

Minerals Council South Africa



EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL - PAPER 4 SUBJECT CODE: COMMEC4 EXAMINATION DATE: 11 OCTOBER 2019 TIME: 14:30 – 17:30	EXAMINER: R A Rabaji MODERATOR: A R Nundlall TOTAL MARKS: [100] PASS MARK: 60%
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Examination Instructions:

This examination question paper consists of **3** pages **FORMULA HANDOUT IS AVAILABLE**

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

QUESTION 1

Risk Management

- a) List six different risk assessment techniques available for identifying hazards and unwanted events. (6)
- b) An existing probability of 0,001(1/1000) is that an eye injury can occur due to wind blown dust from a rock dump. If the frequency of occurrence of windy days per annum is 50 (50/A), calculate the Risk of an eye injury. (2)
- c) A diesel driven Load, Haul and Dump (LHD) machine is to be introduced in a wide reef development area on your mine to speed up the opening of the main ore body:-
- (i) State four basic systems required to power and operate this machine . (4)
- (ii) Which three significant chemical compounds are related to this operation ? (3)
- (iii) State two energy sources involved with this machine and their health and safety hazards. (4)
- (iv) State two hazards from substances involved with this machine. (2)
- (v) Which four major risks may seriously compromise the health and safety of the workforce involved with this operation in the medium to long term. (4)

(25)

QUESTION 2

Gases

- a) A fan exhausts $6 \text{ m}^3/\text{s}$ of air from a development end. A forcing column with a 10 m overlap delivers $2,6 \text{ m}^3/\text{s}$ air onto the face. A flammable gas blower on the face emits $0,06 \text{ m}^3/\text{s}$ of flammable gas. What percentage flammable gas would be present in: (5)
- (i) The exhaust-column
 - (ii) The overlap
 - (iii) The forcing column
 - (iv) The face
- b) An airstream contains $0,6 \text{ kg/s}$ of carbon dioxide. Determine the quantity of carbon dioxide. (Assume an air density of $1,1 \text{ kg/m}^3$) (5)
- c) The total volume of a sealed-off section is 60000 m^3 and consists of an atmosphere containing 80% flammable gas. The pressure inside and outside the sealed area is 100 kPa. The starting of a nearby underground booster fan lowers the pressure outside the seal by 1,3 kPa.
- (i) If the resistance of the leakage paths around the seal is $180\,000 \text{ N s}^2/\text{m}^3$ calculate at what rate the flammable gas / air mixture inside the sealed section starts to flow around the seal.
- (ii) If the airway alongside the seal has a volume of 25 m^3 without flammable gas, what will be the flammable gas percentage in the airstream on the side of the seal immediately after starting up the fan?
Because the flammable gas / air mixture flows out around the seal, the pressure the sealed area will eventually become equal to the new pressure outside seal and the flow will stop.
- (iii) What total volume of flammable gas / air mixture will be displaced from the section before the flow stops? (10)

- d) Give five portable 'Analysis Techniques Available for Monitoring Mine Atmosphere' according to H.S. Turnbull? (5)

(25)

QUESTION 3

Fires

- a) Give ten important functions of a control room . (10)
- b) What is now recognised as the fourth component in a fire? (1)
- c) Give 14 questions that must apply if materials and equipment with the
- d) potential for a fire hazard are considered. (14)

(25)

QUESTION 4

INFORMATION MANAGEMENT

- a. Give seven main reasons for reporting? 7
- b. What may be wrong if the recipient does not understand the report? 2
- c. What are the four things to be considered when you start the report? 4
- d. What will the population and type of readership determine? 3
- e. Give the description of endnotes, footnotes and bracketed reference 3
- f. List the advantages and disadvantages of each 6

(25)

Total (100)

CERTIFICATE IN MINE ENVIRONMENTAL CONTROL
PAPER 4 - MODEL ANSWERS

QUESTION 1

a) Six risk assessment techniques

- (i) WRAC – Workplace Risk Assessment and Control (1)
- (ii) HAZOP – Hazard and Operability Study (1)
- (iii) FEMECA – Failure Modes, Effects and Criticality Analysis (1)
- (iv) JSA/JHA – Job Safety/Hazard Analysis (1)
- (v) FTA – Falt Tree Analysis (1)
- (vi) BTA – Bow Tie Analysis` (1)

b) Then the Risk of an eve injury is;

(Risk) $R = 0,001 \times 50/A$ (1)

Risk (of eye Injury) = $0.05 A$ (1)

c) (i)

- i) Internal combustion engine driven (heat energy engine) (1)
- ii) Mechanicals for loading, hauling and dumping operate on gearbox, standard drive train,suspension and hydraulic systems (1)
- iii) Machine frame and ancillaries are constructed of steel (1)
- iv) Machine travels on large pneumatic tyres (self propelled trackless machine)(1)

(ii)

- (i) Diesel oil as engine fuel (1)
- (ii) Gearbox and Hydraulic system use special oils (1)
- (iii) Rubber / plastic compounds (tyres, hoses and wiring harnesses, paint / anti-corrosive coatings, seating, cabin panels and controls) (1)

(iii)

- 1. Noise - Noise induce hearing loss / warning signs not heard (2)
- 2. Heat - Heat stress / Fires (2)

(iv)

1. The fuel and oils are flammable (1)
2. Large quantities of rubber are a fire fuel (1)

(v)

1. Heat related illness (1)
2. Noise induced hearing loss (1)
3. Respiratory illnesses due to respirable particulates (1)
4. Skin diseases due to chemical compound contact (1)

QUESTION 2

Gases

a) No matter how much air is handled by the force column, the exhaust column will handle 6 m³/s made up of 5.94 m³/s fresh air and 0.06 m³/s. The percentage CH₄ in the exhaust column can then be calculated as:

(i)

$$\begin{aligned}\%CH_4 &= \frac{\text{total quantity } CH_4}{\text{total quantity mixture}} \\ &\times 100\% \\ &= \frac{0.06}{5.94+0.06} \times 100\% \\ &= 0.010 \times 100\% \\ &= 1\%\end{aligned}$$

∴ The percentage CH₄ in the exhaust column is 1%

(ii) What percentage flammable gas would be present in the overlap section

There will be zero flammable gas in the overlap section

(iii) What percentage flammable gas would be present in the force system

There will be zero flammable gas in the force system

(iv) What percentage flammable gas would be present at the face

$$\%CH_4 = \frac{\text{total quantity } CH_4}{\text{total quantity mixture}} \times 100\%$$

$$= \frac{0.06}{0.06+2.6} \times 100\%$$

$$= 0.023 \times 100\%$$

$$= 2.25\%$$

∴ The percentage CH₄ in the exhaust column is 2.25%

- b)** An airstream contains 0,6 kg/s of carbon dioxide. Determine the quantity of carbon dioxide.(Assume and air density of 1,1 kg/m³)

Carbon dioxide has a relative density of 1.5 (this means it is 1.5 times heavier than air)

$$\begin{aligned}\text{Density of carbon dioxide} &= (1.5 \times 1.1)\text{kg/m}^3 \\ &= 1.65 \text{ kg/m}^3\end{aligned}$$

$$\text{Now} \quad M = Q \times W$$

$$\begin{aligned}\therefore Q &= \frac{M}{W} \\ Q &= \frac{0.6}{1.65}\end{aligned}$$

$$\therefore \text{Quantity of carborn dioxide} = 0.363\text{m}^3/\text{s}$$

- c) 1)** If the resistance of the leakage paths around the seal is 180 000 Ns²/m³ calculate at what rate the flammable gas / air mixture inside the sealed section start to flow around the seal.

$$P = RQ^2$$

$$\begin{aligned}\therefore Q &= \sqrt{p/R} \\ &= \frac{1300}{180\,000}\end{aligned}$$

$$= 0.09\text{m}^3/\text{s}$$

$$\therefore \text{Rate of flow of flammable gas/air mixture through the seal will be} = 0.09\text{m}^3/\text{s}$$

- 2)** 80% of 0.09m³/s flammable gas/ air leakage is pure flammable gas

∴ The quantity of flammable gas leakage

$$= \frac{80}{100} \times 0.09\text{m}^3/\text{s of } CH_4$$

$$= 0.072\text{m}^3/\text{s of } CH_4$$

After mixing with the fresh air the percentage flammable gas will be

$$\begin{aligned} &= \text{total quantity methane} / \text{total quantity mixture} \times 100 \\ &= 0.072 / (25 + 0.09) \times 100 \\ &= 0.003\% \end{aligned}$$

3) Initial pressure of mixture inside seal = 100kPa

Initial volume of mixture inside seal = 60 000m³

Final pressure of mixture inside the seal = 98.7kPa

Now using Boyles law: $P_1V_1 = P_2V_2$

$$\begin{aligned} \text{Final volume } V_2 &= P_1V_1/P_2 \\ &= (100 \times 60\,000)/98.7 \\ &= 60\,790 \text{ m}^3 \end{aligned}$$

The initial and final volume inside the seal area is 40 000 m³

∴ The total volume of the mixture displaced from the sealed area

$$\begin{aligned} &= (60\,790 - 60\,000) \text{ m}^3 \\ &= 790 \text{ m}^3 \text{ of mixture} \end{aligned}$$

d) Five portable 'Analysis Techniques Available for Monitoring Mine Atmosphere'

according to H.S. Turnbull are

- 1) Charcoal or silica gel filled glass phials
- 2) Monitoring badges
- 3) Chemically impregnated papers
- 4) Electro chemical oxidation
- 5) Detecto tubes

QUESTION 3

a) Give ten important functions of a control room .

- Strategic planning to reduce the scope of the crisis
- Ensuring good communication networks for emergency operations
- Briefing and debriefing of staff, key personnel, fire and rescue teams
- Co-ordinating fire and rescue strategies, teams and work
- Co-ordinating the involvement of all departments, internal and external services.
- Ensuring safety of all persons directly or indirectly affected by the operation

- Record keeping of all decisions, instructions, actions and the outcomes of these
- Effective managing and damage control to reduce losses
- Initial rehabilitation of the work area affected due to fire, explosion or seismic event
- THE PERSON IN CHARGE This is usually a senior official of mine manager status who takes overall charge and responsibility.

b) What is now recognised as the fourth component in a fire?

- Flames proceed chemically as branched chain reactions due to the formation of free radicals released from the pyrolysis products. These are constantly being formed and consumed as the fire progresses.

c) Give 14 questions that must apply if materials and equipment with the potential for a fire hazard are considered.

- Why must this specific product be used?
- What are the flammable properties?
- What class or classes of fire may result?
- What are the expected products of combustion?
- Is there a history of hazardous fire events regarding this product?
- What special controls or training are needed?
- Where is the product going to be used?
- Who will use or handle the product?
- How many people will use or handle the product?
- How often will the product be used?
- How much of the product will be used?
- How will the product be stored?
- How will the product be transported?
- How are any used containers and packaging disposed of?

QUESTION 4

- a. Give seven main reasons for reporting? 7
- To provide Information on the current status of work and work conditions.
 - To act on substandard conditions or practises that can increase risk.
 - To formulate policy with regard to the work processes.
 - For determining efficiencies and budgetary requirements.
 - For legislation requirements.
 - For formal Risk Management purposes.
 - To provide a history of work and work conditions for record purposes.
 - To create databases on occupational hygiene, health and safety.
- b. What may be wrong if the recipient does not understand the report? 2
- The writer is unable to express facts and data logically and clearly
 - The writer does not know precisely what to say or how to say it.
- c. What are the four things to be considered when you start the report? 4
- Be absolutely clear about your terms of reference.
 - Be sure of the expected level of commitment
 - Establish this immediately the length of the report.
 - Draw up a systematic timetable for long formal reports.
- d. What will the population and type of readership determine? 3
- The shape of the report as a whole and where to place the emphasis.
 - What information can be left out or what can be assumed the readership already knows
 - How to pitch the language, especially if it involves very technical terms
- e. Give the description of endnotes, footnotes and bracketed reference 3
- List the advantages and disadvantages of each
 - Endnotes are the least distracting, but inconvenient to find as they are at the end of a report.

- Footnotes are easy to find, but can be difficult to insert on set page layouts.
- Bracketed references are extremely convenient, but can become distracting if too many are used too often.