Minerals Council South Africa

EXAMINATION PAPER

SUBJECT: CHAMBER OF MINES OF SOUTH AFRICA – CERTIFICATE IN MINE ENVIRONMENTAL CONTROL **PAPER 3 – PLANNING, ECONOMIC, TECHNICAL LITERATURE** **SUBJECT CODE:** COMMEC 3 **EXAMINATION DATE:** 8 May 2025 TIME: **14:00 – 17:00 (3 HOURS)**	**EXAMINER:** George Mapele **MODERATOR:** Aldo Oosthuizen **TOTAL MARKS: [100]** **PASS MARK: (60%)**

NUMBER OF PAGES: 9 (including this page)

Examination Instructions:

All candidates are advised to read the below instructions/requirements and adhere to them. Not adhereing to them could lead to the loss of marks.

This examination question paper consists of **9** pages

1. Answer all **4** 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).

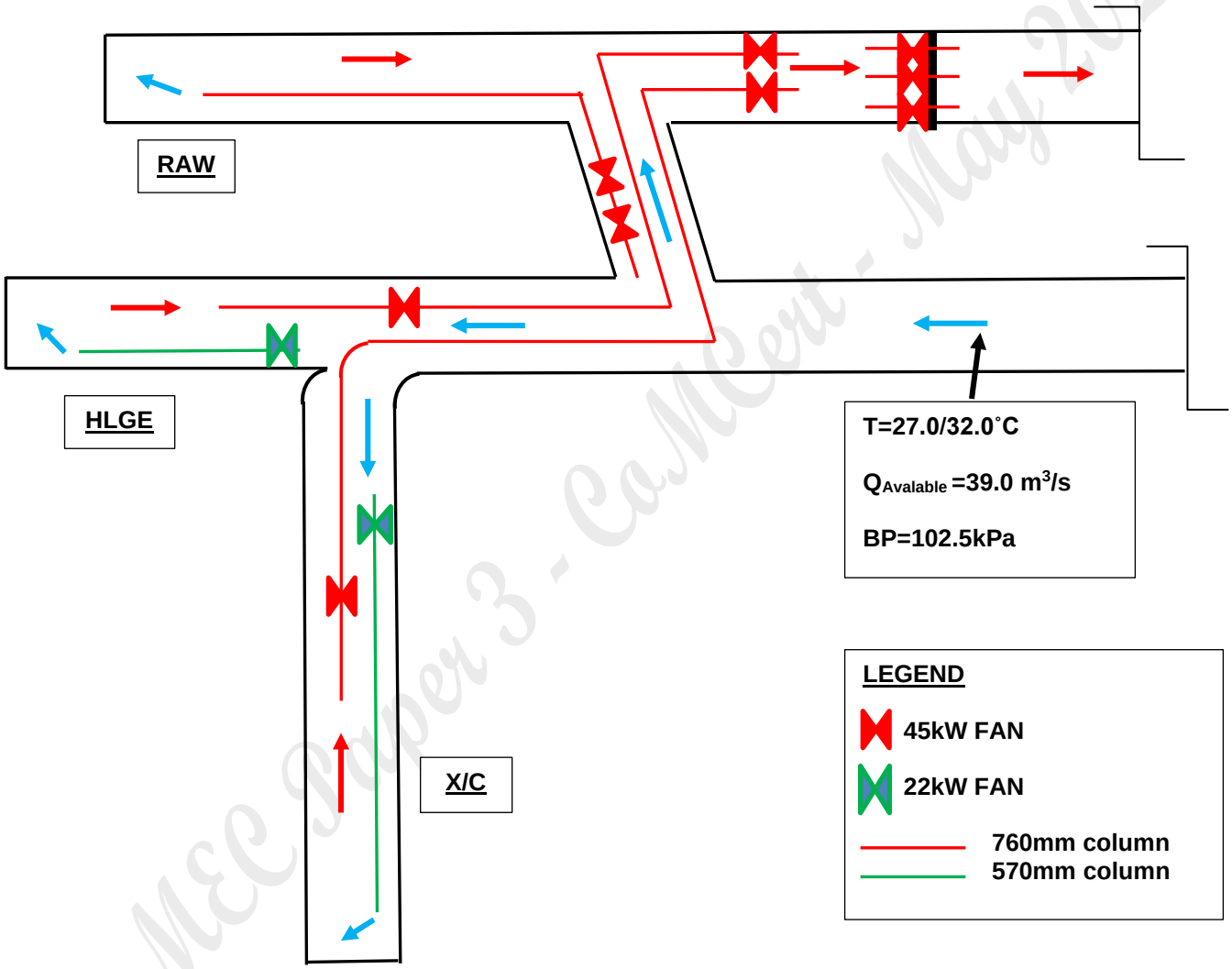
8. In answering the questions, full advantage should be taken of your practical experience as well as data given.
9. Please note that you are not allowed to contact your examiner or moderator regarding this examination.
10. This is **NOT** an open book examination but the approved formula hand out may be used.
11. Cell phones are **NOT** allowed in the examination room.
12. You are encouraged to make use of the CoMCert Tip-off Hotline whenever you witness or suspect any wrongdoing related to the CoMCert Examinations on landline 0800 118 998 or alternatively you can use email COMCert@tip-offs.com. This tip-off hotline and tip-off email is managed anonymously and confidentially through an independent service provider

QUESTION 1

A mine is planning to open a new development section; the plan is to develop 3 flat development ends simultaneously. The 3 development areas will include a haulage (HLGE), return air way (RAW) and a crosscut (X/C). The development is planned to take place at a depth of 2000m below the surface and will be using the conventional mining method.

The following ventilation layouts are considered:

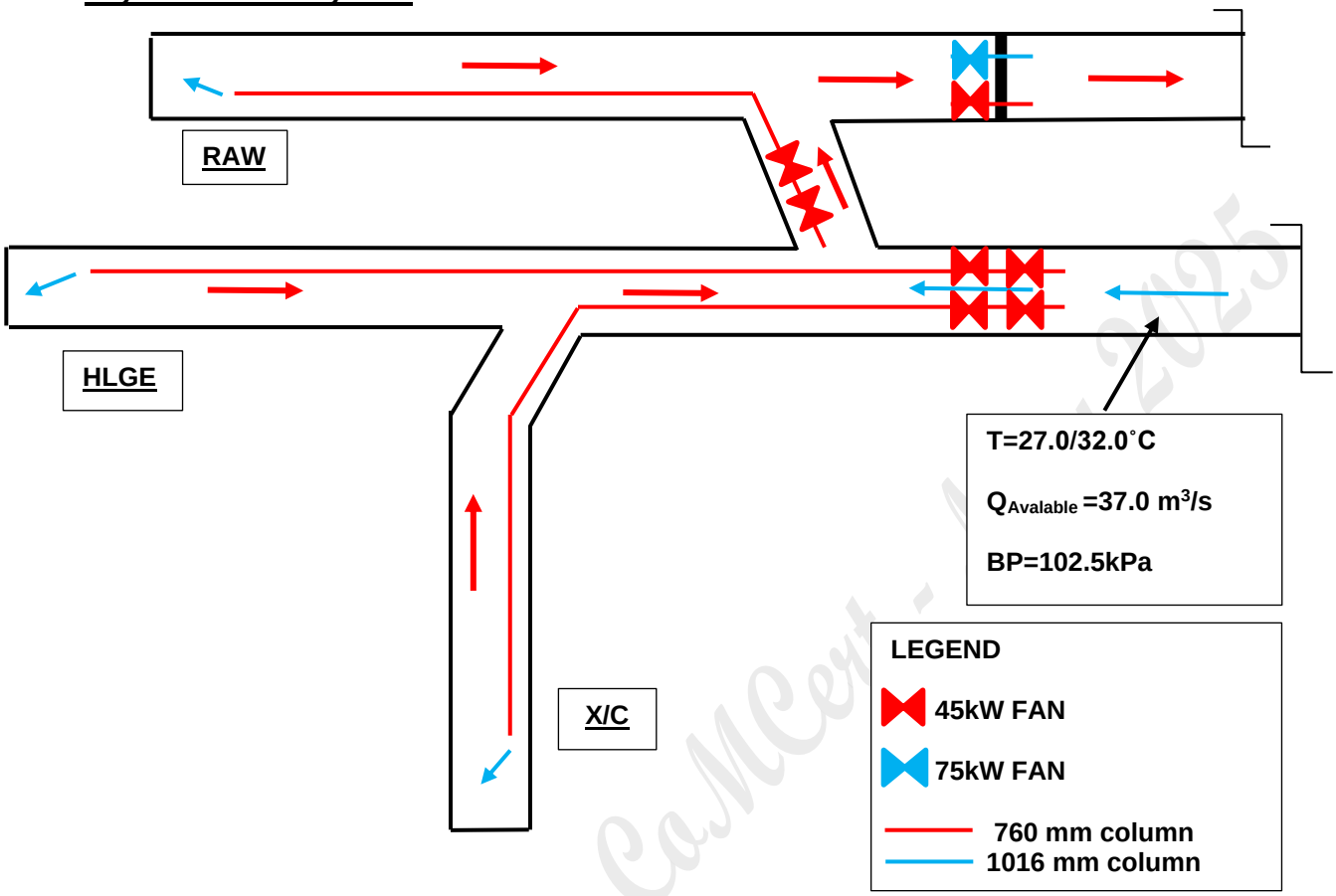
Layout 1. Combination of force and force/ exhaust system:



The following information is provided:

Quantity Available	39.0m^3/s
Temperature before crosscut	27.0/32.0˚C
Barometric pressure before crosscut	102.5kPa
Crosscut (X/C): Force / exhaust system	
Cross cut size	3.5m × 4.0m
Exhaust ventilation column at crosscut	Steel Column 760mm ϕ
Length of exhaust ventilation column from the cross cut to the RAW	350.0m
Force column in the cross cut	Steel Column 570mm ϕ
Length of force column at the cross cut	95.0m
Intake air quantity in the exhaust ventilation column in the cross cut	9.8m^3/s
Discharge air quantity from the exhaust column ventilating the cross cut	13.5m^3/s
Intake air quantity in the force column at the cross cut	7.5m^3/s
Discharge air quantity in the force column at the crosscut	6.7m^3/s
Face Temperature at the cross cut	27.5/32.5˚C
Force column distance at the crosscut to the face	11.0m
Overlap distance in the cross cut	15.0m
Exhaust distance in the cross cut to the face	26.0m
Return Air Way (RAW): Force System	
RAW size	4.0m × 4.1m
Force ventilation column at the RAW	Steel column 760mm ϕ
Length of the ventilation column in the RAW	250.0m
Intake air quantity for the ventilation column ventilating the RAW	14.0m^3/s
Discharge air quantity from the ventilation column in the RAW	11.5m^3/s
Force column distance to face in the RAW	11.5m
Face temperature at the RAW	29.0/34.0˚C
Haulage (HLGE): Force / exhaust system	
Return airway size	4.0m × 4.0m
Exhaust ventilation column at the Haulage	Steel Column 760 mm ϕ
Length of exhaust ventilation column in the Haulage	300.0m
Force ventilation column in the Haulage	Steel Column 570 mm ϕ
Length of force ventilation column in the Haulage	85.0m
Intake air quantity in the exhaust ventilation column in the Haulage	12.2.0m^3/s
Discharge air quantity from the exhaust ventilation column in the Haulage	14.3m^3/s
Intake air quantity for the force ventilation column in the Haulage	7.5m^3/s
Discharge air quantity from the force ventilation column in the Haulage	6.5m^3/s
Face Temperature at the Haulage	28.0/33.0˚C
Force distance at the Haulage	12.0m
Overlap Distance at the Haulage	18.0m
Exhaust distance to the face at the Haulage	30.0m

Layout 2. Force System



The following information is provided:

Quantity Available	37.0m³/s
Temperature before cross cut	27.0/32.0˚C
Barometric pressure before cross cut	102.5kPa
Crosscut (XCUT)	
Cross cut size	3.5m × 4.0m
Force ventilation column for the cross cut	Steel Column 760 mm ϕ
Length of the force ventilation column for the cross cut	370m
Intake air quantity at the force ventilation column for the cross cut	13.7m³/s
Discharge air quantity from the force column in the cross cut	11.6m³/s
Face temperature in the cross cut	29.0/34.0˚C
Force ventilation column distance to face in the cross cut	11.0m
Haulage (HLGE)	
Haulage size	4.0m × 4.1m
Force ventilation column for the haulage	Steel column 760mm ϕ
Length of the ventilation column used for the haulage	270m
Intake air quantity in the ventilation column for the haulage	14.0m³/s
Discharge air quantity from the ventilation column in the haulage	12.5m³/s
Force column distance to face in the haulage	11.5m
Face temperature in the haulage	29.0/34.0˚C

Return Air Way (RAW)	
Return airway size	4.0m × 4.0m
Force ventilation column at the RAW	Steel Column 760 mm ϕ
Length of force ventilation column at the RAW	170.0m
Intake air quantity in the force ventilation column at the RAW	14.5m^3/s
Discharge air quantity in the force ventilation column at the RAW	9.5m^3/s
Face temperature in the RAW	30.0/35.0˚C
Force column distance to face in the RAW	12.0m

Materials Prices	
Price of 22kW fan (570mmϕ) (Excluding) VAT)	R43 800.00
Price of 45kW fan (760mmϕ) (ExcludingVAT)	R57 500.00
Price of 75kW fan (1016mmϕ) (Excluding VAT)	R95 000.00
Price of a Unit of whisper silencer 570mm ϕ) (Excluding VAT)	R3 500.00
Price of a Unit of whisper silencer 760mm ϕ) (Excluding VAT)	R5 600.00
Price of a Unit of whisper silencer 1016mm ϕ) (Excluding VAT)	R7 500.00
Price of 570mm ϕ ventilation steel column/m (Excluding VAT)	R925/m
Price of 760mm ϕ ventilation steel column/m (Excluding VAT)	R1270/m
Price of 1016 mm ϕ ventilation steel column/m(Excluding VAT)	R1700/m
Price of unit 760mm ϕ bend (Excluding VAT)	R1770.00

Use the above sketches and information provided to determine the following:

1.1. The percentage leakage and face volume at each development end and for each ventilation column. Comment on all your answers. **(16)**

1.2. The capital cost for each layout (excluding VAT). **(4)**

1.3. How much will it cost the company (including VAT) to implement each of the above-mentioned layouts? Use 2 silencers for each fan and each fan at the RAW consists of a 2.2m ventilation column of its set diameter (The **VAT is 15%** for each item). **(2)**

1.4. The power cost of each layout. (Power cost = R13 140/kW annum OR R1.5/kWh) **(4)**

1.5. The Present value of running cost, if present value @15% interest over 2 years is R1.63 for each layout. **(2)**

1.6. The total owing cost of each layout (T.O.C). **(2)**

1.7. Which layout is the most economical? **(2)**

1.8. As a ventilation specialist, which layout would you recommend? Motivate your answer. **(3)**

[35]

QUESTION 2

The following designed specifications are provided for a Gold Mine situated in the Free State Province, South Africa:

Parameters	**Unit**
Production rate per month	120 000
Type of mining	Semi concentrated with dip of 20˚ @ 80% of the ore body being mined
VRT (Virgin Rock Temperature)	45.0˚C
Designed Reject temperature	27.0˚C
Expect fissure water	15.0 l/s
Service water used	1 ton of water/ton of rock mined
Surface air temperature	18.0˚C
The air temperature mixture down the shaft after the BAC (Bulk air cooling)	10.0˚C
Positional efficiency of the refrigeration plant if situated on surface	75% (Surface plant)
Barometric Pressure @ a depth of 2000m below surface	103.0kPa
The temperature of the air @ a station 2000m below surface	20.0/25.0˚C
Depth below surface	2000m
Distance from the shaft to the working place	3000m

Use the above information to calculate the following:

2.1 The sutured vapour pressure at the station P'_{ws} (in kPa) **(2)**
2.2 The vapour pressure at the station $P''_{w's}$ with dry bulb temperature **(2)**
2.3 Vapour pressure at station P_w (in kPa), use psychometric constant A= 0.000644˚C^{-1} **(2)**
2.4 Vapour content r(kg/kg) **(2)**
2.5 Specific volume of air. v (m^3/kg) **(3)**
2.6 Volume flow of air required at the station. Use the graph. Q_a (m^3/s) **(3)**
2.7 Mass flow of air at the station. M_a(kg/s) **(2)**
2.8 Heat due to auto-compression (in kW **(2)**
2.9 Heat due to fissure water **(2)**
2.10 Heat due to Rock Broken **(4)**
2.11 Total Head Produced **(2)**
2.12 Total cooling capacity **(3)**
2.13 Net Cooling Capacity **(1)**

Note. Submit all the charts and/or graphs for each question

[30]

QUESTION 3

Ventilation Planning:

3.1 Discuss the factors that you will consider when planning a mine, considering the following aspects:

3.1.1 Conventional and mechaniised mine **(2)**
3.1.2 Ambient (intake) environment **(3)**
3.1.3 Fan operating Cost **(3)**

3.2. The following parameters are provided for a heat load calculation:

Parameters	**Unit**
Mass flow of air downcast	550kg/s
Intake Wet Bulb Temperature	18.0˚C
Reject Wet Bulb Temperature	28.5˚C
Planned Tonnage	126Ktons
Mean Breaking Depth (Forecast life of Mine)	1870.0m
Mean Distance from shaft @ Maximum tonnage	2.4km
Total Mining Heat Produced	9700kW
Heat Due to Auto-compression	8000kW
Metabolic Heat	350kW
Air Cooling Power	13700kW

3.2.1 Determine the heat balance in MW (Mega Watt) **(4)**

3.2.2 Does the heat balance requires any refrigeration? If the answer is yes, give the required duty of refrigeration to be installed (also state what you plan to install) and a clear explanation as to why it would be required. **(3)**

[15]

QUESTION 4

Summarise and describe your understanding on one of the following articles. **(Choose between 4.1 and 4.2)**

4.1. Factor contributing to heat stress incidents among miners in South Africa's mining industry from 2019 to 2023*. (MVSSA Journal - Volume 76 Number 4-October /December 2023)*

OR

4.2. Reporting Silica dust exposure measurements in South African gold and coalmines. (*MVSSA Journal - Volume 77 Number 3 - July /September 2024)*

[20]

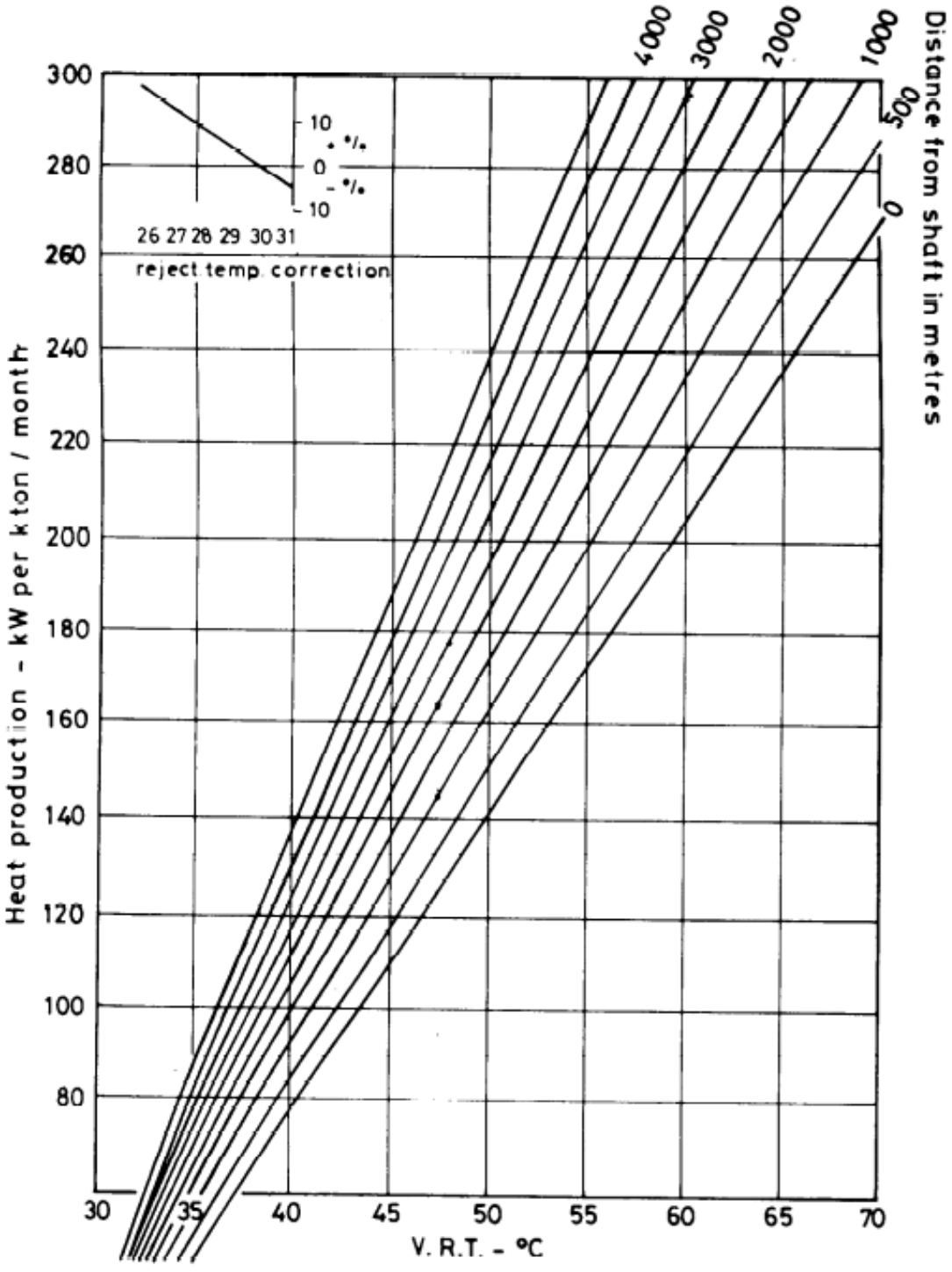

Heat production - kW per k ton / month
300
280
260
240
220
200
180
160
140
120
100
80
30
35
40
45
50
55
60
65
70
V. R.T. - °C
4000
3000
2000
1000
500
0
Distance from shaft in metres
10
+ %
0
- %
10
26 27 28 29 30 31
reject temp. correction

Figure 17.5a

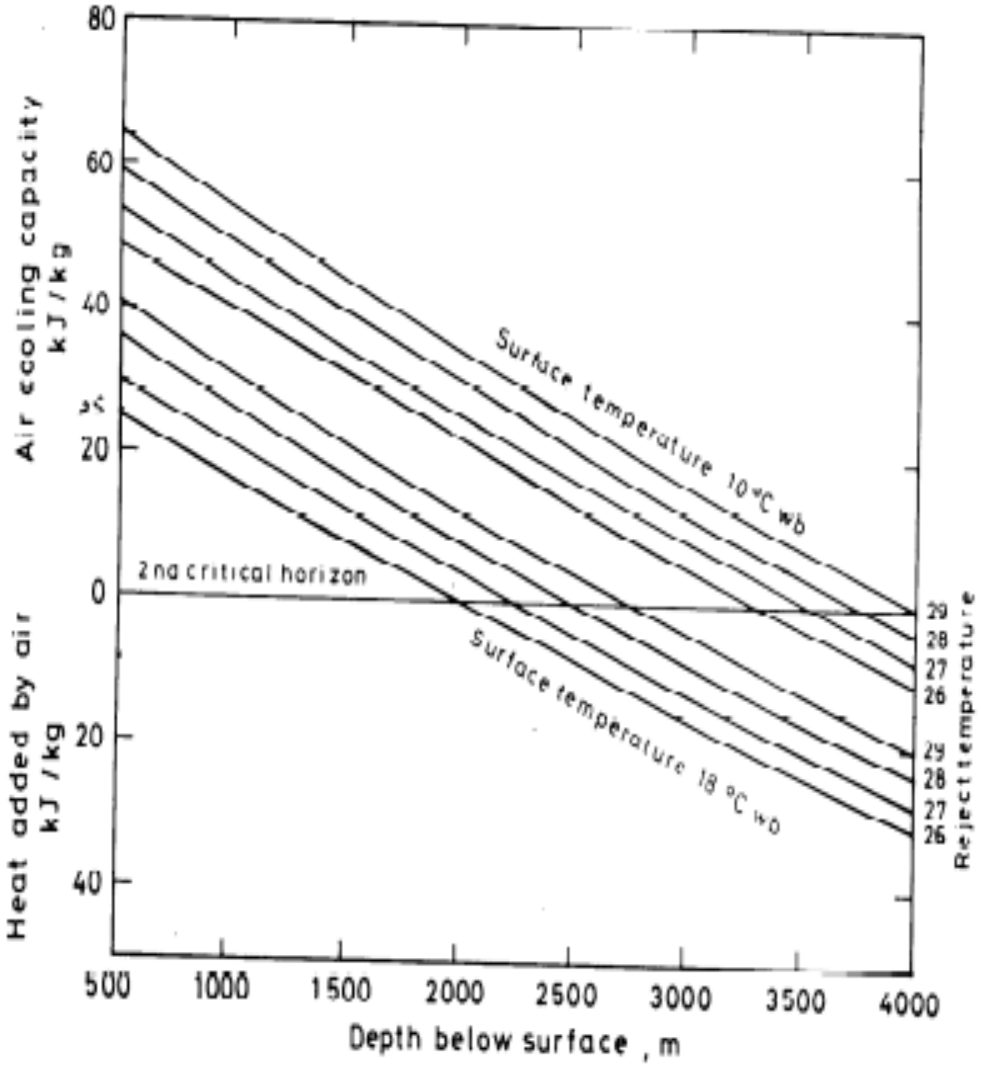

Air ecooling capacity kJ/kg
Heat added by air kJ/kg
80
60
40
20
0
20
40
2nd critical horizon
Surface temperature 10 °C wb
Surface temperature 18 °C wb
29
28
27
26
29
28
27
26
Reject temperature
500
1000
1500
2000
2500
3000
3500
4000
Depth below surface , m

Figure 17.9.1