Examination paper

NSW RESOURCES REGULATOR

Electrical engineering manager of underground coal mines certificate of competence

Written examination held 2 August 2018

CEE1 – Application of electrical engineering to mining

Instructions to candidates

Unless otherwise stated all references to Act and Regulations are to the:

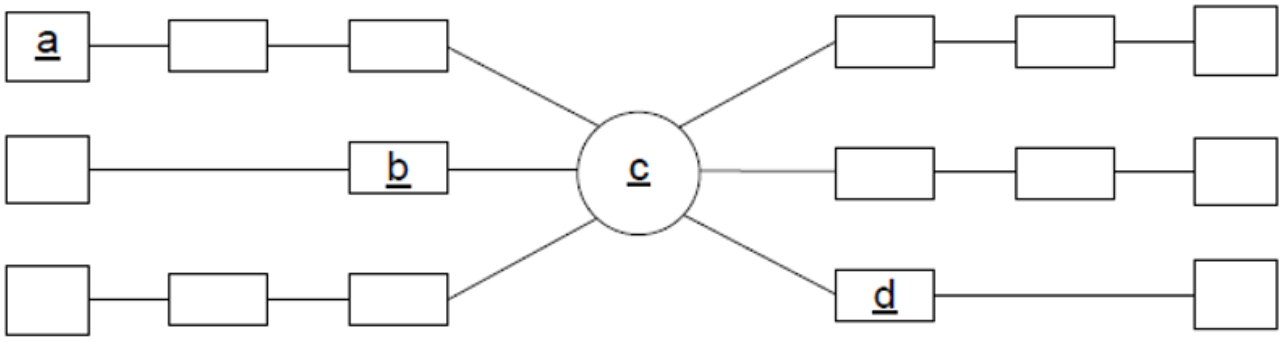
Work Health and Safety Act 2011

Work Health and Safety Regulation 2011

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014

Question 1 - Regulatory response to an Incident



1. Identify what each of the lettered elements represent. (4 marks)

   a

   b

   c

   d

2. Define the term “Critical Control” (2 marks)
3. Identify the controls that you would expect to be in place for to prevent the likelihood of electric shock to a person fault finding within a motor control cubicle. (2 marks)
4. Which of the identified controls would be considered critical? (2 marks)

Question 2

Your mine has gone out to tender for a new longwall AFC and drive package.

One of the tenders received is offering AFC drives complete with 3.3kV VVVF starters.

Prior to the introduction of this type of AFC drive to the longwall.

a) What matters do you require to be addressed? (4 marks)

b) Who would you consider consulting as part of the design stage of the project and why? (2marks)

c) What would be the main benefits of the VVVF drive system? (2 marks)

d) What would be the disadvantages of such a system being introduced underground? (2 marks)

Question 3

As manager of electrical engineering at any underground coal operation in NSW you are required to develop your electrical engineering control plan for your operation.

A fundamental foundation of this plan will be your Fault and Load Flow Studies which when plugged into your current and future mine development dictates your power reticulation design. A primary consideration is Voltage Regulation for your systems.

a) Explain in your own terms what “Voltage Regulation” means? (2 marks)
b) Explain what effects poor Voltage Regulation will have on your operation. (2 marks)

Scenario:

Your longwall has just completed a move to a completely new location on the mine site which is kilometres further away from the surface supply point in the mine. The 11kv supply for this new wall position has been extended through from the previous location.

Commissioning of the new face has started and you are experiencing Voltage regulation issues.

c) Explain what issues can develop if poor Voltage Regulation is evident in this situation. (2 marks)
d) Identify four areas which could be changed to improve your voltage performance (these can be short term or long term) (4 marks)

Question 4 - Management of mobile equipment fires

Load flow modelling for the mine’s new longwall has recommended the mine reticulate the high voltage power at 22,000 Volts from the surface.

The mine currently reticulates high voltage power at 11,000 Volts

As the manager of electrical engineering, what should be considered with respect to the following;

a) Cable Specification? (2 marks)

b) Cable handling and installation? (2 marks)

c) Inspection, testing and repair? (2 marks)

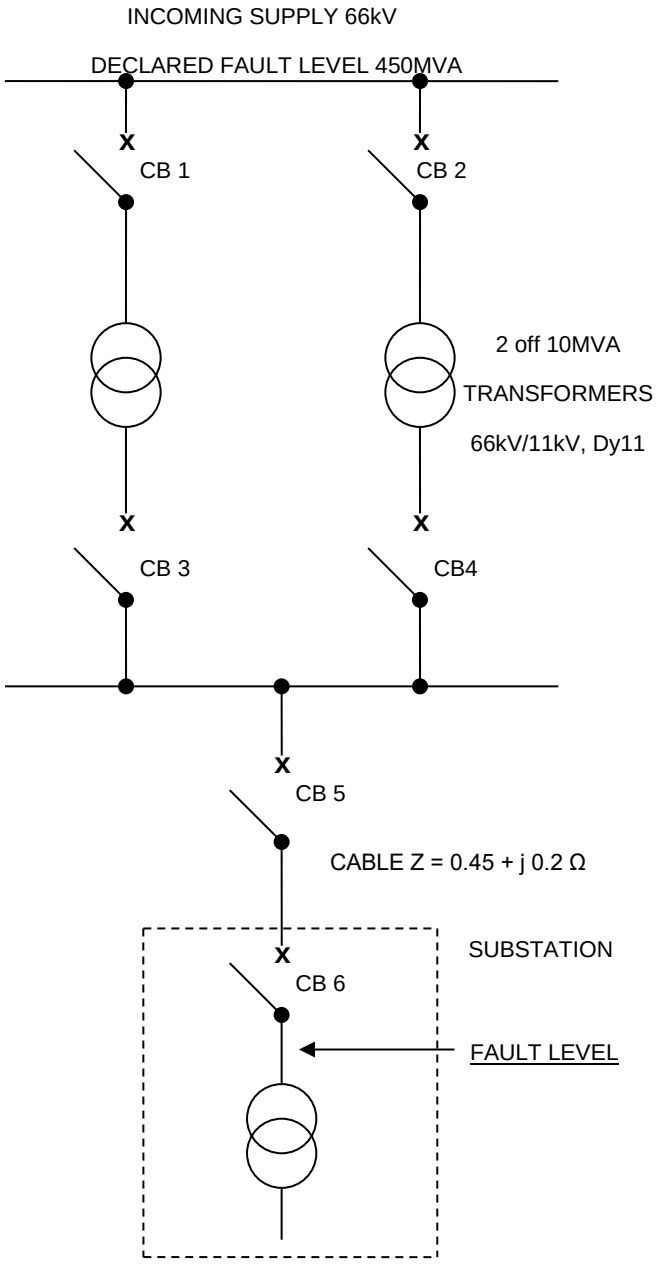
d) Electrical Protection for the 22,000V circuit? (2 marks)

e) Who would you consider liaising with in regard to implementing this project and provide the reasons why you think you would need to involve them? (2 marks)

Question 5 - Mine safety management system

Calculate the fault level for the following scenario in Figure 1.

FIGURE 1



Using a base of ten (10) MVA, determine the fault level on the load side of circuit breaker - 6, (CB 6) when:

a) Circuit breaker - 4 (CB 4) is open; all other circuit breakers are closed. (3 marks)

b) All circuit breakers are closed. (3 marks)

c) Are there any benefits of leaving one of the substations of line If you had the capacity to do so? What advantages or disadvantages would this provide and what circuit breaker/s would you leave open and why? (2 marks)

d) What documentation would you want to see signposted at the substation to meet your standards and those listed in AS3007. (2 marks)

Question 6 - Fatigue management

A main ventilation fan motor is to be installed at your mine. The general specification given to you by the ventilation officer is that there will be around 800kW of load for the motor without taking into consideration the efficiency of the fan itself.

a) What would you calculate to be the full load current of the motor – provide any assumptions you make in the calculations (4 marks)

b) What typical size motor would you select for this installation (1 mark)

c) What supply voltage would you connect to this motor and explain your choice for this installation (2 marks)

d) What size transformer would you estimate you would need to supply the installation (1 mark)

e) Explain what special starting requirements, if any, you would apply to this installation (2 marks)

CEE2 – Legislation and standards applicable to underground coal mines

Instructions to candidates

Unless otherwise stated all references to Act and Regulations are to the:

Work Health and Safety Act 2011

Work Health and Safety Regulation 2011

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014

Question 1

The WHS(MPS) Regulation applies to all NSW mine sites. As the manager of electrical engineering you are expected to have a working knowledge of certain parts of the Regulation.

Complete the missing words for a 1/2 mark per missing word.

Clause 78 Use of plant in hazardous zone (explosion-protection required)

(1) The _____ _____ of an underground coal mine must ensure that any plant used in a hazardous zone is explosion-protected and, if the plant is electrical plant, has an explosion-protection level suitable for that use.

(2) Electrical plant has an explosion-protection level suitable for use in a hazardous zone at a coal mine if:

(a) it has a _____ _____ of conformity or is Departmental _____ plant, and

(b) it meets at least 1 of the following requirements:

(i) intrinsically safe category 'Ex _____', as defined in Australian and New Zealand Standard AS/NZS 60079.11:2011 *Explosive atmospheres—Part 11: Equipment protection by intrinsic safety 'i'*,

(ii) encapsulated level of protection 'Ex ma', as defined in Australian and New Zealand Standard AS/NZS 60079.18:2011 *Explosive atmospheres—Part 18: Equipment protection by encapsulation 'm'*,

(iii) special protection 'Ex s' (Zone _____), as defined in Australian and New Zealand Standard AS/NZS 1826(Int):2006 *Electrical equipment for explosive gas atmospheres—Special protection—Type of protection 's'*,

(iv) special protection 'Ex sa', as defined in Australian and New Zealand Standard AS/NZS 60079.33:2012 *Explosive atmospheres—Part 33: Equipment protection by special protection 's'*,

(v) in the case of gas detectors and monitors using catalytic sensors—level of protection 'Ex da', as defined in Australian and New Zealand Standard AS/NZS 60079.1:2015 *Explosive atmospheres—Part 1: Equipment protection by flameproof enclosures 'd'*,

(vi) in the case of caplights (but only if the concentration of methane in the general body of the air in the hazardous zone is less than _____% by volume)—conformity with:

(A) Australian and New Zealand Standard AS/NZS 60079.35.1:2011 *Explosive atmospheres—Part 35.1: Caplights for use in mines susceptible to firedamp—General requirements—Construction and testing in relation to the risk of explosion*, or

(B) Australian and New Zealand Standard AS/NZS 62013.1:2001 *Caplights for use in mines susceptible to firedamp—Part 1: General requirements—Construction and testing in relation to the risk of explosion.*

(3) Electrical plant has an explosion-protection level suitable for use in a hazardous zone at a coal mine (but only if the concentration of methane in the general body of the air in that zone is less than _____% by volume) if:

(a) It has a valid certificate of conformity or is department approved plant, and

(b) it meets at least 1 of the following requirements:

(i) equipment protection level 'Mb', as defined in Australian and New Zealand Standard AS/NZS 60079.0:2012 *Explosive atmospheres—Part 0: Equipment—General requirements*,

Note.

See table 2.1 of Australian and New Zealand Standard AS/NZS 60079.14:2009 *Explosive atmospheres—Part 14: Electrical installations design, selection and erection* for the explosion protection techniques that achieve equipment protection level “Mb”.

(ii) plant that is _____ _____, Group II associated apparatus, as defined in Australian and New Zealand Standard AS/NZS 60079.0:2012 *Explosive atmospheres—Part 0: Equipment—General requirements.*

(4) The mine operator of an underground coal mine must ensure that any electrical plant used in a hazardous zone is _____ and _____ in accordance with Australian and New Zealand Standard AS/NZS 2290.1:2014 *Electrical equipment for coal mines—Introduction, inspection and maintenance—Part 1: For hazardous areas.*

(5) (Repealed)

(6) A certificate of conformity in relation to restrained plugs and receptacles is not valid for the purposes of this clause unless it attests to conformity with:

(a) Australian and New Zealand Standard AS/NZS 1299:2009 *Electrical equipment for mines and quarries—Explosion-protected three-phase restrained plugs and receptacles for working voltages up to and including 3.3 kV*, or

(b) Australian Standard AS 1299—1993 *Electrical equipment for coal mines—Flameproof restrained plugs and receptacles*.

(7) A _____ (the purchaser) who conducts a business or undertaking at an underground coal mine must not_____ explosion-protected plant from another person (the ***supplier***) unless the supplier provides the purchaser with the following:

(a) if the design of the plant is required to be registered under Part 5.3 of the WHS Regulations if the plant is to be used at an underground coal mine—evidence of that registration and drawings of the plant that:

(i) identify all features of the plant that form part of the explosion-protected properties, and

(ii) give sufficient details so that the plant can be verified as matching the drawings and the design that was registered, and

(iii) are copies of the drawings used for the purposes of obtaining the registration,

(b) if the plant has a valid certificate of conformity—a copy of the certificate and drawings of the plant that:

(i) identify all features of the plant that form part of the explosion-protected properties, and

(ii) give sufficient details so that the plant can be verified as matching the _____ and the _____ of conformity, and

(iii) are traceable to the drawings used in testing and assessment for obtaining the certificate of conformity,

(c) if the plant is department approved plant—evidence that it is approved and any documents and drawings identified on the website of the regulator in relation to the plant,

(d) the information required to be given by the supplier under section 25 (4) of the WHS Act.

(8) A reference in this clause to an Australian Standard or an Australian and New Zealand Standard includes a reference to the following:

(a) an Australian and New Zealand Standard that replaces that Standard, and

(b) any International Electrotechnical Commission Standard that is equivalent to that Standard (or that the regulator has declared by notice published in the Gazette to be equivalent to that Standard).

(9) In this clause:

certificate of conformity means a certificate of conformity issued under:

(a) the _____ scheme (being the Australian/New Zealand certification scheme for explosion-protected electrical equipment), or

(b) the _____ scheme (being the Standards Australia Certification and ExMark Licensing Scheme), or

(c) the _____ scheme (being the International Electrotechnical Commission System for Certification to Standards Relating to Equipment for use in Explosive Atmospheres).

Department approved plant means plant that:

(a) was manufactured before 1 October 2015, and

(b) was specified in the Explosion Protected Electrical Apparatus Approvals List as issued by the (then) Department of Trade and Investment, Regional Infrastructure and Services on 28 May 2012 and continues to be specified in that list as amended from time to time.

plant does not include cables.

Question 2

You have recently taken over as the manager of electrical engineering at a longwall mine. You have been reviewing the electrical engineering control plan and the number of notifiable incidents relating to the failure of explosion protection characteristics of explosion protected plant.

The mine has reported 10 failures of Ex over the last 12 months. Six are associated with damaged flame paths and 4 are in relation to damage bolt hole treads.

a) What areas of your safety management system may have failed to allow these incidents to occur? (2 marks)

b) With respect to the thread damage, what are your options for repair? (4 marks)

c) How will you prevent the occurrence of thread damage in the future? (4 marks)

Question 3

With respect to the **WHS(MPS)R clause 78 Use of plant in hazardous zone (explosion-protection required**) (4) The mine operator of an underground coal mine must ensure that any electrical plant used in a hazardous zone is maintained and overhauled in accordance with Australian and New Zealand

Standard AS/NZS 2290.1:2014 Electrical equipment for coal mines—Introduction, inspection and maintenance—Part 1: For hazardous areas.

Explain your understanding of the following:

a) The standard discusses **life cycle management**, explain your understanding of this? (5 marks)

b) The standard discusses Pre-Overhaul Audit Requirements. What is the purpose of a Pre-Overhaul Audit? (2 marks)

c) Who determines the Pre-overhaul audit Frequencies? (1 mark)

d) Before the pre- overhaul audit is completed, what should the competent person do? (1 mark)

e) What is the purpose of this review? (1 mark)

Question 4 -

AS/NZS 2290.1:2014 provides guidance on assessing corrosion or surface indentations

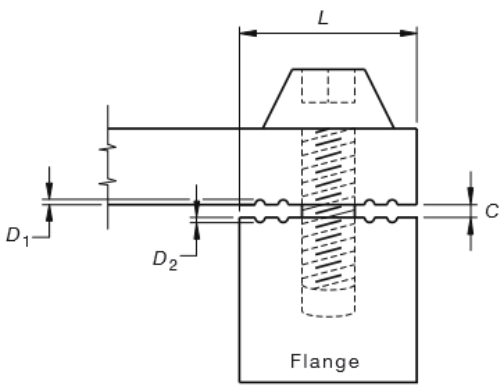


Figure 1

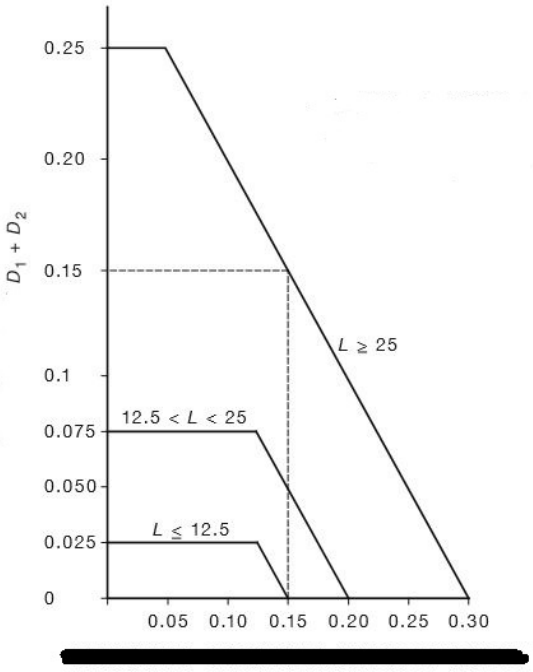


Figure 2

a) From Figure 1 above; identify the following labels; (3 Marks)

i. L = ?
ii. C = ?
iii. D1 and D2 = ?

b) A washer has been jammed in the flame path of the main enclosure on the shearer and left an indentation 0.08mm in the door and 0.07mm in the panel. The enclosure has a flame path length of 45mm and a maximum certified gap of 0.2mm. Explain why it is either safe or, not safe to continue to operate the machine? (3 marks)

c) If the panel was non-compliant, what measures could be taken to return the machine to service. (2 marks)

d) If you were to send this enclosure off site for repair what would be your key requirements / instructions for this type of work to be undertaken if it were to occur while you were away on leave? (2 marks)

Question 5

With respect to Australian Standard AS2290.3 - Electrical Equipment for coal mines – Maintenance and Overhaul. Part 3: Maintenance of gas detecting and monitoring equipment.

Gas monitoring systems used in underground coal mines are classified in four differing classifications, Class I; Class II; Class III and Class IV.

a) Explain the meaning for each of these differing classifications? (4 marks)

b) In the case of a Class II gas monitoring system, what is the required frequency for licensed workshop testing and calibration? (2 marks)

c) How often would you expect class II gas monitors to be calibrated and by who? (2 marks)

d) What are the issues associated with remote gas monitors and current loops? (2 marks)

Question 6

Clause 72 of the *Work Health and Safety (Mines) Regulations 2014* states requirements on the "Control and Monitoring of Methane levels" for an underground Coal Mine.

a) Clause 72 (3) states "The mine operator of an underground coal mine must ensure that methane monitoring plant is provided at the mine that:"

There are five requirements, please identify at least four of (a), (b), (c), (d) and (e) (4 marks)

b) Clause 72 (6) states "the mine operator of an underground coal mine must ensure that each face machine in use at the mine is equipped with a continuous methane monitor that…"

Please identify what is referred to as a "face machine", as defined in the WHS (mines) regulations 2014? (3 marks)

c) Please state the requirements for the above clause

i. The gas level for an audible or visual alarm …. "general body"
ii. The gas level to cut the supply of power …. "general body"?
iii. The gas level to cut the supply of power …. "close to the heads of the face machine"? (3 marks)

Question 7

The mine operator has asked you to prepare for the introduction of the first fully autonomous stockpile bulldozer at your site.

a) Identify three critical tasks to be completed prior to the equipment going into service and briefly describe how you would go about the tasks identified? (3 marks)

b) What would you consider to be the critical risk items that need to be considered in the design and ongoing operation of the Bulldozer. (3 marks)

c) The Australian Standard for remote controlled equipment describes a number of safeguarding techniques with specific failure modes that shall be assessed. Name two of these? (2 marks)

d) What would you put in place to manage the software for this piece of plant? (2 marks)

Question 8

The mine operator has advised that the site will be relocating its tailings dam to a new location with a larger capacity pump to enable more water to be returned to the adjacent CHPP. The pump motor will be energised at 415V. There is no nearby substation, so a power supply will need to be constructed from approximately 2km away. Question (a) will only deal with getting power to the new pump site and Question (b) will deal with the specific pump installation itself.

a) Provide an electrical drawing below, showing what you envisage the reticulation of the new power supply would look like including the catering for a road crossing, to the proposed installation? Provide details of any assumptions you have made in your drawing. (3 marks)

b) Provide a single line electrical schematic for this pump installation from the new power supply shown in (a) above to the new pump. Including:

- The protection devices you would want in your installation
- Show any voltage levels including transformer sizing.
- Show your earthing arrangements for the installation
- What size motor would you expect on this installation
- Show any assumptions made (5 marks)

c) describe what commissioning tests you would want done on the 2km length of the new power supply prior to initial introduction of the supply? (2 marks)

Question 9

The following questions relate to fault level and protection studies.

a) What is meant by the term “Declared fault level” and where does this fit into the overall site fault level and protection study? (1 mark)

b) How would you set up the control system for your protection devices in your high voltage substation and explain the reasons behind your choices? (2 marks)

c) Explain the procedure you would have in place for an instantaneous overcurrent trip on your sites 66kV overhead aerials? (3 marks)

d) Who would be permitted to undertake the work in c) above and list what your competency requirements would be for this person over a 5-year term? (2 marks)

e) What would your instructions be if initial inspections did not reveal a reason for the instantaneous overcurrent trip? Explain what you would want done after receiving this phone call? (2 marks)

Question 10

Increased Safety (Ex e) is a form of Explosion Protection technique commonly used throughout the underground coal mining electrical engineering industry.

The following questions are related to this form of protection:

a) In your own words, what is the definition of “Increased Safety”? (3 marks)

b) List at least four (4) methods used in the design of Exe equipment, and give examples of typical equipment used in the industry? (4 marks)

c) When an inspection of an Exe CH4 enclosure on a face machine was carried out, it was identified that the external cable glands entering the enclosure were standard off the shelf PVC glands. Are these allowed for use in this type of enclosure? Explain your answer? (3 marks)

(continued overpage)

Table 8 - Selection of glands, adapters and blanking elements type of protection according to the enclosure type of protection.

Protection technique for the equipment	Glands, adapters and blanking element protection technique			
	Ex 'd'	Ex 'e'	Ex 'n'	Ex 't' and 'DIP'
Ex 'd' (Note 3)	P			
Ex 'e'	P	P	P	P
Ex 'i' and Ex 'nL'	No stated requirements			
Ex 'm'	Ex'm' would not normally be applied to wiring connections. The protection technique for connections shall suit the wiring system used.			
Ex 'n' except Ex 'nL' (Note 4)	P	P	P	P
Ex 'o'	Ex'o' would not normally be applied to wiring connections. The protection technique for connections shall suit the wiring system used.			
Ex 'p'	P	P	P	P
Ex 'q'	Ex'q' would not normally be applied to wiring connections. The protection technique for connections shall suit the wiring system used.			
Ex 's'	Only as allowed by the conditions of the certificate.			
Ex 't' and 'DIP'	P	P	P	P
Ex 'v'	Type of protection does not apply to the equipment connections			

P denotes permitted use.

Note 1 The gland, adapter or blanking elements are further subjected to selection criteria for IP rating.

Note 2 Requirements for the application of all glands, adapters or blanking elements are given in 5.9 and 9 to

Question 11

Life Cycle Management of Electrical Explosion Protected Equipment is a requirement for all Underground coal operations within NSW, as identified in WHS Regulations 2014 schedule 2, Principle Control Plans.

As the Manager of Electrical Engineering at an underground Coal Operation you have this requirement high on the priority list for your operation.

Technical Reference EES003 identifies “Practices for the Life Cycle Management of Explosion Protected Equipment” for this environment.

a) In the “Purpose” for this industry reference there are eight risks which these practices are designed to protect. State at least five of these risks? (3 marks)

b) Chapter 2 of this reference identifies seventeen different areas which when followed will ensure compliance. Section 2.10 informs “Maintenance of electrical explosion protected equipment at the mine” – there are nine control measures which need to be considered. State at least five of these measures? (3 marks)

c) Portable Electrical Apparatus is also identified in this Technical Reference. Please identify the controls which would be in place at your mine for the use of this type of equipment underground or in a Hazardous Zone? (4 marks)

Question 12

Australian Standard 2290.1 – Electrical Equipment for coal mines – Introduction, inspection and maintenance Part 1: For hazardous areas – Refers to the effective life cycle management of equipment, and the importance that all appropriate documentation needed to comply with the standard, is in place prior to the introduction and commissioning of equipment in a hazardous area.

a) What is the principle document being referred to in this standard? (2 marks)

b) There are fifteen (15) separate documents which need to be included in this principle document. Identify at least five (5) of these associated documents? (5 marks)

c) List at least three (3) “additional documentation” which can be added? (3 marks)

More information

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