Minerals Council South Africa

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CHAMBER OF MINES OF SOUTH AFRICA

~~EXAMINATION PAPER~~

MEMORANDUM

SUBJECT: **CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL - PAPER 4** **SUBJECT CODE: COMMEC4** **EXAMINATION DATE: 12 OCTOBER 2018** **TIME: 14:30 – 17:30**	**EXAMINER: R A Rabaji** **MODERATOR: A R Nundlall** **TOTAL MARKS: [100]** **PASS MARK: 60%**

Examination Instructions:

This examination question paper consists of **3** pages

1. Answer all ~~5~~ questions in *English*.
2. Put your identification number on the outside cover of each book used, and on any graph paper or other loose sheets handed in.

   NB: Your name must NOT appear on any answer book or loose sheets.
3. Show all calculations **and check calculations on which your answers are based**.
4. Hand-held electronic calculators may be used for calculations only.
5. Write in ink on the **right hand page** only – the left hand page will not be marked.
6. Illustrate your answers by means of sketches or diagrams wherever possible.
7. Answers must be given to an accuracy which is typical of practical conditions.

   NB: Ensure that the correct units of measure (SI unit) are recorded as marks will be deducted from answers if the incorrect unit is used (even if the calculated value is correct).
8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. This is **NOT** an open book examination but the approved formula hand out may be used.
11. Cell phones are **NOT** allowed in the examination room

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QUESTION 1

(1.1) An underground trackless section is using the following diesel powered rubber tyre equipment, 132 kW LHD vehicle with exhaust flow rate of 0.30m^3/s, 165 kW dump truck with exhaust flow rate of 0.25m^3/s (both de-rated), an electrically driven drill rig, auxiliary vehicles such as a 45 kW scissors lift and a 41 kW utility vehicle.

a) Name six major airborne pollutants emitted from diesel engines, and their respective Occupational Exposure Limits (OELs) **(6)**

b) Determine the quantity of air required in the section with an air ratio factor of 0.08m/s/kW. **(4)**

c) Calculate the amount of air required at the point of application of the LHD if the exhaust fumes contains 150ppm NO_x fumes. **(4)**

d) How much fresh air would be required if both the LHD and dump truck are operating each emitting 150ppm NO_x concentrations. **(6)**

QUESTION 2

(2.1) An inspector visits your mine to investigate an alleged exposure to fumes where the LHD caught fire in the section. Name <u>thirteen items of information</u> you will present as an appointed Sect 12.1 (MHSA). **(13)**

(2.2) Briefly explain the following terminology in terms of reducing the risk of coal dust explosions. **(7)**

a) Active workings
b) Face Area
c) Last Through Road
d) Too wet
e) Chain Road
f) Multi Road
g) Longwall

QUESTION 3

a) State five common human failing during a fire emergency. **(5)**

b) Give three swift but appropriate actions required during a fire emergency. **(3)**

c) If fires do occur, they should be _____ and _____ without delay. **(2)**

d) List the approximate percentage of CO gas produced by free burning fires for: **(10)**

- Wood
- HDPE
- LDPE
- PVC
- Phenol formaldehyde
- Polystyrene
- Polyurethane
- Rubber
- Explosives
- Diesel Fuel

QUESTION 4

You have been informed that a fire is burning in a section of the mine. Immediately after this the fire was sealed off, the barometric pressure on both sides of the wall was measured as 111kPa. On the next visit, the barometric pressure behind the wall was 118kPa and 111kPa again on the access side. The seal was also found to be leaking. If the specific resistance of the seal was estimated to be $400Ns^2/m^8$, then:-

a) Which way did the air leak through the seal?

b) What is the air quantity leaking through the seal?

c) If 20m^3/s of normal air is containing nil ppm CO, and 3000 CO_2 flows past the seal, where the air leakage from the seal contains 8% CO_2 and 2% CO by volume, determine what the ppm concentrations of these gases would be on the return side of the fire, after dilution.

d) Comment on the resultant gas concentrations and compare them with any statutory requirements. Would you allow people to continue to work downstream of the seal?

e) Determine and comment on the quantity of fresh air required to ensure that conditions comply with statutory requirements. (1**5)**

QUESTION 5

a) List any ten steps of conducting an effective risk assessment. (**10)**

b) Give **SEVEN reasons** for abnormally high flammable gas emissions. (**7)**

c) Describe the four main advantages each of creating an efficient (preferably Computerised) database of occupational hygiene and medical information to: - **(8)**

- The occupational hygienist
- The occupational medical practitioner

TOTAL MARKS: 100

Model Answers:-

Question 1

(a)

- Carbon monoxide (CO) 30ppm
- Carbo dioxide (CO_2) 5000ppm
- Sulphur dioxide (SO_2) 2ppm
- Aldehydes 2ppm
- Nitric oxide (NO) 25ppm
- Nitrogen dioxide (No_2) 3ppm

(b) Equipment kW = (132 + 164 + 45 + 41) kW
= 382kW

The amount of air required = total rated kW x factor
= (342 x 0.08) m^3/s
= 30.56 m^3/s
= 30.6 m^3/s

(c) The quantity of NO_x emitted when operating LHD = $Q_{exhaust\ LHD}$ x $\%NO_x$
= 0.3 x 0.015/100
= 0.000045 m^3/s

The amount of fresh air required can now be determined:-

$$Qgas = \frac{\text{Qgas x } 10^6}{\text{MAC}-\text{N}} - Qgas$$

$$Qgas = \frac{0.000045 \text{ x } 10^6}{3-0} - 0.000045$$

= 14.999, say 15.0 m^3/s

(d) The quantity of NO_x emitted when operating truck = $Q_{exhaust\ truck}$ x $\%NO_x$
= 0.25 x 0.015/100
= 0.000038 m^3/s

The combined Qty of NO_x emitted when operating truck & LHD
= (0.000045 + 0.000038) m^3/s
= 0.000083 m^3/s

Therefore the total fresh air required $Qgas = \frac{\text{Qgas x } 10^6}{\text{MAC}-\text{N}} - Qgas$

$$Qgas = \frac{0.000083 \text{ x } 10^6}{3-0} - 0.000083$$

= 27.499, say 27.5 m³/s

Question 2

(a)

- Number of persons exposed
- Results of exposure
- Place of exposure
- Time of exposure
- Possible cause or causes of exposure
- Reason for cause of exposure
- Preventative measures that should have been taken
- Whether a breach of Regulations was the cause of exposure.
- Preventative measures taken to avoid another such exposure.
- Sketch of place of occurrence.
- Prevailing conditions at time of exposure.
- Latest ventilation report (if applicable)
- Time when the environmental control department was notified

(b)

- **Active workings** – workings of any kind, which are primarily in use for travel or working connection with the production operations of the mine
- **Face Area** – an area within 180m from the coal face being worked
- **Last through road** – the closest holing to the working faces between two companion roadways, which carry a unidirectional flow of air from the intake to the return of the section
- **Too wet** – when coal dust sample of finely divided material is placed om a 2 mm aperture sieve for at least one minute to permit drainage of excess water, and the resultant material when squeezed in the hand exudes water
- **Chain road** – a two or three road mechanical miner development section, which delineates the future longwall panels.
- **Multi road** – mechanical miner section with four or more roads which delineates longwall mining blocks.
- **Longwall** – refer to all total extraction sections, regardless of panel width

Question 3

(a)

- Failure to detect a fire early
- Failure to communicate the danger quickly and sufficiently
- Panic or bravery that leads to irrational and often dangerous actions
- Frequent into inability to use fire extinguishing medium
- Tendencies to stick to normal familiar routes and ignore escape routes

(b)

- Give warning if none has been given
- Evacuate the area in a safe and orderly manner
- Fight the fire at the source if it is safe to do so

(c)

- detected
- extinguished

(d)

- 2 to 5%
- 10 to 15%
- 5 to 15%
- 10%
- 30%
- 20%
- 40%
- 1.2 to 4.0m3
- Depends on the type of engine, quality of fuel & maintenance

Question 4

a) Air moves from a high pressure to a low pressure, 118kPa to 111kPa, therefore the air is leaking out of the sealed area.

b) The rate of air flow from the seal area has to be determined by using the well-known formula $P - RQ^2$

$$Q = \sqrt{\frac{\Delta P}{R}}$$

$$Q = \sqrt{\frac{7000}{400}}$$

$$= \quad 4.18 \text{ m}^3/\text{s}$$

Note:- (this is very high for a sealed off area)

a) Gas quantities leaking from the fire area:-

Quantity of CO = %CO x Q $_{\text{from sealed area}}$

= 2/100 x 4.18

= 0.0836 m^3/s

Quantity of CO_2 = %CO_2 x Q $_{\text{from sealed area}}$

= 8/100 x 4.18

= 0.3344 m^3/s

Quantity of CO_2 in normal air = %CO x Q $_{\text{normal air}}$

= 0.3/100 x 20 (3 000ppm = 0.3%)

= 0.06 m^3/s

The total quantity flowing after the two air streams have mixed, to be determined:

= 20 + 4.18

= 24.18 m^3/s

This mixed air contains gas concentrations of :

CO_2 = 20 + 4.18

= (0.3344 + 0.06) m^3/s

= 0.3944 m^3/s

CO = 0.0836 m^3/s (nil CO in normal air)

= 0.3944 m^3/s

The total quantity flowing after the two air streams have mixed, to be determined:

% CO_2 after mixing = $\frac{qCO_2}{Q_{mix}}$ x 100%

= $\frac{0.3944}{24.18}$ x 100%

= 1.631% CO_2 (16310 ppm)

% CO after mixing = $\frac{qCO}{Q_{mix}}$ x 100%

= $\frac{0.0836}{24.18}$ x 100%

= 0.346% CO_2 (3 457 ppm)

b) The gas concentrations are extremely high, particularly the CO of which the statutory specification is 100ppm, this is a very serious situation. The CO_2 is also more than three times the legal requirements (5000ppm)

c) Exposure to these gases will result in fatalities, unless self-contained self-rescuers are immediately deployed , or a refuge chamber with an independent air supply is entered within ±12minutes of being exposed. (Legal limits specified in (C).

d) Fresh air quantity to dilute the gas concentrations on the return side of the fire to the maximum allowable concentration to enable work to proceed must now be calculated:-

Q_{fresh} to dilute CO_2 = $\frac{q_{gas}\ x\ 10^6}{MAC-N}\ x\ q_{gas}$

= $\frac{0.3944\ x\ 10^6}{5000-3000}\ x\ 0.3944$

= 196.806 or 196.8m^3/s

Q_{fresh} to dilute CO = $\frac{q_{gas}\ x\ 10^6}{MAC-N}\ x\ q_{gas}$

$$= \frac{0.0836\ x\ 10^6}{100-0}\ x\ 0.0836$$

= 835.916 or 835.9m^3/s

Note:- To supply 836 m^3/s of fresh air is impractical and therefore the leakage through the seal must be drastically reduced

Question 5 (a)

- The assessment must be practical and realistic
- All affected parties must be involved in the process
- Use a systematic approach to adequately address all hazards and risks
- Aim to first identify the major risks
- Gather and analyse the relevant information before starting
- Start by identifying the major hazards
- Assess the risks from these hazards by looking at existing controls
- Look and record what happens in the workplace
- Include all persons at risk as well as visitors and contractors
- Record all observations in writing with any assumptions and reasons

Question 5 (b)

- Variations in ventilating current
- Different working methods i.e. bord and pillar or long walling
- Strata movement
- Variations in barometric pressure
- Permeability of the strata
- The petrographic constituents of coal
- The colloidal structure of coal

Question 5(C)

The occupational hygienist

- Easy to cross reference sampling results and exposures
- Keep records of all sampling results for all employees
- To easily transfer these results to medical practitioner
- To notify the medical practitioner of excessive exposure in order to ensure speedy diagnosis and treatment

The occupational medical practitioner

- Directly transfer sampling and exposure results to a surveillance record
- Quickly notify the occupational hygienist of medical problems or ill health, to allow investigations
- Compile regular reports as required
- Keep records of medical surveillance
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