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-3

GUIDELINES ON TAILINGS DAMS

PLANNING, DESIGN, CONSTRUCTION, OPERATION AND CLOSURE

MAY 2012

ANCOLD

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2.5.2.4 Emergency Response Plan/Dam Safety Emergency Plan

An Emergency Response Plan (ERP) or Dam Safety Emergency Plan (DSEP) outlines the required procedures to:

- protect a dam and the associated community in the event of an emergency which may threaten the dam's security;
- define the basis of communication and responsibility in an emergency;
- notify the Emergency Authorities during a potential dam failure emergency;
- provide relevant information to assist the Emergency Authorities in its emergency planning for areas affected by dam breach and loss of water and tailings;
- provide guidance on action that could prevent or minimise dam failure in the event of a safety incident. This could include actions such as placing rockfill in piping breaches, raising the crest during overtopping events, etc.

An ERP/DSEP outlines the required actions of owners and their personnel in response to a range of possible emergency situations.

The ERP/DSEP should be prepared in accordance with Guideline on Dam Safety Management (ANCOLD, 2003).

2.5.2.5 Closure and Rehabilitation Planning

Closure and Rehabilitation Planning should ensure that the tailings disposal area is left in such a way that it is able to:

- be structurally stable;
- maintain an acceptable impact on the environment;
- be resistant to deterioration through erosion or decay;
- be compatible with the surrounding unmined landform; and
- be functionally compatible with the agreed post-mining land use.

The above criteria should apply over the perceived time frame of the post-closure period, which may be indefinite. If there is no defined post-closure design life, ANCOLD recommend adopting 1000 years as a reasonable period as being considered "in perpetuity".

2.5.3 Observational approach

Tailings impoundments take many years to construct and can experience many changes which may require operational response. During the design phase, geotechnical predictions are often based on limited knowledge. The observational approach is a process of verifying design assumptions and using additional data, knowledge and lessons learned to revise, improve and optimise the design.

Central to the observational approach is an instrumentation and monitoring program to observe and record key leading indicators associated with design and performance criteria (e.g. seepage, phreatic surface, density, strength parameters).

The observed values are compared against the design predictions to evaluate if any changes in operation or design are needed. Instrumentation data reviews are helpful in identifying any imminent problems. However, more subtle behaviours may only be identified by yearly review. It is essential to react to changes well before they become a serious problem. The observational method provides the ability to address concerns through "prevention" rather than "cure".

The observational approach has proved to be of value in reviewing pore water pressure predictions. It is unrealistic to expect that the pore pressure conditions within a TSF could be accurately predicted throughout its operational life. During TSF operations it is common that conditions (depositional, mineralogical, process, weather etc.) change, leading to changes in the pore pressure conditions within the impoundment. The observational method addresses this uncertainty by checking the validity of the design pore pressure conditions and giving a basis for reviewing and revising models.

Another benefit of the observational approach is that it can reduce the upfront capital cost of a project. The design is based on "best estimate" conditions and the observational approach is utilised to check estimated parameters. The "best estimate" design is checked against actual conditions. Upgrade measures might be required following start-up if "best estimate" assumptions are incorrect. The observational approach is used to decide if and when any upgrade measures need to be constructed.

The observational approach can be a very effective way of optimising a Tailings Dam design but relies on a consistent input from competent personnel throughout the operation phase.

2.6 External (Third Party) Review

Planning should allow for strategic review by independent parties at critical phases of the TSF life cycle. Review could take place during concept and feasibility studies, design, construction and closure. Third party review is also recommended during operations.

These reviews are in addition to dam safety reviews referred to in Section 8.

velocity measurements, and (4) for gravelly sites, the Becker penetration test. Various correlations have been developed that relate the results from these tests to the resistance of the material against liquefaction, measured as cyclic resistance ratio (CRR). The CRR values are then compared with the seismically induced cyclic stress ratio (CSR) to determine if liquefaction will occur. CSR values could be estimated from the simplified procedure of Seed and Idriss (1982) or could be calculated using a more rigorous site response analysis approach, such as that implemented in the SHAKE computer program.

An alternative approach would be to use critical state based liquefaction assessment (Jefferies and Been, 2006).

If liquefaction is expected, reduced values of the undrained residual or post liquefaction shear strengths are estimated. If a material is not expected to liquefy it is still possible that pore water pressures will increase in the material and its shear strength may be reduced. The reduction in shear strength is generally related to the factor of safety against liquefaction, which is defined as CRR divided by CSR.

Once the post-seismic shear strengths have been determined, a conventional static slope stability analysis is performed to estimate the post-seismic stability of the structure. This analysis is considered to be applicable to conditions after the earthquake has ceased, and no additional acceleration forces are applied in the analysis.

Liquefaction assessment is a specialised area that requires expert knowledge. Susceptibility of materials to liquefaction is not only dependent upon the CRR/CSR values but also on many other material characteristics such as particle size gradations, Atterberg limits, etc. Guidance on liquefaction assessment and post-seismic stability can be obtained from Duncan and Wright (2005), Fell et al. (2005), Youd et al, (2001) and Seed and Boulanger (2008).

6.1.6 Acceptable Factors of Safety and deformation

There are no "rules" for acceptable factors of safety, as they need to account for the consequences of failure and the uncertainty in material properties and subsurface conditions. Table 8 shows the ANCOLD recommended factors of safety for tailings dams under various loading conditions.

Acceptable deformations should be determined in relation to the potential impact on the serviceability of the dam. Deformations should not reduce freeboards to unacceptable levels or result in the potential disruption of the filter with large shear movements. This could lead to delayed failure after an earthquake.

When presenting results, mode of failure (shape and location of the potential slip surface) and the internal stratigraphy of the section should be identified in addition to the calculated minimum factor of safety.

Table 8 Recommended factors of safety

Loading Condition (Note 1)	Recommended Minimum for Tailings Dams	Shear strength to be used for evaluation
Long-term drained	1.5	Effective Strength
Short-term undrained (potential loss of containment)	1.5	Consolidated Undrained Strength
Short-term undrained (no potential loss of containment)	1.3	Consolidated Undrained Strength
Post-seismic	1.0 -1.2 (Note 2)	Post Seismic Shear Strength (Note 3)

Note 1 See Section 6.1.3 for description of loading conditions

Note 2 To be related to the confidence in selection of residual shear strength. 1.0 may be adequate for use with lower bound results.

Note 3 Cyclically reduced undrained/drained shear strength and/or liquefied residual shear strength for potentially liquefiable materials.