# Underground mine fill audit Site: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

# Date conducted:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

|  |
| --- |
| 1 Mine planning and design: general fill |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 1.1 | There is a strategy for the supply and placement of fill, stating source material and schedule in alignment with production objectives. |  |  |
| 1.2 | All stopes requiring fill are filled as soon as practicable after the extraction of ore is complete. |  |  |
| 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. |  |  |
| 1.4 | The mine has a specification for minimum quality of waste fill. |  |  |
| 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. |  |  |
| 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. |  |  |
| 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. |  |  |
| 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. |  |  |

 |
| 2 Mine planning and design: barricades |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 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. |  |  |
| 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. |  |  |
| 2.3 | Hydraulic fill barricades are of sufficient number, layout and permeability to allow required drainage. |  |  |
| 2.4 | Barricades are placed in locations where they can achieve maximum potential strength (e.g. minimal dimensions and blast damage, away from brow). |  |  |
| 2.5 | Fill barricades are designed by a competent person using recognised engineering methods. |  |  |
| 2.6 | Fill barricade designs are specific to the stope and barricade locations. |  |  |
| 2.7 | Fill barricade designs are modelled numerically to ensure the design working load can withstand expected worst-case total pressures in that stope. |  |  |

 |
| 3 Mine planning and design: paste fill |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 3.1 | Paste fill specification includes an acceptable range for PSD. |  |  |
| 3.2 | Paste fill specification includes an acceptable range for pulp density/% solids/%Cw. |  |  |
| 3.3 | Paste fill specification includes an acceptable range for cement addition (%). |  |  |
| 3.4 | Paste fill specification includes an acceptable range for yield stress and slump. |  |  |
| 3.5 | An investigation of fill mineralogy has been undertaken to ensure the final product is of desirable quality. |  |  |
| 3.6 | An investigation of process water chemistry has been undertaken to ensure the final product is of desirable quality. |  |  |
| 3.7 | The fill reticulation system is designed and reviewed by a competent person. |  |  |

 |
| 4 Mine planning and design: hydraulic fill |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 4.1 | Hydraulic fill specification includes an acceptable range for PSD. |  |  |
| 4.2 | Hydraulic fill specification includes an acceptable rangefor pulp density/% solids/%Cw. |  |  |
| 4.3 | Cemented hydraulic fill specification includes an acceptable range for cement addition (%). |  |  |
| 4.4 | Cemented hydraulic fill specification includes an acceptable range for yield stress and slump. |  |  |
| 4.5 | An investigation of fill mineralogy has been undertaken to ensure the final product is of desirable quality. |  |  |
| 4.6 | The fill reticulation system is designed and reviewed by a competent person. |  |  |

 |
| 5 Mine planning and design: fill strategy simulation and modelling |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 5.1 | The entire backfill process is appropriately engineered and is an integral part of a holistic mine design approach. |  |  |
| 5.2 | Modelling for liquefaction potential under dynamic loading has been undertaken by a competent person. |  |  |
| 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. |  |  |
| 5.4 | Stope specific pour-rest cycle fill strategies have been developed to ensure adequate drainage/curing of fill. |  |  |

 |
| 6 Operations: mine management systems |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 6.1 | Organisation and resourcing are clearly defined for the hydraulic/paste fill operations. |  |  |
| 6.2 | Roles and responsibilities are clearly defined and allocated to personnel involved with the hydraulic/paste fill operations. |  |  |
| 6.3 | Clear lines of communication exist for the safe operation of the hydraulic/paste fill system within the overall mining process. |  |  |
| 6.4 | A competent person has been appointed to manage hydraulic/paste fill operations as a single point of accountability. |  |  |
| 6.5 | Training has been provided and competency assessed to ensure all mine and fill plant employees are able to identify potential hazards. |  |  |
| 6.6 | Employees are not exposed to toxic contaminants in the hydraulic/paste fill. |  |  |
| 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. |  |  |

 |
| 7 Operations: fill management plan / risk management |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 7.1 | Hazards are identified and team-based risk assessments have been undertaken for the entire fill system (mill to mine). |  |  |
| 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. |  |  |
| 7.3 | All control measures have been transferred to emergency response plans, procedures, forms and checklists. These are regularly reviewed. |  |  |
| 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. |  |  |
| 7.5 | All decisions, inspections and monitoring with respect to fill are formally documented. |  |  |
| 7.6 | Blasting adjacent to newly constructed barricades and placed uncured or undrained fill is strictly prohibited. |  |  |
| 7.7 | Water is not permitted to build up in paste/hydraulically filled stopes. |  |  |
| 7.8 | Water mass balance should be performed daily in hydraulicfill/wet paste fill to ensure filling and draining are proceeding as expected. |  |  |
| 7.9 | Containment bunds, exclusion zones and other forms ofphysical separation are used to minimise exposure of personnel to the hazard of mine fill egress into workings. |  |  |

 |
| 8 Operations: barricades quality assurance |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 8.1 | Fill barricades must allow drainage, and water should not be allowed to accumulate at the barricade. |  |  |
| 8.2 | Materials to be used for construction of fill barricades must be specified by a competent person. |  |  |
| 8.3 | The method to be used for construction of fill barricades must be specified by a competent person. |  |  |
| 8.4 | Systems exist to ensure barricades are constructed as per design. |  |  |

 |
| 9 Operations: paste fill quality assurance |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 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. |  |  |
| 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. |  |  |
| 9.3 | TAP exists for when specification and quantities go outside of the allowed range. |  |  |

 |
| 10 Operations: hydraulic fill quality assurance |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 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. |  |  |
| 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. |  |  |
| 10.3 | TAP exists for when specification and quantities go outside of the allowed range. |  |  |

 |
| 11 Reticulation quality assurance |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 11.1 | The reticulation system has been installed in accordance with the design. |  |  |
| 11.2 | Ongoing preventative maintenance system for the reticulation system is undertaken and documented. |  |  |

 |
| 12 Fill plant quality assurance |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 12.1 | The fill plant is maintained and operated in a safe manner. |  |  |
| 12.2 | Fill specification quality assurance tests are performed at the fill plant on a daily basis. |  |  |
| 12.3 | TAP exists for when the fill supplied is outside specification or for high flushing water volume events. |  |  |

 |
| 13 Underground monitoring |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 13.1 | Provision made for safe observation underground of all fill operations. |  |  |
| 13.2 | Underground inspections are performed regularly to observe fill and barricade conditions and ensure actual conditions match expected/calculated conditions. |  |  |
| 13.3 | TAPs exist for underground observations where situations appear unsafe. |  |  |
| 13.4 | Underground pressure measurements to determine actual loads on fill and barricades are undertaken. |  |  |
| 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. |  |  |
| 13.6 | Controls are in place to avoid fill reticulation blockages, which could lead to use of excessive flushing water. |  |  |
| 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. |  |  |
| 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). |  |  |
| 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). |  |  |

 |
| 14 Design confirmation / back analysis |
|

|  |  |  |  |
| --- | --- | --- | --- |
| **Point** | **Standard** | **Standard met** | **Comments** |
| 14.1 | Regular observations of fill and barricade conditions are compared with expected/calculated conditions to validate assumptions/verify models. |  |  |
| 14.2 | Incidents involving the fill system are reported and investigated to determine causal factors and appropriate corrective actions. |  |  |

 |