



Trade &  
Investment  
Mine Safety

(CEE1)

## NSW Coal Competence Board

# EXAMINATION FOR CERTIFICATE OF COMPETENCE AS Mine Electrical Engineer

*(Coal Mine Health and Safety Act 2002)*

Thursday 7 March 2013

9.30am – 12.30pm

## Application of Electrical Engineering to Mining

### 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 front cover page with their **Candidate Number only**
- All questions are allocated with their respective marking value
- During the reading time candidates may use a highlighter to mark the key parts of questions.

**QUESTION 1** (total 10 marks)

As part of your mines Environmental Policy, a decision has been made to investigate the installation of a gas flare to reduce the mines Green House gas emissions. The in situ gas content of the coal is 6-8 m<sup>3</sup>/t of methane and the mine is currently using a gas drainage system which is venting methane at the surface in excess of 1000 L/second into the atmosphere.

You have been asked by the mine operator to give consideration to what risks you see could be encountered with this project and any other relevant information you consider will need engineering evaluation.

- a) With the aid of a flow chart, list and describe areas that you would want considered and addressed with any specific risks. Note: Assume the flare will be installed near your current mine fan and that there is sufficient room. Use your current sites surface infrastructure as bases for your answer. (6 marks)
  
- b) As manager of Electrical Engineering at an underground coal mine you have a sound understanding of the term 'Hazardous Zone'. Discuss the differences between a 'hazardous zone' for underground and a 'hazardous area' as defined for surface applications. Nominate if there are any differences in explosion proof (Ex) equipment that can be used in each zone/area. (4 marks)

**QUESTION 2** (total 10 marks)

You have been appointed the Electrical Engineer at a “green-field” coal mine construction site. On commencement of mining-related activities you are to be appointed as the Manager of Electrical Engineering. As a consequence you will be responsible for developing the Mine’s Electrical Engineering Management Plan (EEMP) and the Standards of Engineering Practice (SEP).

When considering Electrical Protection Systems:

- a) According to the *Coal Mine Health and Safety Regulation 2006*, what provisions should be made for electrical protection in your EEMP? (1 mark)
- b) In developing your SEP for Electrical Protection Systems, nominate your key requirements for the management of protection settings. (4 marks)
- c) With reference to *AS3007:2, Electrical Installations –Surface mines and associated processing plant General Protection requirements*, considering the design and construction of electrical installations on the surface of the mine, what general requirements should be outlined in your EEMP and Technical Specifications to ensure the protection of personnel against direct contact with live electrical conductors? (2 marks)
- d) After construction of your Main Substation, the Supply Authority contacts you to advise that, due to alterations to their network configuration the incoming fault level at your substation has risen by 30MVA. What are the potential issues associated with this, and what would be your first action? (2 marks)
- e) The primary fundamental principle that should be applied to the design, selection and installation of electrical protection and earthing systems at your mine is that the first fault to be detected and cleared is always what type of fault? (1 mark)

**QUESTION 3** (total 10 marks)

You have recently taken over as the Manager of Electrical Engineering at a modern longwall mine. Following a review of the mines electrical engineering practices, both documented and the standards of installation, you are surprised to find that:

- longwall installation standards are poor. Some of the poor standards are:
    - Ch<sup>4</sup> heads at the tailgate are hanging on strings,
    - Static cables across the AFC furnishing are hanging out and dragging on the floor
    - 15 m of slack cable is coiled at the tail gate drive motor and dragging on the floor
  
  - maintenance completion records for the longwall within the work order system are:
    - Code A completion rates are on average 50 to 60% for the past 3 months
    - Code C completion rates are 70% with many completed 3 months after the due date.
    - Many maintenance work orders have no signature or date recorded on them
    - Many items of explosion protected electrical equipment have no written work orders
    - Gas calibrations are missed frequently
  
  - longwall electricians
    - Of the team of 8 assigned to the longwall 5 have never had an hazardous area competence training
- a) Discuss how you intend to address these three areas with respect to the maintenance records, installation standards and competency for longwall. Your answer should include your expected time frames and who will be involved specifying your: (6 marks)
- i) short term actions (specifying time frame)
  - ii) longer term (specifying time frame) actions and getting the longwall to compliance
- b) As part of your assessment you have been advised by a cable supplier that some of your control cables used in the hazardous zone of the longwall have not had a flame transmission tests completed for compliance to *AS/NZS 1972:2006 Electric cables - Underground coal mines - Other than reeling and trailing* (4 marks)
- i) Discuss what you will do and who will you involve.
  - ii) Discuss what options you have

**QUESTION 4** (total 10 marks)

*AS/NZS2290.1:2005 Electrical equipment for coal mines—Introduction and maintenance.*

The scope of this Standard is to: set out requirements for the introduction, examination, maintenance, in situ repair and allowable modifications to electrical equipment designed for use in hazardous areas in and around underground coal mines. It details methods for introduction, examination, maintenance, commissioning and testing required to ensure safety, compliance with relevant Standards and supporting documentation for the different types of explosion protection apparatus and reliable operation while the equipment is in service

- a) From your knowledge of this standard comment on considerations prior to the use of lubricants or corrosion inhibitors for flame paths (1 mark)
  
- b) The conditions of operation for individual items of equipment varies significantly from mine to mine; it is not always possible to lay down general requirements for the intervals between examinations and overhaul. This standard gives a guide to the frequency of examination and overhaul.

List the nominated intervals for examination and overhaul: (5 marks)

Type of plant	Examination	Overhaul
Mobile equipment		
Portable equipment		
Transportable equipment		
Longwall equipment		
Fixed Equipment		

- c) With the aid of sketches describe the requirement, competences and precautions that are required to be observed or undertaken to conduct an in situ temporary repair to a damaged thread in a flameproof (Exd) enclosure (4 marks)

**QUESTION 5** (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.

- 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 design and layout of cable construction. (2 marks)
- c) List a minimum of five of the eight pre-repair tests which need to be carried out on every mining cable when sent to a licensed repair workshop. (5 Marks)

**QUESTION 6** (total 10 marks)

The electrical supply to the coal mine is via two 33kV / 11kV transformers. The maximum demand has been recorded as 20MVA at a 0.65 lagging power factor.

- a) Nominate the size of an 11kV connected capacitor bank to correct the power factor to 0.98 lag. (2 marks) Note: Power factor correction units are available in 500kVAr increments
- b) What is the power factor achieved with the power factor unit you selected, at the nominated maximum demand.(2 marks)
- c) The capacitor unit is made up of three banks, delta connected. What is the kVAr value of each of the banks of capacitors? (2 marks)
- d) Calculate the resultant power factor if the capacitor bank you selected remained connected when the demand dropped to 10MVA at 0.65 lag power factor. (2 marks)
- e) List the relative merits of high voltage verses low voltage connected power factor correction units (2 marks)

**END OF QUESTIONS  
END OF PAPER**



(CEE2)

## NSW Coal Competence Board

### EXAMINATION FOR CERTIFICATE OF COMPETENCE AS Mine Electrical Engineer

*(Coal Mine Health and Safety Act 2002)*

Thursday 7 March 2013

1.30pm – 4.30pm

#### Legislation and standards applicable to underground coal mines

##### INSTRUCTIONS TO CANDIDATES:

Unless otherwise stated all references to Regulations are to the  
*Coal Mine Health and Safety Regulation 2006*

Or

*Work Health and Safety Regulation 2011*

*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 front cover page with their **Candidate Number only**.
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- During the reading time candidates may use a highlighter to mark the key parts of questions.

**QUESTION 1** (total 10 marks)

As the Manager of Electrical Engineering at an underground coal operation you attend a daily and weekly mine review meeting. The management team has highlighted an increase in development unit cable damage over recent months.

You have researched the failures and identified the primary areas of damage have come from:

- Miner cable damage in a breakaway situation and
  - Shuttle car cable damage when back spooling
- a) What mine process needs to be in place to deal with these types of issues? Please explain with detailed examples. (5 marks)
- b) What path would you follow when you realise these results and how would you ensure that these issues are being dealt with correctly? (5 marks)

**QUESTION 2** (total 10 marks)

You are the Manager of Electrical Engineering at a major underground coal operation, and your mine is to conduct major maintenance repairs to the surface coal handling facilities during a scheduled shutdown period.

For this maintenance to occur there is a need for a large number of contract labour personnel to be deployed for a short period of time and those contractors will be organising a number of mobile machines on site as part of their scope of work.

- a) What systems or processes need to be in place at your operation that will give guidance on how to handle this type of situation? (2 marks)
- b) Give examples of any shortcomings if these systems are not correct or not followed correctly. (2 marks)
- c) Draw a simple flow diagram as an example of how these systems may operate with respect to your operation. (6 marks)

**QUESTION 3** (total 10 marks)

*AS3000:2007 Wiring Rules Clause 7.7 – Hazardous Areas (Explosive Gas or Combustible Dusts)*

Your mine has a project to install a new 2000 tonne ROM bin. Approval Conditions stipulate the ROM conveyor from the loading point to the top of the bin (some 800m long) and the top of the bin itself must be fully enclosed to minimise dust. Due to operational sequencing the bin will typically run at about 75% of capacity. The ROM coal is typically dry; the in-situ gas content of the mined coal is very high (5m<sup>3</sup>/tonne) with a low desorption rate, and has a high propensity for spontaneous combustion.

- a) Given the information above, outline what should be done at the design stage to establish the requirements for the electrical installation at the top of the bin? (3 marks)
- b) Whose responsibility is it to classify the hazardous area? (1 mark)
- c) For each of the following clauses describe how you would incorporate the requirements of each into the Technical Specifications and Electrical Engineering Management Plan for your Mine. (total 6 marks)
  - i) *Clause 1.5.4.1 - Protection shall be provided against dangers that may arise from contact with parts of the electrical installation that are live in normal service.* (2 marks)
  - ii) *Clause 1.5.5.1 - Protection shall be provided against dangers that may arise from contact with exposed conductive parts that may become live under fault conditions.* (2 marks)
  - iii) *Clause 1.8 – All electrical installations and any alterations additions and repairs to electrical installations shall, prior to being placed into service or use, be inspected as far as practicable and tested to verify that the installation meets the requirements of this standard as applicable.* (2 marks)

**QUESTION 4** (total 10 marks)

*AS/NZS 3800 Electrical equipment for explosive atmospheres—Repair and overhaul*, has been reviewed and republished in 2012.

The Scope of the Standard is:

- specifies requirements for and gives instructions, principally of a technical nature, on the repair, overhaul, reclamation and modification of equipment designed for use in explosive atmospheres;
  - is not applicable to maintenance, other than when repair and overhaul cannot be disassociated from maintenance, neither does it give advice on cable entry systems which may require a renewal when the equipment is re-installed;
  - prevents overhaul without manufacturer and certificate documentation to types of protection 'i' and 'm'; and
  - assumes that good engineering practices are adopted throughout.
- a) Service facilities involved in the repair, overhaul/or modification of explosion protected electrical equipment shall have the capabilities for compliance with this standard independently verified. Who can do compliance assessment as per the standard? (3 marks)
- b) Other than Flameproof (Exd) Intrinsically Safe (Exi) and Increased Safety (Exe), name four (4) other protection methods to which the standard refers. (2 marks)
- c) This Standard recognises the necessity of a required level of competence for the repair, overhaul and reclamation of the equipment. How would you deem a facility to be competent to overhaul Ex equipment other than the original equipment manufacture (2 marks)
- d) The Standard makes reference to reclamation of damaged treaded holes. Discuss your understanding of the requirement of the standards and how you would manage reclamation of treaded holes for Group 1 Exd protection. (3 marks)

**QUESTION 5** (total 10 marks)

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

- a) What are the key objectives of this standard? (4 marks)
- b) According to the Standard, what is the maximum permissible operating time for an Earth Continuity Protection Device? Why is this maximum time important? (2 marks)
- c) Earth continuity protection devices shall be designed to operate if the shunt resistance between the pilot and earth falls below a nominated value. What is this value? (1 mark)
- d) For Earth Fault Protection Devices installed on IT systems, what is the minimum recommended trip ratio between the earth fault limitation device and earth fault trip value? (1 mark)
- e) For an Earth Fault Lockout device, what is the minimum permissible insulation resistance between a phase conductor and earth? (1 mark)
- f) For Frozen Contactor Protection, a trip time of up to 20 secs is permitted for detection of voltage on the load side of a contactor after it is expected to be in the open position. Under what circumstances would such a long trip time be required? (1 mark)

**QUESTION 6** (total 10 marks)

You have taken on the role of Manager of Electrical Engineering at a “green-field” site.

During your first day on the job you take particular note of the following:

- There is a construction camp on the main access road, consisting of a large number of demountable buildings and containers;
- The mine administration area is located separately and also comprises a large number of demountable buildings with 2 large rural sheds being used as “temporary” workshop facilities.
- The administration area is supplied via a 250KVA generator, with a number of distribution boards secured to the buildings.

Over the coming days you establish that:-

- The construction camp is not part of the mine lease, however
- Both the camp and the administration area were installed by the same company, and
- The company is a large organisation and has extensive construction experience, but has not worked on coal mine sites in NSW previously, and
- There appear to be no test reports available

Considering the administration area installation:-

- a) What key Australian Standards and other documentation would you refer to or consider when assessing the installation? (2 marks)
- b) When undertaking an inspection, what would be your particular concerns with regard to the safety and compliance of the generator installation? (3 marks)
- c) You observe that power cables are installed via a combination of being buried directly, on cable trays and suspended via catenary wires. Outline the earthing requirements for the installation. (3 marks)
- d) What would you require to be provided in the testing documentation? (2 marks)

**QUESTION 7** (total 10 marks)

A company Project Manager has been put in charge of the construction of a new ROM surface bin at an underground coal mine that will last 16 weeks. The Project Manager has been informed that welding incidents have been identified as occurring at a high frequency throughout the mining industry and he has asked you for advice on how to manage safe welding processes during the shutdown.

- a) What Australian Standards will you advise him to comply with to assist in his management of safe welding processes? (2 marks)
- b) What is your advice on the category to be used on this project? Designate the control measures for the category you have chosen. (2 marks)
- c) Name the tests that need to be carried out on the electrically supplied welding machine and the frequency required. (3 marks)
- d) Who can work inside a welding power source? (1 mark)
- e) What are the added requirements if you are welding in a confined space? Some of these are specified but are there any other safety improvements you would recommend to the Project Manager? (2 marks)

**QUESTION 8** (total 10 marks)

The *NSW Work Health and Safety Regulation (2011)* contain provisions relating to electrical safety in the workplace. The Safe Work Australia Code of Practice, *Managing Electrical Risks in the Workplace*, provides guidance and information on how the provisions of the Regulation can be met.

- a) Provide three examples of types of electrical work that the Code of Practice does **not** apply to (2 marks)
- b) *AS/NZS3760:2010 In-Service Safety Inspection & Testing of Electrical Equipment* sets out indicative inspection and testing frequencies for electrical equipment.

The *Code of Practice for Managing Electrical Risks in the Workplace* provides guidance on when testing should be undertaken in addition to the testing frequencies recommended in the Standard. When should such additional testing on electrical equipment be undertaken? (2 marks)

- c) In relation to construction work, according to the *NSW Work Health and Safety Regulation (2011)*, when should RCD's be used? (2 marks)
- d) You are performing in inspection at your mine, and observe a fitter removing a coupling-half from the shaft of a 110kW pump motor. You note the motor is still connected to the cable (with the terminal box cover in place) however he has isolated the pump in accordance with your site isolation procedures. Under the *NSW Work Health and Safety Regulation (2011)* is this considered "electrical work"? Support your answer. (2 marks)
- e) The *NSW Work Health and Safety Regulation (2011)* details the circumstances under which work on "energized electrical equipment" is permitted. What are these? (2 marks)

**QUESTION 9** (total 10 marks)

As the Manager of Electrical Engineering for a mine site, you have been asked to provide a Technical Specification for mobile and transportable plant to be operated on the surface.

- a) List any specific standards / guidelines that you would reference in your specification. (1 mark)
- b) What would be some of your specific requirements for your specification? (in point form) (4 marks)
- c) What would you consider to be safety critical that you would not compromise on in your specification? (1 mark)
- d) Where would you install any emergency stops and what specific requirements would you ask for from the supplier? (2 marks)
- e) What documentation would you insist on being provided prior to accepting the machine? (2 marks)

**QUESTION 10** (total 10 marks)

Increased Safety (Exe) 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 lighting box enclosure on a Longwall face 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 this type of enclosure? Explain your answer. (3 marks)

**QUESTION 11** (total 10 marks)

As Manager of Electrical Engineering at a coal operation you need to provide a system that ensure all your electrical contractors are aware of your Standards of Engineering Practice

Describe a system you would put in place that will manage the risk of electricity that will:

- a) Provide the knowledge to your contractors prior to undertaking any task on your site. It should include non electrical people (2 marks)
- b) How would you confirm your requirements are understood? (1 marks)
- c) How would you measure the effectiveness of your standard (1 marks)
- d) How would you make available the support information as required (1 mark)
- e) What would you do at your site to prevent a recurrence? (1 mark)
- f) How would you address your equipment standards for work in the CPP? (1 mark)
- g) If the same incidents continue with welding equipment what do you believe would be some of the causes for this? (1 mark)
- h) How would you address these causes mentioned above at your site? (2 marks)

**QUESTION 12** (total 10 marks)

AS60079:25 *Electrical apparatus for explosive gas systems, Intrinsically safe systems* provides guidance on the assessment of simple IS systems.

Item	IS interface	IS Field Device
Equipment Group	I	I
Level of Protection	Ia	Ib
Temp Classification		T2
Ambient Temp	-20 to +50	0 to +80
Parameter Comparison		
Voltage	$U_o = 28V$	$U_i = 30V$
Current	$I_o = 100mA$	$I_i = 50mA$
Power	$P_o = 700mW$	$P_i = 450mW$
Cable Comparison		
Capacitance	$C_o = 15\mu F$	$C_i = 10\mu F$
Inductance	$L_o = 4.5mH$	$L_i = 10\mu H$
L/R		

For the simple system detailed in the table above:

- What is the Equipment Group of the System? (1 mark)
- What is the Level of Protection of the System? (1 mark)
- What is the maximum permitted capacitance of the connecting cable? (1 mark)
- What is the maximum permitted inductance of the connecting cable? (1 mark)
- For a cable with a specified capacitance of 100nF/m, what is the maximum permissible cable length? (2 marks)
- Based on an evaluation of voltage, current and power parameters, can the field device be utilised with the IS interface? Justify your answer (2 marks)
- Given the temperature rating of the field device, what specific installation requirement would have to be in place for this device to be used in a Hazardous Zone? (2 marks)

**END OF QUESTIONS**

**END OF PAPER**