



MASHA's Ontario Mine Rescue Program

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Alex Gryska
Manager Mine Rescue
Mines and Aggregates Safety and Health Association
760 Notre Dame Avenue, Unit M
Sudbury, ON Canada P3A 2T4

Email: alexgryska@masha.on.ca
Telephone: 1-705-671-6360

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Introduction

During its more than 75 years of existence, Ontario's mine rescue program has established a reputation for high standards in training, equipment and emergency response. This paper will provide a brief overview of the development of the program, and outline legislative requirements, the involvement of the mining industry and Ontario's approach to providing consistent and high-quality mine rescue services.

Background

Ontario Mine Rescue was formed in 1929 following a major fire at the Hollinger Mine in Timmins, which resulted in the deaths of 39 men. Ontario mines were not prepared to deal with an event of this magnitude and not until mine rescue teams from Pittsburgh, USA responded was the fire ultimately brought under control. A commission was established to investigate the incident and make recommendations to prevent any similar event in the future.

This tragic Hollinger fire resulted in the creation of Ontario's mine rescue program and continues to be a catalyst for improvement today. In keeping with the recommendations of the government commission, the first mine rescue station was established in Timmins, followed by other rescue stations in major mining areas.

Other significant changes were made to the program as a result of the following major incidents: the East Malartic fire in 1947, the McIntyre fire in 1966 and lastly the Falconbridge 5 shaft rock burst in 1984. The Ontario mine rescue program originally

focused on fighting fires underground, but the Falconbridge rock burst expanded the mandate to include responding to both fire and non-fire emergencies.



Photo showing Onaping mine rescue station.

In 2001, Ontario Mine Rescue was absorbed by the Mines and Aggregates Safety and Health Association (MASHA). MASHA is a provider of general safety training and consulting to the mining industry, and the partnership has resulted in significant improvements to the program.

Mining in Ontario

Ontario, in central Canada, encompasses approximately 415,000 square miles of land area. A huge mass of rock, the Precambrian Shield, covers the northern part of the province, where the majority of hard rock mines are located. The southern portion of Ontario consists of predominantly sedimentary and metamorphic rock types, home to soft rock operations.

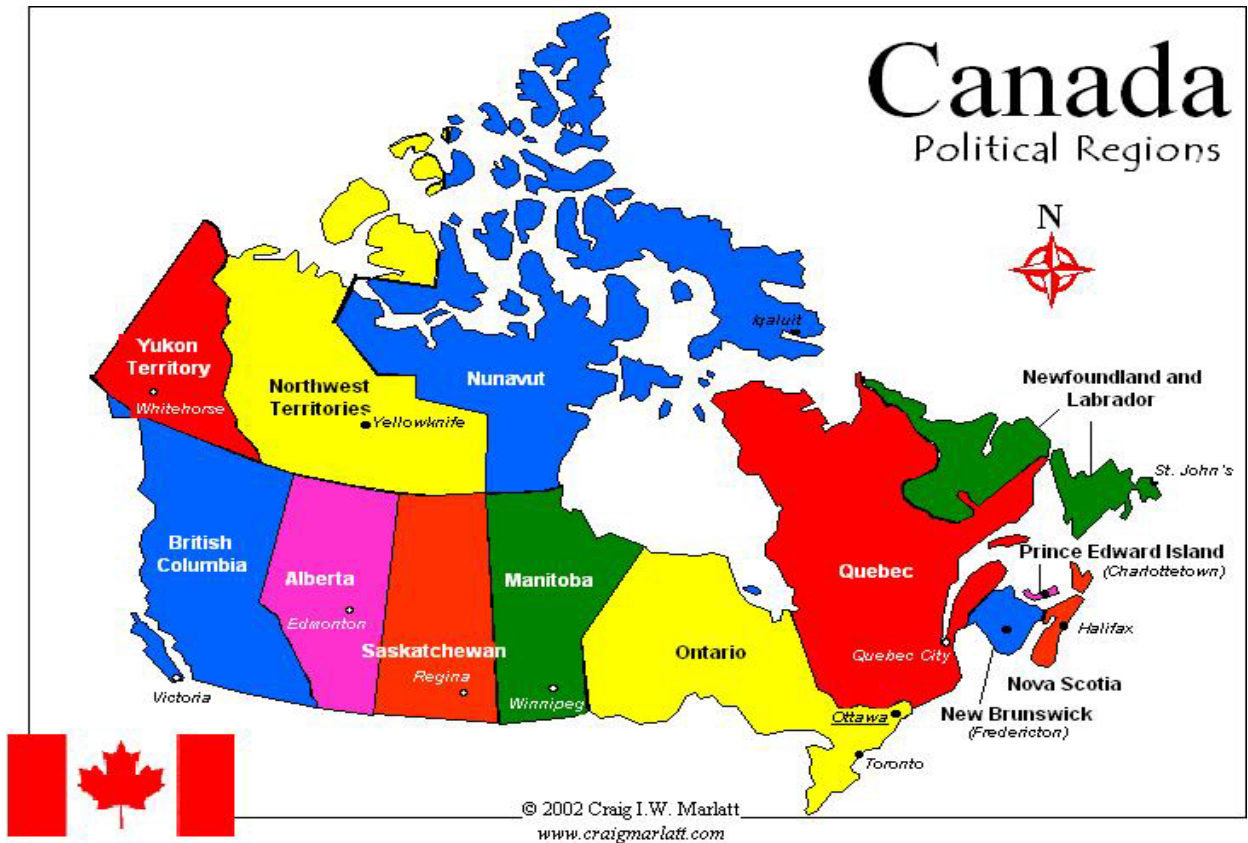


Photo showing Golden Giant Mine.

Ontario hard rock mines produce nickel, copper, gold, silver, lead, zinc, platinum, palladium, cadmium and various other metals. Soft rock mines produce salt, gypsum, talc and other industrial minerals. Ontario's first diamond mine is scheduled to open in the northern part of the province in 2008.

Geological structures of the Precambrian Shield are generally near vertical with ore bodies that tend to run deep. Several mines will soon be extracting ore from 10,000 feet (approximately 3,000 metres) below surface. Safe mining at these depths is very challenging due to the extreme ground pressure and environmental factors such as high heat and humidity.

Mines in the southern part of the province employ room and pillar mining techniques, whereas hard rock mines generally employ blast hole, block caving, long hole, cut and fill mining and other bulk mining methods. There are several narrow-vein, less technologically-advanced mines that extract high grade ore following more traditional mining methods and shrinkage mining.



Map of Canada showing provinces and territories.

Most Ontario mines are highly-mechanized operations employing relatively small numbers of workers and making use of large electric or diesel-powered mobile equipment. Typical hazards associated with mobile equipment include conventional safety issues, electrical fires, diesel fuel fires and tire fires. Most mines have large underground shops where complete maintenance and repair of mobile equipment is conducted. Welding, cutting and burning, and use of compressed oxygen and acetylene are some of the hazards and potential sources of fire underground. Many mines also have extensive underground conveyor systems to transport ore to the head frame or in shallow operations to surface.

Other environmental hazards encountered in our underground mines include methane gas, oxygen deficiency, oxidation of ore resulting in displacement of oxygen, and sulphide dust explosions resulting from mining high sulphide ore bodies.

Legislative Requirements

Every Canadian province and territory has its own specific legislation that addresses mine rescue requirements. In Ontario, the law requires that every underground mine establish and maintain a mine rescue program. Each underground mining operation is required to also establish and maintain a detailed emergency response plan.

The Ontario program is based on volunteer rescuers employed by mines rather than having full-time mine rescue responders. Each mine must recruit and maintain an adequate pool of mine rescue volunteers to respond to emergencies. Remote sites such as fly-in operations require additional volunteers due to shift rotation and the availability of volunteers. A “point in time” guideline has been developed to help employers establish the appropriate number of trained mine rescue volunteers for their site and to assess their availability.

In Ontario, mine rescue stations are required by legislation and are manned, equipped and maintained by MASHA. Currently eight stations are strategically located across the province to ensure timely service to our clients. Each location is manned by a mine rescue officer/consultant employed by MASHA, who ensures that mines within a specified geographic area have adequate emergency response capability. In addition, underground mines have fully-equipped mine rescue substations on the surface that include primary and secondary breathing apparatus and standard mine rescue equipment.

Each underground mine is required to produce an emergency response plan that is tested and evaluated on a regular basis. Furthermore, the plan must be reviewed regularly and updated at least annually to address changes that impact on emergency preparedness. Mine rescue officers review the plans, provide advice and make recommendations regarding areas of weakness or deficiency.

Every underground mine must establish and maintain a fire warning system that must be tested at least once per working shift per year. Most operators use ethyl mercaptan as a warning gas that is injected into the ventilation system and compressed air lines. However, mines that do not have compressed air lines rely on other means of alerting workers such as flashing lights, sirens and the PED system.

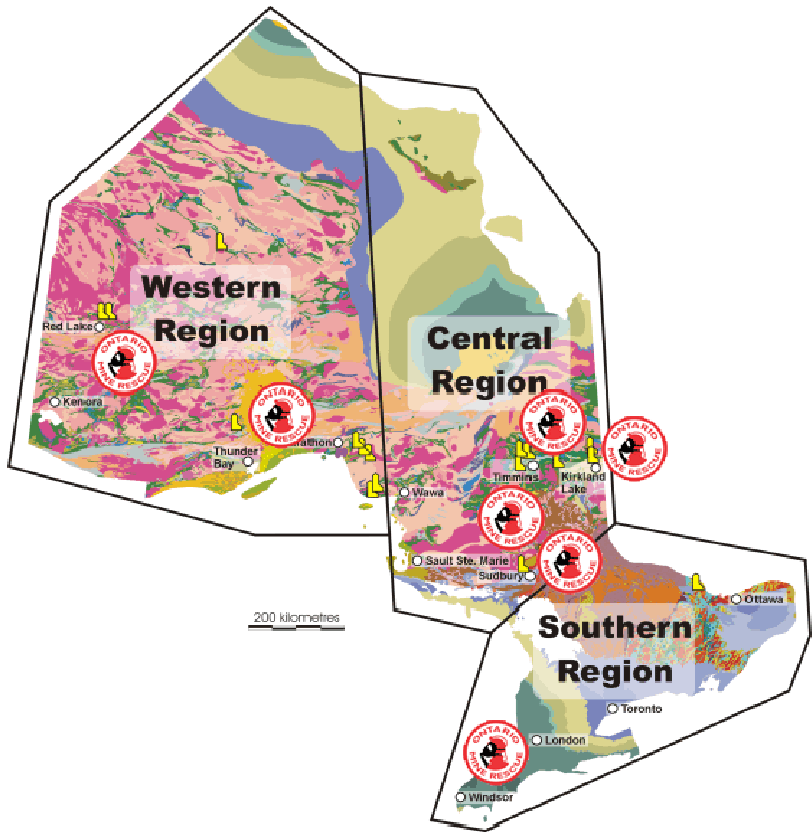
Legislation requires that mine rescue teams be trained in accordance with the standards identified in the “Handbook of Training in Mine Rescue and Recovery Operations” produced by MASHA. The handbook and other supporting training materials consisting of leader’s guides, participant manuals, skill-based check lists, interactive CDs, guidelines and other materials, detail mine rescue emergency procedures and act as a reference to mine rescue volunteers and mine operators.

All volunteers must pass an annual mine rescue medical to actively participate in mine rescue. Some key components of the medical include a physical examination, a pulmonary function test, an exercise ECG (initial and annually after age 40) and a Complete Blood Count/Urinalysis.

Ontario’s Mine Rescue Program

MASHA owns the mine rescue equipment used by first responders and strategically locates equipment at mine rescue stations and substations across the province. These

depots have in excess of 400 primary breathing apparatuses (Drager BG 4) plus various standardized pieces of fire and non-fire equipment at each location. The number of primary breathing apparatus at each substation is determined by the operation's location in relation to neighbouring stations and other operating mines. Remote mines are equipped with 16 Drager BG 4s and have sufficient consumables on site to sustain a response until help from other mines can arrive.



Map of Ontario showing main mining areas and locations of mine rescue stations.

In addition to primary breathing apparatus, MASHA owns, maintains and provides training in secondary breathing apparatus, resuscitators, rope rescue, thermal imaging cameras, bolt cutters, rock breakers, gas instrumentation, lifting bags and hydraulic rescue equipment.

Each mine rescue officer/consultant is responsible for overseeing mine rescue activities in a defined geographic area. This includes delivering training to first responders, providing advice, conducting periodic audits, ensuring MASHA-owned equipment is maintained to the manufacturer's recommended standards, and providing advice during a mine emergency. Mine rescue officers do not have regulatory authority.

Mine rescue officers are provided with fully-equipped mine rescue vans and are available to respond to emergencies around the clock. Each van has additional breathing

apparatus, various consumables and non-fire equipment that can be used during an emergency.

Relief men back up mine rescue officers when the officers are unavailable to respond because of personal or other reasons. These individuals are mine rescue personnel who have extensive experience in Ontario emergency preparedness and receive orientation to mines in the assigned district.

Mine rescue officers from adjacent districts also back up one another in the event of an emergency. Each district officer prepares an annual emergency plan which is rolled into a provincial plan that details contacts, resources, equipment available and quantities of consumables. Plans are distributed to all pertinent operating mines and are readily available in the event of an emergency.

Currently eight mine rescue stations service underground mines across the province. The stations are centrally located in areas where there is a concentration of mines to ensure a timely response during an emergency. Provincial mine rescue headquarters is in Sudbury, in the central part of Ontario.

Mine rescue officers are in regular and frequent contact with the customer group providing advice, delivering regular face-to-face training, evaluating each mine's emergency preparedness system, maintaining equipment or responding to incidents. This frequent interaction results in tremendous credibility and influence with mine operators.

Guiding Principles for Ontario Mine Rescue

The guiding principles for Ontario mine rescue are standardization, consistency and continuous improvement.

Standardized equipment is used by our mine rescue teams in every station and mine across the province, and this is a key reason for the success of the program. This principle allows team members to move from one mine to another anywhere in Ontario and be familiar with the equipment used. Volunteers do not need special or additional mine rescue training to integrate with other teams. Furthermore, in circumstances where a mine requests assistance from a neighbouring operation, the teams require no special preparation.

The "Handbook of Training in Mine Rescue and Recovery Operations" is a compilation of equipment used, procedures followed and standards established for our mine rescue program. Standards and procedures are reinforced through regular training and competition which help to hone the skills and knowledge of our volunteers.

Standardized training material helps achieve consistency in information transfer from trainers to first responders. Leader's guides and participant manuals are developed whenever a piece of equipment is integrated into the program. Competency-based check



lists have been integrated into the training materials. This helps to ensure consistent performance standards are being met by first responders. Other training support materials in the form of interactive CDs, DVDs and on-line training are being developed and these assist with knowledge transfer and skill enhancement.

Numerous government commissions, inquiries and hearings have been conducted since the inception of mine rescue, resulting in many recommendations that have helped mould mine rescue into its present form. Legislation requires that inquests be held whenever a work-related mining fatality occurs. Deficiencies relating to emergency preparedness raised during inquests have led to upgrading rescue equipment, improvements to training delivery and the strengthening of policies and procedures.

In addition, every incident in which a mine rescue crew or crews are deployed is investigated and analyzed to look for trends, weaknesses and opportunities for improvement. A standardized approach is followed to capture pertinent information regarding each incident. Recommendations are relayed to the mine operator for action. Broader province-wide trends and concerns are relayed to all mine operators. Our close working relationship with the customer promotes trust and credibility, resulting in greater acceptance of recommendations for improvement.

MASHA maintains a Mine Rescue Technical Advisory Committee (TAC) that provides advice and guidance to the program. The committee is very active, meeting on a quarterly basis and ensuring the mining industry's mine rescue needs are met.

Response Capability

Currently the MASHA has a staff of 12 individuals responsible for delivering the mine rescue program to our customer group. The role of the mine rescue program is to oversee training, ensure equipment is maintained to established standards, audit the customer's emergency preparedness system, and provide support and advice during an emergency.

More than 650 company-employed mine rescue volunteers are scattered at underground mines across the province. Every mine operator must maintain an adequate pool of trained first responders and ensure they are available in the event of an emergency. Each operating mine is equipped with a substation which provides sufficient equipment to provide a first and second response. For extended emergencies, equipment and teams may be mobilized from neighbouring mines.



Photo of a recent mine rescue team during competition.

Factors such as inclement weather, large geographic territories and availability can affect response times by mine rescue officers during an emergency. A network of approximately 50 mine rescue equipment repair technicians has been established at operating mines in the province. These individuals receive special training in the repair and maintenance of mine rescue equipment to manufacturer's recommended standards. These individuals perform routine equipment maintenance and provide on-site support during an emergency prior to arrival of the mine rescue officer.

Since there are numerous factors that may affect the availability of mine rescue volunteers, a process for assessing emergency readiness has been established. This "point in time" evaluation tool helps mine operators assess the level of preparedness of their mine rescue responders. This tool determines the number of volunteers that are available at any given time and this, in turn, is used to identify manpower deficiencies and offer guidance in making adjustments where necessary.

Equipment

Volunteers are trained in the care, use, maintenance and operation of various breathing apparatus and pieces of equipment used by teams in responding to both fire and non-fire situations.



The Drager BG 4 has replaced the Drager BG 174 as the primary breathing apparatus used by all our mine rescue teams. Drager RZ 25 testers which are no longer being manufactured are currently being replaced with Drager Test-it 6100 testers.

Drager Oxy SR 45 units are used for man-down situations and MSA SSR 90s are used for casualties. New oxy units have not been manufactured for several years. However, MASHA has sufficient replacement parts available to continue to rebuild them until 2008. Suitable replacement units are currently being investigated.

ITX gas monitoring equipment manufactured by Industrial Scientific is used to measure explosive gases, carbon dioxide and oxygen deficiency encountered underground by our teams during emergencies.

Other fire and non-fire equipment used by our teams include:

- MSA New Evolution Thermal Imaging Cameras
- Carevent Resuscitators
- MSA and Chemguard High Expansion Foam Generators
- Low Expansion Foam Generators
- Fire Extinguishers
- Hydraulic Equipment
- High-Pressure Lifting Bags
- Bolt Cutters
- Griptech Rope Rescue

The purchasing of equipment and supplies is done centrally to ensure standardization and interchangeability between districts and mines. Substantial inventories of consumables such as cardioxide, and high and low expansion foam are maintained at stations and substations to ensure a sustained response to a major event is possible. The mine rescue substation acts as a depot for emergency equipment and supplies, and can be used as a facility for accommodating teams during an emergency.

Training

The Ontario mine rescue training program consists of several levels of standardized certification training followed by regular refresher training. All courses have both written and practical components.

Entry level training (Introductory Course) consists of a five-day basic program that provides a fundamental understanding of mine gases, standard equipment and operator capability in the primary and secondary breathing apparatus. The course also introduces new recruits to the practical aspects of performing arduous work in an underground setting. Trainee knowledge is evaluated through a written examination and skill is evaluated by a practical demonstration against competency standards.



Photo of a mine rescue team receiving introductory training in use of Drager BG 4.

To maintain active status in mine rescue, the volunteer must attend regular training and demonstrate competency in the use of mine rescue equipment. This practical training is facilitated by MASHA mine rescue officers.

Many employers have mutual aid agreements with neighbouring mines to ensure they have adequate number of trained first responders available in an emergency. To ensure these volunteers are adequately trained, cross-company training is provided to familiarize first responders with other operations in the district.

Advanced Certification is a competency-based evaluation that ensures first responders have the skills to properly use and operate the various pieces of respiratory and specialty equipment. Individuals who have been in mine rescue for at least two years have the opportunity to attend these sessions. The evaluation focuses on skill demonstrations of station and field testing the BG 4 and various non-fire related equipment (e.g. rope rescue, Jaws of Life, rock breakers, lifting bags, etc.).

A training database maintained by MASHA tracks the mine rescue related activities of all active volunteers. The data is available to trainees and employers, and assists in establishing currency of training, competency in field testing and operation of equipment. It also provides a profile of each volunteer.

A three-day Technician Program has been developed to provide in-depth training, over and above the operator level, to individuals who act in a support function. These

individuals perform maintenance and repair work on standard equipment, primary and secondary breathing apparatus, gas monitoring equipment etc. and are available to provide backup to mine rescue officers.

The management program targets individuals who oversee emergencies at mines. The focus of the program is to improve problem-solving and decision-making skills that are essential during mine emergencies. It also exposes mine managers to the equipment used by mine rescue teams, the importance of good communication and the procedures followed by teams. The practical aspects of the management program focuses on solving scenarios based on actual emergencies at Ontario mines.



Photo showing a mine rescue team encountering an obstacle during competition.

Mine Rescue Competitions

Competitions are held annually to promote consistency, evaluate the quality of training delivered by staff and to test the extent of preparedness of our teams. Each event consists of several components including a written test, a bench test, a field problem that exposes teams to at least two hours under oxygen, sanitizing and cleaning equipment and preparation of various reports. Not only are competitions very demanding but also very realistic. In some circumstances competitions are held in an underground environment and in all circumstances have a substantial first aid component. District competitions are held each year followed by winners advancing to the provincial level competition hosted by one of four districts.

Competitions are an essential component of our program since the number of real-life emergencies responded to by our mine rescue teams is very limited.

Emergency Responses

Ontario Mine Rescue teams are responsible for responding to both fire and non-fire emergencies. The following table summarizes activities for the period from 2000 to 2006.

EMERGENCY RESPONSES

YEAR	Fires	MR Team Resp. (1)	Fire Resp. (2)	Non Fire Resp. (3)	Other Emerg. (4)	Fire Drills (5)	Persons Res./Rec. (6)	Teams Used (7)	Time Und. O2 (8)
2006	63	28	7	3	3	15	4	43	32H 05M
2005	64	36	9	2	0	25	5	46	22H 58M
2004	89	24	6	2	1	15	3 plus 1 recovery	41	19 H 57M
2003	119	38	9	6	1	22	30 plus 1 recovery	48	28H 35M
2002	141	40	10	1	9	20	20 plus 1 recovery	42	51H 15M
2001	92	34	10	1	6	17	0	53	87H 01M
2000	121	30	3	2	8	17	0	31	25H 03M

The number of underground fires indicated in the table includes all fires reported to the Ontario Ministry of Labour. An underground fire is considered anything ranging from an unconfirmed report of smoke to an incident that requires the services of mine rescue teams. Mine rescue teams (1) respond to various situations classified in the following categories: underground mine fires (2); non-fire emergencies including rock bursts, falls of ground, and inundation of material or water (3); other emergencies (4); and fire drills which include emergency simulations (5).

The table also includes: the number of persons rescued and bodies recovered 6; the number of teams used during those emergencies 7; and, the cumulative time under oxygen by mine rescue teams during emergencies 8.

Each incident mine rescue teams respond to is reviewed in detail and analyzed by staff for any weaknesses in procedures, equipment failures or potential shortcomings. All incidents are documented and reviewed with mine operators. Recommendations are made to our clients, and, internally, procedural changes made and equipment upgraded as needs are identified through this process.

Technical Advisory Committee

The Mine Rescue Technical Advisory Committee is composed of individuals representing industry, government and MASHA staff. The group meets regularly to discuss issues and make recommendations relating to specific areas of the mine rescue program. The committee promotes the continual improvement of emergency preparedness at Ontario mines by:

- Providing advice and recommendations on the content of mine rescue training programs;
- Providing advice and making recommendations regarding mine rescue emergency equipment requirements;
- Identifying and recommending research projects; and
- Recommending changes to the mine rescue handbook.

The mine rescue TAC has been instrumental in driving numerous improvements to emergency preparedness and ensures changes are in the best interest of safety.

Research

Research is a vital component of continuous improvement in mine rescue. The mine rescue TAC identifies areas of research that will provide the greatest benefit to mine rescue teams and emergency preparedness at our mines. Academic institutions are principle research investigators, while MASHA ensures the relevance of projects by involving mine operators and ensures the transfer of knowledge back to the workplace.

Current research projects include the application of virtual reality to mine rescue, and heat stress as it relates to mine rescue teams.

Virtual reality research is focussing on producing a virtual reality (VR) training environment for mine rescue control groups. Although the model was initially directed at

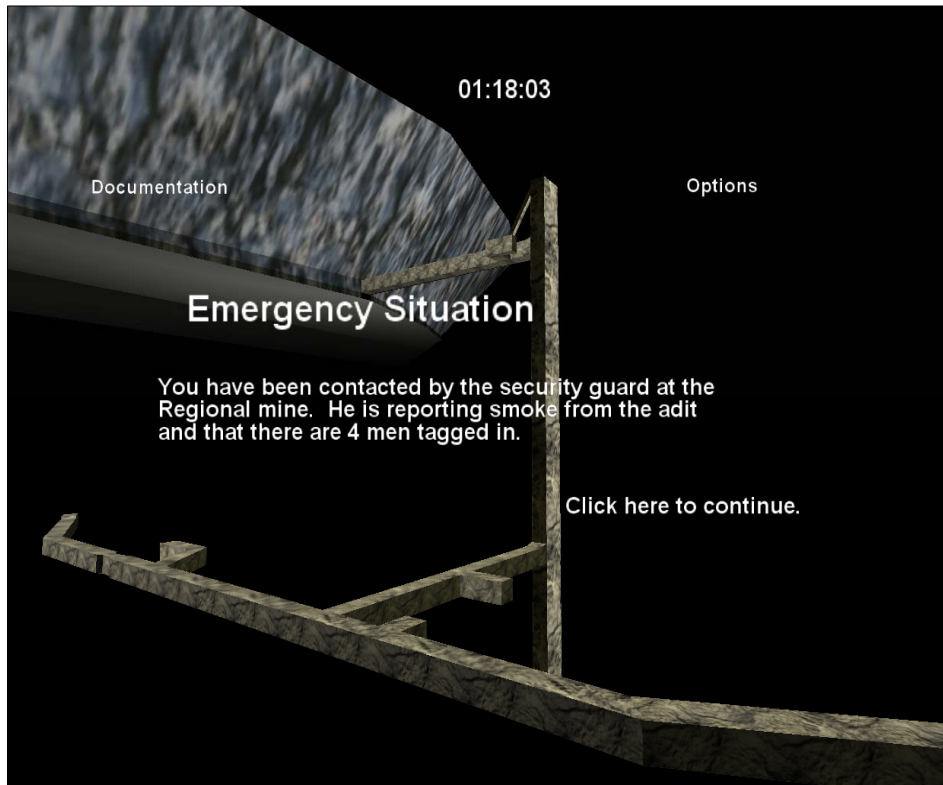


Image of Regional Mine – Virtual Reality Project.



Image from Virtual Reality model showing a mine rescue team requesting directions from a briefing officer.

training mine rescue control groups, the technology may prove useful on mine sites as the control centre for mine rescue emergency response. The initial phase of the project was to produce a demonstration model. The next phase involves digitizing an operating mine and integrating variable environmental conditions, such as a ventilation system and randomly generated emergencies. The model is being developed with input from control group members and is designed to challenge teams or individuals to make good decisions in emergency situations. The preceding images are extracted from the first phase of the project.

MASHA is engaged in heat stress research as it applies to mine rescue teams with the Faculty of Health Services from the University of Ottawa. Increasing levels of heat and humidity due to extreme mining depths are significant factors affecting our mine rescue teams. MASHA is looking into the fitness levels of volunteers and exploring nutrition and hydration strategies to minimize the ill-effects on volunteers exposed to elevated temperatures while performing rescue work. The initial phase of this research has focused on studying typical mining tasks and classifying them into typical activity groups. Laboratory testing has been conducted to quantify energy expenditure of specific tasks and subtasks. Focusing on an extreme task such as mine rescue is being explored as a future target. One desired outcome is to encourage the commercial development of an instrument that will alert individuals, based on their personal characteristics with a given environmental situation, when they become at risk to heat stress.

Closing Remarks

MASHA is committed to continually improve the mine rescue program and ensure our operators and mine rescue teams are capable of safely handling every foreseeable emergency they encounter. Working closely with mine operators, academia, first responders and our colleagues outside of Ontario is absolutely vital in achieving that goal.

Mine rescue was established in Ontario as a result of that very tragic fire that took the lives of 39 men in 1928. Never in Ontario's mining history has an event of this magnitude been repeated. It is our responsibility to ensure it never does.