



mineral resources

Department:
Mineral Resources
REPUBLIC OF SOUTH AFRICA

MINE ENGINEER'S CERTIFICATE OF COMPETENCY EXAMINATION

MINES AND WORKS - PLANT

DATE: 04 JUNE 2018

TOTAL MARKS: 100
TO PASS: 50

TIME ALLOWED: 3 HOURS
(09H00 to 12H00)

NOTE:

- This question paper consists of **ELEVEN** pages including cover page.
- Section A, Questions 1 to 3 are **COMPULSORY**. Section B, choose 2 questions of your choice.
- All answers are to be presented in a neat and decipherable manner. Papers will not be marked if not decipherable.
- The use of highlighters is not allowed.
- Do not use a red pen.
- Read the instructions on the front page of your answer book carefully.
- No cellular phones shall be allowed in the examination venue.
- The use of computers, laptops and palmtops are prohibited.
- The use of programmable calculators are not allowed.

Question 1

You have been transferred from the production section of a deep level mine to your new position as the Shaft Engineer at an adjacent shaft. Your legal responsibility now increased and includes amongst others:

- Four winders on surface and three winders situated underground servicing the sub vertical shaft.
- To ensure that the winders operate safely and that all safety devices are in operation.
- To conduct dynamic tests on the winders periodically.

The man winder is due for its dynamic test and during the test you received the following test results. By looking at the trace you need to determine if the winder is safe or not.

You have the following winder data.

AVERAGE DRUM CIRCUMFERENCE	13,79 m	MAIN SUPPLY PRESSURE	14-16 Mpa
CONTROLLER FAST GOVERNOR SPEED PER m/s	70,10	WORKING STROKE OL	UL- 85 / 90
FULL DRUM TURN DIVISIONS	34,00 divs	QUICK TAKE-UP OL	UL- 33 / 36
DRUM DIVISION SPACING	0,46 m	CONDITION OF BRAKE LINING OL	UL- CHECKED
MASS OF TEST LOAD	5,50 tons	QUICK TAKE-UP LEAK RATE	UL-OL 0 / 0
DISTANCE FROM BANK TO CATCH PLATE	m	CUSHION SPRING STOPPER LENGTH	UL-OL 25 / 25
O/L BRAKE GAP MARK	No. 12	CUSHION SPRING LENGTH OL	UL- 290 / 295
U/L BRAKE GAP MARK	No. 34	SPRING NEST LENGTH	UL-OL 1323 / 1305
WINDER PERMIT SPEED	15 m/s	WINDER PERMIT	34456
UNDERLAY TOP – END OF WIND CAM - LANDING SPEED	1,22 m/s	UNDERLAY MEN OVERWIND DISTANCE ABOVE BANK. MEN POS. TOP DECK	1,80 met
UNDERLAY TOP – LANDING SPEED TRIP TO STOP DISTANCE	1,17 m	UNDERLAY MEN UNDERWIND DISTANCE BELOW STATION MEN POS.	5,50 met
OVERLAY TOP – END OF WIND CAM - LANDING SPEED	1,21 m/s	OVERLAY MEN OVERWIND DISTANCE ABOVE BANK. MEN POS. TOP DECK	1,80 met
OVERLAY TOP - LANDING SPEED TRIP TO STOP DISTANCE	1,26 m	OVERLAY MEN UNDERWIND DISTANCE BELOW STATION MEN POS.	5,50 met
UNDERLAY BOTTOM – END OF	1,20 m/s	UNDERLAY BRAKE HOLDING POWER	5000 Amps

WIND CAM - LANDING SPEED			
UNDERLAY BOTTOM - LANDING SPEED TRIP TO STOP DISTANCE	1,05 m	UNDERLAY POSITION OF CONVEYANCE ABOVE LOADING BOX	1 TURN
AVAILABLE STOPPING DISTANCE (m)	70,19 m	REMAINING DISTANCE TO LANDING (m)	37,44 m
OVERLAY BOTTOM – END OF WIND CAM - LANDING SPEED	1,17 m/s	UNDERLAY MOVEMENT OF DRUM	NIL
OVERLAY BOTTOM - LANDING SPEED TRIP TO STOP DISTANCE	1,22 m/s	OVERLAY BRAKE HOLDING POWER	5000 Amps
OVERLAY MOVEMENT OF DRUM	NIL	OVERLAY POSITION OF CONVEYANCE ABOVE LOADING BOX	1 TURN
CONDITION TESTED	LOADED	OVERLAY MOVEMENT OF DRUM	NIL
AMPS NEEDED TO LIFT MAXIMUM PERMITTED WEIGHT	2200 Amp	CONDITION TESTED	LOADED

By analysing the dynamic test results from the attached trace (The trace to be submitted with the answer book) determine the following:

- 1). State at what speed the winder tripped and indicate this point on the graph. (2)
- 2). Determine and state the brake delay and indicate this on the graph. (2)
- 3). Determine the time from trip to stop and indicate this on the graph. (1)
- 4). Determine the maximum and average rate of retardation. (3)
- 5). Determine the distance the winder travelled from trip to stop. (2)
- 6). Determine the degree of protection. $DOP = \frac{\text{avail. stop (m)}}{\text{actual stop (m)}}$ (2)
- 7). Explain your understanding of the term landing speed and why it is important. V_{trip} . (2)
- 8). In your opinion what safety device will prevent you from making an overwind and is this winder safe for use? *Ally* (2)
- 9). By looking at the trace there is an indication that there is a problem with the brakes. Indicate on the graph where would you see this and give a short explanation why you would say this. (4)

[20]

Question 2

You have been appointed as a services engineer on a gold mine. One of your responsibilities is to make sure that the electrical reticulation is safe and reliable. During your first two months at the shaft you had several problems with major power failures and this caused extensive damage to the rotating equipment on the shaft. You investigated the damage and came to the conclusion that there are several instances of floating earth faults on the shaft. You need to rectify the problem and you want to make sure that the maximum earth current flowing will be between 7 and 10 Amps.

~~NEC~~ use NEC $R = \frac{V}{I}$

The system must be continuous rated for this current. You have a 6600/525 Volt 3 wire system underground.

2.1) What earthing system will you implement? Draw a simple diagram explaining the implementation of the system.

NEC
(5)

2.2) What will the configuration be of the devices implemented to ensure 10 Amps continuous?

series :
(2) Y-Δ

2.3) What are the advantages of the system implemented?

Avoid fault N.
limit I_{FLC}
protect equip

(3) NEC only

2.4) What are the disadvantages of this system? spec, cost, maintenance

(3)

2.5) Explain what the term floating earth or floating neutral means.

(3) Circ. I between
main & circuit

2.6) How would you detect that you have an earthing problem on the mine?

(2)

2.7) What is your understanding of the term sustained earth fault?

(2)

Down to E.M

[20]

Question 3

You have been appointed as the Production Engineer on one of the deep level shafts in South Africa. You have been the engineer for four months and one evening you get a phone call and the control room relayed a message to you that an electrician has been electrocuted on a newly established raise bore site on the shaft. You have no knowledge of the work that was scheduled for that evening on the site. The electrician that was electrocuted was a contract electrician for the raise bore company.

The following evidence was gathered.

x HIRA
x permission to
work
x (COP) SOP

- 1) An electrician was busy cleaning the drive enclosure of the raise bore machine consisting of a DC drive, an outlet choke and secondary circuit to the hydraulic power pack. The circuit breaker feeding the hydraulic system was isolated. EL
- 2) The electrician was not touching any live part due to the plexiglass covers over the high speed drive fuses. The cover only extended to the top of the outlet choke. Connections at the back of the choke was exposed. ES
- x 3) The emergency stop of the control panel was not depressed or operated. ES
- x 4) The operational lockout key was in the possession of the scoop operator that was busy removing the drill chips. ES
- 5) The total power usage of the installation was 750 kVA during normal operation. Incomer breaker at the drive enclosure was an 850 Amp motor breaker. ER
- 6) The incomer breaker box door was locked with a lock that was used to prevent persons opening the lid during normal operations. ES
- x 7) The electrician was using "Handy Andy" to clean the drive enclosure. At his toolkit there was no evidence of a test instrument. ES

EC

8) The distribution box feeding the site was open and the breaker was removed and by-passed by connecting the incoming and outgoing leads with busbars. The breaker removed was a 400 Amp breaker. *wrong breaker removed.*

ES

9) At the station substation the breaker feeding the equipment up to the raisebore site was a 650 Amp breaker. On close investigation you saw the trip coils in the breaker was removed. *impossible*

ES

Taking the above evidence into consideration and making certain assumptions, answer the following questions.

3.1 What are the main contributing factors of the accident according to the following categories.

3.1.1 Root Cause (2)

3.1.2 Electrical reticulation (2)

3.1.3 Electrical Safety (2)

3.1.4 General Operating / Safety Procedure (2)

3.2 Why would the electrician use "Handy Andy" to clean the drive enclosure? *Not norm. But used to clean yst & dust. ... exposure. View of links. old level. ...* (1)

3.3 If you look at the evidence how could the electrician be electrocuted if he did not touch any live conductor. (1)

3.4 In electrical terms what do you understand by the meaning of the following terms

3.4.1 Cascading *- failed lower breakers trip before succeeding CB trip* (2)

3.4.2 Electrical Discrimination *-* (2)

3.5 Taking the groupings in 3.1 above what will you put in place to ensure the accident does not happen again (6)

[20]

*1000 x 1000
T_{fault} = 1/12*

Section B – Choose only TWO questions in this section [40]

Question 4

You have been appointed as a services engineer on a platinum mine. One of your responsibilities is to make sure that you de-water the shaft. During your first two months at the shaft you had several problems with your pumping system. One of the problems is that your high pressure clear water pumps are failing at an alarming rate. On investigation, you gathered some information and you need to rectify the problems. You need to redesign or reconfigure the pump station to give you optimum performance.

The pump station in question has the following equipment:

- a) 2 x 8 mega litre dams
- b) 4 x 12 stage Sulzer high pressure pumps delivering 250 l/sec each
- c) 2 x positive displacement slurry pumps
- d) The main motors are 4 mW Induction Motors
- e) There are 3 x 400 mm steel shaft columns in fair condition.
- f) Pump station is located on level X and it is 1364 m from surface with a horizontal distance of 300 m on surface into an open ended pipe to the collection dam.
- g) All pumps and motors has forced lubrication.

4.1) With reference to the above draw a neat single line diagram with all the necessary equipment needed to ensure the pump will run without any problems. Also make sure that both dams are connected in parallel but with the facility to be able to isolate the dams from each other. All four pumps need to be able to receive water from either of the dams. All four pumps need to

pump into all 3 columns or be able to pump into selected columns of your choice. (6)

4.2) Give a short explanation on what “Water hammer” is and how you stop it from happening? (2)

4.3) How would you safeguard your shaft columns from failing (bursting) if your pumps should trip taking into consideration the condition of the columns? (2)

4.4) What safety device / system will you install to prevent the operators to stop and start the pumps at will, taking into consideration that you will have one pump running at any given time? (2)

4.5) What will the start-up current be of the pumps if you should start two pumps simultaneously and what effect will that have on the power system? (3)

4.6) After the redesign, this pump station should run automatically. In your opinion what safety devices and sequence would you implement to make sure that it will run as it should? (5)

[20]

Question 5

5.1 You are an engineer appointed in a processing plant. Three mills have liquid starters installed to start the mill motors. You have endless problems with the solution and you need to test the strength of the solution.

How would you do the test to ensure the solution is of the correct strength to be able to start the mill motors properly? (10)

5.2 A used 3-phase, 8-pole, 50-Hz motor was salvaged and is to be considered for a special duty.

The following information was obtained after some extensive tests and measurements:

*Direct Start
Conductivity*

- Full load slip 3%
- Rotor resistance 0,0015 Ω /phase
- Standstill reactance 0,0047 Ω /phase

Find the ratio of maximum to the full load torque and the speed at which maximum torque occurs. (10)

[20]

Question 6

6.1 A chairlift installation must convey 400 persons per hour up a 25° incline through a vertical height of 250 m by means of chairs suspended from chain driven carriers running on a rail circuit.

Both landings are horizontal and 22 m long. The velocity of the traction chain is 1.5 m/s and its mass is 7 kg/m. The mass of each carrier is 5 kg while that of the chair is 15 kg.

Assume that the friction factor is 400 N/tonne and calculate:

- (i) the pull in the chain at the driving sheave, and
- (ii) the torque transmitted by the driving sheave and shaft.

Assume that the driving sheave is designed to suit a distance of 900 mm between the centres of the passing chairs. (15)

6.2 Describe how the brakes are dynamically and statically tested on a chairlift. (5)

Dyn - load cement (75 kg) 2 bags up coming. raise slowly. I_{FL} .

Stat - I_{FL} & hold brakes must hold (5 sec)

[20]

Question 7

7.1 Why is a two-part tariff used by electricity supply authorities to bill bulk consumers and how is this applied? (1) MD (2) kW/h usage (6)

7.2 The underground haulage of a mine and some rooms and passages on surface are equipped with 60 W incandescent globes. One of the energy saving drives of the mine is to replace the incandescent globes with Light Emitting Diodes (LED) lights. The cost to change a globe is R15-00 for either and it includes travelling time from globe to globe.

Data:

Quantity of incandescent lights	1 580
Power output of LED's	5 W
Power factor of LED's	0,8
Price per energy unit	R 1.40/kWh
Price per apparent power unit	R 22.50/kVA
Lamp life of a LED	15 000 hours
Lamp life incandescent	1 000 hours
Price of an incandescent	R 5-00
Price of a LED	R 60-00

7.2.1 Calculate the cost in replacing the incandescent globes with the LED's (7)

7.2.2 What will the impact be on the total electrical account? (3)

7.2.3 Propose some other feasible ways to save energy on the mine. (4)

[20]

TOTAL [100]