Government of **Western Australia**
Department of **Mines, Industry Regulation and Safety**
Resources Safety

Underground mine fill audit – guide

Approved: 29 January 2016

1 Adelaide Terrace, East Perth WA 6004
Postal address: Mineral House, 100 Plain Street, East Perth WA 6004
Telephone: (08) 9358 8002
ResourcesSafety@dmirs.wa.gov.au
www.dmirs.wa.gov.au

Table of contents

Introduction

This document was reformatted in November 2015. At this time no material changes were made to the content of the guide, which was originally published in April 2011 under the title *Guide to underground mine fill high impact function (HIF) audit 2011*.

Note: The Safety Regulation System (SRS) has replaced the AXTAT system and all reporting is done online through SRS.

This mine fill audit tool has been provided to ensure consistency and raise standards in the Western Australian mining industry with regard to the use of paste or hydraulic fill and barricades for this purpose.

The applicable legislation, standards and code are listed below.
Where the term "verify" is used in this audit, there is a regulatory requirement for compliance with the standard. Where the term "ensure" is used, there is no mandatory requirement for compliance, but the standard sets out a recommended practice that, if followed, should minimise the potential for a significant incident.
A “competent person” is defined in section 4 of the Mines Safety and Inspection Act 1994.
It is recommended that operations conduct annual audits of hydraulic or paste fill related systems of work using this audit and Australian Standard AS/NZS 4801:2001 or International Standard OHSAS 18001:2007 to ensure:
· engineering design and systems of work adequately address the risks; and
· control measures are implemented, monitored for their effectiveness and reviewed regularly.

Risks should be:
· identified and prioritised using a multidisciplinary team-based approach;
· formally documented; and
· reviewed annually.

Legislation
Mines Safety and Inspection Act 1994
· s. 9 General duty of care
· s. 78(3)(a) and/or s. 78(3)(d) Recording of occurrences in the record book
· s. 79 Report potentially serious occurrences

Mines Safety and Inspection Regulations 1995
· r. 4.11 Flood protection
· r. 4.13 Induction and training of employees
· r. 4.30 Preparation of emergency plan
· r. 4.36 Specific emergency precautions required to be taken for underground mines
· r. 7.16 Stagnant water not to accumulate underground
· r. 7.29 Workplace atmospheric contaminant monitoring to be provided
· r. 9.12 Control of atmospheric contaminants
· r. 9.26 Tailings filled stopes – atmospheric contaminants
· r. 9.29 Monitoring of toxic, asphyxiant and explosive gases
· r. 10.12 Workers to be withdrawn if danger exists
· r. 10.19(1) Dams and plugs
· r. 10.28(3)(c) Rationale for stope sequencing and filling
· r. 10.35 Vertical opening safety procedures
· r. 13.5 Dumping precautions (in pit)

Where the regulations listed above cannot be specifically or literally interpreted for the purposes of the audit elements, "ensure" is used in the intent. "Verify" is used where the regulations are directly applicable.
Standards
· Australian Standard AS 3778.4.1:1991 Measurement of water flow in open channels – Measurement using flow gauging structures – Thin-plate weirs
· Australian Standard AS/NZS 4801:2001 Occupational health and safety management systems – Specification with guidance for use
· International Standard OHSAS 18001:2007 Occupational health and safety management systems – Requirements
Code
· International Cyanide Management Code for the Manufacture, Transport and Use of Cyanide in the

Production of Gold (International Cyanide Management Code) <www.cyanidecode.org>
Resources Safety guidelines
· Geotechnical considerations for underground mines (1997)
Resources Safety Significant Incident Reports and Safety Bulletins
· Mines Safety Significant Incident Report No. 138 (7 August 2006): Paste fill wall failure
· Mines Safety Bulletin No. 64 (31 July 2001): Safety issues associated with hydraulic backfill
· Mines Safety Bulletin No. 55 (29 June 2000): Potential hazards associated with mine fill
· Mines Safety Bulletin No. 3 (23 April 1990): Vertical opening safety practice

Abbreviations
CCTV closed circuit TV
CN cyanide
CMS cavity monitoring survey
DMP Department of Mines and Petroleum
%Cw % solids or pulp density
FoS factor of safety
MSIA Mines Safety and Inspection Act 1994
MSIR Mines Safety and Inspection Regulations 1995
OH&S occupational health and safety
PLC programmable logic control (i.e. telemetry)
PSD particle size distribution
QA/QC quality assurance or quality control
SWP standard working procedure
TAP trigger action plan
UCS uniaxial compressive strength

1 Mine planning and design: general fill

Mine planning and design: general fill

Point	Standard	Guideline
1.1	There is a strategy for the supply and placement of fill, stating source material and schedule in alignment with production objectives.	**Intent:** To verify provision of fill for use in stopes for regional support/confinement and to minimise likelihood of air blast. To ensure source material used for hydraulic/paste fill has undergone feasibility studies to ensure chemistry/rheology will allow fill to reach final specified strength. **Personnel:** Mining/geotechnical/fill engineers **Method:** Interview personnel. Determine availability and source of the fill. Refer to MSIR r. 10.28(3)(c).
1.2	All stopes requiring fill are filled as soon as practicable after the extraction of ore is complete.	**Intent:** To ensure the time that the stope walls have to stand unsupported is minimised. **Personnel:** Mining/geotechnical/fill engineers. **Method:** Interview personnel. Review records. Determine the average delay between completing stope mucking and commencing stope filling. Determine if there have been any excessive delays before filling commenced during the past year. Discover how long it takes, on average, to complete filling a stope. Determine if there have been any major stope wall collapses during the past year.
1.3	The mine has a means to display cumulative stope void, volumes of stope void created and fill placed, which is updated on a monthly basis.	**Intent:** To ensure regular tracking of fill placement and cumulative stope void at the mine so that it is known how much (as a %) of the mine is a void and how much is filled. **Personnel:** Mining/geotechnical/fill engineers. **Method:** View the graph, long section, spreadsheet, or other means, to demonstrate that the rate of stope filling is generally keeping pace with ore production. Check that stope voids are being progressively and systematically filled. Determine if the cumulative volume of stope void is increasing at a faster rate than the cumulative volume of fill placed and if so, why?

1.4	The mine has a specification for minimum quality of waste fill.	**Intent:** To ensure the fill meets the minimum strength properties. To ensure planes or zones of weakness do not develop in the fill and lead to potential slips (could lead to floor failure at tip points). To ensure combustible materials are not disposed in open stopes. **Personnel:** Mining/geotechnical/fill engineers, mine foremen. **Method:** Interview personnel. Sight a statement of the specifications for the minimum fill physical qualities (e.g. strength parameters, grading curve). Find out how the specification for fill quality was determined. The chemical and physical properties of the fill material need to be considered.
1.5	An engineering design by a competent person has been undertaken to ensure cemented waste fill or paste fill attains the required strength before exposure/mining through it.	**Intent:** To ensure stability of the cemented fill mass, particularly where there will be re-entry of personnel by mining through, adjacent to or under the fill material. **Personnel:** Mining/geotechnical/fill engineers. **Method:** Sight internal reports by in-house expertise or external reports by expert consultants. Sight documents relating to mine fill QA/QC to ensure fill delivered is as per specification. Required strength should be a function of variables such as PSD, cement dosage and curing period.
1.6	Tight filling is used to maximise the confinement of the fill in the stope to minimise stope falloff from the hangingwall or crown.	**Intent:** To ensure stope failures are retained/minimised and to prevent hangingwall and crown failures from propagating. **Personnel:** Mining/geotechnical/fill engineers. **Method:** Check schedules, stope notes. Observe underground stopes.

1.7	Before any pillar recovery is attempted below a filled stope, measures are taken to check for free water in the stope and any water encountered is drained.	**Intent:** To ensure procedures exist to prevent sections of the mine being suddenly inundated by large volumes of water, fill and/or other materials (e.g. drilling probe holes in suspected areas). **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, surveyor. **Method:** Interview personnel. Determine what records are kept of old stopes and workings. Determine what records have been kept of dewatering volumes extracted from the old workings. Seek information on how it is demonstrated that these old workings have been effectively drained.
1.8	Where waste is being tipped off the edge of a stope/pit, appropriate safety measures are in place to avoid the risk of the loader, truck or personnel falling into the stope/pit.	**Intent:** To verify safety of personnel around voids/dropoffs. **Personnel:** Mine manager, technical services superintendent, mining/geotechnical/fill engineers, mine foremen. **Method:** Sight evidence of engineered backstops, anchor points for safety harnesses, backs stripping, additional lighting, site specific risk assessments, SWPs, training and competency assessments for this task. Refer to MSIR rr. 13.5, 10.35.

2 Mine planning and design: barricades

Mine planning and design: barricades

Point	Standard	Guideline
2.1	All diamond drillholes, service holes and slash production holes intersecting stope to be filled are grouted to prevent mine/ground water re-charging the stope/fill.	**Intent:** To ensure extraneous water is not added to the stope being filled. To ensure any extraneous water that cannot be prevented is measured (baseline, pre-filling measurements) and accounted for in water mass balancing, particularly for hydraulic fill. If the mine is very wet then this is important for paste fill also. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, surveyors. **Method:** Interview personnel. Look for baseline readings from V-notch weirs to ensure extraneous water is accounted for when not preventable by grouting drillholes.
2.2	Stope-specific worst-case total pressure on barricades is determined by a competent person using recognised modelling tools/methods for the stope layout and dimensions, fill specification and fill strategy to be used.	**Intent:** To ensure modelling of the fill strategy has been undertaken for the fill specification and the stope layout and dimensions to determine total pressure (earth pressure + pore water pressure) acting on the barricades at the stope base (recommend worst case pressure used for design of all barricades for that stope, at least at the stope base). To ensure pour-rest cycles are specified based on modelling/analysis by competent person. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Interview personnel. Sight evidence of modelling/reports by a competent person to determine worst-case total pressures resulting from proposed fill specification and fill strategy. Determine if and how "arching" is accounted for.

2.3	Hydraulic fill barricades are of sufficient number, layout and permeability to allow required drainage.	**Intent:** To ensure sufficient numbers of fill barricades are planned to minimise drainage path lengths, thus pore water pressures acting on the barricades. To ensure barricades are designed to allow free drainage from stope (permeable characteristics, pipes). **Personnel:** Mining/geotechnical/fill engineers. **Method:** Interview personnel. Sight stope designs (stope file notes). Sight guidance material in mine design guidelines, and fill or paste management plan.
2.4	Barricades are placed in locations where they can achieve maximum potential strength (e.g. minimal dimensions and blast damage, away from brow).	**Intent:** To ensure required barricade strength achieved by locating it where minimal blast damage and minimal development dimensions. To ensure barricades are designed for the development dimensions that they are built in (i.e. “Clune wall”/steel-frame extension kits should not be used). To ensure a safe distance from the stope brow is left between the barricade and brow (protect barricade and workers from stope falloff rilling out of stope). **Personnel:** Mining/geotechnical/fill engineers, mine foremen. **Method:** Interview personnel. Sight guidance material in mine design guidelines, and fill or paste management plan.
2.5	Fill barricades are designed by a competent person using recognised engineering methods.	**Intent:** To ensure fill barricades are correctly designed on a stope by stope basis (site specific) by an expert using recognised methods. To ensure "off the shelf" barricade kits are not used universally (unless the universal design is for the worst-case situation and this is constantly checked as appropriate). To ensuredesigns are not copied from other mines without being properly checked by a competent person. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers. **Method:** Interview personnel. Sight design documentation. Check the designs are undertaken by a competent person using recognised methods that are stope-specific. Find out what water drainage provisions have been incorporated into the barricade design. Determine if the pressure behind the barricade is monitored during filling and if so, how do the results compare to design loads?

2.6	Fill barricade designs are specific to the stope and barricade locations.	**Intent:** To ensure stope and site specific details are determined before designing barricades. Stope specific details (width x height x length, fill specification and pour strategy) are considered. The barricade design should include radius (if curved), dimensions (W x H x D, m) and the setback distance from brow. To ensure a "one size fits all" or "off the shelf" kit is not being used, unless based on first principles engineering - worst case scenario. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers. **Method:** Sight plans and sections for barricade design. Sight internal and external consultant reports (e.g. FLAC3D modelling). Interview personnel.
2.7	Fill barricade designs are modelled numerically to ensure the design working load can withstand expected worst-case total pressures in that stope.	**Intent:** To ensure stope and fill specific conditions are accounted for when determining the required working load of the fill barricade. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers. **Method:** Interview personnel. Sight stope specific pressure calculations and numerical modelling to determine required working load, sight designs and FoS (e.g. use continuum analysis techniques for “in-cycle fibrecrete”).

3 Mine planning and design: paste fill

Mine planning and design: paste fill

Point	Standard	Guideline
3.1	Paste fill specification includes an acceptable range for PSD.	**Intent:** To ensure fill specification is designed by a competent person (combination of process control and soil mechanics calculations). To ensure optimal PSD is used to maximise pumpability/flowability in the paste reticulation system (e.g. fines needed for "plug flow"). To ensure PSD is suitable to achieve design strength and avoid liquefaction potential, including under dynamic loading conditions (e.g. blasting, stope failure or seismic event). **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Interview personnel. Sight evidence of test work, preferably in form of a paste fill feasibility report by a competent person. Sight evidence of ongoing checks/test work to ensure fill specification remains within the allowable range (as sources change). Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill or paste management plan for when fill specification (PLC/QA measurements) departs from acceptable range.
3.2	Paste fill specification includes an acceptable range for pulp density/% solids/%Cw.	**Intent:** To ensure minimal water is sent underground but there is enough to allow pipeflow/pumpability. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Interview personnel. Sight evidence of test work, preferably in form of a paste fill feasibility study report by a competent person. Sight evidence of ongoing checks/test work to ensure fill specification remains within the allowable range (as source moisture content changes). Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill or paste management plan for when fill specification (PLC/QA measurements) departs from acceptable range.

3.3	Paste fill specification includes an acceptable range for cement addition (%).	**Intent:** To ensure the specified cement addition rate (and thus fill strength) is determined by a competent person and based on recognised methods such as Terzaghi's arching, Mitchell's confined block or Stone's charts to determine cement addition rate/UCS required based on fill exposure by blasting. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Interview personnel. Sight calculations and/or reports by competent person(s). Ensure specifications adhered to by checking stope specific fill pour specifications (e.g. request form from fill engineer to fill plant). Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill or paste management plan for when fill specification (PLC/QA measurements) departs from acceptable range. Ensure "% cement versus UCS" trials/test work has been undertaken in the process of determining optimal specification.
3.4	Paste fill specification includes an acceptable range for yield stress and slump.	**Intent:** To ensure the specifications acceptable range is based on feasibility study test work by a competent person and is regularly reviewed. Note: Yield stress is a measure of pumpability. Slump is a measure of flowability and strength. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight feasibility study reports by competent person(s), interview personnel. Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill or paste management plan for when fill specification (PLC/QA measurements) departs from acceptable range.

3.5	An investigation of fill mineralogy has been undertaken to ensure the final product is of desirable quality.	**Intent:** To ensure no deleterious chemicals or rheological properties are present (e.g. high toxin or HCN content or high liquefaction potential). If they are, investigate alternate fill source or specifications (iterative process). Mineralogy of the fill influences water-holding capacity and final strength (by influencing chemical reactions that promote strength). **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight feasibility study reports by competent person(s). Interview personnel.
3.6	An investigation of process water chemistry has been undertaken to ensure the final product is of desirable quality.	**Intent:** To ensure no deleterious chemicals are present in process water to be added to paste fill. Water chemistry influences chemical reactions that promote strength. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight feasibility study reports by competent person(s). Interview personnel. Ensure ongoing tests/checks are performed.
3.7	The fill reticulation system is designed and reviewed by a competent person.	**Intent:** To ensure reticulation system is designed by a competent person (in paste fill feasibility study). To ensure annual review by competent person of reticulation extensions and changes to ensure not creating hazards and unsafe systems of work. **Personnel:** Underground manager, mining/geotechnical/fill engineer, fill service crew **Method:** Sight designs and reports by competent person(s).

4 Mine planning and design: hydraulic fill

Mine planning and design: hydraulic fill

Point	Standard	Guideline
4.1	Hydraulic fill specification includes an acceptable range for PSD.	**Intent:** To ensure fill specification is designed by a competent person (combination of process control and soil mechanics calculations). To ensure fines are minimised to maximise permeability/drainage rates (well graded PSD allows best drainage properties). To ensure tests have been undertaken to determine optimal PSD for permeability/drainage, pumping/pipe flowability, fill strength and any other relevant parameter. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Interview personnel. Sight evidence of test work, hydraulic fill feasibility study report by competent person(s). Sight evidence of ongoing checks/test work to ensure fill specification remains within allowable limits. Check PSD curves to ensure fines fraction is minimal (e.g sight cyclosizing tests, ensure maximum fines is <10% passing 10 microns). Check permeability tests have been performed on PSD test samples and level of permeability is adequate to allow free drainage properties in stope (sight tests, ensure minimum permeability >100 mmh-1). Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill management plan for when fill specification (PLC/QA measurements) departs from acceptable range.

4.2	Hydraulic fill specification includes an acceptable range for pulp density/% solids/%Cw.	**Intent:** To ensure pulp density is as high as possible to minimise water to minimise drainage time and pore water pressures in stope. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators. **Method:** Interview personnel. Sight evidence of test work, preferably in form of feasibility study reports by competent person(s). Sight evidence of ongoing checks/test work to ensure fill specification remains optimal. Check % solids is at the level recommended by expert to ensure water content is minimised (check process control data logs to ensure % solids is at specified level, e.g. >70% Cw). Check systems exist for keeping range within acceptable limits. Ensure there is a TAP in the fill management plan for when fill specification (PLC/QA measurements) departs from acceptable range.
4.3	Cemented hydraulic fill specification includes an acceptable range for cement addition (%).	**Intent:** To ensure the specified cement addition rate (and thus fill UCS) is determined by a competent person and based on recognised methods such as Terzaghi's arching, Mitchell's confined block or Stone's charts to determine cement addition rate/UCS required based on fill exposure by blasting. To ensure "% cement versus UCS" trials/test work has been undertaken in the process of determining optimal specification. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Interview personnel. Sight reports by competent person(s). Ensure specifications adhered to by checking stope specific fill pour specifications (e.g. request form from fill engineer to fill plant).
4.4	Cemented hydraulic fill specification includes an acceptable range for yield stress and slump.	**Intent:** To ensure the specifications acceptable range is based on test work and is regularly reviewed. Note: Yield stress is a measure of pumpability. Slump is a measure of flowability and strength. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, plant operators **Method:** Sight reports by competent person(s), interview personnel.

4.5	An investigation of fill mineralogy has been undertaken to ensure the final product is of desirable quality.	**Intent:** To ensure no deleterious chemicals or rheological properties are present (e.g. high liquefaction potential). If they are, investigate alternate fill source or specifications (iterative process). Mineralogy of the fill influences water holding capacity and final strength (by influencing chemical reactions that promote strength). **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight reports by competent person(s). Interview personnel.
4.6	The fill reticulation system is designed and reviewed by a competent person.	**Intent:** To ensure reticulation system is designed by a competent person (in hydraulic fill feasibility study). To ensure annual review by competent person of reticulation extensions and changes to ensure not creating hazards and unsafe systems of work. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight designs and reports by competent person(s).

5 Mine planning and design: fill strategy simulation and modelling

Mine planning and design: fill strategy simulation and modelling

Point	Standard	Guideline
5.1	The entire backfill process is appropriately engineered and is an integral part of a holistic mine design approach.	**Intent:** To ensure competent person(s) are involved in entire process at feasibility study level to operational level. To ensure the fill sequence and requirements have been taken into consideration in all other aspects of mine design and schedule. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Sight mine layout. Underground inspections of existing barricade locations and observation points. Sight life-of-mine schedule (mine fill activities planned and tracked). Look for development design with eventual backfill strategy in mind, such as enough drainage points at base of stope, minimal development dimensions, crosscuts drain away from stope, enough standoff distance from stope brow for access in good ground conditions, and safe observation points (up stope eight) to check fill delivery and ponding on fill surface.
5.2	Modelling for liquefaction potential under dynamic loading has been undertaken by a competent person.	**Intent:** To ensure the fill specification and fill strategy have been verified in modelling to be unlikely to liquefy under dynamic loading conditions (including during stope failures, seismic events and when blasting) thus potentially causing a barricade failure. The modelling should be used to determine at what curing/consolidation stage blasting is safe for hydraulic or paste fill. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Sight reports by competent person(s). Interview personnel for their understanding of the risks.

5.3	The fill (pour-rest) strategy has been simulated using a recognised numerical modelling technique to ensure safe working conditions are maintained throughout the filling of stopes.	**Intent:** To ensure competent person(s) have performed modelling and analysis of fill strategy and specification to ensure final strength can be achieved in required time. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Sight reports by competent person(s). Interview personnel for their understanding of the risks. Check schedules and other site reports to ensure operational consistency with report recommendations. Check modelling is undertaken for pour-rest cycles (ensure adequate drainage in hydraulic fill and that “brow lifts” cure in paste fill), consolidation rate (hydraulic fill), and cement hydration rate (paste fill); and to calculate distribution of stress on fill mass and barricades, and determine peak loads and loadtime characteristics. V-notch weirs (AS 3778.4.1:1991) can be used to calculate water flow out of stope on daily basis for hydraulic fill and wet paste fill. Collate information in spreadsheet. Calculate water level in stope knowing water in – water out, moisture content of drained fill, drainage rate (Darcy’s Law) and volume of stope (e.g. using CMS real slices at 1 m vertical intervals). Verify AS 3778.4.1:1991 used for V-notch weir design, construction and calculations of water flow.
5.4	Stope specific pour-rest cycle fill strategies have been developed to ensure adequate drainage/curing of fill.	**Intent:** To ensure fill drains/consolidates as expected (hydraulic fill) or fill cures as expected (paste fill or cemented hydraulic fill). Further placement of fill before drainage/consolidation/curing is achieved could create undesirable conditions in the stope, leading to potential risks associated with liquefaction potential and barricade failure. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Sight fill management plan, SWPs, fill pour records, schedules. Interview personnel. Underground observations.

6 Operations: mine management systems

Operations: mine management systems

Point	Standard	Guideline
6.1	Organisation and resourcing are clearly defined for the hydraulic/paste fill operations.	**Intent:** To ensure sufficient staff allocated to hydraulic/paste fill to ensure the process is appropriately designed, managed and monitored through the design, installation, delivery and operational phases through to life-of-mine monitoring. **Personnel:** Mine manager, technical services superintendent, mining/geotechnical/fill engineers, metallurgists, fill plant operators, mine foremen, fill/service crew **Method:** Sight organisational chart, job descriptions, fill or paste management plan.
6.2	Roles and responsibilities are clearly defined and allocated to personnel involved with the hydraulic/paste fill operations.	**Intent:** To ensure it is clearly stated who is responsible for what with paste/hydraulic fill for all staff involved. **Personnel:** Mine manager, technical services superintendent, mining/geotechnical/fill engineers, metallurgists, fill plant operators, mine foremen, fill/service crew **Method:** Sight organisational chart, job descriptions, fill or paste management plan (showing template signoff documents and checklists). Refer to MSIA s. 9(1).
6.3	Clear lines of communication exist for the safe operation of the hydraulic/paste fill system within the overall mining process.	**Intent:** To ensure personnel working on fill are aware of who is responsible for different aspects of fill system and communicate clearly and regularly with each other on matters concerning the design, production, delivery and monitoring of fill material, barricades and reticulation. To ensure the general workforce is clearly and regularly communicated with on these matters. To ensure all documents are "controlled" and records are kept and circulated of all operational decisions. **Personnel:** Mine manager, technical services superintendent, mining/geotechnical/fill engineers, metallurgists, fill plant operators, mine foremen, fill/service crew **Method:** Sight organisational chart. Discuss the "mine site culture" with mine personnel.

6.4	A competent person has been appointed to manage hydraulic/paste fill operations as a single point of accountability.	**Intent:** To ensure the quality of the fill process is overseen by a competent person on site, whose name should be clearly stated as the main accountable person on the fill management plan (e.g. fill engineer). **Personnel:** Mine manager, technical services superintendent, mining/geotechnical/fill engineers, metallurgists, fill plant operators, mine foremen, fill/service crew **Method:** Sight organisational chart, job descriptions, fill management plan (template signoff documents).
6.5	Training has been provided and competency assessed to ensure all mine and fill plant employees are able to identify potential hazards.	**Intent:** To verify all staff and the general workforce have been trained by a competent person and/or sent on recognised training courses (e.g. courses and seminars on mine fill run by Australian Centre for Geomechanics or WA School of Mines). **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen, general workforce **Method:** Sight expert consultant's reports, risk assessments and other site specific documentation and determine whether details have been incorporated into the fill management plan and all relevant SWPs. Sight training and assessment records. Refer to MSIR r. 4.13.

6.6	Employees are not exposed to toxic contaminants in the hydraulic/paste fill.	**Intent:** To ensure tailings are treated before they go underground to ensure CN/toxin levels are below a certain level that is deemed safe. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen, general workforce **Method:** Ensure monitoring of tails and underground atmosphere is undertaken to ensure CN levels are below safe limit. Ensure risk assessments are performed when exposing or drilling into fill as concentrated gas pockets of HCN can be encountered. HCN gas monitoring to be made available where fill is exposed. Ensure material delivered underground has CN concentration <50 ppm. Sight records of tailings stream CN testing and HCN gas monitoring underground. Check emergency response plan for TAP when HCN gas concentration over limit. Check SWPs in mill for monitoring CN in tails to fill plant. Interview personnel. Ensure mine staff aware of the International Cyanide Management Code.
6.7	Emergency preparedness drills for possible mine fill egress and/or barricade failure incidents are well practised and understood by all underground and fill plant personnel.	**Intent:** To ensure risks have been assessed and control measures are in place. Control measures to deal with consequences of an incident must be included in the emergency response plan (e.g. purpose-designed containment bunds to control fill egress into mine due to barricade failure; mine layout to avoid fill running down decline into active areas; CCTV monitoring to assess situation before entering areas of risk). **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen, general workforce **Method:** Check emergency response plan for TAPs, mine design layouts. Determine if there are purpose-designed containment bunds (designed by a competent person) to capture fill egress if failures occur (e.g. for “brow lift”/“plug pour” capacity). Check escapeway layouts and that they are designed to prevent inflow of fill if failure occurs.

7 Operations: fill management plan / risk management

Operations: fill management plan / risk management

Point	Standard	Guideline
7.1	Hazards are identified and team-based risk assessments have been undertaken for the entire fill system (mill to mine).	**Intent:** To ensure the processes of filling from process plant through delivery to stope, design and operational issues, barricades and reticulation are all adequately risk assessed by a team that comprises personnel from operator level, supervisory level, engineers and metallurgists. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Sight fill management plan, forms, checklists, SWPs, training manuals. Show consideration for worst case and “what if” scenarios (for best results, this process should be facilitated by an independent expert risk assessment consultant). Ensure the resulting risk registers are adequately transferred to other controls such as mine design guidelines, checklists and signoff forms. Ensure this item is revised annually for the material to be up to date and relevant, and revise with staff and educate new staff.
7.2	On completion of the teambased risk assessment of the fill system, a risk register has been compiled listing all hazards, their control measures and TAPs.	**Intent:** To ensure there is a site risk register covering barricades, mine fill and mining issues affected by fill. Also to cover issues relating to mill/fill plant and reticulation. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Sight site-based risk register or a fill risk register. TAPs must list responsible persons and timelines.

7.3	All control measures have been transferred to emergency response plans, procedures, forms and checklists. These are regularly reviewed.	**Intent:** To verify emergency response plan and fill or paste management plan include control measures derived by risk assessment for fill system. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Check all documentation relating to mine fill and ensure all control measures from risk register have been transferred and are kept up to date. Refer to MSIR rr. 4.30, 4.36.
7.4	Hazard identification and risk assessment are undertaken on a daily basis. All employees are adequately trained to do this and can recognise hazards with respect to mine fill.	**Intent:** To ensure risk assessment and hazard control measures are used on a daily basis by all employees. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Sight evidence of risk assessment in stope file notes, paste fill notes, etc. Look for checklists that list main issues of concern as highlighted by team-based risk assessment. Check that underground observations can be made to validate modelling/calculations to ensure filling is proceeding as it is expected (i.e. process is understood). If not, find out what other measures are in place to manage the hazard.
7.5	All decisions, inspections and monitoring with respect to fill are formally documented.	**Intent:** To ensure thorough and detailed record keeping of all aspects of fill systems on a design, implementation and operational level. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Ensure all procedures, management plans, templates, forms, etc. are under document control, requiring signoff/approvals.

7.6	Blasting adjacent to newly constructed barricades and placed uncured or undrained fill is strictly prohibited.	**Intent:** To ensure fill curing/consolidation times are adhered to before blasting adjacent to or exposing the fill. To ensure sprayed barricades are cured and reach design minimum strength before blasting nearby. To ensure blasting cannot cause liquefaction of uncured paste fill or unconsolidated hydraulic fill by dynamic loading. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Ensure fibrecrete barricade curing and fill curing/consolidation period is determined by a competent person and adhered to, specific to that stope/barricade, production schedule and degree of exposure. Check schedules, fill management plan, stope notes, and minutes of production meetings. Interview personnel. Sight records of stope blasts and stope filling (e.g. on a longitudinal section). Ensure consistency between competent person reports and actual documentation and understanding on site. Determine if fill liquefaction has occurred at the site. Find out how the potential for fill liquefaction is managed.
7.7	Water is not permitted to build up in paste/hydraulically filled stopes.	**Intent:** To ensure the fill can cure/drain as designed and not liquefy or cause high pressures in stope that result in barricade failures or egress of fill into workings, thus exposing personnel to hazards. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Ensure flushing water is minimised. Ensure risk of water re-charge (e.g. through rockmass, drillholes) is monitored and managed for the life of mine. Check provision has been made for additional water from the fill hole in the % solids calculations for the fill. Check draining water is drained/piped away from the filled stope. If mine is very wet, reconsider use of hydraulic/paste fill (may be too hazardous or hard to control). Verify V-notch weirs are designed and built to AS 3778.4.1:1991. Interview personnel.

7.8	Water mass balance should be performed daily in hydraulic fill/wet paste fill to ensure filling and draining are proceeding as expected.	**Intent:** To ensure water mass balance is performed to compare actual versus expected water heights and pressures. Guidance from a competent person is required for this process. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers **Method:** Sight database/spreadsheets of water mass balancing and analysis of water heights and pressures. Measure and record water flows out of filled stopes using V-notch weirs (compliant with AS 3778.4.1:1991). For hydraulic fill, data should be used to calculate the expected height of water in the stope knowing water in (% solids + flushing water + groundwater flows) - drained water (Darcy's Law). Use expected water height to determine expected pore water and total pressure in stope and acting on barricade. Monitor regularly. Check design versus actual height to manage fill process. Establish TAP for when variance is significant. When design versus actual are not the same – stop filling. This should be done for life of mine. Need CMS of stope to get 1 m horizontally spaced areal slices for stope volumetric calculations. Check the process is documented. Check responsibilities for this task are clearly defined in fill or paste management plan and procedures.
7.9	Containment bunds, exclusion zones and other forms of physical separation are used to minimise exposure of personnel to the hazard of mine fill egress into workings.	**Intent:** To ensure consequences of a barricade failure or egress of fill into mine workings are mitigated or managed. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, metallurgists, paste fill plant operators, mine foremen **Method:** Sight documentation/reports calculating containment bund capacity and location, based on what it is designed to hold (e.g. initial "brow lift/plug pour"; what FoS?). Ensure calculations and modelling undertaken by a competent person. Check fill management plan, underground observations, minutes of production meetings. Refer to Mines Safety Bulletins Nos 55 and 64.

8 Operations: barricades quality assurance

Operations: barricades quality assurance

Point	Standard	Guideline
8.1	Fill barricades must allow drainage, and water should not be allowed to accumulate at the barricade.	**Intent:** To ensure unimpeded drainage of water away from barricades (e.g. correct gradient/drainhole/sump pump). **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, mine foremen, general workforce **Method:** Interview personnel. Ensure sump pumps/ drainholes are located wherever water collects from draining stopes/barricades and that they are adequately maintained to ensure full serviceability. Sight SWPs for dewatering/service crews. Sight drainage information in fill management plan. Underground observations (i.e. working sump pumps/drainholes to be located nearby).
8.2	Materials to be used for construction of fill barricades must be specified by a competent person.	**Intent:** To ensure materials used are acceptable, based on latest industry knowledge (e.g. "hybrid walls", which are lower waste bund + upper sprayed fibrecrete walls, are considered substandard). **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, mine foremen **Method:** Check design documents, SWPs. Interview personnel. Ensure the fibrecrete sprayed onto "Clune walls" meets design specifications. If masonry blocks are used, ensure their strength and permeability are adequate (such blocks are slowly being phased out due to problems with modelling their performance). Ensure layout, procedure and materials for drainage are safe and acceptable.

8.3	The method to be used for construction of fill barricades must be specified by a competent person.	**Intent:** To ensure the barricade design contains details on construction method for anchorage into sidewalls, step-by-step instructions, wall layout, drainage system layout, Vnotch weir layout (e.g. as per AS 3778.4.1:1991); catch bund layout and material; and details on curing time required for sprayed fibrecrete or any concrete used. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, mine foremen **Method:** Check design documents, SWPs. Interview personnel.
8.4	Systems exist to ensure barricades are constructed as per design.	**Intent:** To ensure there is a QA/QC process in place. To verify that the installed barricades are constructed as designed by a competent person based on site-specific first principles engineering (based on total pressure in stope). To ensure "one size fits all"/"off the shelf" barricades are NOT used unless they satisfy engineering calculations for mine-wide worst-case scenario. **Personnel:** Technical services superintendent, mining/geotechnical/fill engineers, mine foremen **Method:** Interview personnel. Check the mine has a SWP for barricade construction and sight the document. Determine what method is used to construct the barricades (e.g. "Clune wall"/steel-frame kits sprayed with fibrecrete). Check the underground workforce is trained in the construction of barricades. Discover what method is used to key the barricades into the floor, walls and backs. Ask what problems, if any, have been experienced with barricades. Ensure “Clune walls” are NOT being treated as "one size fits all" with extension kits being used for largedimension development. Ensure materials used and construction method are as per specifications. Ensure task observation, staged and final inspections are performed to certify the barricades are built according to design. Conduct fibrecrete tests (UCS, toughness, slump).

9 Operations: paste fill quality assurance

Operations: paste fill quality assurance

Point	Standard	Guideline
9.1	Specifications for PSD, % solids, % cement, etc. are incorporated into SWPs, fill management plan, fill pour request forms, checklists and any other relevant documentation.	**Intent:** To ensure fill specifications as determined by test work and expert consultation are incorporated in systems of work. To ensure systems are in place to minimise flushing water. **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Specifications for PSD, % solids, % cement, etc. are regularly reviewed to ensure consistency with latest test work/expert recommendations. Sight SWPs, fill management plan, TAP. Interview personnel.
9.2	Systems are in place to ensure fill specification and quantities delivered by the paste plant are as requested by the geotechnical/fill engineer.	**Intent:** To ensure fill is delivered in quantities and to specification requested. To minimise likelihood of excess water, below specification strength (% cement), too little/too much volume placed (in keeping with pour-rest cycles/lift curing times). **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Sight SWPs, fill management plan. Interview personnel.
9.3	TAP exists for when specification and quantities go outside of the allowed range.	**Intent:** To ensure fill is delivered in quantities and to specification requested. **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Sight TAP, interview personnel. If a site risk register exists, check to see if trigger action plan control measures are listed for when specification/quantities are not as per requests (as this could create high risk situations). Check emergency response plan for guidelines on fill/barricade incidents (should note TAP points of relevance).

10 Operations: hydraulic fill quality assurance

Operations: hydraulic fill quality assurance

Point	Standard	Guideline
10.1	Specifications for PSD, % solids, % cement, etc. are incorporated into SWPs, fill management plan, fill pour request forms, checklists and any other relevant documentation.	**Intent:** To ensure fill specification determined by test work and expert consultation is actually put in place in systems of work. To ensure systems are in place to minimise flushing water and provide adequate stope drainage. **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Sight SWPs, fill management plan, TAP. Interview personnel. Specifications for PSD, % solids, % cement, etc. are regularly reviewed to ensure consistency with latest test work/expert recommendations.
10.2	Systems are in place to ensure fill specification and quantities delivered by the paste plant are as requested by the geotechnical/fill engineer.	**Intent:** To ensure fill is delivered in quantities and to specification requested. Minimise likelihood of excess water, below specification strength (% cement), too little/too much volume placed (in keeping with pour-rest cycles/lift curing times). **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Sight SWPs, fill management plan. Interview personnel.
10.3	TAP exists for when specification and quantities go outside of the allowed range.	**Intent:** To ensure fill is delivered in quantities and to specification requested. **Personnel:** Technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, metallurgists, paste fill plant operators **Method:** Sight TAP. Interview personnel. If a site risk register exists, check to see if TAP control measures are listed for when specification/quantities are not as per requests (as this could create high risk situations). Check emergency response plan for guidelines on fill/barricade incidents (should note TAP points of relevance).

11 Reticulation quality assurance

Reticulation quality assurance

Point	Standard	Guideline
11.1	The reticulation system has been installed in accordance with the design.	**Intent:** To ensure a competent person is used to design the reticulation and specify the materials to be used. To ensure any extensions/additions to the system have been done under the guidance of a competent person and are regularly reviewed. To ensure fill/service crew installing the reticulation are adequately trained and deemed competent. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Check QA records for documentation of inspections and certifications. Check training records, SWPs.
11.2	Ongoing preventative maintenance system for the reticulation system is undertaken and documented.	**Intent:** To ensure the reticulation system has its own preventative maintenance system so it is maintained and monitored to insure against abrasive wear and blockage. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Check procedures. Interview personnel. Sight inspection records, maintenance records, test work. Ensure pipes and connections/valves are pressure-rated to avoid blow-outs. For pipes and valves under pressure, check metal fatigue and crack testing is systematically performed. Check pipeline wall thickness monitoring is performed and pipes replaced as necessary. Documentation is required for all testing and monitoring.

12 Fill plant quality assurance

Fill plant quality assurance

Point	Standard	Guideline

12.1	The fill plant is maintained and operated in a safe manner.	**Intent:** To ensure fill plant is maintained and operated in a safe and efficient manner. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight plant. Interview personnel. Ensure plant operators are not exposed to hazards. Ensure the plant is "fit for purpose" considering the tight tolerances required for fill specification and quantities, and the requirement for reliable fill provision. Sight maintenance records.
12.2	Fill specification quality assurance tests are performed at the fill plant on a daily basis.	**Intent:** To ensure regular testing of the fill quality as well as volumes placed, and these data are logged in a database/spreadsheet (as formal records) and provided daily to the fill engineer. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight procedures for mill/fill plant operators and fill engineer. Interview personnel. Ensure QA tests are performed for pulp density/% solids/%Cw using continual logging (measured by Darcy gauge/nuclear density gauge), PSD including cyclosizing of fine fraction for hydraulic fill, % cement addition, UCS (if cement added), yield stress and slump (for pumpability), and volumes placed (to track actual versus modelled fill and water heights in stope as filling).
12.3	TAP exists for when the fill supplied is outside specification or for high flushing water volume events.	**Intent:** To ensure fill supplied is to specification and if not, the fill pour is stopped. When too much water is being sent to stope, to ensure it is identified and stopped immediately so the situation can be rectified. **Personnel:** Mining/geotechnical/fill engineer, metallurgists, paste fill plant operators **Method:** Sight procedures for mill/fill plant operators and fill engineer. Interview personnel. Check TAP details reflect hazards assessed in team-based risk assessment/risk register. Check competent person has given tolerance/set limits (e.g. set at feasibility study stage and reviewed as sources change or as issues arise).

13 Underground monitoring

Undergroung monitoring

Point	Standard	Guideline
13.1	Provision made for safe observation underground of all fill operations.	**Intent:** To ensure underground inspections can be performed safely. Safety measures such as remote monitoring of barricades (e.g. CCTV) and anchor points (where monitoring at dropoff points) should be provided. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Ensure fill surfaces, barricades, stope stability conditions and surrounding workings can be safely checked before, during and after filling to ensure conditions are as expected. Ensure adequate visible checks are undertaken before approaching draining/freshly loaded barricades. Ensure remote monitoring is available to check barricades after suspected incidents (e.g. CCTV and lighting). With regard to stope/ponding observations, a suitable location will have anchorage points (for safety harnesses), lighting, and adequate ground support. For an underground inspection, check fill level, ponding, slurry properties, and beach angle. Interview personnel. Check that a procedure exists for this task.
13.2	Underground inspections are performed regularly to observe fill and barricade conditions and ensure actual conditions match expected/calculated conditions.	**Intent:** To ensure all conditions underground are as expected (actual versus modelled/calculated). **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Check for ponding, slurry thickness/sloppiness, level of fill and water in stope, and moisture content of drained fill. Check barricades are draining. Check records have been kept. Sight database of observations, and documentation for fill strategy modelling validation/backanalysis. Interview personnel.

13.3	TAPs exist for underground observations where situations appear unsafe.	**Intent:** To ensure workforce, supervision and engineers are able to identify hazards with respect to mine fill underground. To ensure hazards are identified promptly and remedial measures taken as soon as possible. Prompt mine or area evacuations can be requested by underground workers if in doubt or concerned. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Check for unsafe conditions such as barricade fill leaks, barricade cracks/deflections, rockmass fill leaks, excessive water ponding on fill surface, excessively runny slurry poring into stope. Check for liquefaction potential (where there is ponding, is it bouncy or wobbly? Does it drain or retain water?). Check that a competent person has listed all "performance indicators" that need to be closely monitored and TAPs have been developed based on risk assessment. Sight procedures, fill or paste management plan and emergency response plan. Interview personnel.
13.4	Underground pressure measurements to determine actual loads on fill and barricades are undertaken.	**Intent:** To ensure pressure probes are used to monitor pressures in fill and on barricades (compare actual and modelled). This information is used as an "early warning system" to highlight when things are no longer going to plan or meeting expectations. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Ensure competent person involved in selection of probe type and layout of probes in stopes/barricades. Sight reports. Interview personnel. Sight emergency response plan or fill management plan for evidence of use of pressure probes. Sight probes underground and data collected.

13.5	Controls are in place to avoid over-pressurising the stope during tight filling, which could lead to a barricade failure and fill egress.	**Intent:** To ensure barricade does not fail due to overpressurising during final stages of filling. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Look for evidence of pressure-relief controls (e.g. breather holes) and diversion mechanisms/storage areas. Look for details about this risk in risk assessment/register, procedures, fill strategy.
13.6	Controls are in place to avoid fill reticulation blockages, which could lead to use of excessive flushing water.	**Intent:** To ensure minimal water is added to the stope and to maximise fill strength. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Look for evidence of "blast points" (where sections that are blocked are blasted off and pipework is relaid) or robust valves and connections that can be removed without too much duress. Check SWPs for rectifying blockages (e.g. use of IT baskets, working from heights, lifting heavy loads). Look for details in risk assessment/register, procedures, fill strategy.
13.7	Checks are made to ensure hydraulic fill is fully drained and consolidated, and paste fill is cured to design strength before it is exposed or blasted against.	**Intent:** To ensure fill exposed by mining through/adjacent is of adequate strength to standup. To ensure all workforce are aware of risks. To ensure procedures exist for mining through and/or adjacent to fill, including investigatory measures such as probe holes to check the condition of fill prior to exposure. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen, general underground workforce **Method:** Check for evidence of probe drilling before decision to blast/expose fill. Check design calculations exist and were done by competent person using recognised methods. These calculations are used to provide fill specifications for stope-specific cases. Check mine production schedule allows for curing time as specified. Ensure adequate communication to workforce of importance of this issue. Check procedures, training and assessment.

13.8	Checks are in place to ensure the fill is placed to correct level and has cured before further stope filling after pouring “brow lifts”/“plug pours” (with paste fill).	**Intent:** To ensure underground observations are performed to check fill level and curing before proceeding to pour additional paste fill over the top of the “brow lifts”/“plug pours”. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Check for evidence of probe drilling or other form of checking strength before decision to continue filling.
13.9	Barricades are inspected prior to being placed under load to ensure not blast damaged or damaged by other operations (e.g. loader bucket).	**Intent:** To ensure barricades are not damaged by blasting or operations (e.g. LHD bucket) before and/or while placed under working load. **Personnel:** Mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, mine foremen **Method:** Interview personnel. Ensure blasting does not cause micro-fracturing inducing weakness nor completely destroy the barricade due to vibration/rockfall/airblast. Ensure load-haul-dump (LHD) operations are kept separate from these barricades. Look for documentation of inspections (checklists?). Check blasting procedures (is there any mention of fill systems?). Check fill management plan. Look for evidence of awareness training of underground operations personnel.

14 Design confirmation / back analysis

Design confirmation / back analysis

Point	Standard	Guideline
14.1	Regular observations of fill and barricade conditions are compared with expected/calculated conditions to validate assumptions/verify models.	**Intent:** To ensure fill is progressing as expected based on design calculations and modelling. **Personnel:** Mining/geotechnical/fill engineers **Method:** Sight database of observations. Sight fill strategy modelling validation/back-analysis documentation. Interview personnel. Check for ponding, slurry thickness/sloppiness, level of fill and water in stope, moisture content of drained fill. Check barricades are draining. Ensure all conditions underground are as expected (actual versus modelled).
14.2	Incidents involving the fill system are reported and investigated to determine causal factors and appropriate corrective actions.	**Intent:** To verify that learnings are captured and applied to improve the fill system and minimise the risk of incidents recurring. **Personnel:** General manager, mine manager, technical services superintendent, OH&S/training, mining/geotechnical/fill engineers, surveyors, metallurgists, mill operators, mine foremen, general workforce **Method:** Check that findings and recommendations are formally documented and communicated to the workforce. Sight site-based risk register, hazard management plans and systems for evidence of learnings being applied. Investigate all fill-related incidents using a multidisciplinary investigation team as soon as possible after incidents occur and report to DMIRS. Ensure learnings from incidents are recorded and applied as future control measures and management plans. Check if industry incidents are also source of learning (e.g. awareness of Coroner's report on Bronzewing incident). Refer to MSIA ss. 78(3)(a and/or d) and 79; Mines Safety Bulletins Nos 55 and 64; Mines Safety Significant Incident Report No. 138.