NSW GOVERNMENT

NSW Resources Regulator

EXAMINATION PAPER

Electrical engineer of coal mines other than underground mines certificate of competence

Written examination 24 July 2019

Instructions to candidates

Unless otherwise stated all references to the Act, Regulations and Standards are to the:

- *Work Health and Safety Act 2011*
- Work Health and Safety Regulation 2017
- *Work Health and Safety (Mines and Petroleum Sites) Act 2013*
- Work Health and Safety (Mines and Petroleum Sites) Regulation 2014
- Australian Standards

CEE3 – Legislation, Australian standards and electrical engineering applicable to open cut mining

Question 1

You are the electrical engineering at a surface coal mine and you have a contract company working with your electrical team completing repairs to a conveyor starter in your workshop.

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

At the time of the incident, 690-volt power was being supplied to the starter panel, which is also transformed to lower voltages within the starter.

a) What first aid protocols should be in place to ensure the person receives the appropriate care? (2 marks)

b) Identify four engineering controls that should have prevented this incident from occurring. (4 marks)

c) You are initially unaware of the electric shock voltage level the person received in the incident. What steps could you take to identify the source of the electric shock? (4 marks)

Question 2

You have recently been appointed to the position of electrical engineer at a surface coal mine, and you have been informed that the mine is two weeks away from commissioning a new surface substation providing electrical power to critical infrastructure including workshop, fuel farm, compressors and pumps etc.

The network supplier has nominated two fault levels at the point of supply. They have defined these as normal supply and alternate supply. This is due to the two possible configurations of the network distribution to allow emergency supply in case of network faults or maintenance events. The alternate supply has a lower fault level than the normal supply and does not provide a stable incoming supply as it can fluctuate between 0.85 to 1.1 per unit. The alternate supply is only in place for short periods typically 8-10 hours during planned maintenance windows and emergency repairs.

a) What should be considered in managing two different declared fault levels at the point of connection? (2 marks).

b) Explain how you would manage the two different declared fault levels. (2 marks)

c) What concerns would you have with the incoming fluctuating supply voltage? (2 marks)

d) What engineering controls could you introduce to manage the fluctuating supply voltage? (2 marks)

e) What documentation would you review to verify the surface substation design addresses the varying fault level and fluctuating supply voltage? (2 marks)

Question 3

AS/NZ 2081:2011- Electrical Protection devices for Mines and Quarries is a recognised standard in coal mines.

a) What are the key objectives of this standard? (3 marks)

b) How does the standard define the following?

   i. Back-up protection (1 mark)

   ii. Earth fault current (1 mark)

   iii. Earth leakage current (1 mark)

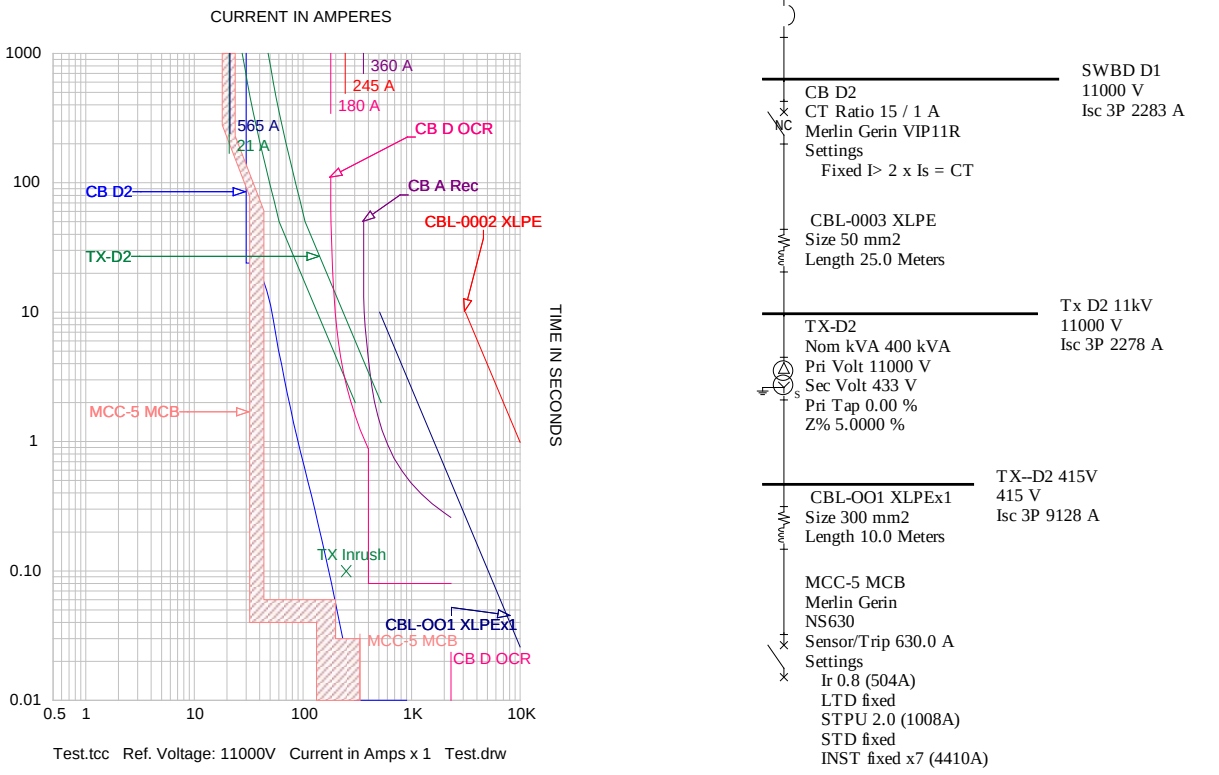
   iv. Operating time (1 mark)

c) On the time current curve below, nominate the operating times for the following protection devices to operate at a fault current of 1000 amps at 11kV. (3 marks)

   i. CB D2

   ii. CB D OCR

   iii. CB A Rec



Question 4

Your mine is supplied from the energy provider at 66kv. The energy provider has advised you they are changing your electricity supply agreement to include penalties for poor power factor. The mine is running at a power factor of 0.65 at a recorded maximum demand of 20 MVA.

a) Nominate the size of an 11kV connected capacitor bank to correct the power factor to 0.98 lag. Note: Power factor correction units are available in 500kVAr increments. (4 marks)

b) From your calculation, how many capacitor banks would you specify and why? (2 marks)

c) Calculate the resultant power factor if the capacitor bank you selected remained connected when the demand dropped to 10 MVA at 0.65 lag power factor and explain any issues you see with this. (2 marks)

d) List the relative merits of high voltage verses low voltage connected power factor correction units. (2 marks)

Question 5

As the electrical engineer at a surface coal mine, you have identified a requirement to improve welding practices on site. You have engaged a training company to develop a welding training package for your site.

a) Nominate four key areas to be addressed within the training package. (4 marks)

b) Provide examples of the welding environment categories as defined in *AS1674.2 Safety in welding and allied processes*. (3 marks)

   i. Category A

   ii. Category B

   iii. Category C

c) What are the control measures required in a Category C environment by *AS1674.2 Safety in welding and allied processes*? (3 marks)

Question 6

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014, Schedule 2 Principal control plans—matters to be addressed. States the following. Fill in the missing words. (1/2 mark each. Note each _____Number_____ is one word).

(1) The operator of a mine or petroleum site must, in preparing an electrical engineering control plan, take the following into account in determining the means by which the operator will manage the risks to health and safety from electricity at the mine or petroleum site:

(a) the overall _____1_____ cycle of the electrical aspects of plant and electrical installations at the mine or petroleum site,

(b) the reliability of electrical_____2_____ used at the mine or petroleum site to protect persons from electrical or other hazards,

(c) the electrical engineering and electrical work practices to be employed at the mine or petroleum site,

(d) the _____3_____ required by workers to safely work on electrical plant or electrical installations at the mine or petroleum site.

(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 or petroleum site taking into account the matters set out in subclause (3):

(a) injury to persons caused by direct or indirect contact with electricity,

(b) injury to persons caused by working on electrical plant or electrical installations,

(c) the unintended initiation of gas or dust explosions,

(d) the unintended operation of plant,

(e) the occurrence of _____4_____ _____5_____ .

(3) The following matters must be taken into account when developing a control measure referred to in subclause (2):

(a) the location of the electrical plant and electrical installations at the mine or petroleum site,

(b) the rating and design of plant for the _____6_____ _____7_____ _____8_____ _____9_____ electrical load, operating frequency, operating voltages and arc fault control,

(c) the design and operation of any electrical plant that contains flammable liquid,

(d) the carrying out of the selection, installation and use of electrical cables and electrical cable accessories at the mine or petroleum site,

(e) the control of _____10_____ _____11_____ at the mine or petroleum site, including preventing the ignition of flammable gas,

(f) the impact of lightning on the mine or petroleum site (especially on an underground mine) including the effect on electrical systems,

(g) the need for reliable circuit interruption for all points in the electrical distribution system at the mine or petroleum site when faults occur taking into account the operating time and tripping current of circuit protection devices,

(h) the type of _____12_____ _____13_____ used, including levels of earth fault limitation,

(i) the potential for persons to contact electricity indirectly,

(j) the prospective touch, step and _____14_____ 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 or petroleum site (including the 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 _____15_____ _____16_____ ,

(ii) the use of electrical test instruments,

(iii) work near overhead power lines and cables,

(iv) the treatment of electric shocks and electric burns,

(v) accessing and working on high 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 security and maintenance of the electrical control system software and control circuits at the mine or petroleum site,

(q) the use of _____17_____ and fibre optic equipment at the mine or petroleum site,

(r) the construction, installation and maintenance of battery-powered vehicles and battery charging stations at the mine or petroleum site,

(s) the supply of electricity in hazardous atmospheres and, in the case of underground coal mines, in hazardous zones,

(t) the use of _____18_____ _____19_____ 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 _____20_____ detect an electrical fault in a circuit and disconnect the supply of power to the circuit.

Question 7

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 441 Trailing Cable" and identify the critical design features of the cable's internal cores, insulation and screening. (4 marks)

b) Describe the primary engineering reasons for this 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 mining cables when sent to a licensed repair workshop (4 marks)

Question 8

You have received a safety alert describing an incident where an electrician received an electric shock and an electrical burn to his hand whilst carrying out routine maintenance in a withdrawable 415 Volt 37kW pump cell in a motor control centre (MCC). The MCC has a design fault rating of 65kA and the modelled maximum fault level of the installation is 25kA.

a) List three design features you may find on the 37kW pump cell to prevent contact with live conductors. (3 marks)

b) List two design features you may find on the 37kW pump cell to eliminate or mitigate arcing faults. (2 marks)

c) List three administrative controls you would expect to see in place to manage the risks associated with this type of incident. (3 marks)

d) The following warning is provided in the manufacturer's Installation manual:

	**ATTENTION:** De-energize, lock out, and tag out all sources of power to the MCC when you install or remove MCC units. If MCC units are installed or removed with power applied to the main power bus, follow established electrical safety work practices.

List two key conditions you would include in a procedure for the withdrawal of an MCC unit with the main power bus energised. (2 marks)

Question 9

Faulty batteries and charging units have been attributed to numerous fires associated with lithium batteries worldwide. Your mine has committed to the introduction of battery-operated troop carrier as part of a trail.

With respect to the lifecycle management of the batteries; list five key areas that would need to be addressed in your risk assessment to ensure safe operation. Briefly explain why each of your nominated key areas needs to be assessed. (10 marks)

Question 10

You are the electrical engineer at a surface mine and have found that there is no process to follow when electrical storms are approaching.

a) You cannot identify if all the site structures have the required lightning protection. What are your next steps and what information would be required? (2 marks)

b) What Australian Standard would you consult to determine if protection is required? (1 mark)

c) After reviewing the relevant Australia Standard, you have decided to do a risk assessment as detailed in the standard. What information do you require? (7 marks)

Question 11

You are the electrical engineer at a surface coal mine that has dragline.

You are at home when you're called on the telephone through the night. The supervisor from your mine site says to you that the draglines power supply had tripped. When it was re-energised the electricians noticed that the main 22kV SF6 withdrawable circuit breaker was making a crackling noise.

a) What would your instruction be? (1 marks)

b) What could be the possible causes of the crackling noise? (1 marks)

c) The site has decided that the circuit breaker requires replacement, though no circuit breaker carriage is available. What would the electrician(s) need to check on the new circuit breaker to ensure it was suitable? (3 marks)

d) You are unable to confirm that the new circuit breaker has had any recent commissioning tests. Detail the minimum tests (and parameters) that you would have conducted and the results you would expect before allowing the circuit breaker to be used. (3 marks)

e) The new circuit breaker has been commissioned and is in place. Detail any further actions that may need to be completed and the expected results, to ensure the circuit breaker is able to be energised without failing? (2 marks)

Question 12

You are the electrical engineer at a surface coal mine that is taking delivery of a new wheeled loader that is powered by an electric drive system.

a) List the main electrical Australian Standards that relate to this loader. (4 marks)

b) List the introduction to site requirements that relate to electrical safety regarding this loader. (4 marks)

c) During testing for de-energisation, it has been found that the drive system de-energisation circuit has not functioned. List the possible actions that can be completed to allow people to work on the drive system. (2 marks)

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