



Trade &  
Investment  
Mine Safety

(CEE3)

## NSW Coal Competence Board

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

*(Coal Mine Health and Safety Act 2002)*

Wednesday 21 August 2013

1.30pm – 4.30pm

#### Legislation and standards applicable to surface 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 Qualified electrical engineer 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 key parts of questions

**QUESTION 1** (10 marks)

Mining cables used for surface 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) With the use of the area below draw a typical cross sectional diagram of a “type 409 Trailing Cable” and identify the critical design features of the cables internal cores, insulation and screening. (4 marks)
- b) Describe the primary engineering reasons for this particular design and layout of the 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 licenced repair workshop. (4 marks)

**QUESTION 2** (10 marks)

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

When considering Electrical Protection Systems:

- a) According to the *CMHS Regulation*, in your EEMP, what provisions should be made for electrical protection? (1 mark)
- b) In developing your Standard of Engineering Practice for Electrical Protection Systems, nominate your key requirements for the management of protection settings. (4 marks)
- c) With reference to AS3007:2, in 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** (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 10000 tonne ROM bin. Approval Conditions stipulate the ROM conveyor from the loading point to the top of the bin (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 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)

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. (2 marks each)

- d) *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.*
- e) *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.*
- f) *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.*

**QUESTION 4** (10 marks)

The electrical supply to a 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 a 11kV connected capacitor bank to correct the power factor to 0.98 lag. (2 marks)  
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) What is the kVAr of each phase if the capacitor bank is delta connected? (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 verse low voltage connected power factor correction units (2 marks)

**QUESTION 5** (10 marks)

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

- a) What are the key objectives of AS2081? (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** (10 marks)

You have taken on the role of Mine Electrical Engineer 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 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 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 see provided in the testing documentation? (2 marks)

**QUESTION 7** (10 marks)

A company Project Manager has been put in charge of a 16 week project for the construction of a new ROM Surface bin at an underground coal mine.

The Project Manager has been informed that welding incidents have been identified as occurring at a high frequency throughout the 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 and 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 do 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** (10 marks)

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

- a) Provide three examples of types of electrical work where the Code of Practice **does not** apply. (2 marks)
- b) AS3760 sets out indicative inspection and testing frequencies for electrical equipment. The Code of Practice for 'Managing Electrical Risks in the Workplace' (Safe Work Australia) 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 *WH&S Regulation 2011*, when should RCD's be used? (2 marks)
- d) You are performing an inspection at your mine, and find 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 site isolation procedures.  
Under the *WH&S Regulation 2011* is this considered "electrical work"? Support your answer. (2 marks)
- e) *The WH&S Regulation 2011* details the circumstances under which work on "energized electrical equipment" is permitted. What are these? (2 marks)

**QUESTION 9** (10 marks)

As the Qualified Electrical Engineer (QEE) 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 in point form for your specification? (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** (10 marks)

You are the Qualified Electrical Engineer (QEE) for a large Open Cut facility which has been on “care and maintenance” mode for a period of time, and has just been given a new life with operations about to start up again.

With the commencement of operations a series of new machinery will be coming to site:

- a) What are some of the issues which may be encountered when bringing new equipment to site? (2 marks)
- b) What process needs to be in place to handle this new equipment? (4 marks)
- c) Draw a basic flow diagram of the process, and how you can ensure that the equipment is suitable for service at your site? (4 marks)

**QUESTION 11** (10 marks)

As Qualified 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 to manage the risk of electricity that will:

- a) Provide training to your contractors prior to commencing work on your site. This would include non-electrical people (3 marks)
- b) How would you confirm your requirements are understood? (3 marks)
- c) Describe how you will measure the effectiveness of your standard. (2 marks)
- d) Describe how you will ensure that supporting information is available (2 marks)

**QUESTION 12** (10 marks)

Explain in your own words your understanding of the following

- a) To reverse a 3 ph induction motor, any 2 phase are reversed. What is the reason why the motor will reverse? (1 mark)
- b) What is meant by the term “Corona” with regards to electrical engineering? (1 mark)
- c) What is meant by the term “Partial discharge” with regards to electrical engineering? (1 mark)
- d) What is the purpose of a circuit breaker? (1 mark)
- e) What is meant by the impedance of a transformer? eg  $Z= 4\%$  (1mark)
- f) Why would you specify a high impedance transformer as opposed to a low impedance transformer? (1 mark)
- g) What is the purpose of a Buckholz relay on a transformer? (1 mark)
- h) Where would you find the “ $I^2t$  rating”? (1 mark)
- i) What is meant by the term “HRC”? (1 mark)
- j) What gases are produced during an arcing fault within an oil filled transformer? (1 mark)

**END OF QUESTIONS  
END OF PAPER**