

SUMMARY REPORT
ELECTRICAL EQUIPMENT - HAZARDOUS LOCATION ZONING
June 29, 2001

Objective: review recent developments in the control of the potential ignition hazard of use of electrical equipment in underground coal mines by restricting use to certain hazardous location zoning requirements. Recommend an appropriate approach for Canadian mines.

A review of the Acts and Regulations governing the use of electrical equipment in some of the major coal producing countries in the world such as the United States, Australia, South Africa, Europe, Britain and Germany was undertaken. This review has shown that these countries permit the use of non-explosion-protected electrical equipment under restricted conditions.

In the coal industry the term non-certified electrical equipment has sometimes been regarded in a synonymous way with the term Non-flame proof electrical equipment . To interchange there meaning is not technically correct. It is a requirement in Canada that all electrical equipment be certified for any use.

Restricting the use of certain types of non explosion-protected electrical equipment within a certain area of the underground coal mine is sometimes referred to as Zoning . In other regulations, it is defined as some area of the mine where the accumulation of methane or explosive vapors is unlikely; therefore, it is suitable for non explosion-protected electrical equipment. Inside the last cross-cut of the intake airway, face or return airway where the potential for accumulations of methane exist, electrical equipment is restricted to flame proof, intrinsically safe or special protection apparatus. Sometimes there are definable distances to the face on an intake airway (South Africa at 180 m/Germany 150m/Nova Scotia 100m) or it is defined by the last full open crosscut to the face (US). In some cases, it is the mine manager s responsibility to designate the mine area and/or zone where non explosion-protected electrical equipment and explosion-protected electrical equipment is used.

In Australia, the emphasis is being placed on risk assessment process conducted by independent experts for the mine manager to define explosion risk zones. Overall, the mine plans in all cases must show the location and the type of electrical equipment used. Such plans must be approved by an authority such as the Chief Inspector of Mines or by other processes.

In the proposed Canadian federal regulations (see below), the use of explosion-protected electrical equipment is approved by the Coal Mine Safety Commission (CMSC). The new regulations also allow for the use of other forms of protection as approved by CMSC but do not give any formal definitions or standards for such protection.

In the proposed Nova Scotia regulations (see below), the use explosion-protected electrical equipment is permitted in **Zone A** as defined by the mine manager. The new

regulations also allow for the use of other forms of protection according to CENELEC standards. **It should be noted that Zone A does not conform with the terms used to describe above ground hazardous locations.**

Canadian Standards Canadian Electrical Code (CEC)

CSA M421- 00 Use of Electricity in Mines

A search of the Canadian regulations governing the use of electrical equipment address the issues of Hazardous Location Zoning in underground coal mines (u/g). In the CEC, the Scope of Part 1, it says that Part 1 applies to all electrical installation that includes underground mines. Part 1 Scope also says For mines and quarry applications, see also CSA Standard CAN/CSA M421. The CE Code Part 1 applies to mines and quarries, but M421 is supplementary to, or amendatory of, the CE Code Part 1. This means that the provisions of Section 18 of the CEC (Hazardous Locations) do apply to u/g coal mines unless there is something specifically stated in M421 to the contrary. There s nothing in M421 that prevents a mine from being **Zoned**; however, M421 does provide retrictions on what kind of equipment can be used.

The CSA had started a series of standards specifically for mine safety under the M 420 series (1) Bossert, J. and Hurst, R. Natural Resources Canada (a federal department) operates a certification service for the use of electrical equipment in underground coalmines, which is accepted in all provinces.

Presently, high voltage equipment used in underground coal mines must be certified flame proof (rule 6.10.3) while process control equipment and signal circuits must be intrinsically safe as stated in CSA standard M-421.

The following section presents some existing and proposed changes for the Canadian, Nova Scotia and international regulations for underground coal mines. The section on Background- European (EEC) - Electrical Equipment Zoning and Britain gives an explanation of how the EEC directives will be implemented in Britain.

Recent Regulatory Reviews

CANADA

Proposed Changes to Federal regulations as of August 28th, 2000:

Electrical Equipment

131. (1) All electrical equipment that is used in the underground portion of a mine shall be installed and operated in accordance with CSA Standard CAN/CSA M421-00, Use of Electricity in Mines, as amended from time to time.

(2) For the purpose of interpreting the standard referred to in subsection (1),

- (a) acceptable or accepted in clauses 3.7.2, 4.7.3.4.1, 5.8.11.1 and 6.13.1.1 means, approved by the Commission ;
- (b) acceptable in clauses 3.7.3.1, 4.2.3, 4.6.3.1, 5.8.3.2, 5.9.4.7, 6.9.1, 6.9.3.5, 6.10.2.3 and 6.10.3, means appropriate ;
- (c) approved in clauses 6.15.2.3 and 6.15.2.4 means appropriate ;
- (d) approved in clauses 4.7.4.3 and 6.15.4.4 means approved by the Commission ;
- (e) approved in clause 5.5.2 means certified ;
- (f) submitted to the regulatory authority in clause 5.10.2.6 means submitted to the Commission ;
- (g) competent person in clauses 5.2.4 and 5.8.2.2 means qualified person ;
- (h) located in clause 6.10.4.11 means protected ;
- (i) Permission may be granted in clause 6.2.1 means Approval may be granted by the Commission ;
- (j) recognized authority in clause 4.4.22 means Nova Scotia Power ; and
- (k) When other than certified electrical apparatus is permitted to be used in clause 6.4 means When the Commission approves the use of non-certified electrical equipment .

(3) For the purpose of applying the standard referred to in subsection (1),

- (a) the following is substituted for clause 6.3.2:
Adjustments or replacements can be made on intrinsically safe equipment.
- (b) the following is substituted for clause 6.14.7:

The Commission shall not approve the use underground of HID lamps containing the elements of sodium unless a procedure acceptable to it for the disposal of used lamps is developed.

(4) For the purpose of applying the standard referred to in subsection (1), the standard shall be read as if the following did not appear in it:

- (a) acceptable to the authority having jurisdiction in the definition of Certified equipment in clause 2.2;
- (b) the definitions of electrician and mine in clause 2.2;
- (c) Except by special permission in clauses 5.9.5.3 and 6.5;
- (d) by special permission in clause 5.9.7;
- (e) designated as gaseous by the regulatory authority in clause 6.2.1;
- (f) clause 6.2.2;
- (g) With the exception of intrinsically safe systems which can be repaired while live with permission of the regulatory authority in clause 6.3.1; and
- (h) except by special permission in clause 6.10.1.4.

132. All electrical equipment that is used underground shall be either

- (a) certified for use in underground coal mines by
 - (i) the Department of Natural Resources; or
 - (ii) a certification agency acceptable to the Commission; or
- (b) subject to section 133, uncertified but approved for use by the Commission pursuant to paragraph 137.2(2)(b) of the Act.

133. (1) Uncertified electrical equipment may be installed underground if it meets the following criteria:

- (a) it is located in intake air which
 - (i) contains not more than 0.5 per cent of flammable gas;
 - (ii) has not ventilated another working face; and
 - (iii) is not supplied by an auxiliary fan;
- (b) it is not located immediately adjacent to old workings or in an area which is prone to re-circulation or ventilation reversals;

(c) it is either

(i) stationary,

(ii) mechanically fastened to another stationary structure, or

(iii) otherwise restricted in a manner acceptable to the Commission;

(d) it is painted a distinguishing colour;

(e) it has the following notice affixed to it which is clearly visible at all times: CAUTION - Uncertified Equipment (Need French Expression)

(f) it is electrically interlocked with a fail-safe continuous flammable gas detector approved by the Commission which

(i) de-energizes the uncertified electrical equipment when flammable gas concentrations exceed 0.5 per cent,

(ii) has a detector head so situated that sufficient response time will be available for the flammable gas detector to de-energize the uncertified electrical equipment and prevent the uncertified electrical equipment's exposure to flammable gas while in the energized state,

(iii) de-energizes that uncertified electrical equipment in the event of the failure of the gas detection instrument, and

(iv) is monitored continuously in the surface remote monitoring station; and

(g) it is designed so that

(i) the ingress of coal dust is restricted;

(ii) it does not produce external surface temperatures hot enough to ignite coal dust; and

(iii) in enclosures where dust ingress is likely to occur, internal component temperatures do not reach temperatures which will ignite coal dust under normal operating conditions.

(2) Where the concentration of flammable gas exceeds 0.5 per cent in an area where uncertified electrical equipment is installed, the employer shall report the concentration of flammable gas to a health and safety officer by telephone within 24 hours and in writing within seven days.

134. (1) Before using any uncertified electrical equipment underground, the equipment shall be examined by a qualified person who shall verify that any conditions which may be contained in an approval granted by the Commission or a person designated by the Commission have been met.

(2) A written record of the verification shall be kept at the mine and be readily available to the employees at the mine.

NOVA SCOTIA

Proposed Nova Scotia regulations as of October , 1999:

183C (2) For the purpose of using electrical equipment underground in a coal mine, the **manager** may divide the underground into designated **zones** in accordance with the potential risk of the presence of flammable gas and shall show the **zones** on a plan of the mine, and shall post a copy of the plan showing the **zones**.

(2B) The **manager** may change the designation of **zones** under subsection (2) and this section applies to any such change.

(3) Where the manager does not designate **zones** under subsection (2), the whole underground at a coal mine shall be treated as **Zone B**.

(4) Where the manager designates **zones** under subsection (2), the manager shall do so in accordance with the opinion of an engineer, who shall give the opinion in accordance with subsections (5) and (6).

(5) In determining whether an area is to be **Zone A**, the engineer shall consider plans showing the normal condition of the ventilation system and the conditions that would prevail should the ventilation system break down for four hours or more, and except for development that has not yet occurred, the plans shall be derived from a ventilation survey.

(6) In the designation of **zones** under this section,

(a) return airways, all areas in or beyond the last open crosscut and all areas within 100 m of a working face shall be designated **Zone B**;

(b) of all other areas underground, areas with minimal risk of encountering flammable gas in quantities equal to or greater than 0.5 percent in the general body of air may be designated **Zone A**, but in no case shall areas designated Zone A have greater than 0.5 percent flammable gas

- (i) under normal conditions, and
- (ii) under conditions that would prevail should the ventilation system break down for four hours or more.

182A (1) Permissible electrical equipment at a coal mine

- I. Flameproof enclosure
- II. e Increased Safety
- III. p Pressurized or Purging
- IV. o Oil immersion
- V. m Encapsulation
- VI. q Powder Filled
- VII. n or N Non sparking and restricted Breathing
- VIII. s Special Protection

INTERNATIONAL

Background- European (EEC) - Electrical Equipment Zoning

Electrical Equipment zoning as a term has its roots in the European IEC 79-1 0/CENELEC classifications of **Zone 0**, **Zone 1** and **Zone 2**, which classify an area according to the likelihood of an explosion due to presence of an explosive gas or vapor.

Moreover, The European Directive 94/9/EC of the European Parliament and council classifies electrical equipment for use in **underground coal mine** equipment into Categories M1 and M2.

(a) Category M1 comprises equipment designed and, where necessary, equipped with additional Special means of protection to be capable of functioning in conformity with the operational parameters established by the manufacturer and ensuring a very high level of protection.

(b) Category M2 comprises equipment designed to be capable of functioning in conformity with the Operational parameters established by the manufacturer and ensuring a high level of protection.

Category M2 equipment is required to be de-energized in the event of flammable gas being detected - it doesn't have to be explosion-proof.

Equipment in this category is intended for use in underground parts of mines as well as those parts of Surface installations of such mines likely to be endangered by firedamp and/or combustible dust.

This equipment is intended to be de-energized in the event of an explosive atmosphere. Category M2 equipment is required to be de-energized in the event of flammable gas being detected - it doesn't have to be explosion-proof.

The means of protection relating to equipment in this category assure the requisite level of protection during normal operation and also in the case of more severe operating conditions, in particular those arising from rough handling and changing environmental conditions.

The principles of explosion protection are electrical apparatus designed with specific safety measures to prevent ignition of a surrounding gas or vapor during normal operation. This means that it will not create or transmit an external ignition source either by spark or hot surfaces.

There are various Ex Protections concepts designed for use in hazardous area applications:

- IX. d Flameproof enclosure
- X. e Increased Safety
- XI. p Pressurized or Purging*
- XII. o Oil immersion
- XIII. m Encapsulation
- XIV. q Powder Filled
- XV. n Non sparking and restricted Breathing*
- XVI. s Special Protection

Notes:

* In XI, p can be designated px, py or pz, depends on the type of pressurization used, and the Zone in which the pressurized equipment is installed.

* In XV, n can be designated as follows:

Ex n A for non-sparking apparatus;

Ex n C for sparking apparatus in which the contacts are suitably protected other than by restricted-breathing enclosure, energy limitation and n-pressurization;

Ex n R for restricted-breathing enclosures;

Ex n L for energy-limited apparatus;

Ex n Z for enclosure with n-pressurization;

ATEX Directive No. 94/9/EC was ratified in Britain March 23, 1994 and implemented March 1, 1996.

There is ongoing international controversy as to whether the category system was really necessary for electrical equipment in hazardous locations. This category designation (M1) was

introduced to cover NON-ELECTRICAL equipment used in hazardous locations. The electrical industry already had their own system of equipment identification and area classification, and there are those in the industry who feel this system doesn't add value. It does add value to non-electrical equipment, which is really what it was intended for. IEC committees are currently debating whether this category system should be introduced in the IEC standards. Currently the category system is in the CENELEC standards, but it is not in the IEC standards.

George Lobay, CERL

Once a European Directive has been agreed by the European Parliament it is published in the Official European Journal in three languages - English, French and German. The 15 member states of the European Union then have 18 months to make it law in their own countries by putting its contents onto their own statute books. Copies of the individual country's statutory requirements are then sent to the EU Commission and they make sure that all member states have introduced the requirements by the deadline.

As far as enforcement is concerned, each country enforces its own laws in the normal way. In the UK, the Department of Trade and Industry (DTI) enforces the "Product Directives" (designed to allow free trade of articles and goods in the EU) and the Health & Safety Executive (HSE) enforces the "Worker Protection Directives" (designed to protect persons at work).

The Product Directives (e.g. Machinery Directive and ATEX Directive 94/9/EC) set down "Essential safety Requirements" which every product placed on the market (by a manufacturer) has to comply with. The Worker protection Directives (e.g. Extractive Industries Directive 92/104/EC) set minimum requirements for the safety of persons and can be made stronger by member states if they wish to have a larger safety factor.

BRITAIN

Publication by the Health and Safety Commission, The use of electricity in mines, Electricity at Work regulations 1989, Approved Code Of Practice Pg 40:

5 The regulation requires **mine managers** to identify **zones** below ground where firedamp is likely to occur in a quantity sufficient to indicate danger. Outside such **zones** dangerous concentrations are unlikely to exist, and therefore the electrical equipment need not be of an explosion protected type. Electrical equipment used within **zones** identified by the manager should be designed and constructed to prevent ignition of a flammable atmosphere.

6 'Explosion protection concepts for electrical equipment are described and specified in various national (e.g. British Standards) and international standards (e.g. European Harmonized Standards) which are recognized in most countries.

The only proposed changes from the original (1989) version of the ACOP is that the new version allows 3,300 volts to be used on the coal face (previously 1200V max).

As far as ATEX category M1 and M2 electrical equipment is allowed to be taken into the Regulation 19 zones identified by the Mine Manager, as places where firedamp can occur in dangerous quantities (this equipment is in addition to that already allowed previously). All ATEX category M1 electrical equipment can remain energized when concentrations of firedamp exceed 1.25% by volume in the general body of air (in addition to that already allowed by virtue of an HSE Approval).

*The above revision of the electricity ACOP is however seen as a temporary measure. To fully implement the ATEX Directive, we are currently drafting new regulations which will call for the mine to be zoned for the presence of both potentially explosive atmospheres of firedamp and potentially explosive atmospheres of dust. They will also call for mechanical equipment to be categorized as either M1 or M2 as well as electrical equipment and for all category M2 equipment (i.e. both electrical and non-electrical) to be switched off/made non operational when firedamp levels exceed 1.25% by volume at the place where it is in use. Thus compressed air haulages, the return end of conveyors in headings, etc, will not be allowed to operate in places where the gas level exceeds 1.25% by volume. These new regulations will be called something like **"The Use of Equipment in Potentially Explosive Atmospheres in Mines"** and will revoke all existing regulations that relate to the use of electricity, diesel engines, explosives and flame safety lamps in potentially explosive atmospheres in mines. No publicly available documents are available on this topic as yet.*

GERMANY

Some type of non-explosion-proof equipment is allowed within a 150 m area around the intake shaft. Signaling and lighting always has to be explosion proof.

Other forms of electrical equipment protection other than flameproof or intrinsically safe are practiced in German underground coal mines. Other types of protection as per IEC 79-0 (see above).

AUSTRALIA: Queensland: New Coal Mining Safety and Health Act 1999, Act no. 39 of 1999

Dictionary: Schedule 3. Definitions: Explosion risk **Zone** means any part of a mine on the return side of a place where methane level equal to or greater than a level prescribed by regulation is likely to be found

AUSTRALIA: Queensland - Proposed regulatory changes (now public):

DIVISION 2: ZONING OF MINE WORKINGS ACCORDING TO EXPLOSION RISK

Risk Assessment Required

44 At each mine a risk assessment must be carried out to determine the location and extent of explosion risk zones. Explosion Risk Zone Type ERZ0

45 The mine or any part where it is known or assessed that methane could be present in general body concentrations greater than 2 percent by volume must be classified as a zone type ERZ0.

46 Without limiting generality, ERZ0 locations must take in any locations, including those normally classified as being of different zone type, where the concentration of methane in the general body atmosphere becomes greater than 2 percent by volume.

Explosion Risk Zone Type ERZ1

47 The mine or any part where it is known or assessed that methane could be present in the general body of the atmosphere in concentrations ranging from 0.5 to 2 percent by volume, must be classified as a zone type ERZ1.

48 Without limiting generality, ERZ1 locations must include places in the mine:

- (1) where coal or other material is being mined; and / or;
- (2) within goaf areas; and / or;
- (3) where ventilation in accordance with regulations 94 to 99 is not taking place; and / or
- (4) connections to or repairs to methane drainage ranges are being made; and / or
- (5) where holes are being drilled in the coal seam or adjacent strata for the purpose of exploration, or seam drainage; and / or
- (6) that are situated, in respect of a panel of bord and pillar a line, defined by the inbye rib line of the most inbye cutthrough through which air may pass from the face into a return; and/or
- (7) all of those places that are on the return side of places specified in items (1) to (6) inclusive.

48A Regulation 48(6) does not apply to long single entries that are being driven as a main roads or as panel development roads.

Explanatory Note:

Roof or floor brushing in outbye locations does not constitute mining for the purpose of Regulation 48 (1).

Explosion Risk **Z**one Type NERZ

49 The mine or any part of it that is not classified as being ERZ0 or ERZ1 in accordance with Regulations 46 to 48 inclusive may be classified as being a **zone** of negligible explosion risk, type NERZ.

Explanatory Note

The methane levels in the general body atmosphere of an NERZ may be greater than zero but less than 0.5% methane.

50 A NERZ may be divided into **sub-zones**, each of which will be classified as a NERZ, to enable discrimination to be applied to tripping of the power supply to electrical circuits caused when gas detectors detect prescribed concentrations of methane.

51 Any area of a mine submerged by water may be classified as a NERZ.
Sign Posting of NERZ / ERZ1 and ERZ0 / ERZ1 Boundaries

52 Where a person or a machine can physically pass through a boundary between a NERZ and an ERZ1 or a boundary between ERZ1 and ERZ0, the actual location of that boundary must be signposted with markers placed in each intake airway that leads into the ERZ1 or ERZ0 concerned.

53 At the surface of a mine, a plan must be displayed on which by suitable means are indicated the NERZ / ERZ1 and ERZ0 / ERZ1 boundaries that are physically signposted within the workings of the mine in accordance with Regulation 52.

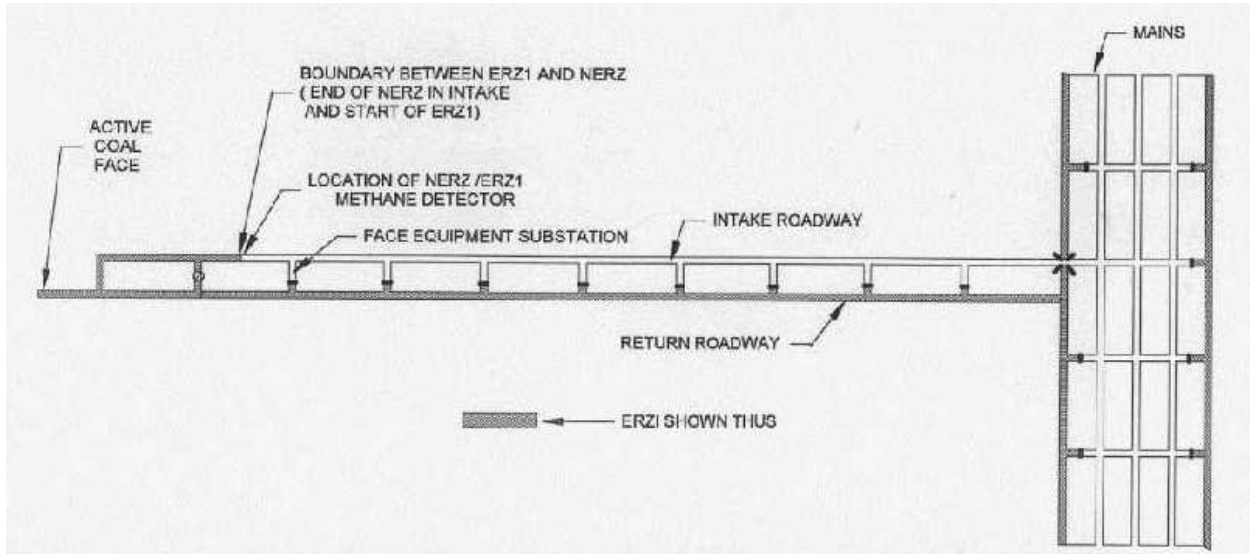
54 The indicators of boundaries required by Regulation 53 must be updated at the end of each shift to reflect the changes in the locations of the boundaries.

55 If at any time a temporary change in conditions occurs that results in a change to the boundaries of an explosion risk zone, it is not necessary to change the location of the boundary signposts underground or the boundary indicators on the surface plan, provided that appropriate precautions are taken to ensure control of persons and machines entering the affected zone.

Explanatory Note:

As an example, a major goaf fall could cause a sudden but temporary flush of methane to back up against intake air in excess of that calculated or anticipated in the risk assessment and change a face area ERZ1 to an ERZ0, at the same time forcing the NERZ / ERZ1 boundaries further outbye. This would invalidate the explosion risk zone boundaries signposted underground and indicated on the surface plan until such time as ventilation clears the methane and restores the situation that existed prior to the goaf fall. In such circumstances, it is not a breach of these Regulations that the signposting and plan are temporarily invalid. Nor is it required to make adjustment to the signposting or the plan to immediately reflect the temporary

situation. In the interests of safety, priority must be given instead to ensuring that appropriate precautions are immediately taken to deal with the actual gas problem, to restore the pre-fall situation and to prevent any hazards arising from persons entering or operating machines in elevated levels of methane.



Example 1 - A Two Heading Development Panel With Only One Zone Boundary Methane Detector

In this case the boundary between the NERZ and panel face ERZ1 has been arbitrarily fixed at the point shown, on the return side of a face substation. This would enable the substation to be an IP55 rather than explosion protected design. An automatic methane detector must be placed at the boundary as shown and wired into the face substation, not only to trip power to all circuits supplied by it but also the power supply to it and to all non-intrinsically safe equipment situated in the intakes going outby (and also inby in the case of the mains) as far as the next set of methane detectors, or the surface, whichever first occurs. Clearly this arrangement could cause considerable disruption to working if a methane trip occurs.

Methane Levels and Actions

Table 2

Equipment Item or Location Details	Methane Level Detected	Action to be Taken
Continuous Miner, Coal Cutter, Longwall Shearer, Tunnelboring, Roadheading or Mobile Bolting machine fitted with either one or two automatic methane detectors.	1.00%	Detector must provide machine operator with an audible and visual alarm to indicate that methane is present.
Continuous Miner, Coal Cutter, Tunnelboring or Roadheading machine fitted with one automatic methane detector located to detect methane near the cutters.	2.00%	Detector must automatically trip power to the trailing cable supplying power to the equipment.
Continuous Miner, Coal Cutter, Tunnelboring or Roadheading machine fitted with two automatic methane detectors, one located to detect methane near the cutters and the other to detect general body concentrations around the machine.	2.00% near cutters	Detector must automatically trip power to the cutters.
	2.00% in general body around equipment	Detector must automatically trip power to the trailing cable supplying power to the equipment.
Mobile Bolting Machine	2.00% in general body around equipment	Detector must automatically trip power to the trailing cable supplying power to the equipment.
Longwall Shearer	1.25% in general body around equipment	Detector must automatically trip power to the cutters.
	2.00% in general body around equipment	Detector must automatically trip power to the trailing cable supplying power to the equipment.

Equipment Item or Location Details	Methane Level Detected	Action to be Taken
Longwall Face /Gate Road Return Junction	2.00% in general body around equipment	Detector must automatically trip power to the cables supplying power to the equipment at the Gate Road Return Junction and return side of it.
Longwall Face /Gate Road Intake Junction	2.00% in general body around equipment	Detector must automatically trip power to the cables supplying power to all longwall equipment.
Electrically powered loader fitted with one automatic methane detector.	2.00% in general body around equipment	Detector must automatically trip power to the trailing cable supplying power to the equipment.
Electrically powered loader not fitted with one automatic methane detector.	1.25% in general body around equipment	Operator must immediately withdraw equipment to location where methane concentration is less than 1.25% or alternatively manually trip power to the trailing cable supplying power to the equipment.
Battery or internal combustion engine powered explosion protected vehicle of any type fitted with one automatic methane detector.	1.00% in general body around equipment	Detector must provide visual and audible alarm and operator must immediately withdraw equipment to location where methane concentration is less than 1.00%.
	1.25% in general body around equipment	Detector must immediately shut down the internal combustion engine and / or electrical motors.

Equipment Item or Location Details	Methane Level Detected	Action to be Taken
Battery or internal combustion engine powered explosion protected vehicle of any type constructed prior to 1 January 2001 and not fitted with one automatic methane detector.	1.00% in the general body around equipment	Operator must immediately withdraw equipment to location where methane concentration is less than 1.00%.
	1.25% in general body around equipment	Operator must immediately manually shut down the internal combustion engine and / or electrical motors.
Battery or internal combustion engine powered non-explosion protected vehicle of any type fitted with one automatic methane detector.	0.25%	Detector must provide visual and audible alarm and operator must immediately withdraw equipment to location where methane concentration is less than 0.25%.
	0.50%	Detector must immediately shut down the internal combustion engine and / or electrical motors.
Battery or internal combustion engine powered non-explosion protected vehicle of any type and not fitted with one automatic methane detector.	0.50%	Operator must immediately withdraw equipment to location where methane concentration is less than 0.25%.
	0.25%	Operator must manually immediately shut down the internal combustion engine and / or electrical motors.
Locations in the mine where welding and hot work is undertaken.	0.25%	Welding operator must immediately shut down operations and quench any hot material where methane concentration is greater than 0.25%.

**SOUTH AFRICA: Mineral Acts and Regulations-
Update to December 31, 1999**

Act No. 27 of 1956, Mines and Works

(11A) "hazardous area" means (i) in respect of a coal-mine(aa) a return airway; or (bb) an area within 180 metres of any working face; or

(ii) any area in or at a mine or at a works in addition to an area referred to in regulation 1 (11A) (i) where there may be a risk of igniting gas, dust, vapor or any other explosive material; (11A)

(44A) "explosion protected apparatus" means any apparatus designed for use in a hazardous area and includes flameproof apparatus, intrinsically safe apparatus and **increased safety apparatus**; (49A)

21.17.4 Prior to the use of any explosion-protected equipment a copy of the test report shall be forwarded by the manager to the Principal Inspector of Mines, who may enforce restrictions and conditions for the use of the apparatus as deemed necessary in the interest of safety.

21.17.5 If any repair or modification which may affect its **explosive-protected apparatus** characteristics is carried out on explosion-protected apparatus by an organization not licensed by the approved inspection authority, the apparatus shall not be put into service in a hazardous area unless a new test report has been issued by the inspection authority.

21.17.6 The manager shall take all reasonable precautionary measures to ensure that all persons operating, running and maintaining **explosion-protected apparatus** are properly instructed in the conditions and requirements contained in the appropriate specifications in accordance with which the apparatus was tested.

(45A) "flameproof apparatus" means apparatus of which the enclosure will withstand, without damage, any explosion of any flammable gas or vapor that may occur within it under practical conditions of operation within the designed rating of the apparatus (and recognized overloads, if any, associated with the rating) and will prevent the transmission of flame such as will ignite any flammable gas or vapour which may be present in the surrounding atmosphere; (54)

(46A) **increased safety apparatus** means apparatus in which special precautions have been taken to prevent sparking, arcing and the occurrence of temperatures high enough to ignite flammable gas; (53)

(50A) "movable electric apparatus" means apparatus which does not fall within the definitions of "self-propelled mobile machine" or "portable electric apparatus" and which is not installed on permanent foundations and is intended to be moved from place to place when it is in use; (39A)

(5013) "portable electric apparatus" means electric apparatus which is designed to be carried by

hand and which may require electric power while it is being carried during use; (41 A)
[Pars. (50A) and (B) inserted by G.N. R. 160 dd. 1.2.1991.]

Exemption from Regulations

3.15.1 When the circumstances at mines and works in general or at any specific mine or works are such that any provision of any regulation cannot be applied or is unduly onerous to a mine or works or whenever it is necessary for the purpose of carrying out any experiment or tests as to the expediency of any regulation or proposed regulation, the Chief Inspector and any Principal Inspector of Mines may grant exemption from any provision of any regulation administered by him under such conditions as he may determine: Provided that any exemption from any regulation in respect of safety, health and related matters at any mine or works shall be granted after consultation with and under the direction of the Deputy Director-General referred to in section 2 (2) of the Act.

3.15.2 The Chief Inspector or any Principal Inspector of Mines may withdraw such exemption if considered necessary in the interests of safety and health.
[Regs. 3.15.1 and 3.15.2 as substituted by R. 3083/1991 w.e.f. 1.1.1992.]

Use of electrical appliances where flammable gas is found

'8.6.1 No person shall use or cause or permit any other person to use any electrical machine or any electrical apparatus other than an electric lamp approved in terms of regulation 15.5.1, or [flammable gas measuring instrument,] a flammable gas warning device or other monitoring or communication system approved in terms of regulation 21.16 in any underground working place in a mine where the atmosphere contains more than [one comma four parts] per 100 by volume of flammable gas.

(Words in square brackets inserted by cl. 6 (c) of R 2062 dd. 23.8.1991.)

'8.6.2 If flammable gas is found in a concentration referred to in regulation 8.6.1 in any underground working place in a mine where electrical apparatus is in use, the supply of electricity to that working place shall be switched off forthwith and shall not again be switched on until

- (a) the working place has been examined by the manager, mitre overseer or shift boss;
- (b) it has been found that the atmosphere contains less than ^{1a} [one comma four parts] per 100 by volume of flammable gas; and
- (c) the working place has been certified by the manager, mine overseer or shift boss to be safe.

UNITED STATES

Code of Federal Regulations Mineral Resources

30 Parts 1 to 199

30 CFR § 57.22302

Approved equipment (I-A and V-A mines).

Equipment used in or beyond the last open crosscut shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36. Equipment shall not be operated in atmospheres containing 1.0 percent or more methane.

30 CFR § 57.22305

Approved equipment (III mines).

Equipment used in or beyond the last open crosscut and equipment used in areas where methane may enter the air current, such as pillar recovery workings, longwall faces and shortwall faces, shall be approved by MSHA under the applicable requirements of 30 CFR parts 18 through 36. Equipment shall not be operated in atmospheres containing 1.0 percent or more methane.

30 CFR § 75.500

Permissible electric equipment.

[STATUTORY PROVISION]

On and after March 30, 1971:

- (a) All junction or distribution boxes used for making multiple power connections inbye the last open crosscut shall be permissible;
- (b) All handheld electric drills, blower and exhaust fans, electric pumps, and such other low horsepower electric face equipment as the Secretary may designate on or before May 30, 1970, which are taken into or used inbye the last open crosscut of any coal mine shall be permissible;
- (c) All electric face equipment which is taken into or used inbye the last open crosscut of any coal mine classified under any provision of law as gassy prior to March 30, 1970, shall be permissible; and
- (d) All other electric face equipment which is taken into or used inbye the last crosscut of any coal mine, except a coal mine referred to in §75.501, which has not been classified under any provision of law as a gassy mine prior to March 30, 1970, shall be permissible.

30 CFR § 18.2

Definitions

Permissible equipment means a completely assembled electrical machine or accessory for which a formal approval has been issued, as authorized by the Administrator, Mining Enforcement and Safety Administration under the Federal Coal Mine Health and Safety Act of 1969 (Pub. L. 91-173, 30 U.S.C. 801 or, after March 9, 1978, by the Assistant Secretary under the Federal Mine Safety and Health Act of 1977 (Pub. L. 91-173, as amended by Pub. L. 95-164, 30 U.S.C. 801).

Conclusions

To reiterate, restricting the use of non explosion-protected electrical equipment within a certain area of the underground coal mine is sometimes referred to as Zoning and in some regulations, it is defined as some area of the mine where the accumulation of methane or explosive vapors is unlikely.; therefore, it is suitable for non explosion-protected electrical equipment. Inside the last cross-cut of the intake airway, face or return airway where the potential for accumulations of methane exist, electrical equipment is restricted to flame proof, intrinsically safe or special protection apparatus. Sometimes there are definable distances to the face on an intake airway (South Africa at 180 m/Germany 150m/Nova Scotia 100m) or it is defined by the last full open crosscut to the face (US). In some cases, it is the mine manager s responsibility to designate the mine area and/or zone where explosion-protected electrical equipment and non explosion-protected electrical equipment is used.

In Australia, the emphasis is being placed on risk assessment process conducted by independent experts for the mine manager to define explosion risk zones. Overall, the mine plans in all cases must show the location and the type of electrical equipment used. Such plans must be approved by an authority such as the Chief Inspector of Mines or by other processes.

In the proposed Canadian federal regulations (see below), the use of non explosion-protected electrical equipment is approved by the Coal Mine Safety Commission (CMSC). The new regulations also allow for the use of other forms of protection as approved by CMSC but do not give any formal definitions or standards for such protection.

In the proposed Nova Scotia regulations (see below), the use of non - explosion-protected electrical equipment is permitted in Zone A as defined by the mine manager. The new regulations also allow for the use of other forms of protection according to CENELEC standards.

Recommendations

It is clear there are several countries that allow the use non explosion-protected electrical equipment use throughout the world . What is needed at this point is a fuller review of the following:

- " review the methods hazardous locations (explosive gas hazards) are treated in other than u/g coal mining situations. There are many industries (oil, gas, petrochemical, manufacturing) that involve explosive gas hazards which use a well-established set of tools for managing the risks involved;
- " review risk analysis methods used, where explosive gas hazards may not be involved. For example, the explosives industry uses a variety of tools to assess hazardous situations, and some of these tools may be useful for u/g coal mining;

Having gone over the above, an attempt to try and identify differences between u/g coal mining and other industries, which might have an effect on an approach to u/g coal mine safety will be made.

The main purpose of these reviews would be to provide a clear presentation of the information so that informed decisions on underground coal mine safety as it is related to hazardous locations and equipment approvals could be made by someone else.

Appendix A

Note: Appendix is listed separately.