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Underground Security International Regulations on Atmospheric Monitoring

Mining Production Security Seminar

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May 9, 2013

Canadian Embassy, Buenos Aires

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Regulation Standards
Type of Mine

International Regulations for Atmospheric Monitoring Determined by Mine Type

1) Non-Gaseous Mines
2) Mines with Presence of Explosive Gases (coal mines, some potash mines, mines with explosive gas pockets nearby).

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

In every underground mining operation, ventilation systems are used to control the atmospheric conditions in the operation

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

Traditionally, Ventilation Systems in mining operations have been run constantly at 100% power, as integrated systems have not been available to determine the actual ventilation needs underground

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

Although great care and planning have gone into the design of these systems in the past, providing ventilation at maximum power throughout an underground mining operation have 2 major drawbacks.

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

Drawbacks:

1) There is no guarantee that adequate fresh air flow is reaching all the active areas of a mining operation without real-time atmospheric monitoring.

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

Drawbacks:

2) A ventilation system running at constant full power through an entire underground mining operation is exorbitant, typically accounting for 35-50% of a mine's energy consumption

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

1) Ventilation to clear toxic fumes, dust and exhaust fumes from the underground workplace, replacing it with fresh air from the surface

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What is the Purpose/Benefit of Atmospheric Monitoring in an Underground Mine?

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

2) Ventilation for cooling the workplace for miners from heat generated by virgin rock temperatures, machinery, auto compression, blasting and fissure water

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Regulation & Standards
Non-Gaseous Mines

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

3) Gas detection in areas of the mine where combustible liquids are stored/used, such as a fueling station, maintenance bay or battery charging stations

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Regulation & Standards
Non-Gaseous Mines

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

4) Mines or areas of mines that have been determined flammable gases can build up due to mining environment

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Regulation & Standards
Non-Gaseous Mines

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

5) Post accident atmospheric monitoring in rescue chambers and refuge stations

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Regulation & Standards
Non-Gaseous Mines

What is the purpose of Atmospheric Monitoring in Non-Gaseous Mines?

5) Targeting airflow to where it is required to maximize ventilation benefits

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Regulation & Standards
Atmospheric Examination

Shall consist of examination for…

(a) Oxygen deficiency

(b) Toxic gas, vapour, dust, mist or fume

(c) Any other dangerous condition

(Ontario Regulation 854, Part XI, No. 255-2a-c)

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Regulation & Standards
Air Velocity

An employer must ensure that a ventilation system in a mine maintains a minimum air velocity at the working faces of 0.3 meters per second.

(Alberta Occupational Health & Safety Code
Part 36 – Mining, Sec.712(1))

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Regulation & Standards
Air Velocity

An employer must ensure that a ventilation system in a mine maintains a minimum air velocity in roadways, other than working headings, of 0.3 meters per second unless methane layering is occurring, in which case the air velocity must be increased.

(Alberta Occupational Health & Safety Code
Part 36 – Mining, Sec.712(2))

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Regulation & Standards
Air Velocity

An employer must ensure that the velocity of the air in a ventilation system is not more than

b) 5 meters per second in a coal conveyor road

c) 8 meters per second in other roadways

(Alberta Occupational Health & Safety Code
Part 36 – Mining, Sec.712(2))

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Regulation & Standards
Temperature

The Wet Bulb Globe Temperature (WBGT) index is by far the most widely used throughout the world:

- NIOSH (1972)
- ACGIH (1990)
- ISO 7243 (1989a)

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Regulation & Standards
Temperature

Metabolic rate M (Wm^{-2})	**Reference value of WBGT**			
	Person acclimatized to heat (°C)		**Person not acclimatized to heat (°C)**	
0. Resting M≤65	33		32	
1. 65<M≤130	30		29	
2. 130<M≤200	28		26	
	No sensible air movement	**Sensible air movement**	**No sensible air movement**	**Sensible air movement**
3. 200<M<260	25	26	22	23
4. M>260	23	25	18	20

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Regulation & Standards
Oxygen Pressure

Ventilation system must provide a partial pressure of oxygen of more than 18 kilopascals

(Ontario Regulation 854, Part XI, No. 253-1a)

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Regulation & Standards
Oxygen

An employer must ensure that a mine has a mechanical ventilation system… that:

c) Ensures that the air contains at least 19.5 percent oxygen by volume and not more than 0.5 percent carbon dioxide by volume.

(Alberta Occupational Health & Safety Code
Part 36 – Mining, Sec.711(1)c)

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Regulation & Standards
Dust

Where dust or other material is likely to cause a hazard by becoming airborne, the dust, or other material, shall be removed by a minimum of delay

(Ontario Regulation 854, Part XI, No. 266)

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Regulation & Standards
Diesel Particulate Matter

According to current Mining Safety and Health Administration (MSHA) standards on Diesel Particulate Matter (DPM), mines are required to comply with the final Permissible Exposure Limit of 160µg/m^3

(microgram per cubic meter of air)

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Regulation & Standards
Flammable Gases

If a flow of flammable gas is encountered in a mine… and the concentration of the gas is unknown:

(a)All sources of ignition in the affected area shall be eliminated

(c) The affected area shall be evacuated

(Ontario Regulation 854, Part XI, No. 35-1a&c)

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Regulation & Standards
Flammable Gases

Work may resume if the concentration of flammable gas is less than 1% (Vol.):

- Below 0.25% - no precautions required
- Between 0-25% & 0.5% - gas detector shall remain for further testing and area designated a fire hazard

(Ontario Regulation 854, Part XI, No. 35-2-4)

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Regulation & Standards
Flammable Gases

- More than 0.5% Vol. and less that 1% Vol. only permissible equipment allowed
- More than 1% Vol. all sources of ignition must be eliminated and only competent personnel to measure gas & make ventilation changes may be allowed to enter

(Ontario Regulation 854, Part XI, No. 35-5-6)

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Regulation & Standards
Battery Charging Stations

In an underground mine, a battery charging station shall be ventilated to prevent the accumulation of an explosive mixture of gases

(Ontario Regulation 854, Part XI, No. 261)

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Regulation & Standards
Blasting Contaminants

No person shall enter or remain, or be permitted to enter or remain, in an workplace affected by blasting contaminants until the ventilation system has removed the contaminants or rendered them harmless

(Ontario Regulation 854, Part XI, No. 260)

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Regulation & Standards
Blasting Contaminants – Ammonia (NH_3)

CAS Number 7664-41-7

- 8-hour Occupational Exposure Limit: 25ppm
- Permissible Exposure Limit: 35ppm

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Regulation & Standards
Blasting Contaminants – Sulfur Dioxide (SO_2)

CAS Number 7446-09-5

- 8-hour Occupational Exposure Limit: 2ppm
- Permissible Exposure Limit: 5ppm

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Regulation & Standards
Toxic Gases

The threshold limit values for chemical substances and physical agents set out in "TLVs Threshold Limit Values and Biological Exposure Induces for 1986-87" by the American Conference of Governmental Industrial Hygienists are adopted

(Ontario Regulation 854, Part XI, No. 283)

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Regulation & Standards
Toxic Gases – Carbon Monoxide (CO)

CAS Number 630-08-0

- 8-hour Occupational Exposure Limit: 25ppm
- Permissible Exposure Limit: 200ppm

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Regulation & Standards
Toxic Gases – Carbon Dioxide (CO_2)

CAS Number 124-38-9

- 8-hour Occupational Exposure Limit : 5,000ppm
- Permissible Exposure Limit: 30,000ppm

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Regulation & Standards
Toxic Gases – Nitric Oxide (NO)

CAS Number 10102-43-9

- 8-hour Occupational Exposure Limit: 25ppm
- Permissible Exposure Limit: 25ppm

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Regulation & Standards
Toxic Gases – Nitric Dioxide (NO_2)

CAS Number 10102-44-0

- 8-hour Occupational Exposure Limit: 3ppm
- Permissible Exposure Limit: 5ppm

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Regulation & Standards
Toxic Gases – Hydrogen Sulfide (H_2S)

CAS Number 7783-06-4

- 8-hour Occupational Exposure Limit: 10ppm
- Permissible Exposure Limit: 15ppm

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Regulation & Standards
Toxic Gases – Sulfur Dioxide (SO_2)

CAS Number 7446-09-5

- 8-hour Occupational Exposure Limit: 2ppm
- Permissible Exposure Limit: 5ppm

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Regulation Standards
Gaseous Mines

In addition to the standards required for atmospheric monitoring in a non-gaseous mine, coal mines and some potash mines have additional requirements due to the levels of methane that can/is present in the atmosphere

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Regulation Standards
Gaseous Mines

In almost every country in the world, an intrinsically safe atmospheric monitoring system is required in all underground operations where levels of methane gas are likely to occur (all coal mines, some potash mines).

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Regulation Standards
Gaseous Mines

Such mines can be zoned underground into higher and lower risk areas for other equipment, and such ratings are often accepted as long as the atmospheric monitoring is continuous

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

As far as atmospheric monitoring and communications systems are concerned, all areas underground are considered as one high-risk area

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

For other equipment, a zoning technique has been adopted to allow equipment with a lower explosive rating in certain sections, when used in conjunction with atmospheric monitors

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

Zone 0 – Where explosive gas atmospheres are continuously present or for long periods of time

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

Zone 1 – Where explosive gas atmospheres are likely to occur in normal operation

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

Zone 2 – Where explosive gases are not likely to occur in normal operation, and if they do occur, they exist only for a short period of time

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Regulation Standards
Gaseous Mines

CSA/ANZ/IEC/ATEX Zoning for Gaseous Mines:

Appropriate zoning is determined by IEC 60079-10, ATEX Directive 94/9/EC, CSA 22.2 no.60079-10

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Regulation Standards
Gaseous Mines

Under the underground zoning system, in the event of a high gas event the atmospheric monitoring system shuts power to all underground systems that do not have an appropriate level of explosion protection and evacuation alarms are activated

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Regulation Standards
Gaseous Mines

As such, all line powered devices are shut down and only devices certified as intrinsically safe can operate, on back-up battery power only

Generally this is only communications and atmospheric monitoring systems

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Regulation Standards
Alarm Levels for Shutdown/Evacuation

Carbon Monoxide (CO) – 25ppm

Carbon Dioxide (CO_2) – 5000ppm

Methane (CH_4) – 20% LEL (0.75% per volume)

Hydrogen Sulfide (H_2S) – 5ppm

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Underground Security
International Regulations on Atmospheric Monitoring

Thank you