WSN Ground Control Committee recommendations

Mine design required under Sect. 6 of Ontario Regulation 854 (Mines and Mining Plants)

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Workplace Safety North (WSN) is the health and safety association serving underground and surface mines, pits, Tunneling, smelters, refineries and related sectors in Ontario. We provide auditing and consulting services, training and information to help our member companies meet our shared vision of an industry where every worker comes home safe and healthy, every day.

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WSN (formerly MASHA) Ground Control Technical Advisory Committee

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Foreword

The recommendations contained in this document are intended to assist Ontario mining companies in developing the mine design required under Section 6 of Ontario's Regulation 854 (Mines and Mining Plants).

This document is intended to assist in the development of the mine design document, but is by no means an exhaustive listing. Individual operations may chose to omit certain unnecessary elements and include additional items, not listed in this document, in order to tailor the mine design to their particular requirements.

The document was reviewed by WSN's Technical Advisory Committee on Ground Control. WSN gratefully acknowledges the contributions of all committee members and their sponsoring organizations.

Ontario legislation

Section 6 of Regulation 854 (Mines and Mining Plants) reads as follows:

(1) The owner of a surface mine producing metallic ore or of an underground mine shall prepare and maintain a mine design assessing the ground stability of the active and proposed workings of the mine.

(2) The mine design shall consist of drawings, plans, specifications or procedures to be used and shall be prepared under the direction of a competent person.

(2.1) The mine design shall be based upon sound geotechnical engineering practices and shall,
(a) describe the geology of the mine;
(b) outline the geometry of existing and proposed excavations;
(c) describe previous occurrences of ground instability;
(d) describe the mining method including stope sequencing and blasting methods;
(e) specify the ground support system; and
(f) describe measures planned and used to assess potential ground instability such as instrumentation and computer modelling.

(3) The mine design shall be assessed and updated at least annually and also before any alteration is made to the mine that may significantly affect the ground stability of the mine.

(4) The mine design shall be kept readily available at the mine site for review by an inspector and by the joint health and safety committee or health and safety representative, if any.

The Ontario Ministry of Labour (MOL) has prepared three Health and Safety Guidelines related to mine design requirements described in Section 6 of the Regulations:

- The Health and Safety Guideline, *Mine design*, (Ontario Ministry of Labour, 1999a) provides a historical review of Sect. 6, and contains general information

on its performance objectives. It also notes that MOL staff conduct audits of the mine design at individual operations. The guideline states that gravel pits and quarries are excluded from the requirements contained in the regulation.

- A second Health and Safety Guideline, *Mine design requirement for surface and underground mines* (Ontario Ministry of Labour, 1999b) establishes the following criteria for "sound geotechnical engineering practices" mentioned in Sect. 6:

    ◊ *The existence of a comprehensive methodology for collecting or making available all of the geotechnical information necessary for undertaking the required excavation stability analyses (including relevant property values for mine rocks, geologic mapping results, ground stress measurements, pertinent groundwater information, relevant ground monitoring data and the results of mine rock mass classification schemes);*

    ◊ *The routine undertaking of pre-mining ground stability analyses to assess the stability of proposed excavations on both a micro and macro mine environment basis (ensuring that proposed excavation dimensions, extraction sequences and ground support requirements are analytically rationalized, and allowing for the necessary design modifications to be made prior to beginning mining).*

    The Health and Safety Guideline establishes the following criteria for the "competent person" mentioned in Sect. 6 of the Regulations:

    ◊ *… requires that a mine have access to a source of engineering expertise capable of ensuring that the mine design is "based on sound engineering practices".*

    ◊ *In the event that a mine has no local source of geotechnical engineering expertise at its disposal, it would be acceptable for that mine to rely on external consultants, provided that the mine is capable of implementing the design as specified by the external source of expertise.*

- A third Health and Safety Guideline, *Management of rockbursts—statement of policy and health and safety guidelines*, (Ontario Ministry of Labour, 2004) describes the policy adopted by the Ontario Ministry of Labour regarding the managements of rockbursts, and establishes the following performance objectives for all underground hard rock mines, which must be incorporated in their mine design:

    ◊ *An assessment shall be undertaken to evaluate the likelihood of the occurrence of rockbursts as a result of mining. The assessment shall evaluate the likelihood over the projected operating life of the mine. The assessment shall be updated annually and before any significant alteration to the mine design that may affect the ground stability at the mine.*

    ◊ *Based on this analysis, all reasonable measures shall be incorporated into the mine design and operational procedures at the appropriate time, in such a way that the potential for rockbursts is minimized. When possible, such measures shall be in place before rockburst occurrences are expected to take place. These measures may include operational procedures, a review of the mine design and sequencing, and the use of instrumentation and monitoring.*

    ◊ *At operations where rockburst occurrences have happened or are likely to happen, all reasonable measures for the protection of underground workers shall be implemented.*

Suggested table of contents for mine design

The suggested table of contents for the mine design document is shown on the opposite page. Details are provided in the following section.

SUGGESTED TABLE OF CONTENTS

Discussion

The following information should be considered as a guide for the development of a mine design document. Individual operations may choose to omit unnecessary elements or include additional items in order to tailor the mine design to their particular requirements.

SECTION	DESCRIPTION
APPROVALS	This page contains signatures, titles and dates for all personnel responsible for approving the mine design.
REVISIONS	This page identifies the date of revision release, and a brief itemized description of the information which has been modified in the new version.
1 INTRODUCTION	This section provides general information concerning the mine (location, history, etc.). Changes made to the mine design since the last annual revision should be outlined.
2 RESPONSIBILITIES IN GROUND CONTROL PROGRAM	This section outlines specific responsibilities, accountabilities and required competencies of workers, front-line supervisors, ground control personnel, other engineering & geology personnel, upper management and external consultants in the ground control program.

3 **GEOLOGY AND GEOTECHNICAL DATA**	This section describes: • the general mine geology and mineralogy • rock types • rock strengths and properties (UCS, elasticity, etc.) • major geological structures or controlling features • dips and strikes of the geological structures • joint orientations, spacing, properties, infilling materials, etc. • rock mass classification data • pre-mining stresses and groundwater conditions • the ongoing program for the collection of geotechnical data (e.g. mapping, core logging, etc.)
4 **MINE CONFIGURATION**	This section describes: • the geometry of existing and proposed mine openings • the current mining plan (a longitudinal section and level plans may be included)
5 **MINE DESIGN PROCESS**	This section describes the mine planning process in place at the mine, such as: • define ore blocks • prepare initial selection of mining method and plan • conduct ground control assessment – modeling, historical data, mapping, definition of pillars and sequence, ground support selection • finalize design • excavate and monitor The approval process and interactions between mine personnel should be described.

6 PREVIOUS OCURRENCES OF INSTABILITY	The review of historical data should include an analysis of rockfalls, rockbursts and ground support failure investigations. A list of recorded falls of ground and rockbursts at the mine should be provided. If pertinent, consultants' reports should be included or referenced, along with relevant data from adjacent sites.
7 MINING METHODS	This section should describe how the mining methods were developed, and explain the rationale for selecting a mining method in a particular area of the mine. The description of mining methods should include plan and sectional views, and stope sequencing practices.
8 BLASTING METHODS	This section describes blasting practices in development rounds and stoping operations. The application of perimeter blasting techniques to minimize damage to the rock mass should be described (e.g. blast hole size, pattern and orientation, explosive selection, delays). Typical diagrams for perimeter blast patterns should be provided. This section should also describe the use of destress blasting techniques to prevent or minimize rockburst occurrences at the operation. Typical diagrams for destress blast patterns should be included.

9 GROUND SUPPORT	This section should describe: • the ground support design criteria • the process for the evaluation of new or changed ground support techniques • the process for the evaluation of excavations that do not meet current ground support standards • specifications for all support elements used at the mine, including all rockbolts types, cablebolts, shotcrete, mesh, shotcrete posts, etc. • minimum ground support standards (primary and secondary) for all excavation types • a support upgrading system that describes supplementary ground support to be installed in response to changing ground conditions • the ground support role of backfill, the type(s) of backfill used, laboratory backfill strength data, minimum design requirements, the backfill distribution system, the construction of fill barricades, etc.
10 GROUND MONITORING	This section should describe: • the application of instruments such as deformation gauges, instrumented cablebolts, etc. The use of monitoring information in routine mine planning, back analysis and application of ground support should be described • the mine-wide seismic monitoring system (description of system and capabilities, typical analyses – day-to-day and historical, re-entry protocols following a seismic event, etc.)

11 GEOMECHANICAL / GEOTECHNICAL EVALUATION	This section describes the methods used to assess ground instability, such as: • site investigations by ground control personnel • use of structural analysis techniques such as wedge analysis • Matthew's method for open-stope design • numerical modelling (finite element, finite difference, boundary element) • the rockburst management protocol
APPENDICES	Attach documents referenced in the mine design, or include a list of available reports at the mine, such as: • external geotechnical consultants' reports (e.g. feasibility studies, numerical modeling, post-analysis of ground failures, etc.) • program for communication of ground control information (required under Sect. 65 of Mining Regulations) • ground support installation procedures for all ground support types in use at the operation (required under Sect. 67 of Mining Regulations) • quality control program for ground support installations (required under Sect. 73 of Mining Regulations) • standard operating procedures for all ground control activities • ground control training programs (e.g. Supervisory Common Core) • site-specific ground control protocols

References

Ontario Ministry of Labour, 1999. *Mine design*. 4 pp.

Ontario Ministry of Labour, 1999. *Mine design requirement for surface and underground mines*. 4 pp.

Ontario Ministry of Labour, 2004. *Management of rockbursts—statement of policy and health and safety guidelines*, 9 pp.