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Introduction:

To ensure the person and or persons performing the work are deemed competent as defined in the OSHA(1).

Competent Person Means; (a) is qualified because of knowledge, training, and experience to organize the work and its performance.

(b) is familiar with this act and the regulations that apply to the work and

(c) has knowledge of any potential or actual danger to health or safety in the work place.

1. OBJECTIVE

To provide guidelines that ensure the safety of any worker exposed to under fill mining is maintained. This policy will comply with Ontario Occupational Health and Safety Acts and Regulations for Mines and Mining Plants, Regulation 67 (1) (2).

2. SCOPE

This procedure applies to any non-sill mining under fill associated with First Nickel Inc.

3. INTRODUCTION

The following procedure standardizes mining under fill and any associated development activities. It will include the 3-pass minimum support standard and the intersection support standard.

4. RESPONSIBILITIES

Personnel involved with the execution of this standard have the following responsibilities:

4.1. Shift Supervisor

The Shift Supervisor is responsible for:

4.1.1. Ensuring adequate precautions are taken to minimize worker exposure and risk while performing tasks in preparation for ground support installation under unsupported ground.

4.1.2. Personally assessing the ground conditions during the shift routine and providing corrective action if required.

4.1.3. Following up with workers at the end of shift to discover any troublesome areas, and ensuring that the oncoming supervisor is aware of any problem areas.

4.1.4. Taking every precaution reasonable in the circumstances for the protection of the worker.

4.1.5. Inspecting steel set installation for intersection support prior to shotcreting.

4.2. Worker

The worker is responsible for:

4.2.1. Using the 5 point safety system and marking any corrective actions or hazards on the card.

4.2.2. Washing down the excavation before beginning to install ground support.

4.2.3. Utilizing all the required PPE for the task.

4.2.4. Using or operating any equipment, machine, device, or thing of work in a manner that will not endanger himself/herself or any other worker.

5. DEFINITIONS

5.1. Plug

The bottom portion of the hydraulic backfill pour, mixed with higher binder content.

5.2. Panel

The upper, bulk portion of the hydraulic backfill pour, mixed with a decreased binder content.

6. PREPARATIONS

6.1. Personal Protective Equipment

Personal protective equipment required during the execution of this procedure includes:

6.1.1. Standard PPE as per FNI policy.

6.1.2. Specialized PPE for installing shotcrete and as required for other specific tasks (i.e. fall protection).

6.2. Other Requirements

6.2.1. All tasks to be conducted as per FNI policies and procedures.

7. STANDARD

7.1. General

7.1.1. No person is permitted to enter under unsupported ground to perform any activity unrelated to the installation of ground support.

7.1.2. The area to be supported will be washed down properly prior to installing ground support.

7.1.3. No other activity will occur in the area being supported until proper ground support is installed.

7.1.4. Ground support will be installed as soon as reasonably possible. If for whatever reason, support cannot be installed immediately, the area will be barricaded off with an appropriate sign posting the hazard and **noted in the Supervisor log.** In addition, further instructions may be issued for site specific conditions, which will be included in the driving layout.

7.1.5. This procedure comes into effect when mining is occurring under a previously mined stope. The stope will be filled with a mixture of hydraulic backfill and waste rock. The “plug” is filled with 8:1 hydraulic backfill to 2m above the drift brow. The “panel” is filled with 25:1 hydraulic backfill or a waste and backfill mix.

7.1.6. Workers and supervision performing work in underfill headings will be provided a copy of the driving layout which will indicate the support standards required in the heading.

7.2. 3-Pass Minimum Support Mining Under Fill Standard

7.2.1. Drilling and Blasting

The under fill drift will adhere to the following:

- Maximum round length = 3m
- Width = 4.2m
- Height = 4.2m
- Arch Height = 0.84m
- **Maximum span of under fill rounds = 5m**
- Arch height is 20% of round span
- Perimeter blasting techniques according Lockerby Standards
- **Do not slash if off line or out of ore;** adjust stope drilling

7.2.2. First Pass Support

The under fill drift will adhere to the following during the First Pass Support:

- Walls and back must be well scaled to remove any loose material; wash down the round, removing dust, oil, grease, or any other foreign substances
- Apply the shotcrete (King MS-D3 Accelerated Shotcrete or equivalent) with a remote shotcreting arm; however, should the arm not be available, manual shotcreting will be permitted and round length will be reduced to 1.8m**.**
- Minimum shotcrete thickness is 50mm to within 1.2m of the floor and 0.2m of the face
- Avoid overspraying shotcrete onto the face
- Allow proper cure time based on shotcrete type before proceeding to **Second Pass Support and Reinforcement**

7.2.3. Second Pass Support and Reinforcement

The under fill drift will adhere to the following during the Second Pass Support and Reinforcement:

- The bolt will be a 1.68m (66”) long – 35mm diameter Friction Lok FL35 Galvanized (“Split Set”)
- The screen will be a 1.5m (5 ft) by 3.3m (11 ft) #6 Gauge Galvanized with 0.1m by 0.1m squares
- Install screen with Friction Lok bolts on a 4-3-4 pattern spacing to within 1.5m of the floor and 0.3m of the face

- Install bolts in second square from outside edge of screen and maintain 2 square overlap between separate pieces of screen
- As bolt installation occurs, confirm thickness of the shotcrete applied during the **First Pass Support**; clearly mark any discrepancies in thickness on the wall so it can be remedied during the **Third Pass Support**

7.2.4. Third Pass Support

The under fill drift will adhere to the following during the Third Pass Support:

- Cut 50mm strand of screen and bend outwards in a 1.2m by 1.2m pattern on the walls and back to act as a shotcrete thickness indicator
- Wash down the round, removing dust, oil, grease or any other foreign substances
- Apply the shotcrete (King MS-D3 Accelerated Shotcrete or equivalent) with a remote shotcreting arm; however, should the arm not be available, manual shotcreting will be permitted and round length will be reduced to 1.8m
- Minimum shotcrete thickness is 50mm and all screen and bolts are to be covered and shotcrete applied to within 1.2m of the floor and 0.5m of the face; 2 squares of screen should be exposed at the face to allow proper overlap of next round
- Avoid overspraying shotcrete onto the face
- Allow proper cure time based on shotcrete type before proceeding to **Drilling and Blasting**
- Confirm thickness of **Shotcrete**, every 1m at five equally spaced points on the shoulder and back of that particular cross sectional area (10 per 3m round); **ANY SUBSTANDARD AREAS NEED TO BE RE-SHOT TO ACHIEVE 100mm OVERALL THICKNESS**

7.3. Intersection Support Standard

Arched Ribs are placed in all 3-way intersections when mining underneath a backfilled stope. The arches provide secondary support for the larger span of the intersection. When installed, these enhance the support provided by the **3-Pass Minimum Support Mining Under Fill Standard.**

7.3.1. Drilling and Blasting

The under fill intersection will adhere to the following:

- Maximum round length = 3m
- Width = 4.2m
- Height = 4.2m
- Arch Height = 1.5m
- **Maximum span of under fill intersection = 7m**

- Arch height is 20% of round span
- Perimeter blasting techniques according Lockerby Standards
- **Do not slash if off line or out of ore;** adjust stope drilling

7.3.2. Intersection Arched Rib Placement

- Place 2 steel set-formed ribs in an "X" pattern across the span of the intersection (Layout)
- Place first rib from the North-East corner of the entrance to the South-West wall of the Intersection
- Place second rib from the North-West corner of the entrance to the South-East Wall of the Intersection

7.3.3. Steel Set Installation

The under fill intersection installation of steel sets will adhere to the following:

- Secure steel sets to walls and back with 1.68m (66") long – 35mm diameter Friction Lok FL35 Galvanized ("Split Set")
- Minimum 3 Friction Lok bolts for 2.1m (7ft) steel set
- Minimum 4 Friction Lok bolts for 3.1m (10ft) steel set
- Minimum 0.5m overlap of each steel set
- Steel set may be cut at intersection of one arch to cross through the other

7.3.4. Shotcrete Installation

The under fill intersection shotcrete installation will adhere of the following

- Wash down the area, removing dust, oil, grease or any other foreign substances
- Fill and cover steel sets completely with King MS-D3 Accelerated Shotcrete or equivalent
- Spray shotcrete to a thickness of 25mm beyond the outside of the steel set
- Fill steel sets from bottom, working upwards
- Complete arches in one continuous spray if possible, to avoid cold joints

7.4. Enhanced Ground Support System

Enhancements to this ground support system is necessitated by the following:

- Rubble on floor of previous stope
- Reduced competence of reinforced shotcrete roof beam due to deformation cracking

- Shoulders in fill
- Seismically active areas

If any of the aforementioned situations are encountered, contact the Engineering Department. They will determine if enhanced support is required on a site specific basis.

8. MONITORING MECHANISMS

8.1. Quality Control and Quality Assurance

Redpath, FNI Operations and FNI Engineering will both be responsible for proper quality control and quality assurance during under fill development.

8.1.1. **Shift Supervisor and Workers**

- Evaluate fill in back each round to determine if rubble necessitates enhanced support
- Confirm **First Pass Support** thickness as bolt installation occurs during **Second Pass Support and Reinforcement**; clearly mark any discrepancies in thickness on the walls and/or back
- Third pass shotcrete to be inspected visually by checking for cut 50mm strands of screen and measuring the probe holes in the shotcrete
- Inspect steel sets before applying shotcrete

8.1.2. **Engineering**

- Use standard quality control for each component of the ground support system as defined by the Ground Control Management Plan (GCMP)
- Pull test to be done every 25m (once per stope block). After final shotcrete is cured, each type of bolt will be installed in fill (back) and rock (wall) to be pull tested
- Third pass shotcrete to be inspected visually by checking for cut 50mm strands of screen and measuring the shotcrete thickness at the probe hole locations
- As development of the underfill headings progress, FNI Engineering personnel will conduct ongoing inspections and audits (as outlined in the GCMP). Timing of the inspections/audits will be communicated to Redpath and a Redpath resource may accompany the ground control person if so desired.
- Copies of inspection/audit reports will be provided to Redpath and will also be kept on file in the Engineering Office for future reference.