12.2 Competence

Technical inspections should be carried out by the owner/operator on a regular basis, as described in this document, and may be supplemented by regulatory inspections, generally undertaken annually, by or on behalf of the Competent Authority. The owner/operator's inspections shall cover all aspects of the MWF operation, and should be undertaken by appropriately-trained operators, facility engineers and departmental managers, with annual safety, stability and compliance audits by an independent qualified engineer or team of engineers/inspectors.

For Category A facilities, both regulatory and technical inspector(s) or inspection team should possess the minimum required competence based primarily on years of experience of facility inspections together with suitable engineering qualifications, including relevant academic engineering degrees.

12.3 Background data for inspection and reporting

The inspection process shall draw upon background data and studies available for the MWF as well as other relevant information, including the design and operating parameters, the detailed design documentation and the permit, the site setting, related social, topographical, environmental, hydrological and seismological impacts, the extractive operation associated with the MWF, a description of the design and the operation's history.

12.4 Technical inspections

12.4.1 General

Depending on its complexity, the technical inspection of a MWF and the subsequent reporting should follow the general procedures shown in Figure 9 and be undertaken as follows:

— daily by the owner's operators;

— weekly by the owner's senior operators;

— monthly by the responsible MWF supervisor;

— quarterly by the MWF manager;

— annually by an appointed independent qualified engineer or team of engineers/inspectors, on behalf of the owner.

The proposed frequency of technical inspections should be included in the Waste Management Plan and, in particular, be informed by the risk categorization. It is likely that in some jurisdictions a similar frequency of technical inspection regimes would apply to Non Category A facilities in cases where the risks posed are considered to require a higher level of observation and control. Non Category A facilities where a significant volume of water is stored above ground level may come into this category.

It is not anticipated that stability or hydrological reassessments will be required where technical inspections are undertaken annually, but it is the responsibility of the owner/operator to ensure that such reviews take place, at minimum, at five- or ten-yearly intervals, dependent on the risk.

Typical technical inspection frequencies for all project phases of a MWF are presented in summary in Annex J, Table J.1.

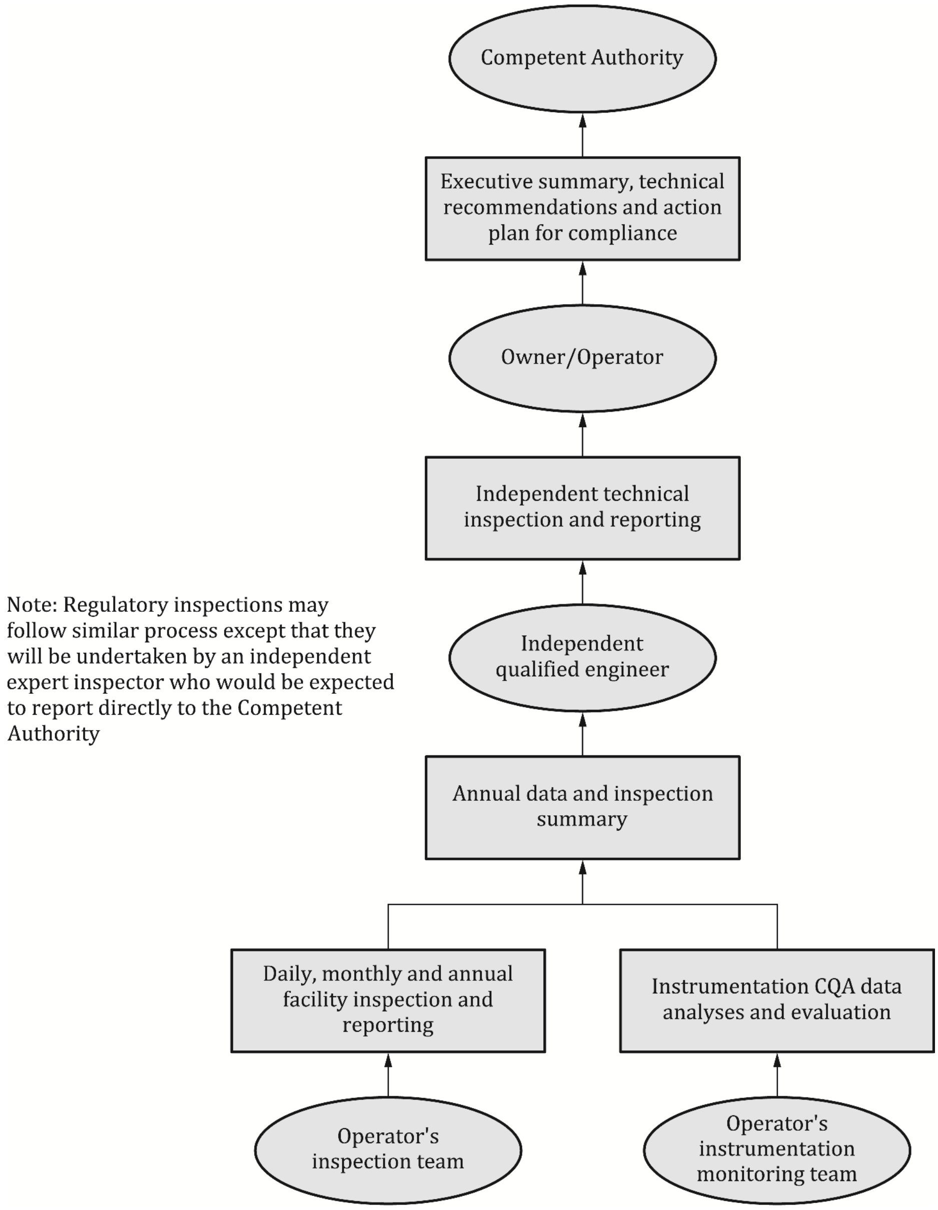

Figure 9 — Example of the Owner/Operator's technical inspection and reporting process

12.4.2 Daily inspections

Daily inspection of the MWF and its operation, together with the review of all specified monitoring records, shall be carried out by suitably qualified operators appointed by the owner/operator (Annex K, Table K.1). The frequency of these technical inspections may vary depending on the sensitivity of the facility and parameters to be monitored, with certain technical inspections and follow-up monitoring being required during each shift and others only at less-frequent intervals.

Any anomalies or deviating trends shown by the monitoring records or during inspections shall be promptly investigated and evaluated against the need for remediation and the risk posed to the safety of the MWF. These activities shall be documented to provide a continuous follow-up of the MWF so that any malfunction, as well as long-term trends, can easily be detected and enable remedial works to be undertaken early and without delay.

12.4.3 Weekly inspections

In addition to the daily technical inspection of the MWF a weekly technical inspection by the senior operator/shift supervisor should also be undertaken (Annex L, Table L.1). The facility supervisor should identify suitably-qualified personnel to undertake the weekly technical inspections and to follow up any contra-indications noted during the daily inspections and monitoring.

12.4.4 Additional technical inspections

Extraordinary events or incidents, e.g. heavy rainfall, pipe leakages or high water levels, should lead to an evaluation of the need to carry out technical inspections of specific aspects.

The operator should, in addition, consider the need for technical inspections of the facilities by senior personnel when appropriate in order to ensure that the regular monitoring and technical inspection routines are being undertaken adequately and that nothing untoward passes unnoticed. At minimum, the MWF supervisor should undertake a monthly inspection to confirm both safety and stability as well as compliance with all operating and inspection and monitoring criteria.

12.4.5 Inspection records

All daily, weekly, monthly and quarterly inspections shall be recorded in a suitable format and be signed by the responsible inspector and countersigned by an immediate supervisor. The inspection records should include comments on all non-compliances with operating, safety or environmental protocols. Any non-compliances shall be reported to the immediate supervisor and subsequent corrective actions suitably recorded. The OMS Manual should clearly identify reporting and remedial protocols to ensure that all non-compliances are suitably recorded and corrected and that the mitigating measures are detailed for future reference.

All inspection records shall be stored securely in a suitable future-proofed archive system.

12.4.6 Instrumentation records

Instrumentation records shall be regularly reviewed and compared with the operating criteria defined in the OMS Manual. The owner should identify suitably-qualified personnel for the data review process and the OMS Manual shall include a protocol for the event that instrumentation records exceed the operating criteria. Emergency protocols, including both reporting and mitigating actions, shall be clearly defined in the event that any data from a measurement device exceeds the maximum/minimum allowable or critical criteria.

All instrumentation records shall be stored securely in a suitable future-proofed archive system.

12.4.7 Regular surveys

To ensure that the MWF operates in accordance with the design criteria the following regular surveys should be undertaken:

— minimum embankment crests levels;

— deposition levels;

— reservoir levels, including the accuracy of any gauge boards or automatic level devices;

— control levels on all appurtenant structures such as decants, spillway weirs and critical pipeline/valve installations;

— surface control points for all instrumentation such as piezometers, settlement gauges and surface monitoring beacons;

— any other surveys deemed necessary by the operator.

The relevant frequency should be set based on an assessment of local conditions, such as rate of rise and climatic conditions. These records shall be regularly reviewed to ensure that the key operating parameters such as freeboard indicators (gauge boards) are accurately set.

12.4.8 Annual tests

Annual testing of all safety systems shall take place in order to ensure that all systems will operate in an extreme event and discharge excess water safely. The operation of any failsafe closure systems shall also be checked, and the sensors confirmed to be fully functional. Details of the tests and any remarks regarding the functioning of the valves and their operating condition shall be recorded on technical inspection sheets for further action.

12.4.9 Competence

The owner/operator shall ensure that any MWF is under the management of a competent person and that all personnel engaged in operation, surveillance, maintenance, safety preparedness, monitoring and control have the relevant competences and have been advised in writing of their duties and responsibilities. The expertise of all such personnel should be fully documented and include information related to education, training and experience.

The competence needed to act as an independent qualified engineer is detailed in subclause 12.5.1.

12.4.10 Annual reporting

The results of all technical inspections by the owner/operator shall be fully documented and stored in a future-proofed format. The results of all technical inspections, instrumentation and operational data, together with the results of any geotechnical/geochemical testing or other investigations, should be prepared annually and include a summary of the following:

— inspection records;

— construction records and CQA summary;

— deposition data;

— instrumentation records;

— details of any untoward incidents and the subsequent remedial measures;

— any health and safety or other issues.

12.5 Independent inspection regimes

12.5.1 The independent qualified engineer/inspector

The owner/operator shall appoint an independent qualified engineer to undertake regular independent inspections and reviews of the MWF's design and operation activities. The inspector shall possess the relevant qualifications and experience to be able to recognize best practice and to identify poor procedures and potentially serious defects so that these may be corrected and failures prevented. It is recognized that the range of skills and technical expertise required for an inspection of an MWF is broad, and thus it is unlikely that a practitioner with less than ten years' experience will have the necessary knowledge to undertake the role. The minimum qualifications should reflect the skills likely to be necessary to appropriately inspect and report on MWFs and to assess their potential environmental impacts.

12.5.2 Independent technical inspection procedures

The MWF technical inspection may require significant preparation and planning from the appointed independent engineer, who shall review all MWF data and inspect all relevant facets of the facility. The WMP and the OMS Manual should be used to provide the background to these technical inspections, and the performance of the facility should be assessed against these parameters in order to enable compliance with design and permitting objectives to be confirmed. The operator should prepare in advance a synopsis of all relevant inspection and monitoring data and instrumentation records, and provide this to the inspecting engineer before the inspection. Where necessary, additional data or sampling should be gathered during the inspection for confirmatory purposes.

Upon completion of the inspection, the operator should arrange a round-up meeting to discuss the preliminary results and recommendations of the technical inspection process with the relevant site personnel. This meeting should provide the opportunity to review any safety, stability or other issues which require urgent attention, and also for additional data requests to be made. This meeting should be fully minuted and be included in the final technical inspection report. A programme for technical inspection and reporting by the independent engineer is shown in Annex M, Table M.1.

12.5.3 Reporting

The preparation of the technical inspection report will involve significant data review and analysis, and may from time-to-time require stability assessments and hydrological reviews. The report shall summarize all the information obtained and shall identify any shortfalls, whether in the technical inspection regime, operations or sampling.

If the inspection has been contracted by the Competent Authority as a regulatory inspection or is required to validate the monitoring and technical inspection report provided by the operator, the report should be submitted directly to that authority.

Typical contents of the independent qualified engineer's inspection report are shown in Annex N, Table N.1.

12.5.4 Recommendations

The most important outcome of the independent technical inspections shall be clearly summarized in the conclusions and recommendations of the inspection report. In particular, any measures undertaken or planned by the operator in the interests of safety are of crucial interest. Recommendations for modifications to any aspect of the management, operation or technical inspection and monitoring of the facility shall be identified in the report and conclusions as being either in the interests of improving operational efficiency or in the interests of safety. It is therefore anticipated that the report would provide the following as part of these recommendations:

— Recommendations in the interests of improving operational/environmental performance;

— Recommendations in the interests of safety;

— Specific issues related to extractive waste phases;

— Timetable/action plan for compliance with the recommendations.

The recommendations included in the technical inspection report should be reviewed on a regular basis by the owner/operator and a record in the form of a compliance register made of the satisfactory completion of each where applicable. This record should then be made available for review at the subsequent technical inspection. Where the recommendation has not been addressed, the register should provide a clear and concise summary of the reason and of any interim risk mitigation measures taken.

Annex A
(informative)

Non-standardized geotechnical tests on hydraulic fill

A.1 Introduction

The characterization of the physical and mechanical properties of hydraulic fill requires the use of some tests not covered in the current European standard for geotechnical laboratory testing EN ISO 17892 (series). Some of these tests are presented in this Annex and include:

— Solids content test;

— Particle settling velocity test;

— Undrained settling test;

— Drained settling test;

— Air-drying test;

— Slurry consolidation test.

The above list is not exhaustive, and specialist advice should be sought when specifying and performing any of these tests, as well as any other test not covered in standards. The description that follows has been adapted from a document originally prepared by WLPU consultants.

A.2 Solids content test

A.2.1 Description

This test is used to determine the solids content (also known as concentration or pulp density) of a sample of hydraulic fill. The test measures the mass of solid material in a sample. Tests can be prepared at different solids contents to allow for process discharge changes. The same test can also be used to determine the water content of the slurry.

A.2.2 Apparatus

The following is needed to carry out the test:

— Oven set at (105 ± 0,5) °C;

— Balance.

A.2.3 Procedure

A sample of slurry is placed in a container and weighed. The slurry is then placed in an oven set at a temperature of 105 °C for 24 h, after which is weighed again. This process is repeated at regular intervals until the weight of the slurry equilibrates.

The following quantities are measured during the test:

— Mass of container, C (g);

— Mass of wet slurry and container before drying, W_{sc} (g);

— Mass of slurry and container after drying, D_{sc} (g).

A.2.4 Results

The solids content, *P*, as a percentage can be calculated from the following expression:

$$P(\%) = \left(\frac{D_{sc} - C}{W_{sc} - C} \right) \cdot 100$$

The gravimetric water content, w, can also be obtained from the same data:

$$w(\%) = \left(\frac{W_{sc} - D_{sc}}{D_{sc} - C} \right) \cdot 100$$

The solids content and water content are obtained from evaporation of the pore fluid. If the fluid filling the pores has a density significantly different to that of water, the above two equations will give erroneous results. For a pore fluid with a specific gravity, G_f, greater than 1 the following expressions should be used to determine *P* and *w*:

$$P(\%) = \left[\frac{(D_{sc} - C) - (W_{sc} - D_{sc}) \cdot (G_f - 1)}{W_{sc} - C} \right] \cdot 100$$

$$w(\%) = \left[\frac{W_{sc} - D_{sc}}{(D_{sc} - C) - (W_{sc} - D_{sc}) \cdot (G_f - 1)} \right] \cdot 100$$

A.3 Particle settling velocity test

A.3.1 Description

This test is used to determine the settling velocity of the coarse fraction of hydraulic fill. This allows definition of the minimum required operating pond area. During the test the time taken for particles of a given size fraction to fall a certain distance in a column of water is measured.

A.3.2 Apparatus

The following is needed to carry out the test:

— Stopwatch;

— 1 l measuring cylinder;

— Ruler;

— Thermometer;

— Balance.

A.3.3 Procedure

The following procedure should be observed during the test:

— The cylinder is filled to the 1 000 ml mark with deionised water.

— Both the internal diameter of the cylinder and the temperature of the water are recorded.

— The sample is divided into fractions depending on particle size:

  — Material retained in the 0,15 mm sieve;

  — Material passing the 0,15 mm sieve and retained in the 0,1 mm sieve;

  — Material passing de 0,1 mm sieve and retained in the 0,063 mm sieve;

— For each fraction, approximately 5,0 g are placed inside a small container and this is held over the measuring cylinder. The material is then tipped and the stop watch started.

— The time taken for all the particles that can be identified with the naked eye to reached the bottom of the cylinder is recorded.

— The process is repeated 5 times for each fraction, using fresh deionised water for each test.

A.3.4 Results

Results should be derived as follows:

— The average of five measurements is taken as the time for a given fraction to reach the bottom of the cylinder.

— Both the temperature of the water and the height of the water column should be reported.

— The particle setting velocity, obtained by dividing the height of the water column by the time taken for all the samples to reach the bottom of the cylinder, should be given in m/s.

A.4 Undrained settling test

A.4.1 Description

The test is conducted on a sample of slurry (hydraulic fill) at a given solids content by filling a one-litre measuring cylinder and monitoring the height of the mudline. The information derived from this test can be used to determine the rate at which the free (supernatant) fluid separates from the slurry (known as the bleeding rate) and the minimum density of the settled material when deposited under water (sub-aqueous deposition).

A.4.2 Apparatus

The following is needed to carry out the test:

— Balance;

— 1 l measuring cylinder;

— Stopwatch;

— Oven set at (105 ± 0,5) °C.

A.4.3 Procedure

The following procedure should be observed during the test:

— The mass of the 1 l measuring cylinder is recorded;

— A sample of slurry is placed inside the measuring cylinder and the mass and volume recorded;

— The top of the cylinder is covered to prevent evaporation and loss of material during shaking;

— The sample is vigorously shaken to ensure a homogeneous mix at the start of the test;

— The cylinder is placed on an even surface and the stopwatch started;

— The volume of the settled solids is recorded at intervals of time. The following recording times are recommended for plotting volumes against the square root of time: 0,25 min, 0,5 min, 1 min, 2,25 min, 4 min, 9 min, 16 min, 25 min, 36 min, 49 min, 64 min, 1,5 hr, 2 hr, 4 hr, 8 hr, 24 hr;

— Readings are taken until the volume of settled solids is constant;

— At the end of the test the slurry is removed from the cylinder and placed in a container of known mass. The slurry is dried in an oven set at (105 ± 0,5) °C and the mass of solids determined;

— Some of the dry material is used to determine the particle specific gravity as indicated in EN ISO 17892-3.

The following quantities are measured before the start of the test:

— Mass of measuring cylinder, C (g);

— Mass of measuring cylinder and slurry, W_{sc} (g);

— Initial volume of slurry in the cylinder, V_{T0} (ml);

— Initial time at start of test, T_0 (s).

The following quantities are measured during the settling period:

— Time when reading is taken, T_n (s);

— Volume of settled solids, V_{Tn} (ml).

The following quantities are measured at the end of the test:

— Time of final reading, $T_{f.}$ (s);

— Volume of final settled solids, V_{Tf} (ml);

— Mass of dry solids after drying, D_s (g).

A.4.4 Results

The mass, W_f, and initial volume, $V_{f.T0}$, of fluid in the slurry is obtained from the following expressions:

$$W_f\left(g\right) = W_{sc} - C - D_s$$

$$V_{f.T0}\left(ml\right) = \frac{W_f}{G_f \cdot \rho_W}$$

where ρ_w is the density of water (in g/ml) and G_f is the specific gravity of the pore fluid. The value of G_f can be determined with a hydrometer. The final dry density of the slurry, $\rho_{dry.Tf}$, is given by:

$$\rho_{dry.Tf}\left(\frac{g}{ml}\right) = \frac{D_s}{V_{Tf}}$$

An indication of the density of the solid particles, ρ_s, can be obtained from the expression:

$$\rho_s\left(\frac{g}{ml}\right) = \frac{D_s}{V_{T0} - V_{f.T0}}$$

The value of ρ_s obtained with the above expression can be compared with results from specific gravity tests.

The final volume of supernatant fluid expressed as a percentage of the initial volume of fluid in the sample, $V_{sup.Tf}$, is given by:

$$V_{sup.Tf}\left(\%\right) = \left(\frac{V_{T0} - V_{Tf}}{V_{f.T0}}\right) \cdot 100$$

The dry density of the slurry, $\rho_{dry.Tn}$, and the volume of supernatant fluid, $V_{sup.Tn}$, at any time T_n during the test can be obtained with the following expressions:

$$\rho_{dry.Tn}\left(\frac{g}{ml}\right) = \frac{D_s}{V_{Tn}}$$

$$V_{sup.Tn}\left(\%\right) = \left(\frac{V_{T0} - V_{Tn}}{V_{f.T0}}\right) \cdot 100$$

Values of $\rho_{dry.Tn}$ and $V_{sup.Tn}$ can be plotted against $(T_n - T_0)$.

A.5 Drained settling test

A.5.1 Description

A drained settling tests is similar in principle to an undrained settling test, except that the sample is allowed to drain from the base. The main purpose of this test is to determine the increase in final density when underdrainage is provided. The test can also be used to obtain an indication of quality of the free (supernatant) and underdrainage fluid emanating from the hydraulic fill.