EXAMINATION: Electrical engineer of coal mines other than underground mines

EXAM PAPER: CEE3 – Legislation, Australian Standards and electrical engineering applied to open cut mining

DATE: 23 November 2021- 1.35pm to 4.45pm, Tocal College

EXAMINATION FOR CERTIFICATE OF COMPETENCE TO BE AN ELECTRICAL ENGINEER OF COAL MINES OTHER THAN UNDERGROUND MINES

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

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.

If you are unable to fit your answer in the allocated space provided, please use the extra pages at the back of the examination booklet. Make sure you clearly label the answer with the question number it applies to.

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 engineer of coal mines other than underground mines.

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. Themarks applicable to each part of a question will be indicated in the question.

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 15minutes.

This examination is a **closed book** examination. No reference material can be brought into the exam room with you.

Q #		Mark	Availabl emark	Marked by *Initials*	Summary comments to justify marks awarded (if required)
1	a		1		
	b		1		
	c		4		
	d		4		
	Total		**10**		
2	**Total**		10		
3	a		4		
	b		2		
	c		1		
	d		2		
	e		1		
	Total		**10**		
4	a		1		
	b		1		
	c		1		
	d		1		
	e		1		
	f		1		
	g		1		

Q #		Mark	Availabl emark	Marked by *Initials*	Summary comments to justify marksawarded (if required)
	h		1		
	i		1		
	j		1		
	Total		**10**		
5	a		4		
	b		4		
	c		2		
	Total		**10**		
6	a		2		
	b		4		
	c		4		
	Total		**10**		
7	a		2		
	b		4		
	c		2		
	d		2		
	Total		**10**		
8	**Total**		**10**		
9	a		5		
	b		2		

Q #		Mark	Availabl emark	Marked by *Initials*	Summary comments to justify marks awarded (if required)
	c		3		
	Total		**10**		
10	a		**2**		
	b		**4**		
	c		**4**		
	Total		**10**		
11	a		4		
	b		2		
	c		2		
	d		2		
	Total				
12	a		6		
	b		1		
	c		1		
	d		1		
	Total				
PAPER	**TOTAL**		**120**		*Marks checked by:*

ANSWER BOOKLET

Answers are to be written in the allocated spaceswithin 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

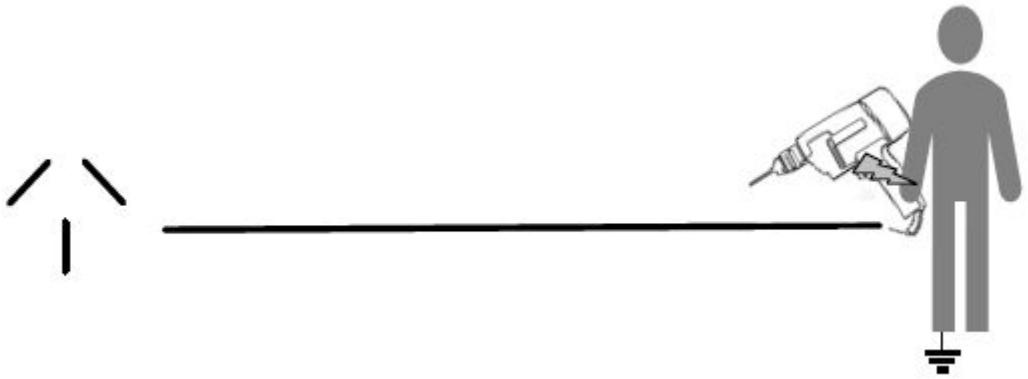
Additional space is provided at the end of the paper in case you runout of space for an answer. Please label which question the answer relates to if you do use this additional space.

Question 1

You are the Electrical Engineering Manager at a mine and have been notified that a worker has received anelectric shock from a Class I, handheld 240Vac power drill in the surface workshop.

The following information has been gained from your investigation:

- The handheld 240Vac power drill frame has become live from internal contact with the activeconductor
- The protective earth was intact and continuity from the frame of the handheld 240Vac power drillto the source was measured at 0.1 Ohms
- The estimated human body resistance path to earth is 1000 Ohms
- The workshop is supplied from a MEN system.



a) Draw an equivalent circuit showing the electric shock current flow paths through the human body andvia the protective earth. (1 Mark)

b) As defined in *AS/NZS 3000 Wiring Rules*, what type of 'contact' was the worker exposed to? (1 Mark)

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

d) Applying the hierarchy of controls, describe the top four (4) controls to manage the risk of electricshock associated with the use of 240Vac hand tools. (4 Marks)

i

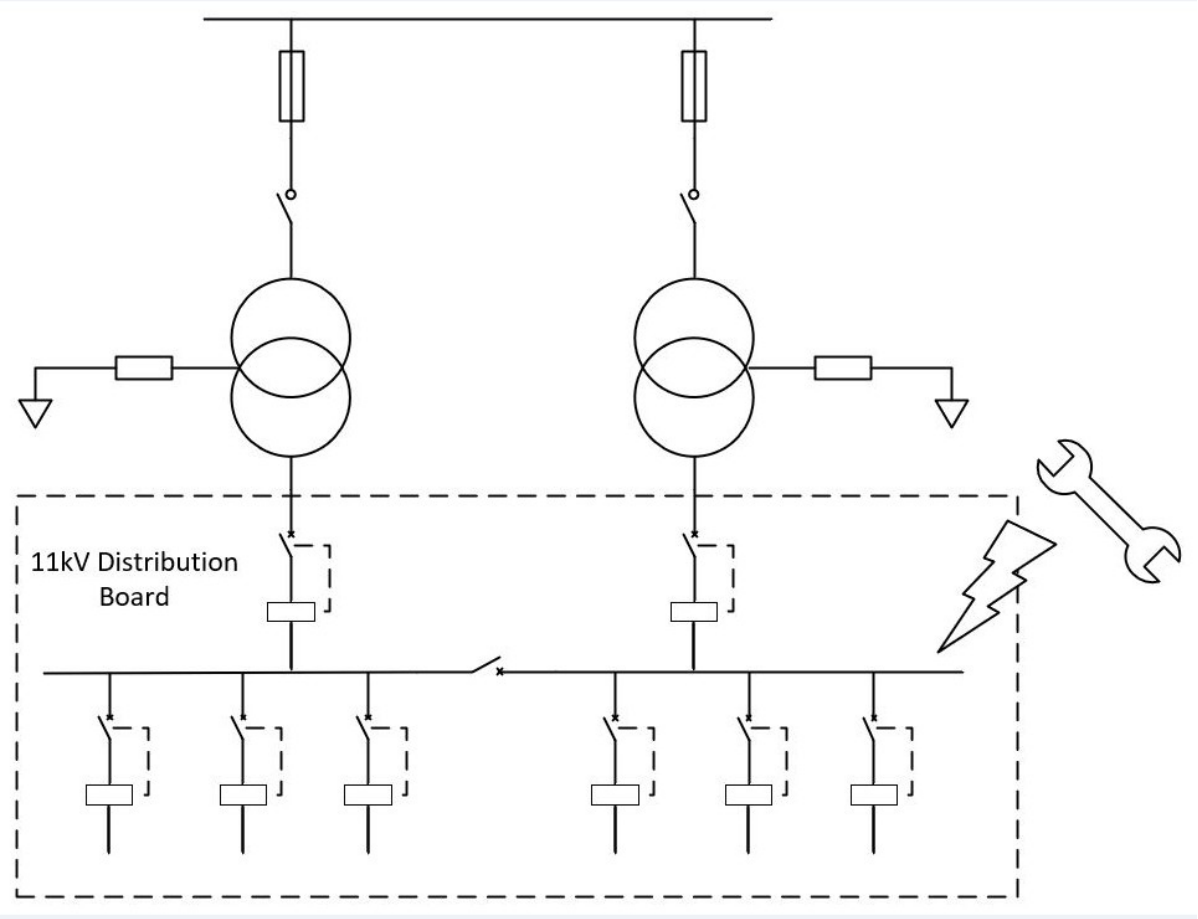
ii

iii

iv

Question 2

Refer to the simple diagram below for high voltage switch yard which includes two (2) 33/11kV 5MVA 8.2%Ztransformers each feeding three (3) 11kV circuit breakers on a bus with a normally OPEN bus tie.



A worker replacing an inspection cover on the top of the 11kV distribution board has dropped a spanner ontothe live 11kV bus.

Identify and describe five (5) features of the installation that will mitigate the risk to the worker from thesubsequent arc fault. (2 marks each)

i)

ii)

iii)

iv)

v)

Question 3

The mine you are working at has had an electrical fault on one of the CHPP conveyor motors.

This conveyor motor is a single drive configuration 200kW 415v motor. The only spare motor onsite that hasthe same shaft coupling, frame size and terminal configuration is a 160kW 415v Motor.

One formula for calculating the power needed for the conveyor is;

Power to move the load horizontally (kW) = 2.72 x L x F x (C+46) /

1000 Power to move empty belt (kW)= 14.6 x F x G x (C+46) x S /

1000Power to elevate or lower the load (kW) = 2.72 x L x H / 1000

where:

Maximum loading (L)	*2,000 tph.*
Conveyor length (centre distance) (C)	*500 m*
Belt width (W)	*1,400 mm.*
Idler friction factor (F)	*0.02*
Inertial Factor (G)	*68*
Nett change in elevation (H)	*+ 15 m*
Belt Speed (S)	*4 m/sec*

a) Calculate the power required to operate the conveyor at full load and determine if the 160kW motorwill be a suitable replacement. (4 marks)

b) For the nominated motor operating at a power factor of 0.91 calculate the full load current. make anynecessary assumptions (2 Marks)

c) What is the estimated starting current for this motor? (1 Mark)

d) Draw a vector diagram showing apparent power, true power and reactive power at full load. (2 Marks)

e) Nominate what needs to be considered if the new motor was installed in the system. (1 Mark)

Question 4

Define the following electrical protection related terms. (10 marks)

a) EIC

b) Blocking scheme

c) CT Burden

d) DMT

e) TCC

f) Differential protection

g) DOLF

h) BIL

i) Buchholz protection

j) Service Factor

Question 5

Workers interacting with mobile electrical plant supplied by trailing cables can be exposed to hazardous touchvoltages 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* describe how (4) four of the devices mayeliminate 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)

i)

ii)

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

i)

ii)

Question 6

Due to the relocation of your main high voltage switch yard you will be required to operate your site on a large diesel generation plant (mini power station) for a short period. The business plan requires the site to operate afull capacity during the relocation. Your maximum demand is between 7 -10MVA.

(a) What information would you need to supply to the generator company to confirm equipmentspecification? (2 marks)

(b) Based on the information you have provided; the generator company has supplied you with the detailsof a multi generator system they believe will meet your requirements.
Prior to the equipment arriving on site, what matters will you need to verify to ensure the equipmentwill operate safely and reliably. (4 marks)

c) Describe the commissioning tests for the you will require for the installation prior to the equipment entering full operation. (4 marks)

Question 7

You have taken responsibility for a mine site which has a 1970s vintage switch room which includes an 11000V main distribution board fitted with four (4) manually operated oil filled circuit breakers. One of the circuit breakers supplies a 2MVA pad mount transformer. You have not been able to find any maintenance records or procedures for the installation.

a) Describe any hazards that the switch board may pose to workers. (2 marks)

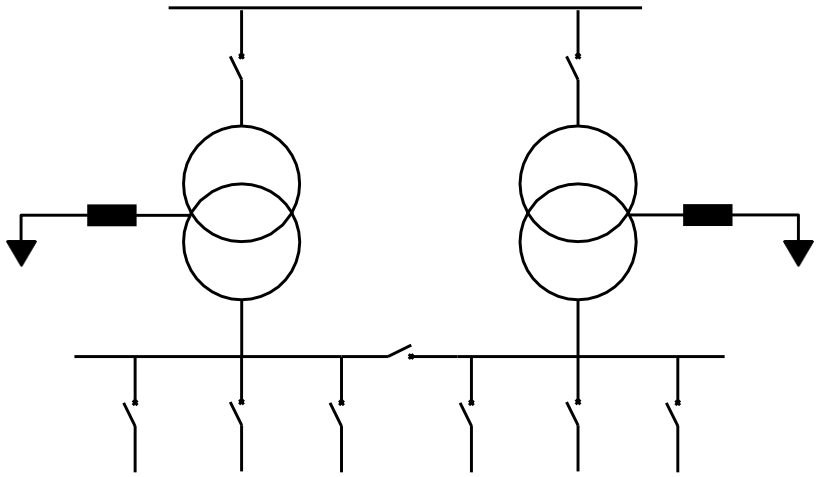
b) Describe any short or long term actions you may be able to take with respect to managing any hazards during the lifecycle of this distribution board. (4 marks)

c) The 2MVA transformer has a cooling designation LNAN. What do the letters LNAN designate? (2 marks)

d) What is your understanding of ‘DGA ‘ and ‘SOT’ for transformer oil (2 marks)

Question 8

Your high voltage switch yard has two (2) 33/11kV 5MVA transformers each feeding three (3) 11kV circuitbreakers. The transformers are each fitted with 10 Amp NERs.



Discuss five (5) things to be considered before closing the bus tie for the first time. (2 marks each)

i)

ii)

iii)

iv)

v)

Question 9

The *Work Health and Safety Regulation 2017 Clause 34* states; *A duty holder, in managing risks to health and safety, must identify reasonably foreseeable hazards that could give rise to risks to health and safety. AS/NZS IEC 31010:2020 Risk management - Risk assessment techniques* describes various risk assessment techniquesto assist in identifying, analysing and evaluating risk.

a) Name five (5) different risk assessment techniques. (5 marks)

i)

ii)

iii)

iv)

v)

b) List the hierarchy of control measures as described in the Work Health and Safety Regulation 2017 Clause 36. (2 marks)

c) List the three (3) requirements for the maintenance of control measures as described in the WorkHealth and Safety Regulation 2017 Clause 37. (3 marks)

i)

ii)

iii)

Question 10

You are the Electrical Engineer at a surface coal operation and you have become aware of a number of incidents where the unintended operation on the electric rope shovel has caused the dipper to drop to thefloor. Earlier incidents had gone unreported and the operators had continued to use the machine.

a) What are your immediate actions with respect to this incident? (2 marks)

b) Itemise the key steps you will take in your investigation of the root cause of this incident. (4 marks)

c) The outcome of your investigation was inconclusive as to root cause. What actions will you take toreturn the shovel to service? (4 marks)

Question 11

Clause 32 - Electrical Safety - Work Health and Safety (Mines and Petroleum Site) Regulation 2014 states:

(2) In managing risks to health and safety associated with electricity at the mine or petroleum site, the operator must ensure—

(a) that electrical installation work at the surface is carried out in accordance with the Wiring Rules, and

(b) that before a circuit is first energised at the mine or petroleum site, or is first energised following the circuit being recommissioned—

(i) the circuit is tested in accordance with the Wiring Rules by a competent person,

a) You are developing a testing and commissioning document for you site that will satisfy this requirement. Describe the contents and tests you will include in your document. (4 marks)

b) With respect to clause 32, define your requirements for a person to be deemed a "competent person". (2 marks)

c) You are required to install methane monitors at each of you reclaim tunnel coal valves, what competencies would be required by the person doing the commissioning and testing to satisfy clause
32. (2 marks)

d) A work order has been issued to change out all of the emergency stop stations at your lime treatment plant due to issues with ingress protection. What additional requirements might need to be addressed before and after the change out. (2 marks)

Question 12

Welding plant is heavily used on mine sites to complete repairs to mobile plant. *AS1674.2 2007 Safety in welding and allied* - Electrical is commonly used across the mining industry to develop safety and maintenancepractices.

a) The standard nominates several categories of welding environments. Nominate these categories andexplain how they are applicable to your mine site (6 Marks)

b) What is meant by the term HRD applied to welding equipment (1 mark)

c) What are the issues of using more than one welding machine of the same item of plant? (1 Mark)

d) The standard nominates the maintenance cycles for welding machine nominate the maintenance cyclefor Transportable and fixed welding plant. Nominate the frequency. (1 marks)

e) What voltage does the standard stipulate as a minimum voltage that is used to test the insulationresistance for in service welding power sources (1 mark)

END OF QUESTIONS

End of examination paper