CANDIDATE NUMBER: _____/_____

EXAMINATION: Electrical engineering manager

EXAM PAPER: CEE1 – Electrical engineering applied to underground coal mines

DATE: 23 November 2021- 9:20am to 12.30pm

EXAMINATION FOR CERTIFICATE OF COMPETENCE TO BE AN ELECTRICAL ENGINEERING MANAGER OF UNDERGROUND COAL MINES

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014

INSTRUCTIONS TO CANDIDATES:

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 withthe 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 engineering manager of underground coal 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. The marks 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 30 minutes.

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

Q #	Q Part	Marks	Available Marks	Marked by *Initials*	Summary comments to justify
1	a		1		
	b		1		
	c		4		
	d		4		
	Total		**10**		
2	**Total**		**10**		
3	a		6		
	b		4		
	Total		**10**		
4	a		4		
	b		2		
	c		1		
	d		2		
	e		1		
	Total		**10**		

5	a		2		
	b		2		
	c		2		
	d		2		
	e		2		
	Total		**10**		
6	a		1		
	b		1		
	c		1		
	d		1		
	e		1		
	f		1		
	g		1		
	h		1		
	i		1		
	j		1		
	Total		**10**		
Paper Total			**60**		*Marks checked by:*

EXAMINATION BOOKLET

Answers are to be written in the allocatedspaces 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 anyway, pages are not to be added or removed

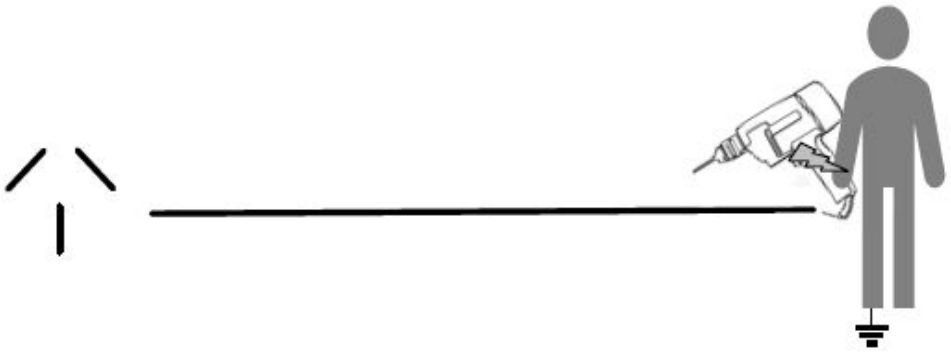
Additional space is provided at the end ofthe paper. Please label which question theanswer relates to.

Question 1

You are the Electrical Engineering Manager at a mine and have been notified that a worker hasreceived an electric 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 active conductor
- The protective earth was intact and continuity from the frame of the handheld 240 Vac power drill to 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 and via 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 thehuman body. Show all working (4 Marks)

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

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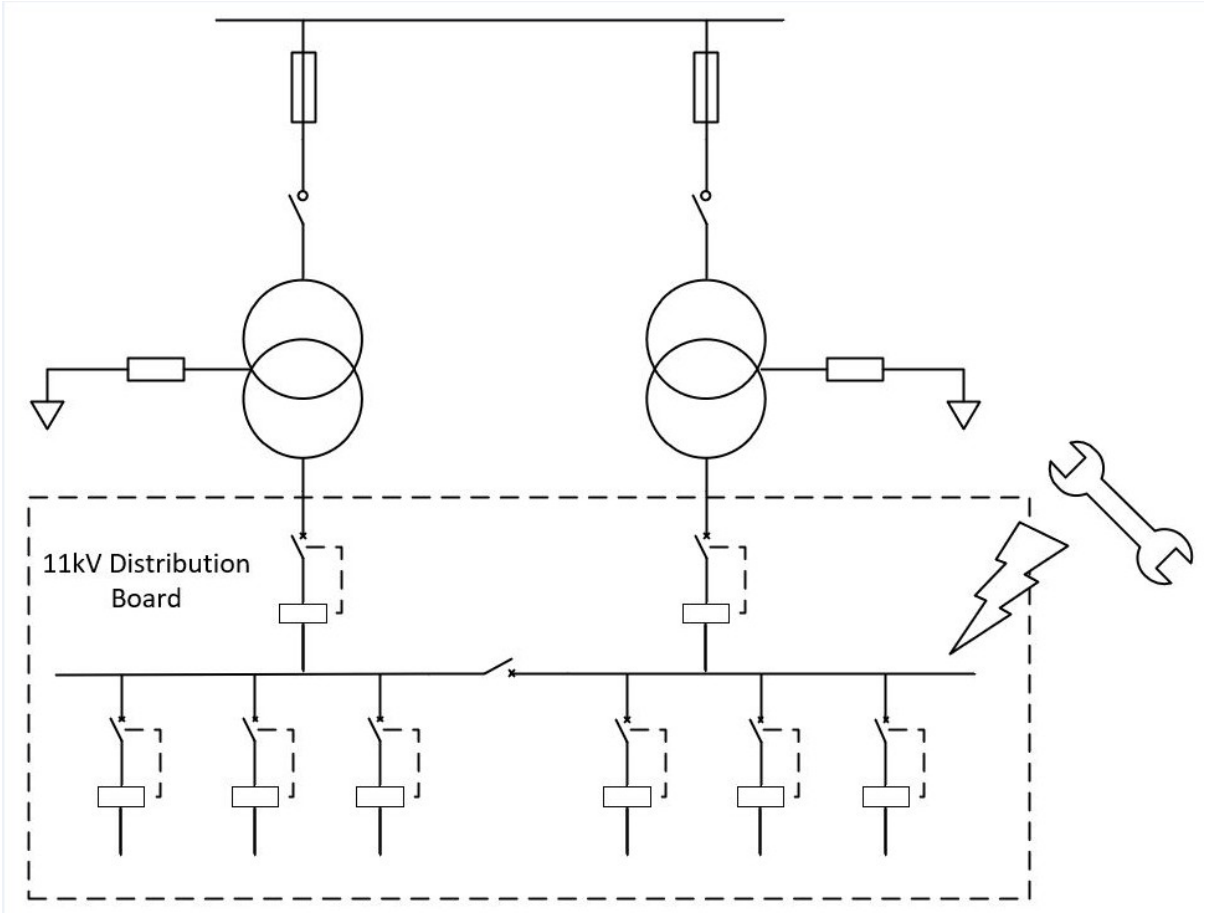
Question 2

Refer to the simple diagram below for high voltage switch yard, which includes two (2) 33/11kV 5MVA 8.2%Z transformers 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 onto the live 11kV bus.

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

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Question 3

Your mine is upgrading the system of electrically interlocking the mines main ventilation fan to theunderground high voltage power supply. The main ventilation fan is 11km from the main switch room where the underground power is switched.

a) Describe the hardware components you would expect to find in the new interlocking systemdesign to ensure safe operation. (6 marks)

b) Describe the lifecycle management of the software that forms part of the new interlockingsystem design. (4 marks)

Question 4

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 onsitethat has the 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 the160kW 415v motor will 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 any necessary 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 conveyorsystem. (1 Mark)

Question 5

You have received a safety alert from the manufacturer of your longwall shearer advising you that the type 245.3 cables supplying each of the motors has come from a cable batch that has been recently tested and the minimum conductivity of the semi conductive insulation has been found tohave deteriorated and no longer meets the requirements of AS/NZS1802:2003 *Electric cables— Reeling and trailing— For underground coal mining.*

You are going to do a risk assessment to continue operating the shearer until the end of the longwallblock.

a) Describe the test used to determine the conformance of the semi conductive insulation asper the Australian Standard? (2 marks)

b) What hazards could be created if these cables remain in service with low or no conductivityin the semi conductive insulation? (2 marks)

c) What are the current risk controls that are in place for the hazards associated with using electrical cables on the longwall face? (2 marks)

d) What are the attributes of the type 245 cable that make it suitable for the application on the shearer? (2 marks)

e) What changes to the mines safety management system would this issue generate? (2 marks)

Question 6

Define the following electrical protection related terms and acronyms: (10 marks, 1 mark for eachquestion)

a) EIC

b) Blocking scheme

c) CT burden

d) IDMT

e) TCC

f) Differential protection

g) DOLF

h) BIL

i) Buchholz protection

...

j) Motor Service Factor

End of examination paper

CANDIDATE NUMBER: _____/_____

EXAMINATION: Electrical engineering manager

EXAM PAPER: CEE2 – Electrical engineering applied to underground coal mines

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

EXAMINATION FOR CERTIFICATE OF COMPETENCE TO BE AN ELECTRICAL ENGINEERING MANAGER OF UNDERGROUND COAL MINES

Work Health and Safety (Mines and Petroleum Sites) Act 2013

Work Health and Safety (Mines and Petroleum Sites) Regulation 2014

INSTRUCTIONS TO CANDIDATES:

Legislation to be assessed:

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Work Health and Safety (Mines and Petroleum Sites) Act 2013

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1	a		5		
	b		5		
	Total		**10**		
2	a		1		
	b		3		
	c		1		
	d		2		
	e		2		
	f		1		
	Total		**10**		
3	**Total**		10		
4	a		2		
	b		2		
	c		2		
	d		2		
	e		2		
	Total		**10**		
5	a		4		
	b		4		

	c		2		
	Total		**10**		
6	a		2		
	b		4		
	c		2		
	d		2		
	Total		**10**		
7	a		1		
	b		2		
	c		3		
	d		2		
	e		1		
	f		1		
	Total		**10**		
8	a		2		
	b		1		
	c		1		
	d		2		
	e		1		
	f		2		
	Total		**10**		
9	a		5		
	b		2		

	c		3		
	Total		**10**		
10	a		2		
	b		2		
	c		4		
	d		2		
	Total		**10**		
11	b		4		
	bi		1		
	bii		1		
	biii		1		
	biv		1		
	bv		1		
	bvi		1		
	Total		**10**		
12	a		2		
	b		2		
	c		2		
	d		2		
	e		2		
	Total		**10**		
Paper Total			**120**		*Marks checked by:*

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Question 1

The provision and integrity of critical electrical infrastructure can have a significant impact when responding to emergency situations. The *WHS (M&PS) Regulation 2014* prescribes a number of measures to be addressed.

a) Describe the legislated requirements for fixed communications devices at an underground coal mine? (5 marks)

b) Describe the legislated requirements for fixed devices used to determine or monitor the presence of gas at an underground coal mine? (5 marks)

Question 2

With reference to Australian Standard *AS/NZS 1802 Electric Cables - Reeling and Trailing - ForUnderground Coal Mining*:

Mining cables used for underground coal operations in reeling and trailing applications are designedto be fit for purpose for their duty in a particularly harsh environment.

a) For a ‘type 245.3 Trailing Cable’, what does the ‘xxx.3’ indicate? (1 mark)

b) Draw and label a typical cross-sectional diagram of a ‘type 245.3 Trailing Cable’. (3 marks)

c) A feature of this cable is it is a ‘symmetrical cable’, what are the benefits of this? (1 Mark)

d) Describe (2) two additional critical features of this cable design. (2 marks)

e) *AS/NZS 1747:2003 Reeling, Trailing and Feeder Cables Used For Mining - Repair, Testing AndFitting Of Accessories* lists eight (8) pre-repair tests which need to be carried out on every mining cable when sent to a licensed repair workshop. Describe four (4) of those tests. (2 marks)

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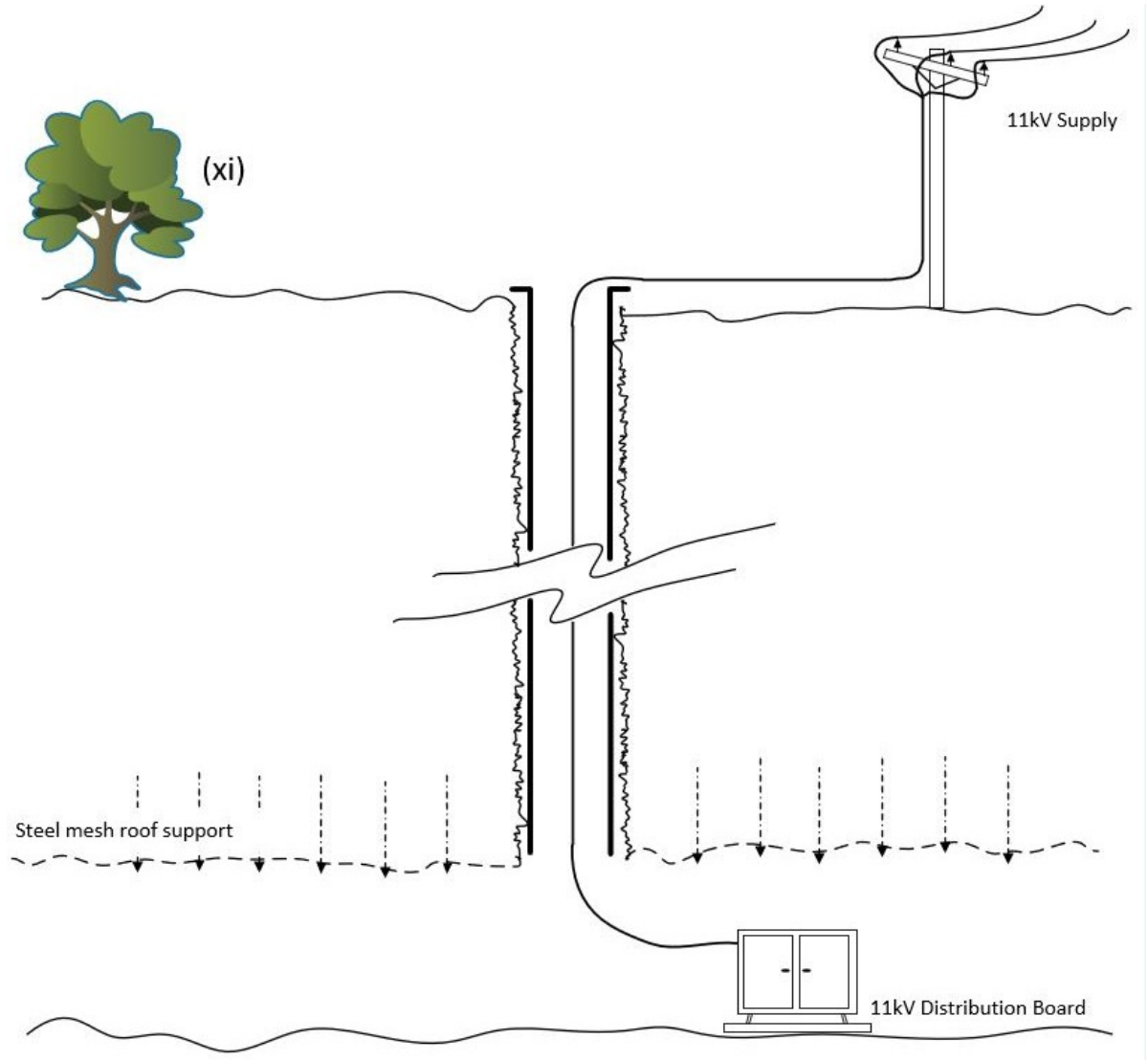
f) What equipment would you typically find this cable installed on, in an underground operation? (1 mark)

Question 3

Advancing underground workings and infrastructure require the installation of an 11000V supply viaa surface to seam borehole. Add to the drawing below and provide a brief description of the controlmeasures you would apply to the installation design to mitigate the transfer of hazardous voltages to underground parts of the mine. (10 marks)



Answer e.g. - (xi) *trees to be deciduous*

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Question 4

In reference to *AS/NZS 60079.25 Intrinsically safe electrical systems contain specific requirements forconstruction and assessment of I.S systems*:

a) Connect the devices below (*Figure 1*) to form a simple intrinsically safe circuit. (2 marks)

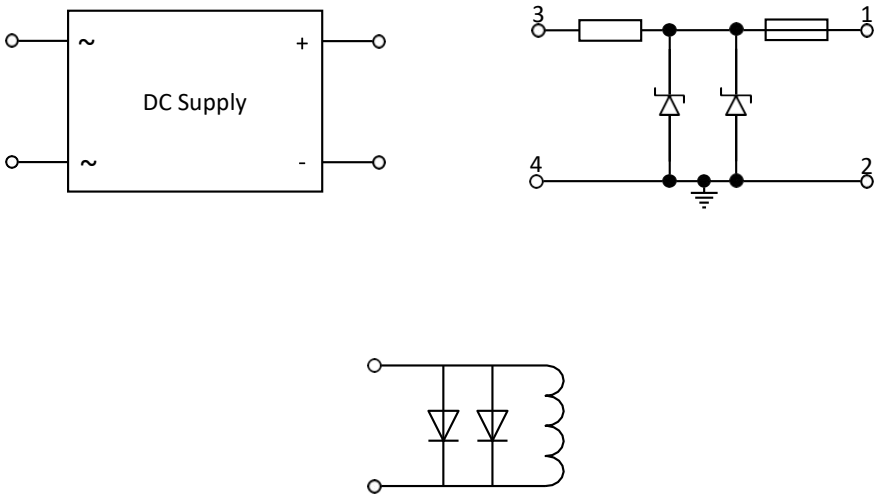

Figure 1

b) When determining the suitability of a cable for use in an intrinsically safe circuit, what cableparameters would you require? (2 marks)

c) Parameter matching and Ex marking. (2 marks) Circle most correct answer:

i. Which certification would be suitable for the longwall face?

a. Ex e d m (ib) I IP66 T5

b. Ex db [ia Ga] IIC Gb

c. Ex e d m (ia) I IP66 T3

d. Ex ma IIC T4 Da

ii. Which combination of certified components maintain an intrinsically safe system?

a. Vo-12.1V, Co-1µF, Lo-0.0µH & Vi-11.0V, Ci-1.1µF, Li-0.01µH

b. Vo-12.1V, Co-1µF, Lo-10.0µH & Vi-12.8V, Ci-0.1µF, Li-0.001µH

c. Vo-12.1V, Co-1µF, Lo-0.0µH & Vi-12.1V, Ci-1.1µF, Li-0.0µH

d. Vo-12.1V, Co-1µF, Lo-0.0µH & Vi-12.8V, Ci-1.1µF, Li-0.10µH

d) Explain the significance of Ex equipment certifications marked with the symbol "U" and symbol "X". (2 marks)

"U"

"X"

e) Describe the requirements you would include in your safety management plan for the testing of intrinsically safe circuits in the hazardous zone. (2 marks)

Question 5

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 minesand 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 devicesmay eliminate or mitigate the risks of hazardous touch voltages. (4 marks)

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b) For two (2) of the devices you have nominated above, describe the testing methods in detailthat would be undertaken to ensure the devices operate correctly. (4 marks)

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c) Describe two (2) locations at a surface operation where *AS/NZS 2081* compliant equipmentwould be used. (2 marks)

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Question 6

You have taken responsibility for a mine site which has a 1970s vintage underground 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 notbeen 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 managingany hazards during the lifecycle of this distribution board. (4 marks)

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

d) What should be considered with respect to the ventilation arrangements for theunderground switch room? (2 marks)

Question 7

AS/NZS 3800:2020 Electrical equipment for explosive atmospheres—Repair and overhaul gives instruction, principles of a technical nature on the repair, overhaul reclamation and modification ofequipment designed for use in explosive atmospheres.

a) What are the two (2) key requirements a repair workshop must satisfy before it can overhaulexplosion protected equipment for a NSW coal mine? (1 mark)

b) Within the appendixes of this standard *AS3800*, the terms *Normative* and *Informative* areused. What is the meaning of these with respect to the standard? (2 marks)

Normative

Informative

c) Appendix ZG describes pull test method for a threaded hole repair. With the aid of a labelled sketch, describe how this test is carried out. (3 marks)

d) If the mine does not have a certificate of conformity for an item of Group I flameproof equipment, can the workshop overhaul it to the standard and supply a declaration that it issafe to use? Explain your answer. (2 marks)

e) What do the following markings symbolise? (1 mark)

f) What qualification must the responsible person for the workshop have? (1 mark)

Question 8

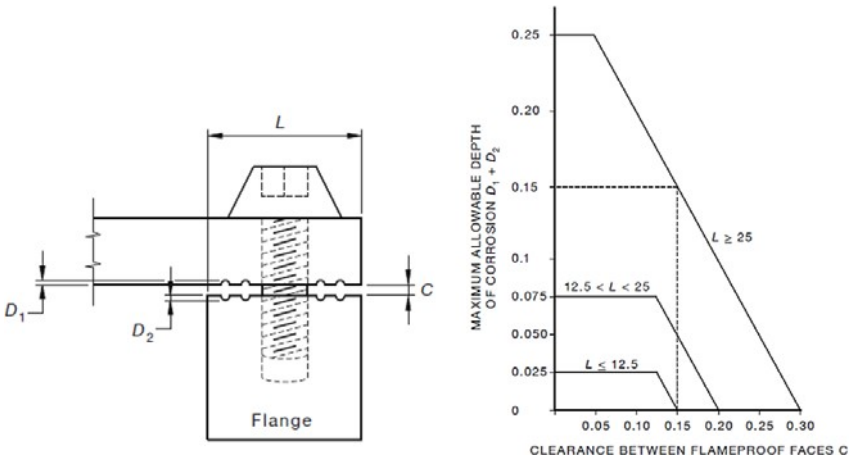
AS/NZS 2290.1 2014 Electrical equipment for coal mines – Introduction, inspection and maintenance sets out requirements for the inspection and maintenance of electrical equipment designed for use in hazardous areas in and around underground coal mines.

a) The standard outlines pre-overhaul audit requirements. From the standard, what is thepurpose of a pre-overhaul audit and who should be consulted? (2 marks)

b) What time frame does the standard recommend for the pre overhaul audit of mobileequipment? (1 mark)

c) What time frame does the standard recommend for Motors and Cable reels to beoverhauled? (1 mark)

The standard sets out corrosion or surface indentations tolerances in Appendix B.



After inspecting indentations on a flame path, you find D1 measures 0.08mm and D2 measures 0.06mm and C measures 0.1mm. From the certification drawings the flame path length is 40 mmand the maximum allowable flame path gap is 0.2mm.

d) What are you actions with respect to these indentations? (2 marks)

e) Does the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 requirecompliance to *AS/NZS 2290.1:2014*? (1 mark)

f) Explain the process you would follow to extend the in-service life of a continuous miner pastits four (4) year overhaul as recommendation in the standard. (3 marks)

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 healthand safety. AS/NZS IEC 31010:2020 Risk management - Risk assessment techniques* describes variousrisk assessment techniques to assist in identifying, analysing and evaluating risk.

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

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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 Work Health and Safety Regulation 2017 Clause 37. (3 marks)

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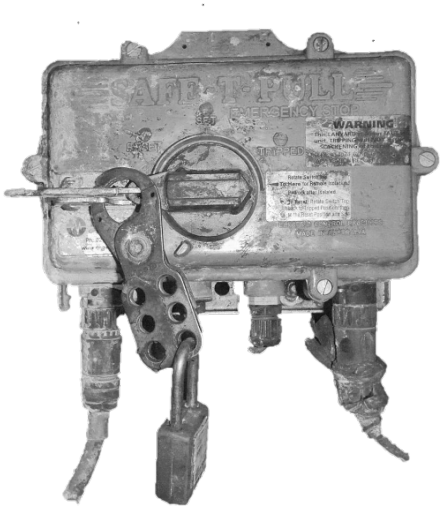
Question 10

You are investigating an incident that occurred at your site where a worker has fallen from an underground conveyor belt and suffered significant injuries when the conveyor unexpectedly started. The worker had used the mine's remote isolation system before climbing on to the conveyorand his lock was still in place when the incident occurred.



a) Nominate two Australian standards that would apply to the remote isolation system. (2 marks)

i

ii

b) The requirements of clause 32 Electrical safety part (m) of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 may apply to this incident. What does it say? (2marks)

...

c) Describe the methods the worker could use to verify the isolation is successful and how theverification methods could fail and contribute to the root cause of this incident? (4 marks)

d) Pre-start alarms are used on underground conveyors. What are their key features thatminimise the risk to workers? (2 marks)

Question 11

Clause 47 of the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 describes mandatory requirements for winding systems.

Clause 47 (b) requires; *control measures to prevent, so far as is reasonably practicable, any shaft conveyance from overwind, moving at an unsafe speed, excessive acceleration and deceleration and uncontrolled movement*.

Further to these requirements *NSW Government Gazette No 26 of 7 February 2020 Registration of Powered Winding System* requires all vertical shaft winding systems must be designed to meet the design requirements of the *Technical reference guide - Powered winding systems.*

a) Describe the location and purpose of each tachometer or encoder you would specify for the installation on your new shaft friction winder to facilitate compliance with this requirement. Use diagrams if required. (4 marks)

NSW Government Gazette No 26 of 7 February 2020 Registration of Powered Winding System requires all vertical shaft winding systems be designed to meet the design requirements of the *Technical reference guide - Powered winding systems, including Part 5: Winder control systems.*

b) With reference to the Technical reference guide;

i. What is *Stop category 1?* (1 mark)

ii. What is the minimum safety integrity level (SIL) specification of an *ultimate safetycircuit*? (1 mark)

iii. What is *Gear loss protection?* (1 mark)

iv. What are *Proof tests* (1 mark)

v. What is a *Torque-sensing circuit?* (1 mark)

vi. Winder drums should be provided with an overspeed device set to operate at whatpercentage of the nominated winder speed? (1 mark)

Question 12

Legislation requires significant controls for electrical equipment in a hazardous zone.

a) How does the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 define a
Hazardous zone at an underground coal mine? (2 marks)

b) As defined in the Work Health and Safety (Mines and Petroleum Sites) Regulation 2014 Clause 79, what is the mandated criteria for the use of non-explosion protected electrical apparatus in the hazardous zone? (2 marks)

c) A cable may be used in a hazardous zone where the concentration of methane in the general body of the air is 1.25% by volume or greater only if? (2 marks)

i

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d) The Work Health and Safety Regulation 2017 defines an atmosphere as a hazardous atmosphere if? Complete the definition: (2 marks)

the concentration of flammable gas, vapour, mist or fumes
……

e) Australian and New Zealand Standard *AS/NZS 3000:2018 Electrical installations* defines a
hazardous area as? (2 marks)

End of examination paper