



EXAM PAPER | CERTIFICATE OF COMPETENCE

Electrical engineer of coal mines other than underground coal mines

SEPTEMBER 2015

CEE3 Legislation and standards applicable to surface coal mines

Examination date:	16 September 2015
Examination times:	1.30pm to 4.30pm
Examination venue:	Hunter TAFE, Kurri Kurri.
Instructions to candidates:	Unless otherwise stated all references to Act and Regulations are to the <i>Work Health and Safety (Mines) Regulation 2014</i> <i>Work Health and Safety Regulation 2011</i> <i>Work Health and Safety (Mines) Act 2013</i> <i>Work Health and Safety Act 2011</i>

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 workings in calculations. Credit marks will be given for such work in assessing marks for these questions. If you unable to fit your answer in the allocated space provided please utilise the blank page opposite the question.

Neatness in diagrams is essential and will be considered in the allocation of marks. Provide answers in point form wherever appropriate. State any assumptions you make in order to answer the question.

Questions are to be answered from the perspective of an electrical engineer nominated to exercise the statutory function of electrical engineer by a mine operator at a NSW mine.

Electronic aids may not be used, apart from calculators.

All questions are compulsory and candidates must attempt each question.

All questions are of equal value, but parts of questions may vary in value. The marks applicable to each part of a question will be indicated adjacent to the question.

Place your identification number only, NOT your name, on your paper.

10 minutes reading time is allowed prior to the start of the examination. Candidates can use a highlighter to mark points of importance during the reading time, but may not begin answering the questions. The examination time is three (3) hours. Each whole question is intended to be able to be answered in 15 minutes.

This examination is a closed book examination.

Question 1 (10 marks)

The following questions relate to AS/NZS 4871:1 – 2012 Electrical equipment for mines and quarries (the “Standard”).

The Standard discusses the need for interlocking to be fitted in certain circumstances. As the electrical engineer nominated to exercise the statutory function of electrical engineer of a coal mine other than an underground coal mine by a mine operator:

- How would you determine when interlocking would be required on your site? (1 mark)
- What factors should be considered when determining if, and when, interlocking is required? (4 marks)
- What, specifically, should be considered in the design of covers giving access to live conductors above extra low voltage? (2 marks)
- Name three (3) types of acceptable interlocking methods. (3 marks)

Question 2 (10 marks)

The following questions relate to AS3012:2010 – Electrical installations – Construction and demolition sites (the “Standard”).

- How is compliance with the Standard required? (1 mark)
- What are the specific installation requirements relating to the use of switchboards installed for the purpose of construction and demolition sites? (3 marks)
- Produce an electrical drawing for a single-phase generator installation with integral RCD-protected multiple socket outlets. Show the necessary protection devices. (5 marks)
- What is different about the construction wiring in relation to the installed permanent wiring? (1 mark)

Question 3 (10 marks)

The following questions relate to the *Work Health and Safety Act 2011* (the “Act”).

- With regard to the management of risk, section 17 of the Act imposes what duty? (2 marks)
- According to section 18 of the Act, what matters should be weighed up in determining what is “reasonably practicable”? (4 marks)
- According to section 19 (3) of this Act, which relates to “Primary duty of care”, what must a person conducting a business or undertaking (PCBU) ensure? (4 marks)

Question 4 (10 marks)

You are in the process of designing a new power supply to three buildings on your site. The supply will be 11kV to a 1MVA (11kV/415V) transformer with an impedance of 6%. The design has considered additional loads from this transformer in the future with only one building being constructed now and two more in future years.

- Determine what the maximum possible fault level at the 11kV transformer would be. (2marks)
- What would be the short circuit current on the secondary side of the transformer? (2 marks)
- The 415V secondary supply will be via a 240mm² PVC/PVC cable 80m from the building. Given that (V_c) for this cable is 0.210 mV/Am, calculate the expected voltage drop over this length of run. (2 marks)
- Will the voltage drop calculated above in part (c), be within the guidelines of AS/NZS 3000:2007 –Electrical installations (Australian/New Zealand Wiring Rules) giving reasons to support your answer? (2 marks)
- What in this installation would you consider to dictate the circuit breaker rating on the secondary side of the transformer for the building supply? (1 mark)
- What electrical protection would you specify (as a minimum) on the supply to the building? (1 mark)

Question 5 (10 marks)

You were the electrical engineer at a surface coal mine, on 1 February 2015, when the new *Work Health and Safety (Mines) Act 2013* and *Work Health and Safety (Mines) Regulation 2014* came into effect. You have been asked by the mine operator to advise what effect this new legislative framework will have on the operation.

Draft a short report advising of key areas specific to electrical engineering safety that he should be made aware of. Dot points may be used to note key issues.

The report should include:

- Any key dates or times specified in the *Work Health and Safety (Mines) Act 2013* and *Work Health and Safety (Mines) Regulation 2014*, for electrical engineering (2 marks)
- The prescribed statutory functions specific to electrical engineering and the requirements for each (4 marks)
- Any items from the *Work Health and Safety (Mines) Regulation 2014* you consider important to bring to the attention of the mine operator (2 marks)
- Any changes to notifications to the regulator you consider important (1 mark)
- Report clarity (1 mark)

Question 6 (10 marks)

In reviewing your mine's notifiable incident statistics over a three year period you observe that 30% of all reported electric shocks at your site involve electricians; and that in all cases, these shocks were reported as occurring during fault-finding or testing activities on low-voltage circuits. You are concerned enough that you consider this represents a significant deviation from the mine's standards, and notify the mine operator accordingly.

In response, the Operations Manager for the mine has requested an action plan to be developed and implemented with the intent being to eliminate or minimise the risk of electric shock to electrical workers on site.

- 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. (2 marks)
- b) Considering the requirements of both the *Work Health and Safety Act 2011* and *Work Health and Safety Regulation 2011*, would your plan include procedures for work undertaken on motor vehicle electrical systems? Justify your answer. (2 marks)
- c) The *Work Health and Safety Regulation 2011* outlines the circumstances when electrical work on energised electrical equipment is permitted. What process would you use to justify a requirement to do such work? (1 mark)
- d) Outline the minimum requirements, according to the *Work Health and Safety Regulation 2011*, for undertaking electrical work on energised electrical equipment? (5 marks)

Question 7 (10 marks)

The following questions relate to *AS/NZS 3000:2007 – Electrical installations (Australian/New Zealand Wiring Rules)* (the "Standard").

The Standard describes the requirements for the protection of overcurrent in electrical installations.

- a) Draw a simple time-current curve showing the typical characteristics of a circuit breaker, fuse, as well as the damage curve of a cable on the one graph. (4 marks)
- b) What is the principle of "Automatic disconnection of supply" as described in Appendix B Circuit Protection Guide of the Standard? (2 marks)
- c) What is the maximum touch voltage that may be sustained by a person indefinitely? (2 marks)
- d) What are the mean tripping currents for Type B, C and D circuit breakers as described in AS/NZS 3000:2007 Appendix B Circuit Protection Guide when discussing automatic operation of the protective device? (2 marks)

Question 8 (10 marks)

The following questions relate to AS/NZS 4836:2011 – *Safe working on or near low-voltage electrical installations and equipment* (the “Standard”).

- What specific piece of documentation needs to be prepared prior to any work on or near any electrical installations and equipment? (1 mark)
- Draw a simple illustration showing the requirements in relation to “ON” or “NEAR” and how an exclusion zone would be included as described in the standard. (2 marks)
- Risks can be increased when live testing due to a number of factors. List three (3) of these. (2 marks)
- What tools and equipment with exposed conductive parts should not be used on or near exposed energised conductors or live conductive parts? List two (2) of these. (1 mark)
- Isolation plays a large part in safely accessing electrical equipment, what other considerations must be considered when assessing isolation requirements for the intended task? (1 mark)
- What does the *Work Health and Safety Regulation 2011* require in relation to live testing? (1 mark)
- How would you apply the requirements of the work health and safety legislation to your workplace? (2 marks)

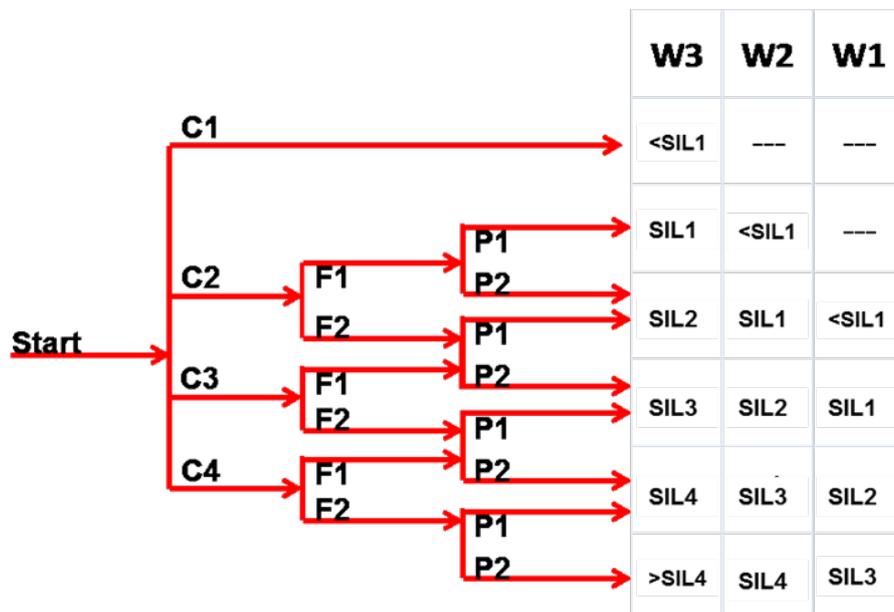
Question 9 (10 marks)

An over-pressure protection system is to be installed on a longwall pump station at your mine. Over-pressurising of the hydraulic system due to malfunction of the pump control system is seen as a hazardous event with the potential for serious injury and/or death to workers if not adequately controlled.

- Use the risk graph method of AS61508.5 - 1999 Examples of methods for the determination of safety integrity levels to determine the Safety Integrity Level (SIL) required of the over-pressure protection system for the longwall pump station at your mine. (2 marks)

You may assume that:

- Over-pressurisation due to a malfunction of the pump control system is an infrequent event. Only one (1) such event has been recorded across the company’s five (5) mines in the last year.
- Workers are infrequently in proximity of the pump station and hydraulic system and when they are, it is only for short durations.
- Pressure relief valves are also installed on the pump station and hydraulic system as an additional layer of protection. Many of the hydraulic parts and lines are also guarded.



C (Consequence) Parameter	Description
C1	Minor injury (non-permanent).
C2	Serious injury (non-permanent).
C3	Permanent disability or fatality.
C4	Multiple fatalities.
F (Exposure) Parameter	Description
F1	Rare to frequent exposure.
F2	Permanent exposure or almost permanent exposure.
P (Avoidance) Parameter	Description
P1	Avoidance is possible under certain conditions (eg. independent facilities are provided to alert exposed persons, independent facilities are provided to shut-down the plant, danger is easily recognised and there is sufficient time for persons to escape the hazard, or actual safety experience indicates that avoidance is possible.).
P2	Avoidance is not possible or is almost impossible.
W (Demand) Parameter	Description
W3	Function is demanded more than once per year.
W2	Function is demanded less than once per year but more than once per 10 years.
W1	Function is demanded less than once per 10 years.

- b) Is the over-pressure protection system a “low demand” or “high demand” safety function? Explain your reasoning. (2 marks)
- c) Should the over-pressure protection system be designed to be independent of the pump control system? Explain why, or why not. (2 marks)
- d) Sometime after the over-pressure protection system is installed the Longwall Superintendent wants to increase its proof-testing interval (the interval at which a test is done to confirm that the system is operating correctly and that no hidden failures are present that would prevent its correct operation when demanded).

Explain briefly to him the potential effect of this on the safety integrity of the over-pressure protection system and overall plant safety. How would you determine if his proposed increase in proof-testing interval is allowable, given the original SIL allocation? (4 marks)

Question 10 (10 marks)

Schedule 2 of the *Work Health and Safety (Mines) Regulation 2014*, “Principle control plans- matters to be addressed”, outlines the requirements of the electrical control plan.

Within the extract of Schedule 2 below, fill in the missing words in the spaces.

(10 marks in total, with ½ mark per missing word).

3 Electrical engineering control plan

- (1) The mine _____ must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the mine operator will manage the risks to health and safety from electricity at the mine:
- the overall _____ of the electrical aspects of plant and electrical installations at the mine,
 - the _____ of electrical safeguards used at the mine to protect persons from electrical or other hazards,
 - the electrical engineering and electrical work practices to be employed at the mine,
 - the _____ required by workers to safely work on electrical plant or electrical installations at the mine.
- (2) An electrical engineering control plan must set out the control measures for the following risks to health and safety associated with electricity at the mine taking into account the matters set out in subclause (3):
- injury to persons caused by _____ or _____ contact with electricity,

- (b) injury to persons caused by working on electrical plant or electrical installations,
 - (c) the unintended initiation of _____ or _____ explosions,
 - (d) the _____ operation of plant,
 - (e) the occurrence of uncontrolled fires.
- (3) The following matters must be taken into account when developing a control measure referred to in subclause (2):
- (a) the _____ of the electrical plant and electrical installations at the mine,
 - (b) (b) the _____ and _____ of plant for the prospective electrical fault level, electrical load, operating frequency, operating voltages and arc fault control,
 - (c) the design and operation of any electrical plant that contains flammable liquid,
 - (d) (d) the carrying out of the _____, installation and use of electrical cables and electrical cable accessories at the mine,
 - (e) the control of static electricity at the mine, including preventing the ignition of flammable gas,
 - (f) the impact of lightning on the mine (especially on an underground mine) including the effect on electrical systems,
 - (g) the need for _____ circuit interruption for all points in the mine's electrical distribution system when faults occur taking into account the operating time and tripping current of circuit protection devices,
 - (h) the type of _____ system used, including levels of earth fault limitation,
 - (i) the potential for persons to contact electricity indirectly,
 - (j) the prospective _____, step and transfer voltage,
 - (k) variations in operating conditions,
 - (l) preventing persons inadvertently contacting energised parts of electrical plant and electrical installations,
 - (m) the consultation, co-operation and co-ordination of activities between persons conducting businesses or undertakings at the mine (including the mine operator) and persons conducting businesses or undertakings installing, maintaining or carrying out work on an electricity supply authority's infrastructure,
 - (n) the procedures for the following:
 - i. the use of electrical welding plant,
 - ii. (ii) the use of electrical _____ instruments,
 - iii. work near overhead power lines and cables,
 - iv. the treatment of electric shocks and electric burns,
 - v. accessing and working on _____ voltage electrical installations,
 - (o) signage and notices in relation to the risks arising in relation to particular electrical plant and electrical installations such as electrical switchgear,
 - (p) the _____ and maintenance of the mine's electrical control system software and control circuits,
 - (q) the use of lasers and fibre optic equipment at the mine,
 - (r) the construction, installation and maintenance of battery powered vehicles and battery charging stations at the mine,
 - (s) the supply of electricity in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

- (t) the use of electrical plant in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,
- (u) Safe work systems for persons dealing with electrical plant and electrical installations including the isolation, dissipation and control of all electrical energy sources from the electrical plant or electrical installation,
- (v) the use of switchgear and electrical protection devices that can automatically detect an electrical fault in a circuit and disconnect the supply of power to the circuit.

Question 11 (10 marks)

You are the electrical engineer nominated to exercise the statutory function of mine electrical engineer at a NSW surface coal operation and you have a contract company working with your own electrical team on repairs to a conveyor starter and drive in your workshop.

You have been alerted that one of the tradesmen has received an electric shock while attempting to open the door to the starter enclosure with power on.

At the time of the incident, 1100 volts was being supplied to the starter panel, which is also broken down into other control potentials within the starter.

- a) What process needs to be initiated directly after the site electric shock protocols have been followed? (2 marks)
- b) You are initially unaware of the potential of the shock the tradesman received in the incident – identify the process that would be followed at your mine in this situation? (2 marks)
- c) Is this a “notifiable incident” in terms of the *Work Health and Safety (Mines) Regulation 2014*? (1 mark)
- d) If you believe this incident is a reportable incident, under what clause of the *Work Health and Safety (Mines) Regulation 2014* is this type of incident identified? (2 marks)
- e) If you believe this incident is a reportable incident, what is the time period for notification? (1 mark)
- f) After investigation, it has been identified that a 48 volt AC control supply had inadvertently contacted the enclosure door – does this affect the management of the incident? Please explain your answer. (1 mark)

Question 12 (10 marks)

The following questions relate to mining cables.

- a) In undertaking cable repairs on trailing cables in accordance with AS/NZS1747:2003 Reeling, trailing and feeder cables used for mining - Repair, testing and fitting of accessories – what is the purpose of the following tests?
 - i. Symmetrical load test (1 mark)
 - ii. Partial break test (1 mark)
 - iii. Spark test (1 mark)
- b) Why is the symmetrical load test important? (1 mark)
- c) Briefly, define what is meant by “partial discharge”, how it may occur in a cable, and its consequences. (2 marks)
- d) Of the tests detailed in Section 5 of AS/NZS1747:2003 *Reeling, trailing and feeder cables used for mining - Repair, testing and fitting of accessories*, which tests (if any) would be likely to detect a partial discharge problem with a cable? (1 mark)
- e) With regard to handling and moving of cables, section 6 of AS/NZS 3007:2013 – *Electrical equipment in mines and quarries – Surface installations and associated processing plant* identifies several issues to be considered in relation to formulating a Cable Management Plan. Name any four (4) of these considerations. (2 marks)
- f) What is a typical type of cable used in Surface operations for use with electric face shovels and explain its main principles of design? (1 mark)

END OF QUESTIONS

END OF PAPER

More information

Business Processes & Authorisations

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Acknowledgments

Electrical engineering manager/Electrical engineer examination panel

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