed for the tailings pond so that the designer can determine whether there will be a net gain or loss of water into the pond. To make such a calculation the designer must have accurate data concerning : mill production rates, concentration of slurried tailings, bulk density of deposited tailings, reservoir capacity volumes, mill reclaim water volumes, evapotranspiration losses, seepage losses, and hydrology of the watershed for the tailings pond.

For " closed circuit " tailings pond designs the following two basic requirements must be met :

— Seepage from the tailings pond must not be allowed to bypass the tailings dam and flow downstream of the mining property (usually accomplished by constructing a small seepage recovery dam downstream of the main tailings dam which collects all seepages for return to the tailings pond).

— As much water as possible must be reclaimed from the tailings pond for re-use in the milling operation. This means that the volume of fresh, make-up water used in the milling operation must be kept to a minimum. Failure to do so can result in a surplus of free water in the tailings pond, which over a period of time can amount to very large quantities of water that must either be stored along with the tailings or treated to meet environmental water quality specifications before being released.

Accurate tailings pond volume curves must be developed from the water balance calculations, to show the relationships between height of dam and : total volume of tailings pond created; total volume of tailings solids; and total volume of free water in the pond using average yearly runoff figures. Superimposed on these volume curves should be the sudden increase in volume of water storage required to store the design spring runoff and/or any major design storms or flows that must be stored in the tailings pond.

To minimize the amount of runoff water that must be stored behind the tailings dam, as much runoff as possible should be diverted around the tailings pond. However, even this precaution may not eliminate the need to store an appreciable volume of water behind the dam during periods of heavy spring runoff or extended, heavy rainfall which might exceed the design capacity of the diversion ditches and overflow into the tailings pond. This sudden surcharge of runoff water can be a very critical factor and usually controls the dam crest elevation that must be maintained to provide the required storage for such flood flows.

Where decant towers and pipelines are used for reclaiming water from the tailings pond they must be adequately designed to resist the soil and water pressures that will be exerted on them by the ultimate height of the tailings facility. They must also be constructed of materials that will satisfactorily resist attack from any corrosive elements contained in the tailings pond. For new tailings facilities, floating pump barges are frequently used to reclaim water from the tailings pond. This alternative eliminates the concern for the safety of decant towers and lines that must be kept operative for long periods of time, under very high dams, in a corrosive environment.

Emergency spillway alternatives should be incorporated into the tailings pond design so that in an emergency surplus water can be discharged by spilling rather than risk overtopping the tailings dam which could result in a catastrophic failure.

Wave erosion protection should be provided for those tailings ponds that are constructed like a conventional water storage dam and operate with a free water surface against their upstream face. However, for those tailings ponds that maintain a wide, flat beach between the tailings dam and the free water in the pond, wave protection is not required.

4.5. DAM INSPECTION

The designer should prepare a set of guidelines setting out the inspection, monitoring, and quality control requirements for both the Stage I, starter dam construction, and the Stage II, construction by the owner.

These guidelines should clearly define the purpose and objectives for each of the above items so that the owner understands the reasons and the need for the recommended inspection, monitoring, and quality control.

In cooperation with the owner and the Regulatory Agency, the designer should develop instructions for the handling, processing and circulation of data and information obtained from inspection.

4.6. EMERGENCY PLANS AND PROCEDURES

Due consideration should be paid by the designer to possible emergency situations that would affect the dam's safety, and the resulting necessity for emergency operations. Corresponding provisions should be made in the design.

4.7. REHABILITATION PLANS

At the end of the mining operation (closure) the owner should prepare for the Regulatory Agency a report outlining in detail the proposed rehabilitation plan for the tailings dam and tailings pond. The report should cover such items as : method of rehabilitation, surface and subsurface seepage control, spillways, erosion protection measures, the rehabilitation monitoring plan, etc. The rehabilitation plan must be site specific as rehabilitation requirements will vary from one tailings pond to another, in somes instances the entire tailings pond area may be drained and seeded, whereas in other instances, this may not be possible and a permanent pond may be maintained over part or all of the area.

4.8. DESIGN APPROVALS

The procedure and requirements for the formal approval of design documents and authorization of construction may be the subject of National or State (Provincial) legislation. As part of its supervisory function, however, the Regulatory Agency should directly or indirectly participate at least in the formal approval of the basic design documents and in the issue of the construction authorization.

In countries where there are no legal requirements that call for checking of the quality and formal approval of all detailed documents, an efficient routine checking procedure should be established, preferably by mutual agreement between the Regulatory Agency, the owner and the designer. Such checking and approval should include at least the design criteria, design concepts, design methods, input parameters, major decisions, factors of safety, and safety-relevant details. Detailed design documents should undergo essential in-house checking by the designer's own staff. Additional checking by a specialized unit of the owner's organization or by independant consultants retained by the owner may be agreed upon if deemed necessary.

APPENDIX B

GUIDELINES ON TAILINGS DAM LEGISLATION

INTRODUCTION

The first Committee on Mine and Industrial Tailings Dams was formed during the 44th Executive Meeting of ICOLD held in Mexico City, Mexico, in 1976. In 1982 it drafted ICOLD's Bulletin 45, entitled " Manual on Tailings Dams and Dumps ".

" Tailings Dams " are defined as structures (dams) constructed of mill tailings, mine and other industrial wastes or earth or rockfill, for the impoundment of tailings. Tailings from the mining industry consist of fine waste (usually silt or sand size) transported hydraulically for disposal in tailings impoundments which are eventually rehabilitated.

" Tailings Dams " differ from conventional dams in that they retain solid materials as well as water.

Bulletin 45 covers all technical aspects of the siting, design, construction, operation, maintenance and eventual closure and rehabilitation of Tailings Dams and Dumps. Suggested guidelines for drafting and enacting legislation and regulations applying to the undertaking of these activities are now submitted herein.

Some countries have already introduced legislation to regulate the design, construction, operation and maintenance of water diversion or storage dams (water retaining dams), to assure their permanent safety and environmental compatibility vis-a-vis human property and life. In only a few countries have similar measures been taken in connection with tailings dams, although they have many features in common with water retaining dams.

Priority has properly been given to the introduction of regulatory legislation applying to water retaining dams because they frequently consist of very large structures impounding enormous volumes of water and flooding extensive land areas in well-developed regions, thus presenting the potential risk of catastrophic disasters in case of structural failure.

Water retaining dams are usually built and maintained by public service licensees or concessionaires already subject to regulatory legislation and operating under the jurisdiction of Government authorities, thus facilitating the registration and inspection of the structures as well as the enforcement of any applicable safety and environmental regulations.

However, tailings dams and tailings dumps may be constructed as an operating routine by a large and varied number of enterprises whose activities, excepting those of mining developments and a few others, may not be subject to specific regulatory legislation and to the jurisdiction of Government authorities.

Therefore, if any country desires to introduce legislation and regulations applying to tailings dams and tailings dumps, adopting, if it so decides, the guidelines suggested below, it must determine within the law of the country, which national, regional and/or local authorities will be charged with the execution and enforcement of the regulations.

RECOMMENDED GUIDELINES

1. Complying with the applicable provisions of the law of the country, the Government should institute a " National Commission of Tailings Dams " (hereinafter referred to simply as National Commission), with the responsibility and commensurate authority to :

a) prepare or complete a comprehensive Register of Tailings Dams, existing, under construction or planned, as well as those closed or abandoned;

b) draft specialized regulatory legislation applying to tailings dams (hereinafter referred to simply as Legislation), and promote its enactment through the proper legal channels.

2. The members of the National Commission should have a mandate limited to five years and would represent the various sectors involved (Civil and mining engineering, health, environment, public communities, etc.).

3. The Register should include the location and owners of existing or planned tailings dams, either mining, industrial or any other enterprise, and should list the existing regulations or legislation, if any, applicable to such enterprises although not specifically referring to tailings dams, and the existing Government authorities, if any, under whose jurisdiction the said enterprises operate.

4. The Legislation should regulate the permit application, design, construction, operation, maintenance, through and including the closure and rehabilitation of tailings dams, so as to ensure their permanent safety against possible loss of life, health hazards or damage to property if a failure occurs. To provide the technical and procedural basis for this regulation, the National Commission should also prepare, or have prepared by competent engineering consultants, appropriate Guidelines, which will also be enacted as an appendix to the Legislation. In the preparation of these Guidelines the information and recommendations contained in ICOLD's Bulletin 45 should be taken into due account.

5. The Legislation should be compatible with the information obtained through the Register, i.e. with the number, location and variety of existing and planned tailings dams, and the enterprises owning them; as well as with any Legislation already in effect applicable to the licensing and operation of such enterprises but not specifically referring to tailings dams. It should also appoint the national, regional and/or local Government authorities (hereinafter referred to simply as " Authority ") and specify the areas of jurisdiction that will be permanently assigned to each Authority, which thereafter will be responsible for the enforcement of the legislation and monitoring all the phases of tailings dam construction, from permit application through rehabilitation and afterwards. It shall also be the duty of the Authority to maintain up to date its section of the Register of Tailings Dams for the

National Commission, and to make copies of the updated register available for inspection at all reasonable times by any person.

6. As allowed by the law of the country, and convenient from the administrative standpoint, the Authority may be the National Commission itself whose activities would then be permanent and extended beyond the elaboration of the Register and of the Legislation. In this case, the National Commission, after expiration of the mandate of its members, the staff of the Commission may be reorganized to fit the requirements of its permanent functions as recommended elsewhere in these Guidelines.

7. The Legislation should apply, with full enforcement, to tailings dams that :

a) have a final height of 15 m or more above adjoining land, or

b) impound a tailings volume greater than 20 000 m^3; or

c) irrespective of these dimensions, could either cause health hazards or lead to loss of life or damage to property if failure occurs.

8. The Legislation should make it clear that, despite the enforcing powers granted to the Authority to register, license and monitor the development of tailings dams through all their stages, this should not exempt the mining, industrial or other enterprises owning them, from their full responsibility for any accident or prejudice caused directly or indirectly by the failure of their tailings dams or associated with the creation of tailings impoundments, be it loss of life, damage to property or environmental impact. This responsibility should be extended beyond the time of closure if the structures represent a long-term hazard.

9. The Government agency to be permanently responsible for the enforcement of the Legislation (the Authority, or the National Commission itself if the latter's activities are permanently extended) should be administered and directed by a civil engineer experienced in the design and construction of tailings dams and reservoirs and it should employ such clerical, engineering, and other assistance as are necessary for the efficient monitoring and supervision of all phases of tailings dam development in accordance with the Guidelines and the Legislation, including necessary procedures whereby the siting, design, construction, maintenance and operation of the tailings dams would be undertaken under the effective supervision of duly qualified engineers.

10. Mine or industry owners should apply to the Authority for a permit prior to undertaking tailings operations. The application should be duly supported by information on the intended concept and scope, the physical and chemical nature of the tailings, results of surface and subsurface investigations and environmental impact. The supporting information should comply with the requirements of the Guidelines. The Authority could, on its judgment, request further information or impose independent assessment by a third party. Any change brought in the course of operations to the size of the dam or associated impoundment would be subject to further permit application.

11. Owners of tailings dams should notify the Authority in advance of the proposed closure of any tailings operations. The notification should be followed by information on the state of conditions and a description of the rehabilitation procedures. Those should be supported by a certificate of inspection issued by a qualified engineer. The Authority could, on the recommendation of the inspecting

engineer or its own judgment, make the owner responsible for monitoring (stability assessment, control of effluents) over a period of time from the closure operations, and to undertake any repair or remedial work which could become necessary at any time over that period. The Authority would reserve the right to proceed, from time to time, with independent inspection and controls.

12. The development of any tailings dam through all its phases, including siting, design, construction, operation, maintenance, closure, rehabilitation, and afterwards, should always be under the technical supervision of qualified engineers, representing the owner of the tailings dam. Check may be required, particularly :

a) at completion of design, before the start of construction;

b) as soon as possible after any alteration of design;

c) at regular intervals during construction;

d) immediately after construction completion, and

e) two years after closure and rehabilitation.

13. The routine supervision of the works by the owner's engineers should ensure, as provided by the Legislation and its Guidelines and through duly recorded recommendations, the safety of the tailings dam and its impoundment against loss of life, health hazards or damage to property.

14. The construction of any tailings dam, or any significant alteration of its design or construction procedure, should be preceded by an Initial Certificate, signed by both the owner's and the Authority's engineers and submitted to the Authority confirming that all the siting and field investigations and all the designs are approved and that construction may start.

15. At the end of operations and just after closure and rehabilitation, a final certificate should also be submitted by the owner's and the Authority's engineers, testifying that the works have been properly executed in accordance with detailed drawings and engineering information. It should be accompanied by a full description of the project as constructed including dimensions, levels, details of the site geology, and properties of the tailings.

The Authority should consider the possibility of securing a bond for closure and rehabilitation, prior to issuing a permit to operate.

CONCLUSIONS

In order to enable the Authority to perform its functions and duties properly, the Legislation should give it full powers to :

a) require the owner to produce documents related to its tailings dams;

b) be able to enter the tailings dam area for inspection purposes at any time;

c) require the owner to carry out remedial work;

d) carry out essential and urgent remedial work whenever the owner is unable to do it at the proper time; in such cases the Authority will have the powers to recover from the owner the cost of this remedial work.