# IGO GROUP SAFETY STANDARD 10 - GROUND CONTROL IN UNDERGROUND MINES

## INDEPENDENCE GROUP NL

## DOCUMENT APPROVAL FOR USE

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Prepared by: Keith Ashby

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# 1. INTENT

This Standard outlines the requirements for identifying and controlling the risks associated with potential ground movement in underground mines.

# 2. APPLICATION

This standard shall apply to all IGO owned and or operated underground mines, and must be adhered to by all IGO employees, contractors, and sub-contractors.

# 3. RISK ASSESSMENT

A documented ground control risk assessment, with detailed control measures, must be maintained for each site. The risk assessment must address the following potential hazards as a minimum:

- The geotechnical characteristics of any cover sequence and rock mass, and the likely failure modes covering static and dynamic failure modes.
- Any natural or induced seismic activity.
- Any previously excavated or abandoned workings.
- Presence of ground water and other corrosive environments.
- Life expectancy and design requirements of the excavation.
- Appropriate application of acceptance criteria (factor of safety, probability of failure).

The completed risk assessments, inclusive of the defined controls, shall be approved by the site's Registered Manager, or their delegate.

# 4. GEOLOGICAL AND GEOTECHNICAL DATA COLLECTION, MODELLING AND ANALYSIS

Qualified and appropriately experienced personnel shall coordinate the management of the geological and geotechnical databases and modelling used to determine mining methods, mine design, structures, excavations, stopes, slopes, caving, or other failure mechanisms.

## 4.1 Geological and Geotechnical Data Collection

The collection of geological and geotechnical data shall include, but may not be limited to:

- Regional and local geology interpretations and descriptions of the lithological units.
- Structural data and interpretations.
- Rock mass characterization model.
- Assessment of void data (natural, man-made, open or backfilled).
- Soil and rock material properties data.

- In-situ stress field data.
- Regional and mining induced seismic activity.
- Hydrogeological investigations.
- Climatic data, including rainfall, rainfall intensity and flooding.
- Rock support and reinforcement materials database.
- Areas of known water bodies and dams.
- Historical mining information.

## 4.2 Modelling and Analysis

Geotechnical analytical tools, techniques for selecting appropriate data, engineering principles and specifications shall be used as the basis for:

- Defining geotechnical domains within the mine.
- Defining the engineering properties of the rock mass in each geotechnical domain.
- Maintaining a geotechnical model of the operation of suitably quality to describe the complexity of the mining environment.
- Assessing the potential modes of failure by applying appropriate design methods (kinematic, empirical, deterministic, numerical).
- Analyzing stress regimes during different stages of development and production.
- Assessing the rock mass response to mining.
- Assessing response of structures to mining.
- Assessing the response of the hydrogeology to mining.
- Evaluating the influence of blasting and seismic activity on the rock mass, ground support systems, and stability of excavations.
- Reviewing the geotechnical incident history and conducting back-analyses.

## 4.3 Mine Planning, Design and Scheduling

Formal processes shall be in place to integrate the geotechnical data collection, modelling, analysis, risk assessments, ground control and stability issues into the mine planning, design and scheduling systems. This process shall include the following steps:

- A formal mine design process using an integrated team approach with sign-off (as a minimum) by mine planning, geology, geotechnical, survey, operations personnel, and the Registered Manager.
- Definition of appropriate geotechnical mine design criteria and mining methods.
- Ensuring the scheduling / sequencing of development, stopes, pillars, backfill reflects the mine

planning and design restraints.

- A formal process for designing ground control systems.
- The identification of exploration, and other drill holes that may connect workings to other workings, groundwater aquifers, or to the surface.
- Identifying and assessing all geotechnical sources of potential inrush.
- Identifying and assessing backfill requirements for stability, and preparing fill preparation notes with all QAQC, reticulation, and barricade requirements.
- Addressing potential environmental impacts during mine lifecycle.
- Consideration for mine closure issues such as: stability of walls, voids, accesses and safety to the public.

## 5. GROUND CONTROL MANAGEMENT PLANS

All IGO underground mines shall have a site-specific ***Ground Control Management Plan.*** The plan shall be based on the results of the geological and geotechnical data collection, modelling and analysis, and the associated risk assessments. The plan shall take the form of a standard IGO management plan, and must include the following as a minimum:

- Background geological and geotechnical information of the operation, including rock types, structures, geotechnical parameters, and hydrogeology conditions.
- A list of roles and the assigned responsibilities of those roles in managing all ground control management related items.
- A list (or reference to appropriate storage locations) of all relevant technical reports, presentations and information with provision for ready access to this information
- Reference to relevant sections of all other relevant sections in site management plans.
- Reference to the Regulations applicable for the jurisdiction of the operation.
- Specifications of the technical data utilised in modelling and design of excavation and construction of open pits, and surface excavations where ground control and stability risks exist related to the mine operations.
- Specifications of the technical data utilised in modelling and design of excavations, stopes, caving and support methods.
- Technical competency requirements of personnel and resources involved in the management of ground control (including inspections) and analysis of technical data.
- A list of relevant Standard Work Procedures for all relevant ground control management practices.
- Specification of methods, materials certification, and quality criteria for ground control materials used at the site.
- Specification of backfill requirements, with links to relevant management plans and design

documentations.

- Inspection and reporting requirements for ground control management related items, including rectification requirements where deficiencies or issues are identified.
- Monitoring parameters developed around hazards, risks and controls identified in the risk assessment process
- Thresholds identified for the monitoring parameters, with supporting Trigger Action Response Plans (TARPs).
- Specifications of monitoring and alarm equipment for type, location, and frequency of data collection and review
- Workforce training requirements.

If separate *Surface and Underground Ground Control Management Plans* are developed they shall be consistent and coordinated with each other.

The *Ground Control Management Plan* must be prepared by qualified and appropriately experienced personnel and approved by the site's Registered Manager.

## 6. COMMUNICATION, MONITORING, INSPECTIONS AND VERIFICATION

Site's must ensure the effective communication of the plan and the associated control measures to relevant underground employees and contractors.

Site's shall verify that work is completed in accordance with the Inrush and Outburst Management Plan. Specifically, site's must ensure that mine planning, design and scheduling is completed with due regard to the Inrush and Outburst Management Plan. Records of verification audits must be documented in INX.

Further, site's must ensure that:

- formal inspections and measurements are completed to schedule to verify the adequacy of control measures
- quality control and assurance processes for ground control and backfill management are fit for purpose.
- rock mass monitoring, data collection, instrumentation is fit for purpose.
- mine design, scheduling, mine sequencing, support systems, rock mass failure modes analysis remains fit for purpose
- geotechnical incident history and back-analyses is completed
- observations and monitoring data is collected, collated and displayed in a manner that a) enables the ready identification of trends indicative of changing hazards, and b) validates or otherwise the predictions of the local and regional rock mass responses to mining, including the effectiveness of ground control measures.

## 7. REVIEW OF MANAGEMENT PLANS

Site's shall have an established process for the reviewing the *Ground Control Management Plan*, and relevant sections in other referenced controlled documents. The plan must be reviewed at least annually by qualified, competent site staff to confirm that all significant hazards are addressed, and the monitoring systems, controls, and training requirements are fit for purpose. The review must also address how well or otherwise the plan is understood by the underground mine management team.

Additionally, the Inrush & Outburst Management Plan must be reviewed:

- When ground control hazards change, new geotechnical hazards are identified, or when existing key assumptions are updated because of new information or practices adopted.
- Prior to the mine being extended into any new area, including extension at depth or along strike which was not considered as part of the mine design at the time of approval.
- Biennially by an external expert in collaboration with senior mine-based staff. This process must include a review of the hazards, the risk assessment, the effectiveness of controls, training, and communication of controls and control monitoring, and the general adequacy and likely effectiveness of the overall management plan.
- Cooperative review every three years between a team comprising senior mine based staff and an external expert. This process must include a review of the hazards, the risk assessment, the effectiveness of controls, training, and communication of controls and control monitoring, and the general adequacy and likely effectiveness of the overall management plan.
- Following any ground control related incident where established controls are deemed inadequate.
- Given a proposed change to mining method. In such circumstances, the review must be completed by external expert in collaboration with senior mine-based staff.

## 8. TRAINING

Persons working in the mine area shall be provided with routine ground awareness and control training as required by local statutory requirements, and as appropriate to safely execute the requirements of their job description.

## 9. RELATED DOCUMENTS

- CMS ST-03 Risk Management
- IGO Group Safety Standard 39 – Inrush
- Relevant Management Plans (Ground Control, Water Management, Backfill, Tailings Storage)

## 10. GLOSSARY OF TERMS

| Term | Definition |
|---|---|
| Ground Control | A combination of rock support, rock reinforcement, and processes of excavation to create a stable mine opening suitable for personnel access. |
| Hazard | A hazard is a source, or a situation, with the potential for harm in terms of human injury or health, damage to property, damage to the environment, or a combination of these. Refer to CMS ST-03 Risk Management. |
| Hydraulic Fill | A type of mine fill made from either naturally occurring material, or mine tailings with a prescribed particle size, placed into underground voids as a slurry via boreholes and / or pipelines. The material used must be strictly controlled to ensure excess water can freely drain. Hydraulic fills can be either cemented or uncemented, depending on the mine design and long-term fill stability requirements. |
| Inrush | The occurrence of a liquid, gas, or other substance that can flow into a workplace at a rate or volume that creates a risk to health and safety of mine workers, which may create an emergency situation. |
| Paste Fill | A type of mine fill consisting of ultra-high-density thickened tailings with an added binder. This fill type differs from hydraulic fill in that it contains higher quantities of fine material, and only sufficient water to hydrate the binding agent being used. |
| Risk | A risk is the chance of an unwanted event happening that will have a negative effect. The level of risk reflects the likelihood of the unwanted event, and the potential consequences of the unwanted event. Refer to CMS ST-03 Risk Management. |
| TARP | Trigger Action Response Plan. A document or process to prevent a risk from escalating by identifying potential indicators to the hazard, assigning an appropriate action or trigger point for each hazard, and outlining responses for each trigger level. |