CANDIDATE EXAM PAPER

CANDIDATE NUMBER: _____

CEE3 – Legislation, Australian Standards and electrical engineering

applicable to open-cut mining

ELECTRICAL ENGINEER OF COAL MINES OTHER THAN UNDERGROUND COAL MINES

EXAMINATION FOR CERTIFICATE OF COMPETENCE

Legislation to be assessed:

Unless otherwise stated all references to Act and Regulations are to:

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
Explosives Act 2003
Explosives Regulation 2013
and
Australian/New Zealand Standards (the standards)

This Examination is held in the following location:

Region: New South Wales

Venue: Tocal College

Room: Glendarra 2 conference room

Start date/time: 28 Sep 2022 12:50:00

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

INSTRUCTIONS TO CANDIDATES

Q #	Marks	Available Marks	Marked by *Initials*	Summary comments to justify
1		10		
2		10		
3		10		
4		10		
5		10		
6		10		
7		10		
8		10		
9		10		
10		10		
11		10		
12		10		
Paper Total		**120**		*Marks checked by:*

EXAM BOOKLET

Answers are to be written in the allocated spaces within this booklet ONLY

Answers must be written in pen however, drawings may be completed in pencil

This booklet is not to be altered in any way, pages are not to be added or removed

Additional space is provided at the end of the paper. Please label which question the answer relates to.

Some questions in this paper are marked as essential and that candidates must get X out of 10 to pass the question. Failure to achieve this mark in each of the nominated questions will result in the candidate not passing the paper

Question 1

Operational decision making and initiative

- Referring to evidence and objective information when establishing standards and procedures
- Taking actions prescribed under WHS laws when safety concerns or risks have been identified, where appropriate

Electric shock (Essential)

Candidates must get 7 out of 10 to pass this question

You are the Statutory Electrical Engineer at a mine and have been notified that a worker at your mine has received an electric shock whilst in contact with a 1000Vac conveyor motor.

The following information has been gained from your investigation:

- Operator received a shock while contacting the frame of the piece of equipment
- The supply to the equipment has tripped on earth leakage protection
- Event logs identified that a one of the drive head motors was starting at the time of the incident
- The motor supply cable has been found to be damaged and worn through
- The protective earth was intact and continuity from the frame of the equipment to the source of supply was measured at 1.5 Ohms
- The estimated human body resistance path to earth is 1000 Ohms
- The equipment is supplied from a 5A earth fault limited system.

a) Draw an equivalent circuit showing the electric shock current flow paths through the human body and via the protective earth. (2 Marks)

b) As defined in AS/NZS 3000 Wiring Rules, nominate what form of contact did the worker make and what is the definition of: (2 Marks)

- "Direct contact"
- "Indirect contact"

c) Using the information gained from the investigation, calculate the current flow through the human body. Show all working. (4 Marks)

d) What clause would you notify this incident under, and what are the obligations under the Work Health and Safety (Mines and Petroleum Sites) Act and Regulation, specific to this electric shock incident? (2 Marks)

Question 2

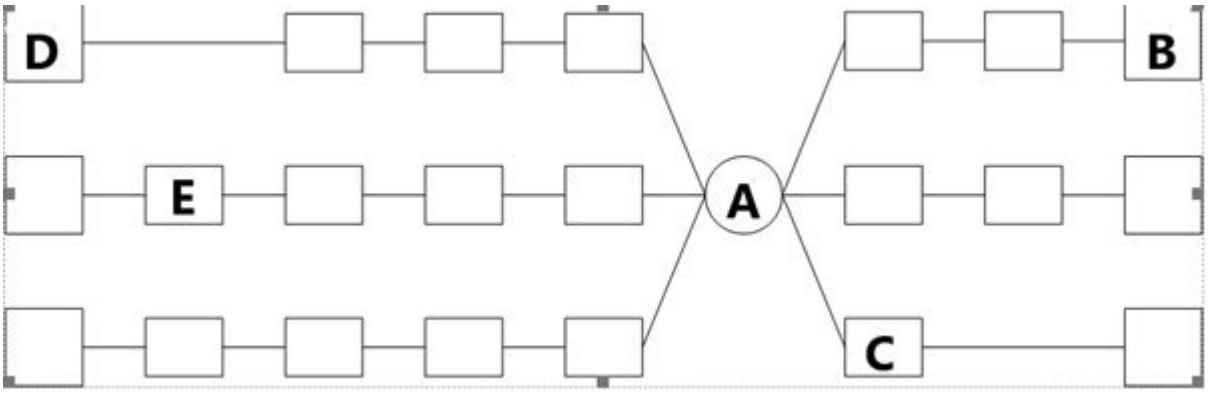
Situational Awareness and Risk Assessment

- Assisting or participating in risk assessment processes

Bow Tie Analysis (Essential)

Candidates must get 5 out of 10 to pass this question

Bowtie Risk Assessment (RA) is a methodology that allows risk to be evaluated in terms of multiple scenarios surrounding an unwanted situation and presents a holistic picture of the overall risk which is easy to communicate.



a) Using the Bow Tie diagram above, Identify the elements using the list below. (2.5 Marks)

Recovery control

Consequences

Preventative control

Unwanted Event

Threat

b) Define the term “critical control”. (2 Marks)

c) Identify the controls that you would expect to be in place to prevent the likelihood of electric shock to a person that is completing maintenance on a 66kV/22kV switch yard. (3.5 Marks)

d) Which of the identified controls would be considered critical and why? (2 Marks)

Question 3

Organised and disciplined

- Monitoring and reviewing compliance with standards in a systematic, organised and timely manner

Welding - AS 1674.2 Safety in Welding allied processes

The following questions refer to AS 1674.2 Safety in Welding allied processes, answer the questions using your knowledge of this standard

Answer the questions from your knowledge of the welding standard AS1674.2

a) Before welding commences, the work areas shall be assessed and the welding environment classified for the risk of electric shock. Name the categories and what are the key points to determine what classification is used. (3 Marks)

b) AS 1674.2 - Routine inspection and testing,

An inspection of the power source, an insulation resistance test and an earth resistance test shall be carried out:

i. What is the frequency for fixed welding equipment? (1 Mark)

ii. What is the frequency for transportable welding equipment? (1 Mark)

c) The table from AS 1674.2 Safety in Welding allied processes, identifies the Minimum Insulation resistance (MΩ).

Fill in the three blank spaces with the Minimum insulation resistance (MΩ) values. (3 Marks)

Table 5.1.2

MINIMUM INSULATION RESISTANCE

Parts to be tested			Minimum insulation resistance (MΩ)
Input circuit (including control circuits connected to it)	To	Welding circuit (including control circuits connected to it)	5 MΩ
All Circuits	To	Exposed conductive parts	
Welding circuit (including control circuits connected to it)	To	Any auxiliary circuit which operates at a voltage exceeding extra low voltage	
Welding circuit (including control circuits connected to it)	To	Any auxiliary circuit which operates at a voltage not exceeding extra low voltage	
Separate welding circuit	To	Separate welding circuit	1 MΩ

d) Accessories - Welding

In AS 1674.2 it outlines how often welding accessories shall be inspected and by whom.

i. Outline frequency of this inspection. (1 mark)

ii. Who can complete these inspections? (1 mark)

Question 4

Collaboration

- Providing advice on implementation of standards, processes and systems, and verifying implementation and compliance, and on how risks should be managed

Powerline Management

a) You have just started at a mine as the statutory Electrical Engineering which has approximately 20km of overhead powerlines on the operating lease that you own. What are three (3) key controls which should be in place to assist in managing the risk associated maintaining and interaction with overhead powerlines? (3 Marks)

b) You identify there is no maintenance strategy for the powerlines onsite. Identify three (3) key items you would include in your new maintenance strategy for your powerline infrastructure. (3 Marks)

c) AS/NZS 3007 Electrical equipment in mines and quarries – surface installations associated processing plants, documents Information that should be readily available to mine staff to facilitate risk assessments and controls related to operations near OHL (overhead lines) (4 Marks)

List 6 points**.**

Question 5

Driven by safety and integrity

- Setting, upholding and monitoring the health and safety expectations by developing, supervising and following the safety management system

Protection

You are the new Statutory Electrical Engineer at a site. Within your inspections over the first week, you find that numerous additions have been made to the infrastructure and no up to date power system studies can be found, additionally you find protection settings have been changed throughout the electrical plant with no due diligence applied.

a) What are your first actions? (2 Marks)

b) List four points that you would include in a scope of work for an external service provider to complete power system studies for the site. (4 Marks)

c) Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 Clause 32 -Electrical safety

i. What form of protection is required to be installed on all circuits including sub circuits? (2 Marks)

ii. Except for circuits that are isolated from earth, or that have a supply voltage that is extra-low voltage, what other protection is required? (2 Marks)

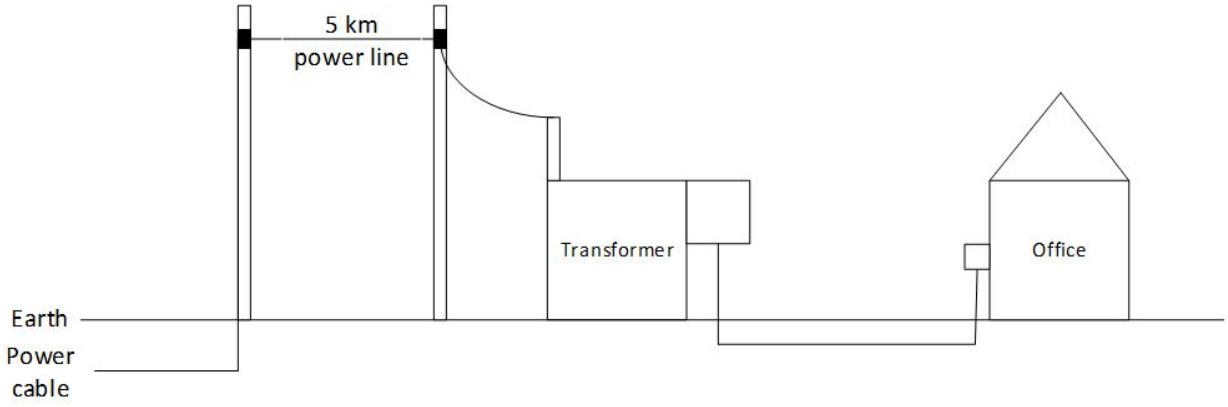
Question 6

Technical knowledge and skills

- Mining and WHS systems
- Legislation

Lightning

The Drawing below illustrates a power supply arrangement:



a) Indicate the typical lightning protection that you would have on the diagram above, along with any assumptions. (4 Marks)

b) Draw and explain the rolling sphere protection method in the below space. (4 Marks)

c) Explain your understanding of “leaders” in reference to lightning strikes. (2 Marks)

Question 7

Technical knowledge and skills

- Mining and WHS systems

Trailing cable

a) Mining cables used for open cut coal operations in reeling and trailing applications are designed to be "fit for purpose" for their duty in a particularly harsh environment.

i. For a "type 450.11" Cable, what does the ".11" indicate? (1 Mark)

ii. Draw a typical cross-sectional diagram of a "type 450.11 cable" and identify three (3) 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. (2 Marks)

c) Is this cable symmetrical or non-symmetrical and explain you reasoning. (2 Marks)

d) What equipment would you typically find this cable installed on, in an open cut operation? (1 Mark)

e) How does this cable type fulfil the philosophy that “cables should be designed so that the first fault is a low energy earth fault”? (1 Mark)

Question 8

Situational Awareness and Risk Assessment

- Reviewing by measuring the effectiveness of the relevant standards and procedures
- Verifying relevant standards and procedures in principal hazards management plans and principal control plans

AS/NZS 2081 Electrical protection devices for mines and quarries (Essential)

Candidates must get 6 out of 10 to pass this question

Workers interacting with mobile electrical plant supplied by trailing cables can be exposed to hazardous touch voltages under fault conditions. *AS/NZS 2081 Electrical protection devices for mines and quarries* specifies performance requirements for protection devices which are designed to minimise the risks associated with these touch voltages.

a) With respect to the devices nominated in *AS/NZS 2081, name and* describe (4) four of these devices that may eliminate or mitigate the risks of hazardous touch voltages. (4 Marks)

i.

ii.

iii.

iv.

b) For two of the devices, you have nominated above, describe the testing methods in detail that would be undertaken to ensure the devices operate correctly. (4 Marks)

c) Describe two locations at a surface operation where AS/NZS 2081 compliant equipment would be used. (2 Marks)

Question 9

Effective Communication

- Explaining the results of their analysis of data, information and/or audit outcomes

Terminology

Define the following electrical protection related terms and acronyms: (10 Marks, 1 Mark for each question)

a) SIL

b) IDMT

c) VVVF

d) KVAr

e) DGA

f) ONAF

g) BIL

h) Buchholz

i) Blocking protection

j) Draw power triangle and nominate phase angle, correctly label KW, KVAr, KVA.

Question 10

Responsiveness to change

- Reviewing standards, processes and the SMS to instituting change where necessary, as per changes in conditions

Electrical Engineer Statutory Function (Essential)

Candidates Must get 6 out of 10 correct answers

Work Health Safety (Mines and Petroleum Sites) Regulation 2014 Schedule *10 Statutory Functions at mines Part 3 Coal mines other than underground mines.* Nominates the statutory function requirements

a) Electrical Engineer: (5 Marks)

i.

ii.

b) The requirement for nomination to exercise the statutory functions is that the individual nominated must: (2 Marks)

i.

ii.

c) Clause 14 of schedule 10 discusses *Qualified electrical tradesperson*

Give your understanding of what the statutory function is of a qualified electrical tradesperson (3 Marks)

Question 11

Driven by safety and integrity

- Setting, upholding and monitoring the health and safety expectations by developing, supervising and following the safety management system

Multiply choice (Essential)

Candidates Must get 6 out of 10 correct answers

These multiple choice questions relate to **AS/NZS 4871 series- Electrical equipment for mines and quarries.** Circle the correct answer to the following questions. (1 Mark each)

i) *Enclosures shall—*

(a) have a minimum degree of protection --_____in accordance with AS 60529; or

(b) be located in a controlled environment that eliminates exposure to water spray.

- IP23
- IP43
- IP55
- IP68

ii) For a main power conductor up to and including 70 mm2, the cross-sectional area of the associated neutral earthing conductor between the transformer neutral terminal and the earth-fault limitation device shall be

- 25% of the cross-sectional area of the main power conductor
- 50% of the cross-sectional area of the main power conductor
- 75% of the cross-sectional area of the main power conductor
- 100% of the cross-sectional area of the main power conductor

iii) Where earth-fault limitation is required the ratio of earth-fault current to earth leakage protection trip should be at least:

- 2
- 5
- 8
- 10

iv) What is shunt trip?

- Means of causing a circuit breaker to open that is de-energized in normal service and energized by a voltage source to cause a trip.
- Means of causing a circuit breaker to close that is de-energized in normal service and energized by a voltage source to cause a trip.
- Means of causing a circuit breaker to open that is energized in normal service and energized by a voltage source to cause a trip.
- Means of causing a circuit breaker to open that is de-energized in normal service and De-energized by a voltage source to cause a trip.

v) What is Undervoltage?

- Means of causing a circuit-breaker to open with or without delay when the voltage across the terminals of the release mechanism goes above a predetermined value.
- Means of causing a circuit-breaker to close with or without delay when the voltage across the terminals of the release mechanism falls below a predetermined value.
- Means of causing a circuit-breaker to open with or without delay when the voltage across the terminals of the release mechanism falls below a predetermined value.
- Means of causing a circuit-breaker to open with or without delay when the current across the terminals of the release mechanism falls below a predetermined value.

vi) _____ may be considered as a means of preventative maintenance for identifying hot joints in high current applications

- Thermography
- Capacitive Coupling
- Cable repairs
- Residual Voltage

vii) What do the following controls relate to:

Positioning of operating handles, explosion vents, integrity and guarding of windows.

- Overhaul
- Arc Blast
- Intrinsically Safe Equipment
- Earth Grid Design

viii) What does CFS stand for?

- Circuit breaker fixed supply
- Cubic feet per second
- Combination fuse switch
- Calculated fault system

ix) Explosion vents shall be installed on what electrical equipment.

- 240 volt Low voltage distribution boards
- Explosion protected high voltage switchgear assemblies
- Explosion protected low voltage Distribution boards
- Non-explosion protected high voltage switchgear assemblies

x) As outlined in AS/NZS 4871.6, The cable from the alternator that supplies charging current to the batteries shall be

- Non resettable fuses
- Rated for the maximum output of the alternator
- Twice the rated output of the alternator
- Cross-sectional area greater then 35mm

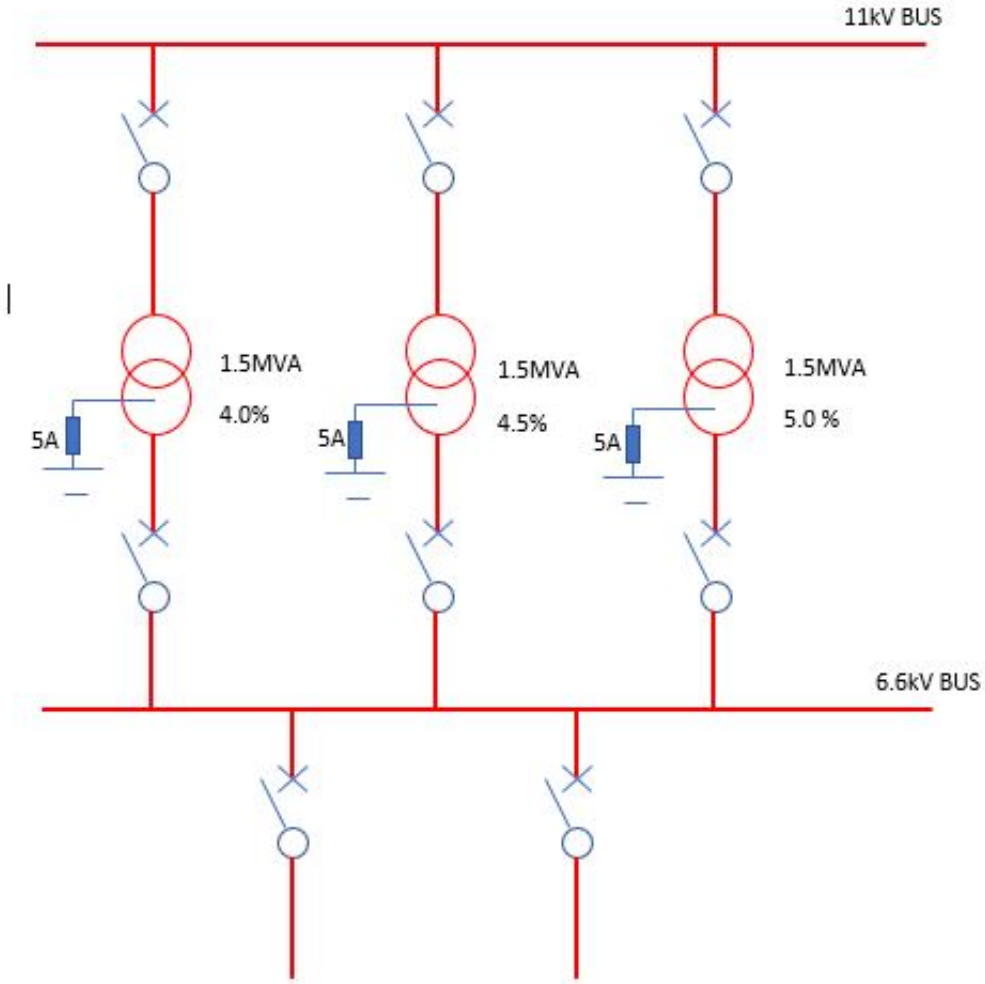
Question 12

Operational decision making and initiative

- Providing advice on implementation of standards, processes and systems, and verifying implementation and compliance, and on how risks should be managed

Fault calculation (Essential)

Candidates must get 6 out of 10 to pass this question



MIA 1	MIA 2
CABLE #1	CABLE #2
95mm2	35mm2
PILSWA 1km	PILSWA 2km
Cable Data	Cable Data
FLC = 155A	FLC = 115A
Z = 0.353 Ω/km	Z = 0.696 Ω/ km

You are the new Statutory Electrical Engineer at a mining operation that wishes to expand into a new area. The new area is an older mining operation that has existing infrastructure that you wish to utilise for the construction phase of the project. The infrastructure consists of a switchyard containing three transformers that feed two different areas of the lease by means of a buried service.

The incoming supply is 11kV with a fault level nominated by the Network Service Provider at 150MVA. The switchyard is arranged such that a maximum of two transformers may be taken out of service on maintenance days. The two existing feeders will be used to support Mining Infrastructure Areas.

a) Assuming all Circuit Breakers are closed, what is the maximum prospective earth fault. (1 Mark).

b) What is the effect on the maximum prospective earth fault if one of the transformers is taken out of service for maintenance. (1 Mark)

c) Using any calculation method you are comfortable with, calculate the fault level at the 6.6kV surface busbar with all transformers on line. (4 Marks)

d) Calculate the maximum load in MVA that can be utilised without overloading any of the transformers. (2 Marks)

e) Nominate the protection current settings for MIA Feeder #2 CB ANSI Code 51P ANSI Code 50P (1 Mark)

Note: ANSI 51P is the code for Timed Overcurrent.

ANSI 50P is the code for Instantaneous Overcurrent.

f) Justify your answer. (1 Mark)

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