



EXAMINATION PAPER | CERTIFICATE OF COMPETENCE

# Electrical engineering manager of underground coal mines

July 2017

## 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 are 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 beneath the answer lines.

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 an underground coal mine that is undertaking an upgrade and modification of a mine winder.

The upgrade includes increasing the end of rope capacity from 65T to 80T.

- a) What are the legislative requirements of this upgrade? (1 mark)
- b) What is meant by the term Primary Safety Circuit? (1 mark)
- c) What is meant by the term Secondary Safety Circuit? (1 mark)
- d) What is meant by the term SIL rating and what standards are applicable to this topic? (1 mark)
- e) What is the relationship between SIL rating and reliability of a circuit? Give an example of plant or equipment where this may be applicable. (2 marks)
- f) Nominate the SIL rating that would be desired for a primary safety circuit on a mine winder and explain how this would be derived. (1 mark)
- g) List 4 functions that would be included in the primary safety circuit of a mine winder. (2 marks)
- h) Safety audits are a condition of design registration on powered winding systems. What is the required frequency of this audit? (1 mark)

## Question 2 (total of 10 marks)

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

- a) Determine the full load current on the primary side of the transformer when a 250kW DOL pump motor is installed. The transformer supplying the installation is a 1.5MVA 11kV/415V with an impedance of 5%. Make any necessary assumptions in the calculation. (2 marks)
- b) You have three 3000KVA transformers with impedances of 5%, 6%, and 7 % 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 375MVA? (2 marks)
- c) What CT ratio would you expect to be installed for a transformer primary installation that is rated at 4MVA 11kV with 5% impedance? (2 marks)
- d) Calculate the short circuit current of a 1.5MVA 11kV / 415V transformer which is connected DY11 with an impedance of 5.5%? (2 marks)
- e) A 66/11kV transformer has a 20A 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)

## Question 3 (total of 10 marks)

The following questions relate to typical high voltage substation installations.

- a) Draw a single line drawing of a new typical high voltage substation including protection devices. (3 marks)
- b) Briefly outline your requirements prior to initially energising the substation. Reference all relevant legislation in your outline. (2 marks)
- c) What Australian Standards would apply to your installation? List the minimum that you would want referenced in your specification. (1 mark)
- d) Who would you consult prior to energising the new substation? (1 mark)
- e) What documentation would need to be produced prior to energising the substation? (1 mark)
- f) On the single line drawing you produced in a), indicate what earthing arrangements you would have in place for the installation. (2 marks)

## Question 4 (total 10 marks)

Safety Bulletin SB17-04 was issued by the NSW Planning and Environment Resources Regulator in 2017. The bulletin related to Uninterruptible Power Supply (UPS) installations at mines.

As the Electrical Engineering Manager:

- a) What would your immediate actions be at your operation to address the requirements associated with Safety Bulletin? (2 marks)
- b) What recommendations were associated with this particular Safety Bulletin? (2 marks)
- c) What were some of the key risks detailed with this particular Safety Bulletin? (2 marks)
- d) What process would you have in place at your mine to manage these recommendations? (1 mark)
- e) Who might you involve to address some of the recommendations in the Safety Bulletin? (1 mark)
- f) Describe a suitable process you would put in place at your mine to manage safety bulletins or alerts. (2 marks)

## Question 5 (Total 10 marks)

You are the Electrical Engineering Manager at an underground mine that is undergoing a major upgrade to the surface Coal Handling and Preparation Plant (CHPP) for which you have responsibility.

The upgrade will involve the modification of a reclaim tunnel that will have two valve entries fitted with hydraulically controlled gates and a power pack adjacent to the gates. The power pack is installed in the coal valve chamber which is 3 metres above the conveyor belt and out of the ventilation flow.

You have been asked by the mine operator to provide your electrical requirements to the Project Manager for the tunnel upgrade.

- a) What are the requirements you would specify to be carried out as part of the design stages? (2 marks)
- b) What specific monitoring equipment would be required to be installed within the tunnel and where would you want these located? (2 marks)
- c) Define the controls you would want implemented to manage the control of people entering the reclaim tunnel and any specific requirements with entry. (2 marks)
- d) For any monitoring equipment you have nominated, what explosion protection group classification would you consider acceptable for use? (1 mark)
- e) Define the competency requirements for personnel undertaking maintenance and repairs to the type of equipment you have chosen in the reclaim tunnel. (1 mark)
- f) On the monitoring equipment you have chosen for the installation, what specific trip levels would you implement and where are these figures derived from? (1 mark)
- g) If there was to be a fire in the tunnel, what electrical shutdown systems would you want implemented? Give details of any specific timing or risks you envisage if this was to occur. (1 mark)

## Question 6 (total 10 marks)

The following represents a typical dam pump installation on the surface of an underground mine.

- a) Draw a typical dam pump electrical installation that is supplied some 5km from the main surface substation by overhead aerials.
- b) The drawing should show typical sizes of transformers / motors where applicable. Make any necessary assumptions. (3 marks)
- c) Describe the process you would put in place for personnel to follow in the event that the high voltage circuit breaker feeding the installation had tripped on earth fault? (3 marks)
- d) What would your process describe in the event that the high voltage circuit tripped again during re-closure? (1 mark)
- e) What competency requirements would you put in place on your site for the necessary repairs and maintenance on this type of equipment? (1 mark)
- f) What differences would you have in your process in b) above, if this installation was feeding a dewatering installation in an underground installation? (2 marks)

# CEE 2 – Legislation and standards applicable to underground coal mines

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*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 beneath the answer lines.

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 2290.1:2014 – Electrical equipment for coal mines – Introduction, inspection and maintenance for hazardous areas** (the “Standard”).

- Does the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 require compliance with the Standard? (1 mark)
- According to the Standard, what processes should be followed to determine the accessibility of components in determining an inspection strategy for equipment? (1 mark)
- What processes should be followed to determine the frequency of periodic inspections on electrical equipment installed in “hazardous areas”? (1 mark)
- What is the purpose of a pre-overhaul audit? (1 mark)
- For Exd electrical equipment, what checks should be included in an internal inspection? (3 marks)
- For Exe electrical equipment, what checks should be included in an external inspection? (3 marks)

## Question 2 (total 10 marks)

Describe, with the aid of sketches, and with regards to Explosion Protection Techniques applied to underground coal mines in NSW:

- What Ex protection technique is best described as “Containment”? (1 mark)
- What Ex protection technique is best described as “Energy Limitation”? (1 mark)
- What is pressure piling with respect to flameproof enclosures Exd? (2 marks)
- State the minimum number of threads to be engaged on flameproof enclosure Exd for threaded entries e.g. gland. (2 marks)
- How many faults are applied during testing of Exi (a) and Exi (b)? (1 mark)
- What is meant by the term systems and entity concepts with respect to intrinsically safe systems? (2 marks)
- If you read in a hazardous area assessment report ‘Zone 20’ what would you understand it to mean? (1 mark)

## Question 3 (total 10 marks)

**AS/NZS 3800:2012 Electrical equipment for explosive atmospheres—Repair and overhaul** sets out requirements for electrical equipment designed use in hazardous areas of underground coal mines.

- List two circumstances where a flameproof enclosure must be overpressure tested. (2 marks)
- According to the Standard, where an overhaul facility is intending to omit tests on overhauled equipment that are required under the Standard, what should the facility do? (2 marks)
- Appendix A describes the marking of overhauled equipment. List the minimum requirements for marking of overhauled equipment. (2 marks)
- List the information that should be presented on the Repair/Overhaul and Examination Report. (2 marks)
- What are the requirements for facilities that conduct overhauls on explosion protected electrical equipment? (2 marks)

## Question 4 (total 10 marks)

- AS/NZS 3800:2012 Electrical equipment for explosive atmospheres—Repair and overhaul** sets out requirements for electrical equipment designed for use in hazardous areas of underground coal mines.
  - What does Symbol “X” on a certificate of conformity denote and briefly give one example you are familiar with at your coal mine? (2 marks)
  - Where a pyramid or button headed bolt is used, what should be checked? (2 marks)
  - What is/are the criteria for selecting replacement bolts? (2 marks)
- AS/NZS 2290.1:2014 Electrical equipment for coal mines— Introduction, inspection and maintenance**, Part 1: For hazardous areas clause 2.8.3, refers to REPAIR IN SITU.
  - What are the requirements of the standard when repairs which affect the explosion-protection of an enclosure have to be carried out ‘in situ’? (2 marks)

- ii. Sketch and describe a method of temporary repair for hole or thread in a flameproof enclosure. Appendix C of the standard sets out typical methods for carrying out a temporary repair to a damaged hole or thread. (2 marks)

## Question 5 (total 10 marks)

You are the Electrical Engineering Manager at an underground coal operation when you are advised by an electrician that “We have had an unplanned movement of a Mine Winder”.

The initial information is that the dolly car was selected to move outbye, however the winder moved in the inbye direction approximately 1m and faulted.

- What steps will you now take with respect to this incident? (2 marks)
- What are your responsibilities under legislation? (2 marks)
- Who and how would you notify in respect to this situation? (2 marks)
- Who would you involve in the incident investigation? (2 marks)
- What key areas would your investigation focus on? (2 marks)

## Question 6 (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 issue with relocatable buildings arriving on your site and the issues that may arise when connecting to the mine site power supply? (1 mark)
- What are the risks of a) above? (4 marks)
- To overcome the above issue what should be installed between the supply and the relocatable building? (1 mark)
- What are the special requirements where a 240V supply is an IT system for equipment such as air conditioners, hot water services and lighting services etc.? (2 marks)
- Draw a typical 415/240V 2 phase IT system for the above installation via a centre tap on the 240V winding. (2 marks)

## Question 7 (total 10 marks)

The following questions relate to **AS3760 In-service safety inspection and testing of Electrical Equipment.**

The mine operator has asked you to review the current site standards for using portable electrical tools and their general inspection and testing requirements.

- Draw a table recommending your site requirements to the mine operator, based on the requirements of AS3760 for the test and inspection intervals for your site.
- The table should indicate the specific requirements for both office and workshop type environments as well as hired equipment. (4 marks)
- List three (3) in service general testing and inspection requirements as described in the standard. (3 marks)
- Based on the requirements of AS3760:2010, write in point form to the mine operator the opportunities that may now exist or differences between your standard and the requirements of AS3760. Detail any reasons for having these differences. (3 marks)

## Question 8 (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:

- Plans need to be in place for the mine electrical reticulation. What are six (6) of these specific requirements? (3 marks)
- What are the four (4) requirements for electrical plant at the mine (other than plant connected, and in close proximity, to a wall socket with a switch)? (2 marks)

- c) What are the specific requirements around the use of adequately rated switchgear? (2 marks)
- d) What is the statutory function of the Qualified Electrical tradesperson at the mine as described in schedule 10 of the legislation? (1 mark)
- e) What are the two (2) requirements that are listed under clause 32 regarding mobile electrical plant fed via trailing or reeling cable? (2 marks)

## Question 9 (total 10 marks)

The following questions relate to **AS3000 Wiring Rules 2007**.

- a) The fundamental principles of AS3000 describes the three (3) major type of risk. What are they? (3 marks)
- b) There are four (4) methods of Basic Protection. What are they? (2 marks)
- c) What are the requirements for accessibility to electrical enclosures and the specific requirements for switch room doors when exiting? (2 marks)
- d) Explain with the aid of a sketch, how you would test the continuity of the earthing system for a 2.4kW pump installation supplied at 240V and 100m from the MCC? (3 marks)

## Question 10 (Total 10 marks)

The following question relates to Uninterruptible Power Supplies (UPS's)

- a) As the Electrical Engineering Manager at an underground coal mine, you have a contractor coming on site to replace your existing UPS and battery pack.
- b) Write a list of your specific requirements, expectations, and concerns you may have that you will provide to a contractor. The list should be in point form and include a brief description of the requirements, expectations, or risks to be dealt with. (6 marks)
- c) Thinking about the risk assessment for this task, what would you consider being the biggest risk and why? (2 marks)
- d) Explain if this would be considered live electrical work. Detail your reasons for such a decision as well as how you would progress the task. (2 marks)

## Question 11 (total 10 marks)

As the Electrical Engineering Manager you have been asked to provide your specific requirements for an automotive specification for mobile plant on the surface.

- a) What would be some of your specific requirements for your specification? Provide your requirements in point form. (4 marks)
- b) List any specific standards / guidelines that you would reference in your specification. (1 mark)
- c) What would you discuss with the manufacturers' representatives regarding the wiring systems to the factory fitted braided covering of the wiring? (2 marks)
- d) Where would you install any emergency stops and what specific requirements would you ask for from the supplier? (1 mark)
- e) What documentation would you insist on being provided prior to accepting the machine? (2 marks)

## Question 12 (total 10 marks)

The mine operator has asked you to apply for an electrical exemption from the *Work Health and Safety (Mines and Petroleum) Regulation 2014*.

- a) Explain in your own words the process you would follow on site before applying for the exemption. (3 marks)
- b) List the documentation you believe you would need to support or accompany the exemption. (3 marks)
- c) Draft a time frame you would expect to prepare the submission and the time for the Department of Planning and Environment to consider such an exemption. (2 marks)
- d) Specifically, who applies for the exemption and who is the application to be addressed to? (2 marks)

## More information

NSW Department of Planning and Environment

Resources Regulator

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## Acknowledgments

Electrical Engineering Manager Examination Panel

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Disclaimer: The information contained in this publication is based on knowledge and understanding at the time of writing (July 2017). However, because of advances in knowledge, users are reminded of the need to ensure that information upon which they rely is up to date and to check currency of the information with the appropriate officer of the NSW Department of Planning and Environment or the user's independent advisor.

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