

EXAMINATION PAPER | CERTIFICATE OF COMPETENCE

# Electrical engineering manager of underground coal mines

August 2016

## 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*

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 engineering manager 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 30 minutes.

This examination is a closed book examination.

## Question 1 (total of 10 marks)

You are the Electrical Engineering Manager at a modern Longwall mine. You are involved in a project that will introduce a new item of plant at your mine and you will be involved in managing its safety life-cycle.

The safety lifecycle requires that a 'safety requirements specification' be produced?

- a) Why is it required? When is it produced? What information does it contain? (3 marks)
- b) You are asked to identify workers to perform the various safety life-cycle tasks on the project.
  - i) List and briefly describe three (3) factors that you would consider when determining the adequacy of a person's competence to do a particular safety life-cycle task. (3 marks)
  - ii) At what stage in the safety life-cycle of the plant should the safety-related systems be validated and why? (1 mark)
  - iii) During validation of the safety-related system, the supplier informs you that a software change is required. Briefly explain the process that is required when changes are to be made to safety-related systems. (3 marks)

## Question 2 (total 10 marks)

Scenario: You have recently been appointed to the position of Electrical Engineering Manager at a large underground Longwall operation, and you have been informed that the mine is two weeks away from a Longwall Change-out.

With this change-out process there will be a number of contract electricians employed short term and also there will be a number of short term hired machines being deployed underground to cater for this event.

In your position, you are responsible for the electrical labour workforce on site, and also ensuring that all electrical equipment on site is both fit for purpose and duty.

- a) What are the two management systems at your site which are required to control and manage the electricians and new machines, as this process can be a regular occurrence in many mining operations? (2 marks)
- b) If any of the above management systems are not followed, provide three examples of what the implications may be from a day to day point of view? (3 marks)
- c) From one of processes identified in section (a) above, Draw a simple flow diagram to map out the process chosen. (5 marks)

## Question 3 (total 10 marks)

You are the Electrical Engineering Manager at a high capacity longwall mine. You have received a phone call from the longwall electrician who advises that following a breakdown of the longwall shearer, he had lost a bolt, but inadvertently used a replacement bolt with a different tread pitch. This has resulted in the threads being stripped from the bolt hole. He tells you that he has since got the correct bolt and when he has installed this, it will not tighten up.

Outline your course of action that you would take. Your answer must include the following:

- a) What standards are applicable to this repair? (1 mark)
- b) If you choose to use a Repair Service facility (RSF), how would you assess the RSF is capable of carrying out the work? (2 marks)
- c) What information/documentation would you supply to the RSF? (2 marks)
- d) How would you monitor the repair is effective until a permanent repair can be carried out? (1 mark)
- e) What would your long term action be? (2 marks)
- f) What actions would you take after the repairs had been completed? (2 marks)

## Question 4 (total 10 marks)

*Work Health and Safety Act 2011.*

- a) With regard to the management of risk, s17 of the Act imposes what duty on whom? (1 mark)
- b) According to s28 of the Act, what are the duties of workers? (4 marks)

- c) According to s19(3) of the Act, regarding Primary Duty of Care, what must a PCBU ensure? (5 marks)

## Question 5 (total 10 marks)

**AS/NZS3800 and Licencing requirements under the *Workplace Health and Safety (Mines and Petroleum Sites) Regulations 2014*.**

- a) Who is responsible for ensuring an underground coal mine only uses a workshop licenced to undertake overhauls of explosion-protected electrical equipment? (1 mark)
- b) Can a workshop located in England overhaul Ex d (flameproof) electrical equipment for a NSW UG coal mine? (1 mark)
- c) Can a workshop with a licence to overhaul Ex d (flameproof) equipment overhaul an item of equipment marked Ex(d)(e)(m) for a NSW UG coal mine? (1 mark)
- d) Can a mine operator allow the manufacturer of a piece of explosion-protected electrical equipment, to overhaul the equipment if the OEM does not have a licence? (1 mark)
- e) According to AS/NZS3800:2012 – Where an overhaul facility cannot overhaul an item of Group 1 explosion protected equipment against its certification, and instead overhauls it against the standard it was certified to, how should this equipment be marked? (1 mark)
- f) According to AS/NZS3800:2012 – When a pressure test is required, and a reference pressure is not stated on a certificate of conformity for an item of Ex d (flameproof) plant, what pressure should the enclosure be tested at, and for how long? (1 mark)
- g) According to AS/NZS3800:2012 – Where it is proposed to alter an Ex d enclosure by replacing an internal component such as a contactor with a replacement of a different type and dimensions, what should be done? (2 marks)
- h) According to AS/NZS3800:2012 – What should be included in the job report prepared for the end user? (2 marks)

## Question 6 (total 10 marks)

The following represents a number of typical electrical engineering scenarios that are encountered in a typical mining operation.

- a) Determine the full load current on the primary side of the transformer when a 500kW DOL pump motor is installed. The transformer supplying the installation is a 2MVA 11kV/1kV with an impedance of 5%. Make any necessary assumptions in the calculation. (2 marks)
- b) You have three (3) 2500KVA transformers with impedances of 6%, 7%, and 8 % respectively. What would be the resultant fault level on the secondary bus when connected in parallel to a 66kV supply with a declared fault level of 450MVA? (2 marks)
- c) What CT ratio would you expect to be installed for a Transformer primary installation that is rated at 5MVA 11kV with 6% impedance? (2 marks)
- d) Calculate the short circuit current of a 1MVA 11kV / 415V transformer which is connected DY11 with an impedance of 4.69%? (2 marks)
- e) A 66/11kV transformer has a 25A NER fitted (resistor only type rated for a duty of 10s), what would you expect the total resistance of this unit to be? (2 marks)

# CEE2 – Legislation and standards applicable to underground coal mines

## Instructions to candidates

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*Work Health and Safety Act 2011*

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

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

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 engineering manager 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 (total 10 marks)

The following questions relate to AS/NZS 60079.1:2007 – *Explosive atmospheres - Equipment protection by flameproof enclosures 'd'* (the “Standard”).

- a) With reference to the Standard, explain your understanding of the following terms:
  - i) The principles of how an Ex d (flameproof) enclosure operates. (4 marks)
  - ii) Explain pressure piling associated with an Ex d enclosure and what could be the ramification if this was to occur? (2 marks)
  - iii) What is the minimum thickness allowable at the bottom of a hole used for a screw or stud that does not pass through the wall of a flameproof enclosure? (2 marks)
  - iv) What is the minimum number of threads that must be engaged in a cylindrical threaded Ex d (flameproof) joint (1 mark)
- b) With reference to part a) iv) what is the minimum depth of the thread engagement for flameproof Ex d enclosure with an internal volume above 100 cm<sup>3</sup>. (1 mark)

## Question 2 (total 10 marks)

As the Electrical Engineering Manager you are a member of the senior management team of a coal operation and you have a duty to:

- Develop, supervise, monitor and review the electrical engineering standards and procedures forming part of the operations of the mine, and
- Supervise the installation, commissioning, maintenance and repair of electrical plant at your mine.

Management of change is a critical management focus in your day to day operations at the site.

- a) What is meant by the term, “management of change” process, with respect to your operation? (3 marks)
- b) Is the “management of change” process a requirement of legislation, and if so where or how is it identified? (3 marks)
- c) Set out and describe a simple “management of change” procedure using a flow diagram. (4 marks)

## Question 3 (total 10 marks)

Clause 32 of the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014* requires the operator of a mine to manage the risks to health and safety associated with electricity.

With regard to this clause of the Regulation:

- a) What must occur before a circuit is energised for the first time, or first energised after the circuit is recommissioned? (1 mark)
- b) For electrical plant at a mine, what provisions must be made with regard to isolation? (2 marks)
- c) What must be included on plans for electrical installations? (4 marks)
- d) What arrangements must be in place with regard to mains-fed hand-held electrical equipment? (1 mark)
- e) For electrical equipment energised at greater than extra-low voltage, what electrical protection must be in place? (2 marks)

## Question 4 (total 10 marks)

From the *Work Health and Safety (Mines and Petroleum Sites) Regulations 2014* – Schedule 2 Principal Control Plans – matters to be addressed

Your **Electrical Engineering Control Plan** must take the following into account to manage the risks to health and safety from electricity at your mine.

**Schedule 2**, Clause (3) (b) Identifies:

The rating and design of plant for the prospective electrical fault level, electrical load, operating frequency, operating voltages and Arc fault control.

As a newly appointed Electrical Engineering Manager at a mine you become aware that the ageing electrical infrastructure within your mine has not been assessed or appropriate controls implemented to deal with Arc Fault Control.

- a) Formulate an action plan to manage this risk at the operation in relation to Arc Fault Control. (3 marks)
- b) You need to draft a memo to your Mine Manager in relation to these risks and the requirement for Capital Expenditure for Arc Blast Control at your mine. What would be your key elements in the memo? (3 marks)
- c) What would your Control Plan define as the limits for each Arc Fault Category Level for PPE? (4 marks)

## Question 5 (total 10 marks)

AS/NZS 2290.1:2014 *Electrical Equipment for Coal Mines – Introduction, inspection and maintenance for hazardous areas.*

- a) Is compliance with this standard mandated under the NSW *Work Health and Safety (Mines and Petroleum Sites) Regulations 2014*? (1 mark)

According to this standard:

- b) Name 5 types of records that should be included in a verification dossier? (1 mark)
- c) Who is responsible for identifying the competencies required for personnel responsible for the maintenance of equipment? (1/2 mark)
- d) What is the purpose of a pre-overhaul audit? (1 mark)
- e) Who is responsible for determining pre-overhaul audit frequencies? (1/2 mark)
- f) For Ex d (flameproof) electrical equipment, what checks should be included in an external inspection? (3 marks)
- g) For Ex e (increased safety) electrical equipment, what checks should be included in an internal inspection? (3 marks)

## Question 6 (total 10 marks)

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

The following questions are related to this design requirement:

- a) Draw a typical cross sectional diagram of a “type 241.1 Trailing Cable” and identify the critical design features of the cables internal cores, insulation and screening. (3 marks)
- b) Describe the primary electrical engineering reasons for this particular cable design and layout of the cable construction. (3 marks)
- c) List six of the eight pre-repair tests which need to be carried out on every mining cable when sent to a licenced repair workshop? (3 marks)
- d) What equipment would you typically find this cable installed on, in an underground operation? (1 mark)

## Question 7 (total 10 marks)

The following question relates to the use of generators.

- a) Draw a single line schematic of a three phase 50KVA 415V generator which is set up in an IT configuration. The drawing will include the electrical protection devices necessary for the installation which will supply a distribution board via a sub-main 20m away. (4 marks)
- b) If the installation was feeding a temporary supply board, what would you need to consider in regards to the earthing system connections. (2 marks)
- c) Name four (4) Australian Standards, as a minimum, would you apply to the generator and its connected installation. (2 marks)
- d) What maintenance inspections and frequencies would you apply to the installation? (2 marks)

## Question 8 (total 10 marks)

### Electrical Work on Energised Electrical Equipment

*Work Health and Safety Regulation 2011 and Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*

- Provide 4 examples of work involving electrical equipment that may not be considered electrical work under the *Work Health and Safety Regulation 2011*. (2 marks)
- According to the *Work Health and Safety Regulation 2011*, when is electrical work on energised electrical equipment permitted? (1 mark)
- According to the *Work Health and Safety Regulation 2011*, what are the preliminary steps that must be taken prior to commencing electrical work on energised electrical equipment? (2 marks)
- According to the *Work Health and Safety Regulation 2011* how should electrical work on energised electrical equipment be carried out? (3 marks)
- According to the *Work Health and Safety (Mines and Petroleum Sites) Regulation 2014*, what is the waiting period after submitting a High Risk Activity notification for electrical work on energised electrical equipment a high risk activity? (1 mark)
- According to the requirements of the prescribed HRA notification form, what information is required to be submitted with the application? (1 mark)

## Question 9 (total 10 marks)

You have been asked to supply and install a 415V motor for a new pump installation that is required to pump 60 litres of water per second up over a high wall of 150m vertically. The pump has an efficiency of 80% with a motor efficiency of 80% and power factor of 0.7 lag.

- What will be the motor current of the pump installation? (4 marks)
- What size motor would you choose for this installation? (2 marks)
- How much capacitance needs to be added to get the power up to 0.95 lag? (4 marks)

## Question 10 (total 10 marks)

The following questions relate to AS3007:2013 – *Electrical equipment in mines and quarries – Surface installations and associated processing plant*.

- What is the specific requirement for removal of power in a closed electrical operating area? (1 mark)
- What design provisions are to be included for the prevention of Arc Flash / Blast protection injury? (1 mark)
- What is the requirement for miniature circuit breakers inside low voltage distribution boards where two or more circuit breakers are mounted in the same row? (1 mark)
- What needs to be maintained over the full life cycle of electrical equipment as far as information requirements? (1 mark)
- What is the general rule for protection of electrical equipment and live conductors when it comes to protection against overloads and faults? (1 mark)
- What is the requirement for inspecting earth fault current limiting devices? (1 mark)
- What are the specific requirements for isolating equipment and machinery for electrical isolation?(1 mark)
- When should cable reel interlock limits operate – name two of these? (1 mark)
- What are the “no go zones” when it comes to overhead powerlines >33kV? (2 marks)

## Question 11 (total 10 marks)

The following questions relate to Earthing of High Voltage Installations.

- In the space provided below, draw a detailed earth system, including rough dimensions, which you would expect to find under a typical 66kV/11kV substation where the soil resistivity is measured at 40Ω-metres. The drawing will include your placement of the substation on the earth system and all relevant features and earth connections including the security fence.

Include into the drawing, the overhead earth wire from the 66kV overhead aerials supplying the installation. (6 marks)

- b) How would you want the earth system dealt with after construction and before placing into service? (2 marks)
- c) What test value would you expect from any tests conducted on the earth system and how would check that they are correct? (2 marks)

## Question 12 (total 10 marks)

### Intrinsic Safety Concepts

- a) Can a MDA Ex i (intrinsically safe) item of plant be used in the hazardous zone of a NSW UG coal mine if it was manufactured after 1st Oct 2015? (1 mark)
- b) What is the definition of “associated apparatus”, and what would be an example of “associated apparatus”, as defined in AS/NZS60079.11? (1 mark)
- c) Further to b), what issue must be addressed with the use of “associated apparatus” in a hazardous zone? (1 mark)
- d) According to AS/NZS60079.11, where separate IS circuits are being considered what are the required clearances between the circuit connections, and between the circuit connections and earth? (1 mark)
- e) According to AS/NZS60079.11, what clearance must be maintained between terminations of IS and non-IS circuits? (1 mark)
- f) Considering the following table, can the IS field device be connected and used with the IS interface in the hazardous zone of a NSW UG coal mine. Provide a detailed justification as to your decision. (3 marks)

Item	IS interface	IS Field Device	Connecting Cable
Equipment Group	IIC	I/IIB	
Level of Protection	ia	ib	
Temp Classification		T3	
Ambient Temp	45deg	45deg	
Voltage	$U_o = 13.2V$	$U_i = 13.0V$	
Current	$I_o = 90mA$	$I_i = 120mA$	
Power	$P_o = 900mW$	$P_i = 1.2W$	
Capacitance	$C_o = 100nF$	$C_i = 10nF$	$C_c = 1nF/m$
Inductance	$L_o = 10mH$	$L_i = 10uH$	$L_c = 10uH/m$
L/R Ratio	$L_o/R_o = 54uH/ohm$		$L_c/R_c = 40uH/ohm$

- g) When considering only the inductance and capacitance parameters of the devices and the interconnecting cable, what would be the maximum length of cable? (2 marks)

## More information

NSW Department of Industry  
Governance Branch  
Mining Competence Team

T: 02 4931 6625

Email: [minesafety.competence@industry.nsw.gov.au](mailto:minesafety.competence@industry.nsw.gov.au)

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Electrical Engineering Manager Examination Panel

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