Trade & Investment Mine Safety

MINE ELECTRICAL ENGINEER CERTIFICATE OF COMPETENCE | AUGUST 2014

Examination for Certificate of Competence as a Mine Electrical Engineer

CEE1 Application of Electrical Engineering to Mining

Examination Date: 21 August 2014

Examination Times: 9.30am to 12.30pm

Examination Venue: Hunter TAFE, Kurri Kurri.

Instructions to candidates: It is expected that candidates will present their answers in an engineering manner making full use of diagrams, tables, and relevant circuits where applicable and showing full working in calculations. Neatness in diagrams is essential and will be considered in the allocation of marks. Questions are to be answered as a prospective manager of electrical engineering at a NSW mine.

Examination time 3 hours. Each whole question is designed for a 30 minute answer. Candidates should attempt all questions. Candidates must mark this paper with their Candidate Number only. All questions and parts are allocated their respective marking value. During the reading time candidates may use a highlighter to mark the key parts of questions. If you unable to fit the answer in the allocated space provided please utilise the blank page opposite the question.

Question 1 (10 marks)

You are the Manager of Electrical Engineering at a mine that has a design registered bulk friction winder. The control system for the winder has undergone a functional safety assessment and been assigned a SIL2 rating. The mine is planning to increase production and as a consequence, the winder speed has to be increased to its maximum permissible design speed.

a) Prior to increasing the speed of the winder, who would you approach and what would you have them do? (4 marks)
b) After making contact with those you have nominated above, what further steps or actions would you take? (6 marks)

Question 2 (10 marks)

As Manager of Electrical Engineering at an underground coal operation you are required to develop an Electrical Engineering Management Plan (EEMP) for your operation.

A fundamental foundation of this plan will be your “Fault and Load Flow Studies”. The data from these studies will dictate your electrical engineering mine design with Voltage Regulation being heavily considered into this area.

a) Explain in your own terms “Voltage Regulation”. (2 marks)
b) Explain what effects poor Voltage Regulation will have on your operation.(2 marks)
c) Your Longwall has just completed a move to a new area on the mine site. The new area is approximately five kilometres further from the surface supply point in the mine. The 11kv supply for this new longwall position has been extended through from the previous area.

   Commissioning of the new longwall face has commenced and you are experiencing Voltage Regulation issues. The Voltage Regulation is occurring when the AFC is running and the operators attempt to start the shearer.

Explain the effects that poor voltage regulation creates 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 3 (10 marks)

Atmospheric lightning can and has caused risks to both surface and underground mines in recent years.

a) What Australian Standard is applicable for lightning protection? (2 marks)
b) What direct strike protection does your mine have? (2 marks)
c) How do you manage indirect lightning strikes at your mine? (2 marks)
d) Lightning strikes have been considered a possible cause of underground fires and explosions in recent times. The Trade & Investment website features published information on events in the form of safety alerts, safety bulletins and investigation reports. Specifically *SA 11-12 - Ignition of gas leads to underground fire*, discusses possible causes of ignition, one of these being lightning. (SA 11-12 attached)

   Explain how you would use the information contained within the safety alert to manage the effects of lightning at your mine. (4 marks)

Question 4 (10 marks)

Part 4.7 General electrical safety in workplaces and energised electrical work of the *Work Health and Safety Regulation 2011* places specific obligations on a PCBU with regard to electrical safety in workplaces.

a) Is the 24V DC electrical system in an off-road truck considered electrical equipment? (1 mark)
b) Is mounting a switchboard onto a brick wall considered electrical work? (1 mark)
c) What must be done with electrical equipment that has been deemed unsafe? (2 marks)
d) Outline what steps must be taken prior to undertaking electrical work on energised electrical equipment. (4 marks)
e) What are the key requirements for the tools and testing equipment employed when undertaking electrical work on energised electrical equipment? (2 marks)

Question 5 (10 marks)

Cables used for underground coal mining operations in reeling and trailing applications are designed to be “fit for purpose” for their duty in this particularly harsh environment.

The following questions are related to this design requirement:

a) Draw a typical cross sectional diagram of a type 245.1 Trailing Cable and identify the critical design features of the cables; including internal cores, insulation and screening.

   Explain why it is designed in this manner. (4 marks)

b) Describe how and where the Type 245.1 cable design is utilised in the underground mining industry, and why it may be chosen over other cable types? (3 marks)
c) Explain what is meant by a “Type Test” on this form of cable for the underground coal mining industry, as per AS/NZS1747:2003, *Reeling, trailing and feeder cables used for mining - Repair, testing and fitting of accessories*. (2 marks)
d) Explain what voltage range this type of cable is designed to operate within, as per AS/NZS 1802:2003, *Electric cables – Reeling and trailing – For underground coal mining*. (1 mark)

Question 6 (10 marks)

FAULT LEVELS

The following questions relate to a parallel transformer installation with two transformers 20MVA 66/11kV with 5% impedance. A bus tie is also installed on the secondary side. A load is supplied from the bus via a cable that that is 800m in length and has an impedance of 0.39 +j0.1Ω per km. The declared fault level on the line side of the transformers is 375MVA.

a) Draw the typical mining substation circuit described above using Australian Standard symbols. Show all the necessary hardware and protection devices you would require on this substation. Provide any assumptions made. (4 marks)
b) Calculate the fault level at the end of the cable when the bus tie is both open and closed. Use a base of 5MVA for your calculation. (4 marks)
c) Under normal operating conditions, in what position would you want to see the bus tie? Explain the reasons why. (1 mark)
d) What labelling/signage would you want on your substation fence/gates? (1 mark)

END OF QUESTIONS

END OF PAPER

CEE2 Legislation and standards applicable to underground coal mines

Examination Date: 21 August 2014

Examination Times: 1.30pm to 4.30pm

Examination Venue: Hunter TAFE, Kurri Kurri.

Instructions to candidates: It is expected that candidates will present their answers in an engineering manner making full use of diagrams, tables, and relevant circuits where applicable and showing full working in calculations. Neatness in diagrams is essential and will be considered in the allocation of marks. Questions are to be answered as a prospective manager of electrical engineering at a NSW mine.

Examination time 3 hours. Each whole question is designed for a 15 minute answer. Candidates should attempt all questions. Candidates must mark this paper with their candidate number only. All questions and parts are allocated their respective marking value. During the reading time candidates may use a highlighter to mark the key parts of questions. If you unable to fit the answer in the allocated space provided please utilise the blank page opposite the question.

Question 1 (10 marks)

You are the Manager of Electrical Engineering at a major underground coal operation. The mine is conducting maintenance repairs to the surface coal handling facilities during a scheduled shutdown period as planned.

a) For this maintenance to occur there is a need for a large number of contract labour personnel to be employed for a short period of time. The contractors will be organising a number of mobile machines (elevated work platforms; welding machines; cranes etc.) onto your site as part of their scope of work.
b) What systems/processes need to be in place at your operation to give guidance on how to handle this type of program? (3 marks)
c) Give three detailed examples of possible outcomes if these systems are not in place or followed correctly. (3 marks)
d) Draw a simple flow diagram for each of the systems/processes listed in part a) as an example of how these systems may operate within your operation. (4 marks)

Question 2 (10 marks)

Increased Safety (Exe) is a form of Explosion Protection technique commonly used throughout the electrical engineering underground coal mining 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, providing examples of typical equipment used in the industry. (4 marks)
c) During an inspection of an Exe (Methane Group 1) enclosure on a face machine it was identified that the external cable glands entering the enclosure are standard off the shelf PVC glands.

   Are these allowed for use in this type of enclosure? Explain your answer. (3 marks)

Question 3 (10 marks)

Work Health and Safety Act 2011

a) What duty is imposed in section 17 ‘Management of Risks’ of the Act? (2 marks)
b) According to section 18 of the Act, what matters should be weighed up in determining what is “reasonably practicable”? (4 marks)
c) According to section 19 (3) of the Act, Primary Duty of Care, what must a PCBU ensure? (4 marks)

Question 4 (10 marks)

You are the Manager of Electrical Engineering at a major underground coal operation. The mine has four development panels and a longwall panel. Your operation has two underground 11kv feeders from the

surface switch room, one is dedicated to Longwall supply and the second supplies the development panels, coal clearance systems and outbye services.

It is the end of night shift, just prior to a Longwalll services move and you receive a phone call saying that both underground 11kv supplies have tripped in the surface switchroom.

An initial investigation has identified that a Load Haul Dump (LHD) was working outbye in the Longwall roadway preparing for the services move and had struck a HT cable in the rib.

a) As the Manager of Electrical Engineering what initial thoughts occur to you when this situation is presented? (2 marks)
b) What steps would be taken to verify the failure point and allow some operations to continue? (2 marks)
c) What Electrical Engineering systems identify a path to follow in this situation? (2 marks)
d) Once all required investigations have been completed and operations have been restored, what long term issues need to be considered? (4 marks)

Question 5 (10 marks)

AS/NZS 2081:2011, *Electrical Protection devices for Mines and Quarries*

a) Does a relay designed to comply with this Standard require independent verification or certification? (1 mark)
b) According to this Standard, what is the purpose of a “type test”? (1 mark)
c) According to this Standard, what are “routine tests”, and who performs them? (1 mark)
d) Where remote start functionality is provided via a pilot circuit, what condition is required to be prevented, and how is this achieved? (2 marks)
e) For neutral-connected impedance earth fault current limitation devices the standard states these devices are to be rated for the stated earth fault current at the rated phase to earth system voltage. This can be a short-time (10sec) rating.

   The use of a short-time rated NER can lead to a specific problem, particularly where the connected load includes multiple variable speed drives.

   What is this problem? (3 marks)

f) The standard states the typical maximum setting for EC resistance is 45 ohms. In practice, a setting of 45 ohms may not be appropriate. Why? (2 marks)

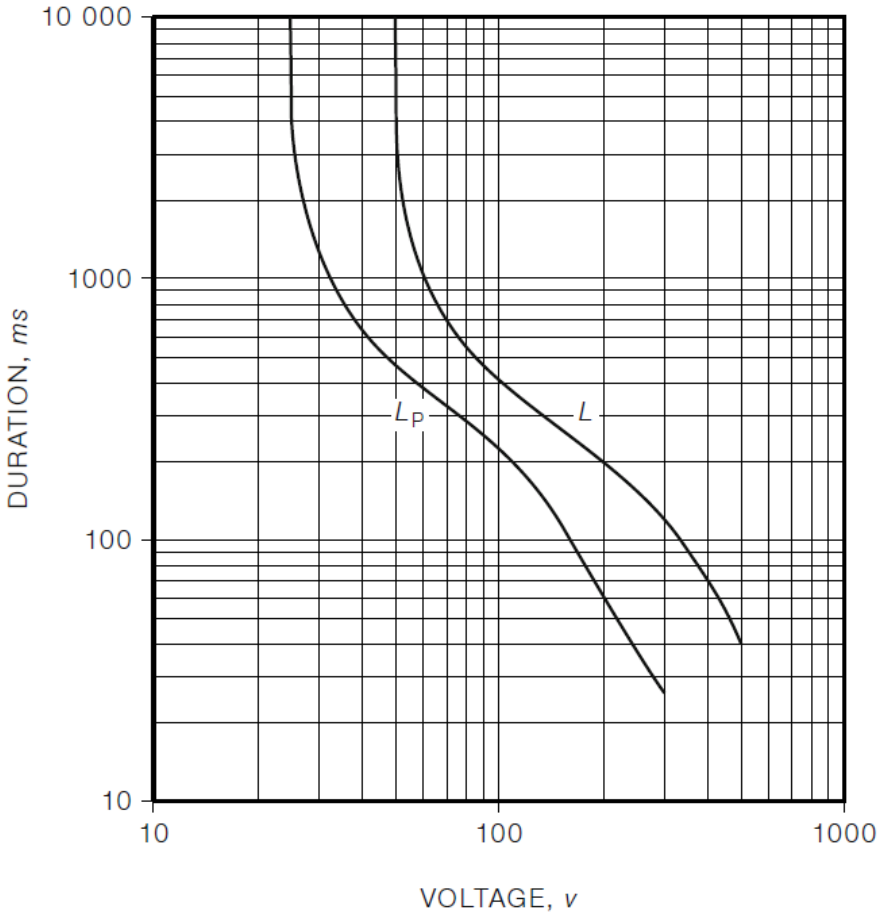
Question 6 (10 marks)

AS/NZS 4871.1:2012, *Electrical Equipment for Mines and Quarries - General Requirements* sets out the general requirements for the design, construction and testing of electrical equipment directly associated with mining and quarrying activities, and covers any plant intended to be relocated.

a) AS/NZS4871.1:2012 defines a ‘flameproof enclosure’. Using your own words or the words from the standard accurately to define a flameproof enclosure (2 marks)
b) The design of all enclosures used in both safe and hazardous areas shall consider a number of parameters outlined within the ‘Enclosure Requirement’ of the standard. An understanding and general knowledge of these will assist mine engineers when conducting off site inspections of new or overhauled electrical plant.

   State any two of these parameters. (2 marks)

c) What are the minimum Ingress Protection (IP) requirements and considerations for non-hazardous and hazardous areas, according to this standard? (2 marks)
d) Using the following curve, what is the max time under normal and wet condition a human can withstand 150 volts? (2 marks)



L	for normal conditions	touch voltage limit 50 V
L_P	for wet conditions	touch voltage limit 25 V

e) Explain how mines manage the risk of touch voltages. (2 marks)

Question 7 (10 marks)

In reviewing your mines' notifiable incident statistics over a three year period you observe that 40% of reported failures of explosion protected electrical equipment involve headlights mounted on mobile equipment.

You are concerned enough that you consider this represents a significant deviation from the mines' standards, and notify the operator accordingly.

In response, the Operations Manager has requested an action plan to be developed and implemented so the frequency of headlight damage is reduced to an acceptable level.

a) Applying the obligations of Section 19 (3) of the Work Health and Safety Act 2011, identify broadly the type of issues you would consider in developing your plan to reduce the incidence of headlight damage. (2 marks)

b) In considering the guidance provided in Section 2.4 and 2.6 of AS/NZS 2290.1:2014, *Electrical equipment for coal mines – Introduction and maintenance - For hazardous areas*, describe the approach you would adopt, and the issues to consider, when reviewing the inspection regime for headlights mounted on mobile equipment. (4 marks)

c) In your review, it is revealed that there are several hire machines in service at your mine where the headlights appear to have not been overhauled for 5 years; however scheduled internal inspections have been completed every six months. Your Standard of Engineering Practice

(SEP) for Explosion-protected electrical equipment stipulates 4 years between overhauls for this type of equipment.

i. What would be your immediate actions? (1 mark)
ii. Who would you inform? (1 mark)
iii. In consideration of guidance in Section 2.5 and Appendix A of AS/NZS 2290.1:2014, what actions would you take to prevent a recurrence? (2 marks)

Question 8 (10 marks)

AS/NZS 3007:2013, *Electrical Equipment in Mines and Quarries – Surface Installations and Associated Processing Plant*

a) What is a 'closed operating area' and list two examples. (2 marks)
b) Name two places where the standard describes that overloads should not be installed. (2 marks)
c) Name two specific requirements that apply to all cables installed external to an electrical enclosure on mobile machinery. (2 marks)
d) Over Head Line (OHL) Corridors and Work near OHLs require certain criteria set in relation to the minimum distances so that direct contact or flashover is prevented under normal operating or foreseeable abnormal circumstances.

For OHLs energised at greater than 33kV, draw a sketch showing these distances. (4 marks)

Question 9 (10 marks)

Clause 19 of the *Coal Mine Health and Safety Regulation 2006* outlines the elements that must be included in the Electrical Engineering Management Plan (EEMP).

Within the extract of clause 19 (1) (a) to (r) of the CMH&S Regulation fill in the missing words in the spaces below (10 Marks, ½ mark per missing word).

19 Electrical engineering management plan

The electrical engineering management plan for a coal operation must make provision for the following:

(a) the _____ , _____ , _____and repair of electrical plant and installations being undertaken only by a qualified electrical engineer or qualified electrical tradesperson, or people under the supervision of a qualified electrical engineer or qualified electrical tradesperson,

(b) the standards of engineering practice for electrically powered plant, electrically controlled plant, installations, electrical engineering practices used at the coal operation, and, in particular, all electrical installations located on the surface at a coal operation being required to comply with the _____ _____ and AS 3007:2004 *Electrical installations—Surface mines and associated processing plant*,

(c) the use of electrical plant only of a Gazetted type in a hazardous zone,

(d) the maintenance of explosion-protected plant and installations in an explosion-protected state,

(e) the overhaul and repair of electrical plant and installations, including the following:

(i) the overhaul and repair of explosion-protected plant (being work that may alter the explosion-protected properties of the plant) being carried out only by a person licensed to carry out that work,

(ii) the repair of flexible reeling, trailing and feeder cables for use in a hazardous zone being carried out only by a person licensed to carry out those repairs,

(f) the prevention of arcing faults compromising explosion-protection properties of plant and installations (including cables),

(g) the prevention of the ignition of gas by a static electric charge,

(h) the provision of _____ _____ on all electric circuits, including the following:

(i) the construction of electrical protection devices to an appropriate standard,

(ii) the _____ of the supply of electricity to mobile or portable electrical apparatus when the continuity of the connection to earth is compromised,

(iii) the prevention of the connection of electrical power to explosion-protected mobile or portable electrical apparatus in the event of an earth fault on a flexible cable supplying the apparatus,

(i) the provision of effective earthing, including the following:

(i) the minimisation of risk from _____ , _____ or _____ potential,

(ii) the prevention of the effects of lightning being transferred to the underground parts of the coal operation,

(iii) the limitation of earth fault currents to mobile plant fed via flexible cables and to electrical plant in the underground parts of the coal operation,

(j) the control of electrical energy in parts of the coal operation, including the provision of suitable switch gear to safely switch electric power in the coal operation and parts of the coal operation,

(k) the interruption of the supply of electricity in any of the following circumstances:

(i) in the presence of flammable gas,

(ii) if ventilation falls below a specific quantity (to be determined by the operator in consultation with the manager of mining engineering and the manager of electrical engineering),

(iii) if inspections required by the inspection program under clause 15 have not been conducted,

(iv) in the event of an electrical fault,

(v) if there has been a _____ to _____ plant in accordance with the electrical engineering management plan,

(vi) if unsafe electrical plant or practices have been detected,

(l) the safe _____ of the supply of electricity by competent people,

(m) the control of portable electrical plant in the underground parts of the coal operation and, in particular, the use of non-explosion-protected plant in a hazardous zone only under Gazetted conditions,

(n) the safe operation of _____ _____ installations throughout their life cycle,

(o) the prevention of _____ _____ work on electrical plant and installations under the control of the operator or a contractor, except:

(i) where that work is carried out on a circuit at or below extra low voltage (as defined by the Wiring Rules), or

(ii) where that work is carried out in accordance with any relevant requirements of the regulations made under the Occupational Health and Safety Act 2000,

(p) the safety from hazards within the responsibility of the operator of the coal operation of people undertaking installation, maintenance or emergency work on an electricity supply authority's infrastructure,

(q) the reasonable access of people undertaking installation, maintenance or emergency work on an electricity supply authority's infrastructure to that infrastructure,

(r) a commissioning, testing and notification process prior to the initial application of power to circuitry, including the following:

(i) commissioning and testing of electrical plant and installations, to the standard set out in _____ _____ of the Wiring Rules, to be undertaken by a qualified electrical engineer or a qualified electrical tradesperson,

Question 10 (10 marks)

Risk management at mines has become an established practice. Mine Safety published MDG 1010 2011 Minerals industry safety and health risk management guideline. It can be said that, 'the purpose of applying a risk management process might be best described as an attempt to proactively and

systematically reduce losses'. From your knowledge and understanding of risk management answer the following questions.

a) In your own words, describe the meaning of WRAC and where it is suitable to be used. (2 marks)
b) What is meant by the term 'Risk Reduction'? (2 marks)
c) What is meant by the term JSA? (2 marks)
d) What is meant by the term FMEA in relation to risk management? (2 marks)
e) List four of the common 'pit falls' when conducting a risk assessment. (2 marks)

Question 11 (10 marks)

AS1674.2:2007 *Safety in Welding and Allied Processes – Electrical*

a) Draw a connection diagram and explain your connection preference for three (3) welding machines that will be located adjacent to each other in a heavy workshop environment. The machines will be connected to a 3 phase supply. (4 marks)
b) What tests would you expect to be done on the installation prior to and following the installation? (2 marks)
c) The standard requires that minimum insulation resistance tests to be undertaken for different parts of the welding machine. Name one of these areas and what test voltage is to be applied and what insulation value is required for the test chosen. (2 marks)
d) What is the maximum permitted open circuit voltage for a category C Environment? (2 marks)

Question 12 (10 marks)

Intrinsic Safety (IS) Concepts

a) In an underground coal mine, can a Group II IS device be used in a hazardous zone? Justify your answer. (2 marks)
b) What would be an example of 'associated apparatus', as defined in AS/NZS 60079.0:2012, *Explosive atmospheres - Equipment - General requirements*? (1 mark)
c) Further to b), what issue must be addressed with the use of an 'associated apparatus' in a hazardous zone? (1 mark)
d) An IS interface with a specified Co of 20uF is to be connected to an IS field device with a Ci of 2uF. For a cable with a capacitance of 180nF/m, what is the maximum permissible length of cable? (2 mark)
e) Draw a sample block diagram for the following simple IS system.

   An IS gas sensor is located in a hazardous area connected to a IS power supply located in a safe area. Include all key parameters for the sensor, power supply and connecting cable utilising typical expected values.

   In your diagram, the relationship between all input and output parameters (eg Um; Uo; Ii; Io; Co; Ci; Lo; Lr) must demonstrate that the circuit is compliant. (4 marks)

END OF QUESTIONS

END OF EXAM

More information

Business Processes & Authorisations

Phone: 4931 6625

Acknowledgments

Mine Electrical Engineer Examination Panel