Chamber of Mines of South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL PAPER 3 **SUBJECT CODE: COMMEC P3 – ECONOMICS, PLANNING AND TECHNICAL LITERATIUE** **EXAMINATION DATE:** 12 OCTOBER 2017 **TIME**: 14:30 – 17:30	**EXAMINER:** M. Coelho **MODERATOR:** M. Beukes **TOTAL MARKS:** 100 **PASS MARK:** 60%
NUMBER OF PAGES: 7	

SPECIAL REQUIREMENTS:

FORMULA HANOUTS ARE ALLOWED. THIS IS NOT AN **OPEN BOOK EXAMINATION**

INSTRUCTIONS TO CANDIDATES:

1. Answer all questions **legibly** in English.
2. Write your **ID 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 the answers are based.**
4. Hand-held electronic calculators may be used for calculations.
5. Write **legibly** in ink on the **right-hand page** only – **left hand pages 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 unit 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 and clearly state any assumptions you make.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. Cell phones are **NOT** allowed in the examination room.

QUESTION 1 **[20]**

A new shaft is planned for a mine in the Limpopo region. The following data is available:

- Maximum production planned 150 000 tons per month
- Average depth of work places 2000 m
- Predicted heat load for work places 210 kW per kton broken per month
- Station Twb at average depth 25,3ºC
- Down cast shaft average diameter 9 m
- Barometric pressure at 2000 m is 105 kPa

The Sigma Heat values at the different temperatures at the mean barometric pressure are given as follows:

Temperature	**Sigma Heat (kJ/kg)**
°C	**kJ/kg**
25.3	73.5
27.0	80.3
28.0	84.6
29.0	89.0

1.1 Calculate the air mass flow rate necessary to ventilate the mine, to ensure the following reject temperatures, if no cooling is supplied. (6)

1.1.a 27ºC

1.1.b 28ºC

1.1.c 29ºC

1.2 What is the mass flow rate of air that the shaft can handle if the average density of the air is given as 1,0kg/m^3 and the average velocity in the shaft is 10 m/s? (3)

1.3 With the mass flow rate as calculated in (1.2), determine the amount of cooling that will be needed to ensure that a reject temperature of 27ºC wet bulb will not be exceeded. (3)

1.4 List three factors that can influence the underground station wet bulb temperature. (3)

1.5 The chilled water use is 1,2 ton water/ton of rock mined. Assume a typical temperature for the chilled water and determine the approximate cooling that will be delivered by the water. *(Hint use a 26 day measuring cycle)* (5)

QUESTION 2 **[20]**

In a highly mechanised mine a minimum ventilation quantity is often set by supplying 0,06 m^3/s of air per kW of diesel equipment used. Comment on this value using the following information:

The fuel consumption of a rated 40 kW diesel LHD is 8,6 kg/hr when hauling and 2,3 kg/hr when idling. The following table gives the exhaust gas analysis for the two situations:

Equipment	**Exhaust gas**	**% CO_2**	**% CO**	**% NO_x**
Idling	12.6 m^3/kg of fuel	0.73	0.04	0.0022
Hauling	62.3 m^3/kg of fuel	4.71	0.058	0.0191

The following are the maximum allowable concentrations of diesel exhaust gases in the general air stream:

- CO_2 5000 ppm
- CO 100 ppm
- NO_x 5 ppm

Assume that normal air contains 300 ppm of CO_2 and 0 ppm CO or NO_x.
{HINT: You will need to calculate the quantity of exhaust gas produced as well as the quantity of the fresh air required in both situation when the LHD idling and hauling to be able to comment on the dilution factor}

QUESTION 3 **[20]**

3.1 Two fans operate in parallel at the top of an Upcast shaft of a mine. Over the past 15 years the mines, the mines overall resistance has decreased far more rapidly than was originally designed for. As a result, these fans do not operate at the original design efficiency. The present operating conditions of these fans are:

Total fan inlet volume (both fans combined) = 660 m^3/s

Pressure at fan inlet = 6.0 kPa

Motor efficiency (including drive efficiency) = 95%

Fan efficiency = 60%

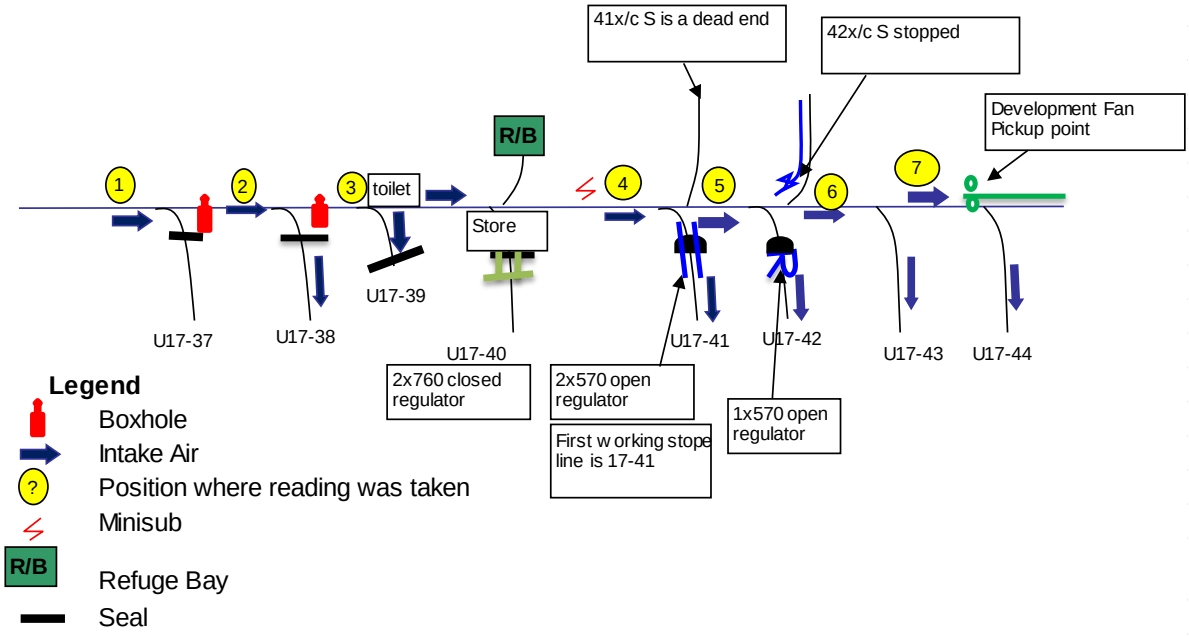
Motor input power = 6947kW

The remaining life of mine, is a further 15 years and the mine's overall resistance is not expected to decrease further. Bearing this in mind it is being considered to replace these existing fans with two new fans, designed to operate more efficiently under the prevailing conditions. These new fans would cost R 2 300 000 each, the efficiency of these fans would be 80%. It is estimated that the cost of changing the fans would be R 1 200 000 in addition to the purchase cost of the new fans.

The existing motors, will be used to drive the new fans. (the motor efficiency will remain unchanged.

An interest rate of 12% is applied and the power costs are R 1 752/kWhr. Will it be economically feasible to replace these fans submit comments with your answers? (10)

3.2 The sketch below shows the result of a volume survey. (10)



Position	Temperature		BP	Velocity	Area	Density	Humidity	Quantity	Massflow
	WB (°C)	DB (°C)	kPa	m/s	m^2	m^3/kg	%	m^3/s	kg/s
1	16.3	24.0	94.0	6.4	8.2	1.11	46.55	52.5	58.3
2	16.4	23.6	94.0	6.2	7.4	1.11	49.12	45.9	50.9
3	17.3	23.4	94.0	5.5	7.6	1.11	55.83	41.8	46.4
4	17.3	23.4	94.0	4.3	8.8	1.11	55.83	37.8	42.0
5	17.5	23.1	94.0	3.7	9.1	1.11	58.81	33.7	37.4
6	17.3	23.4	94.0	3.3	8.1	1.11	55.83	26.7	29.7
7	17.0	23.3	94.0	1.7	10	1.11	54.45	17.0	18.9

3.2.1 Calculate the half level leakage (volume from split to first working stope)? Comment on the leakage figure (3)

3.2.2 What construction work would you recommend be done to reduce the leakage and improve the volume delivered to cross cut 44? (5)

3.2.3 At a cost of R 250 000 the construction work, which took 3 months to complete, resulted in a 5 m^3/s improvement in the volume delivered to crosscut 44. The cost of 1m^3/s of air is 1 000 000 per annum. Calculate the payback period? (2)

QUESTION 4 **[20]**

4.1 Name six (6) factors that govern the air volume requirements when designing a shaft system (6)

4.2 Name five (5) factors to be considered when designing an up-cast shaft and a fan drift. (5)

4.3 When testing ventilation systems use is made of airflow and pressure readings. Why are these tests performed on these systems (name 5)? (5)

4.4 Name four (4) factors to considered when planning a recirculation station? (4)

QUESTION 5 **[20]**

Comment on and discuss the content of the article related to mine environmental control and occupational hygiene, which have appeared in the following publications:

PLEASE NOTE - ADDRESS ONLY *ONE* OF THE FOLLOWING TWO TECHNICAL PUBLICATIONS:

5.1 Practices for conveyor roadway segregation and designation of escape ways in Australian underground coal mines

(M.J. Olsen. January/March Volume 70 No 1)

Use the following headings in your answer:

1. Abstract
2. Introduction
3. History in Australia
4. International Practice
5. Different schools of thought
6. Mine Scenarios
7. Conclusion

OR

5.2 Ventilation planning at the P.T. Freeport Indonesia's GBC Mine

(K.G. Wallace, Jr., B.S. Prosser, R. Sani, T. Semestario. April/June Volume 70 No 2)

Use the following headings in your answer:

1. Abstract
2. Introduction
3. Design Criteria
4. General ventilation design layout

TOTAL MARKS: [100]