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:** 09 October 2025 TIME: **14:00 – 17:00 (3 HOURS)**	**EXAMINER:** George Mapele **MODERATOR:** Aldo Oosthuizen **TOTAL MARKS: [100]** **PASS MARK: (60%)**

NUMBER OF PAGES: 13 (including this one)

SPECIAL REQUIREMENTS:

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 IS **NOT** AN **OPEN BOOK EXAMINATION**. FORMULA HANDOUTS AVAILABLE

1. Answer all 4 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) is 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 and any other electronic devices are **NOT** allowed in the examination room. **Only Calculator**
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

The following design specifications are provided for a Gold Mine in Orkney (Northwest Province - South Africa):

Production rate ton per month	150 000
Barometric at surface @ Orkney	105kPa
Design Reject temperature	27.0˚C
Expect fissure water used	15.0l/s
Service water used	1 ton of H_2O/ton of rock mined
Surface air Temperature	18.0˚C
Difference water temperature (inlet and outlet) at the surface B.A.C	10.0˚C
Temperature Bulk volume air down shaft	10.0˚C
Positional efficiency of the B.A.C	80%
Barometric Pressure at bottom level of the mine @ Station	112.5 kPa
Temperature at the bottom level of the mine @ Station	23.0˚/27.0˚C
Cooling capacity of Primary Downcast Ventilation (CCPDV)	3730kW
Maximum distance from shaft (station)to working place	1000m
Heat from fissure water	942kW
Chiller water temperature at the stope	10.0˚C

Use the above information provided to calculate/determine the following:

1.1 Virgin Rock Temperature (VRT) (1)
1.2 Volume flow of air (2)
1.3 Specific Volume of air (1)
1.4 Mass flow of air (1)
1.5 Air Cooling Capacity (S_a) in kJ/kg (1)
1.6 Depth below surface or the bottom level of production (1)
1.7 Heat due to Auto compression (1)
1.8 Heat from rock(Q_{Rock}) (4)
1.9 Total Load heat (Q_{Total}) (1)
1.10 Surface Bulk Air Cooling (Q_{BAC}) (1)
1.11 Net Cooling Capacity of Downcast primary ventilation(NCCDPV) (1)
1.12 Nominal Air-Cooling Duty of Surface B.A.C $(NACD)_{BAC\ surface}$ (3)
1.13 Quantity of chilled water flows through the surface B.A.C (1)
1.14 Cooling distributed to underground infrastructure ($Q_{UND-INF}$) (1)
1.15 Service water (chilled water) (M_{cw}) (1)
1.16 Cooling Duty of Cold Service Water(CDCSW) and comment (2)
1.17 What will the required underground air-cooling capacity (RUACC) be and will you achieve this? (2)

[25]

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

QUESTION 2

Summarize and describe your understanding on one of the following articles.
Choose between 2.1 and 2.2

2.1. Assessment of innovative mitigating solutions for fires occurring on conveyor belts in coal mines. *By W. Marx, A. Thomson, M. Van der Bank, N. van der Merwe, Bluhm Burton Engineering (MVSSA Journal – Volume 78 Number 1 January /March 2025)*

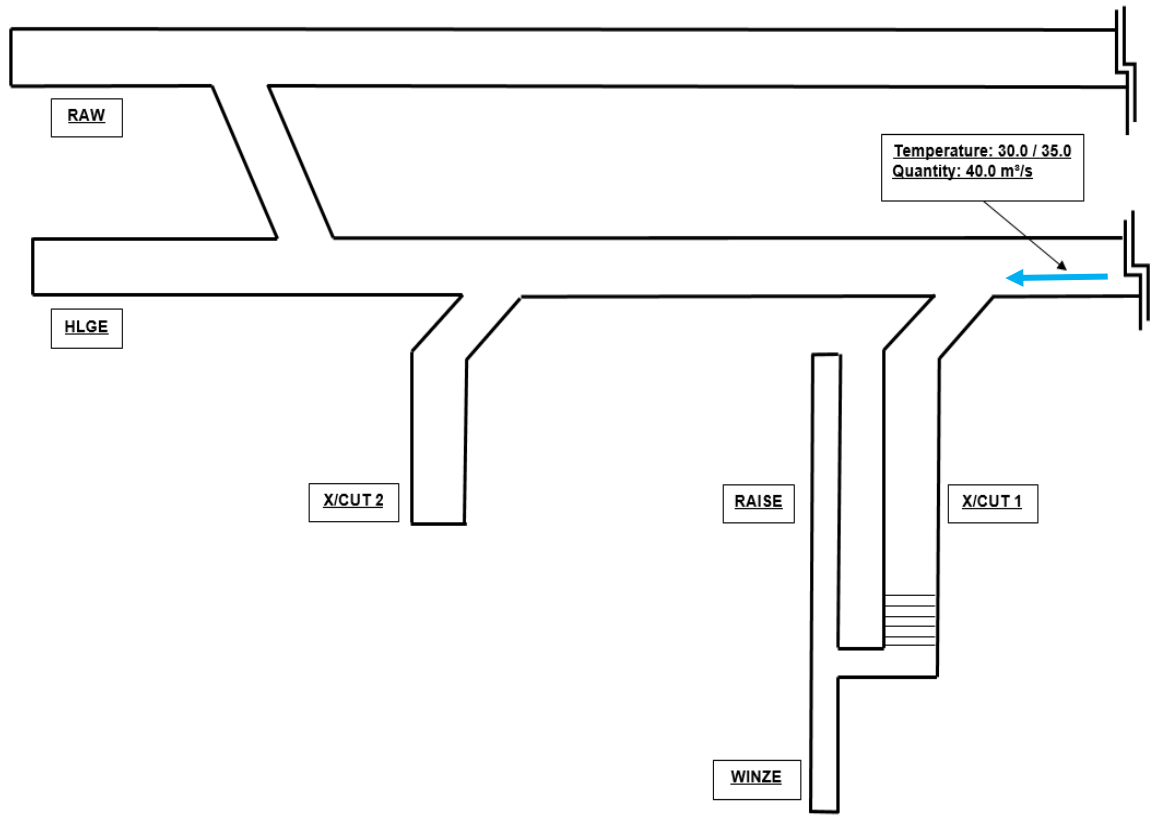
OR

2.2. Preparing a mines ventilation network to support expansion of the underground workings. *By FS. Bergh Howden Africa, SK. Ambrosio Howden Ventsim (MVSSA Journal -Volume 77 Number 1 January /March 2024)*

[20]

QUESTION 3

The sketch below illustrates development ends in a gold mine that is mining simultaneously, (Winze, Raise, Cross Cut (X/CUT2), Haulage (HLGE) and a Return airway (RAW)).



The following information is provided:

Dimensions	**Size**
Cross Cut, Haulage and Return airway	3.2m×3.7m
Raise and Winze	2.5m×1.7m
Connecting Cross Cut	4.0m×4.0m
Airway lengths/distances	
Cross cut 1 (X/CUT1)	200m
Raise	80m
Winze	50m
Cross Cut 2 (XCUT 2)	150m
Haulage (HLGE) (from the connecting Cross Cut to face)	150m
Return airway (RAW) (from the connecting Cross Cut to face)	100m
Connecting Cross cut	30m
Other relevant information	
Column distance to face for all the development ends	12m
Distance between the two (2) Cross Cuts	180m
Required Face volumes	
Winze (WZE)	$0.65m^3/s/m^2$
Raise(Rse)	$1.25m^3/s/m^2$
Cross cut 2 (X/CUT 2)	$0.70m^3/s/m^2$
Haulage (HLGE)	$0.55m^3/s/m^2$
Return airway (RAW)	$0.65m^3/s/m^2$

Material Prices	
Price of 15kW fan (570mmϕ) (Excluded VAT)	R35 000
Price of 22kW fan (570mmϕ) (Excluded VAT)	R48 200
Price of 45kW fan (760mmϕ) (Excluded VAT)	R63 250
Price of 75kW fan (1016mmϕ) (Excluded VAT)	R104 500
Price of Unit Price of whisper silencer 570mm ϕ) (Excluded VAT)	R3 800
Price of Unit whisper silencer 760 mm ϕ) (Excluded VAT)	R6 100
Price of Unit whisper silencer 1016 mm ϕ) (Excluded VAT)	R8 250
Price of 570 mm ϕ ventilation steel column /m (Excluded VAT)	R1100/m
Price of 760 mm ϕ ventilation steel column/m (Excluded VAT)	R1400/m
Price of 1016 mm ϕ ventilation steel column /m(Excluded VAT)	R1900/m
Cooling Car (500kW)(Excluded VAT)	R570 000
Cooling Car (300kW) Excluded VAT)	R390 000

Use the above information provided and determine the following:

3.1 Compile a ventilation layout (draw a rough sketch in you script as per the above OR alternatively use **ANNEXURE G** and submit it with your script) on how you will ventilate each of the above-mentioned development ends/ working places. Ensure that you comply with all the legislative requirements (temperatures, re-circulation etc.) **(15)**

3.2 Determine the intake and delivery quantity for each fan. **(5)**

3.3 Determine and comment on the leakage for each ventilation column. **(5)**

3.4. Based on your experience, give the expected face temperature at each of the development ends face. **(3)**

3.5. Use two silencers for each fan. The power cost is R13140/kW per annum or (or R1.5/kWh) and Present value @10% interest over 3 years is R2.49.
Calculate the total owing cost (T.O.C) for your layout. **(7)**

[35]

QUESTION 4

4.1 The required items and costs for a new capital ventilation and refrigeration project for a gold mining company are summarized in the table below**:**

Description	**Item**	**Total Price**
Underground Refrigeration	Refrigeration plants/machines (2 × 7MW)	R56 557 307
	Condenser circuit	R14 042 693
	Electrical work & Instrumentation	R28 600 731
	Cooling distribution incl. 2 × BACs	R47 410 230
	Installation including P&Gs(60% supply)	R38 263 135
	Engineering and project management	R16 361 674
Booster fans	4 units on 4 different levels	R45 091 249
Cooling cars[new]	10 units	R7 729 923
Cooling car [refurbished]	20 units	R5 153 288

The power used for ventilation fans and refrigeration are indicated below:

- Main fan station 16.5MW
- Refrigeration 16.7MW
- Auxiliary ventilation 2.8MW

4.1.1. Determine the total owing cost (T.O.C) for the present value of 15% interest over 10 years. The power cost is R13140/kW per annum or (or R1.5/kWh). **(5)**

4.1.2. How many kilograms (kg) of gold needs to be produced monthly to reach the T.O.C, providing that the gold price is R61 355 per ounce (1 ounce = 28.3495 gram)? **(2)**

4.2. The Diesel Engine Certificate is done using an **Exhaust Quality Index (EQI).** This formula combines the measurements of the different pollutants and applies various weightings to several of these:

$$EQI = \frac{CO}{50} + \frac{NO}{25} + \frac{DPM}{2} + 1.5\left[\frac{SO_2}{3} + \frac{DPM}{2}\right] + 1.2\left[\frac{NO_2}{3} + \frac{DPM}{2}\right]$$

Were:

CO is the concentration of Carbon Monoxide (ppm)
NO is the concentration of Nitric Oxide (ppm)
SO_2 is the concentration of Sulphur Dioxide (ppm)
NO_2 is the concentration of Nitrogen Dioxide (ppm)
DPM is the concentration of Diesel Particulate Matter (mg/m^3)

The denominators are the accepted occupational exposure limits of the various substances. However, weighing attempts to take into consideration the synergistic effect of numerous toxins.

In the case of DPM that appears three times in the formula and weighted on two occasions, the equivalent limit from this formula would be 0.54mg/m^3 (2:3).

The EQI, once calculated, is used in a formula and together with the air density and the exhaust gas flow rate (which is measured during the engine certification).

The flow of dilution by ventilation air is given by the formula below:

$$Q_{dva}=\frac{M_{dxg}\times\frac{EQI}{3}}{\rho\times 3600}$$

Where :

Q_{dva} is the required flow of dilution ventilation air (m³/s)
M_{dxg} is the dry exhaust mass flow (kg/h)
EQI is the exhaust quality Index as calculated above
ρ is the dry air density (kg/m^3)

The MHSA had formally adopted a system whereby the ventilation rate for an area where several diesel works was not simply additive but followed the following format:

- The largest engine would require its full rate of air quantity
- The second largest engine would require 75% of its rated air quantity
- The third- largest and subsequent would require 50% of its total air quantity
- The total of the above air quantities would be required in the working place

A section of the mine has the following engines:

Engine	Number	Rate
Drill rig DD321	1	135 kW
Bolter DS311	1	74 kW
LHD 410 7t	1	140 kW
LHD 410 10t	1	150 kW
Dt fermel 14t	1	109 kW

The measurements taken from the exhaust gas are as follows:

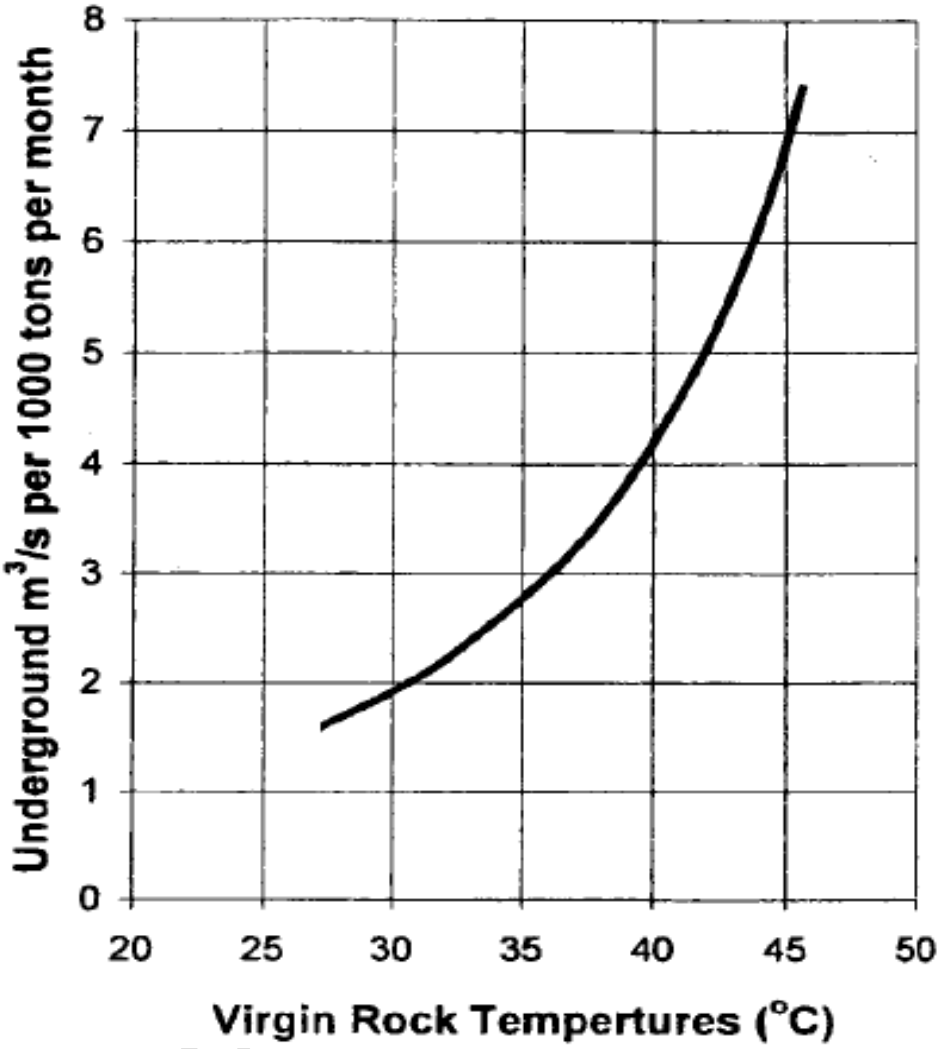
Engine	CO (%)	NO (%)	DPM(mg/m^3)	SO_2 (%)	NO_2 (%)	M_{dxg}(kg/h)
Drill rig DD321	0.0458	0.0363	81.2	0.0072	0.00090	499.27
Bolter DS311	0.0251	0.0199	44.5	0.0040	0.00050	273.67
LHD 410 7t	0.0475	0.0376	84.2	0.0075	0.00093	517.76
LHD 410 10t	0.0509	0.0403	90.2	0.0080	0.00100	554.74
Dt fermel 14t	0.0370	0.0293	65.5	0.0058	0.00073	403.11

By using EQI method, determines the amount of air to dilute the gases (The density of air is 1.2kg/s). **(7)**

4.3 Give the steps that must be followed in a systematic approach for ventilation planning. **(6)**

[20]

ANNEXURE A



ANNEXURE B

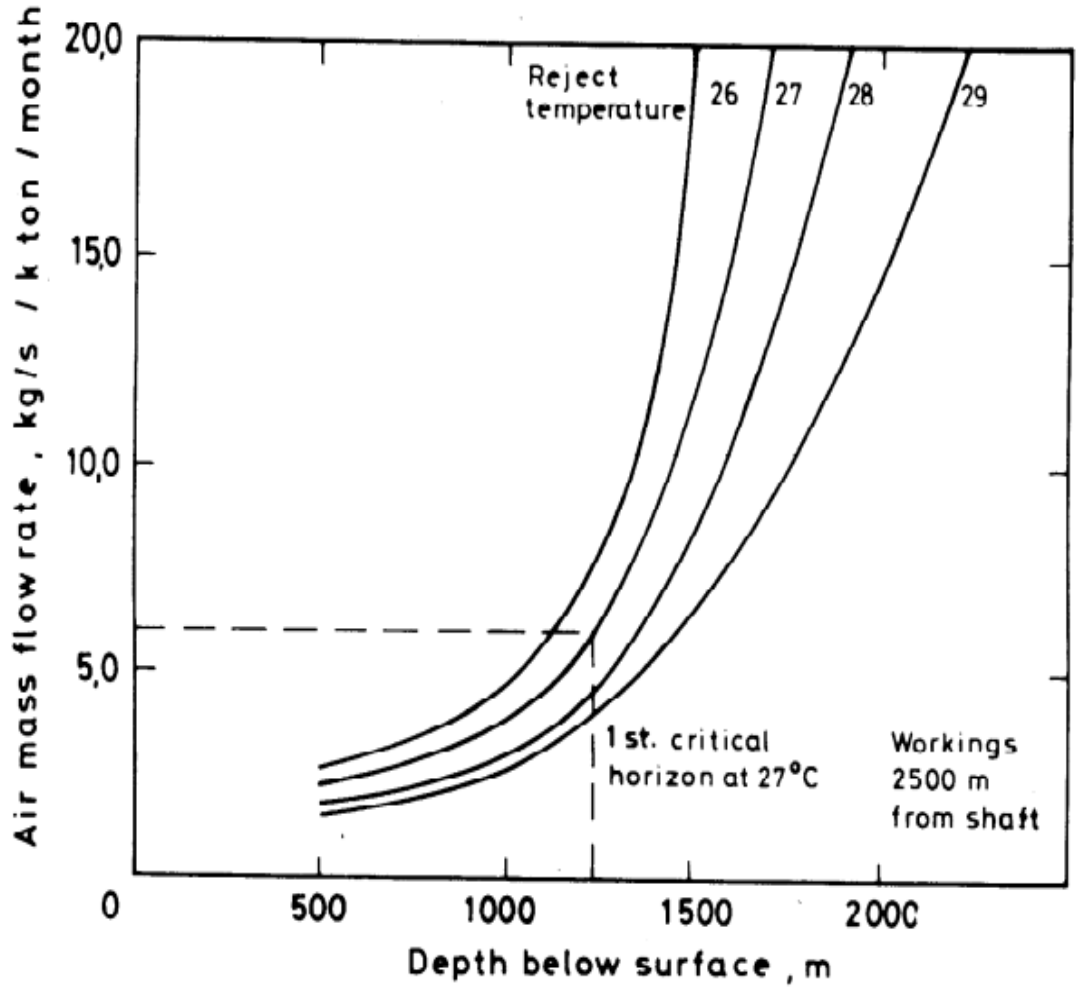


Figure 17.5

ANNEXURE C

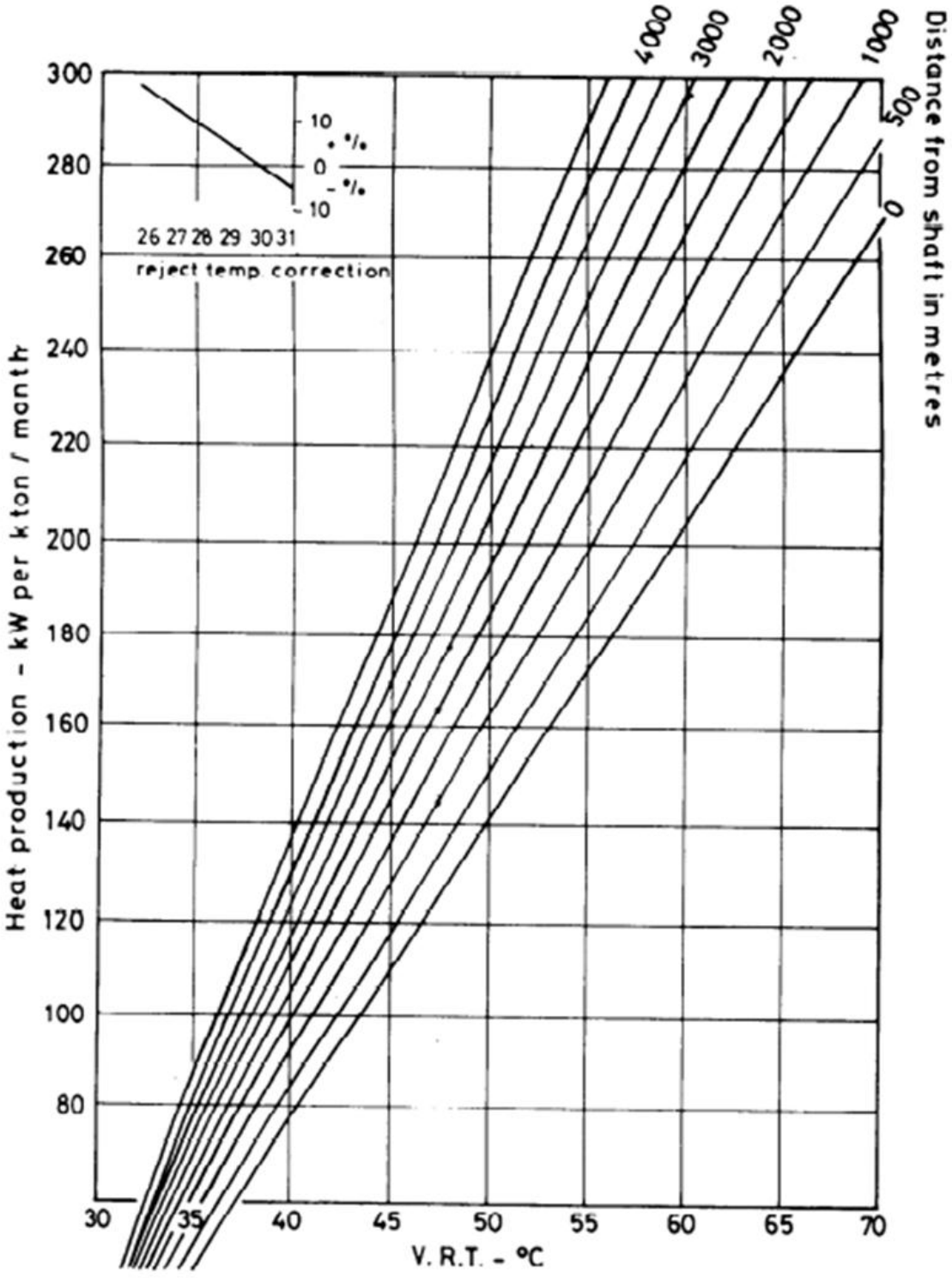


Figure 17.5a

ANNEXURE D

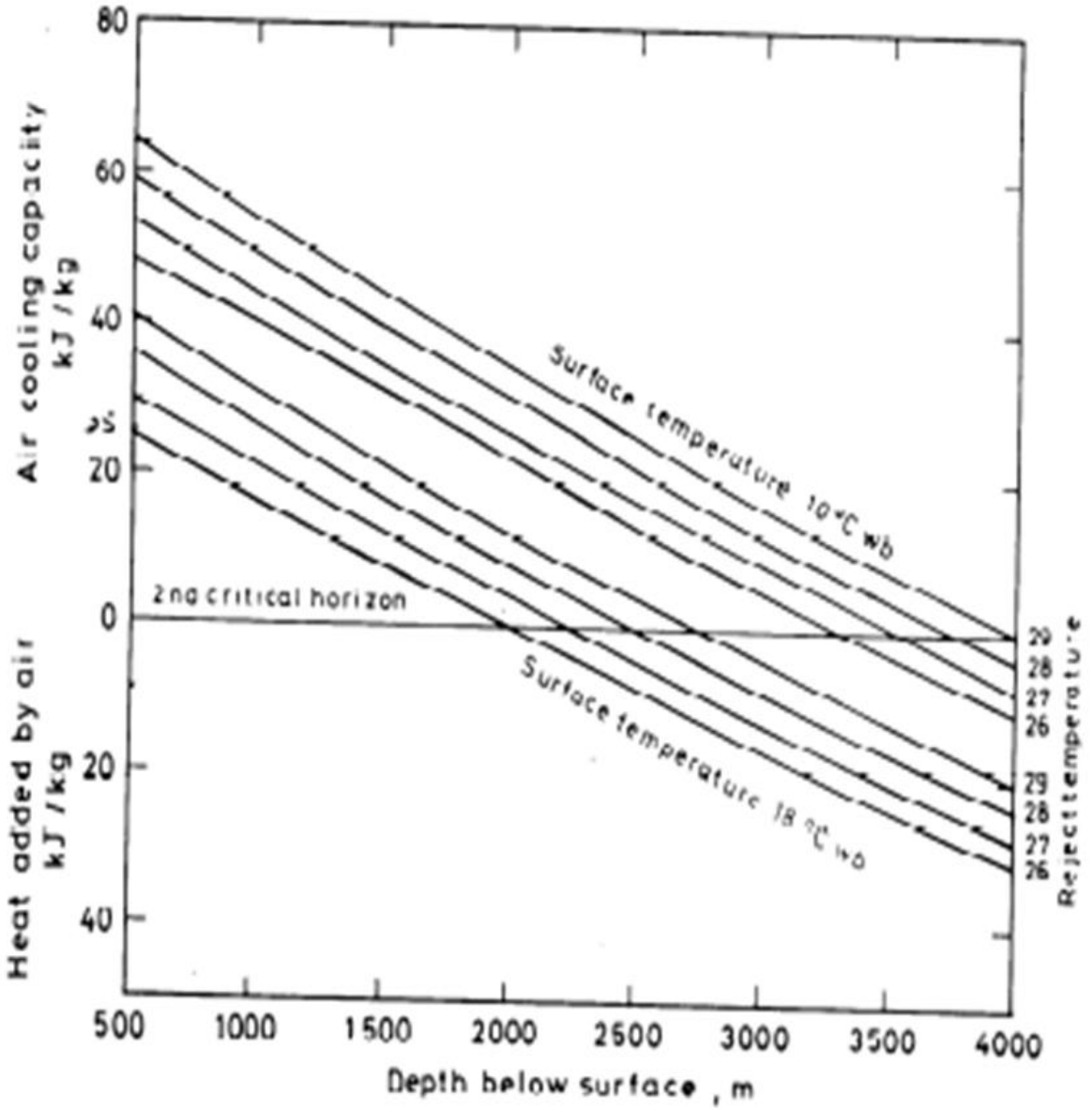
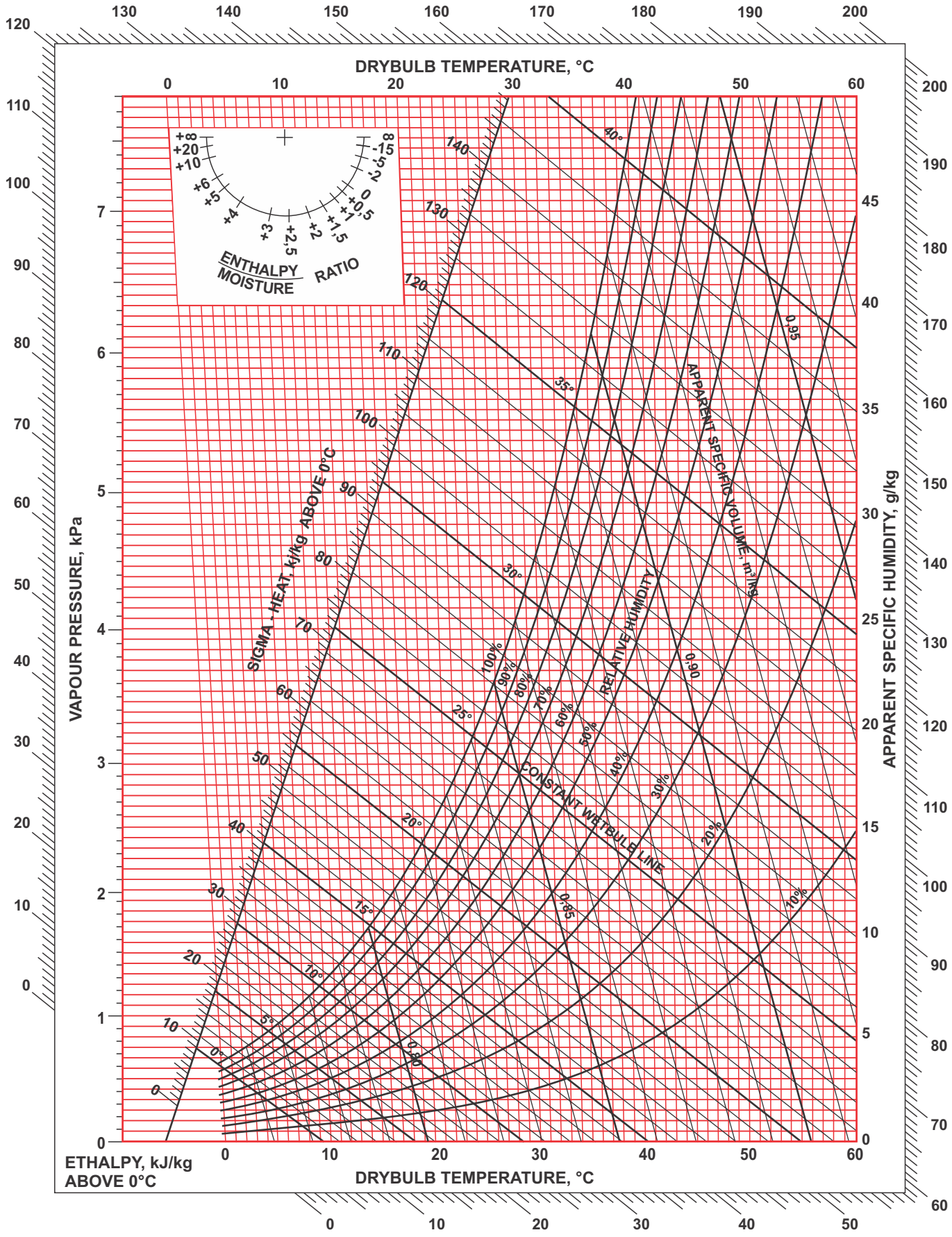


Figure 17.9.1

ANNEXURE E

PSYCHROMETRIC CHART
105,0 kPa

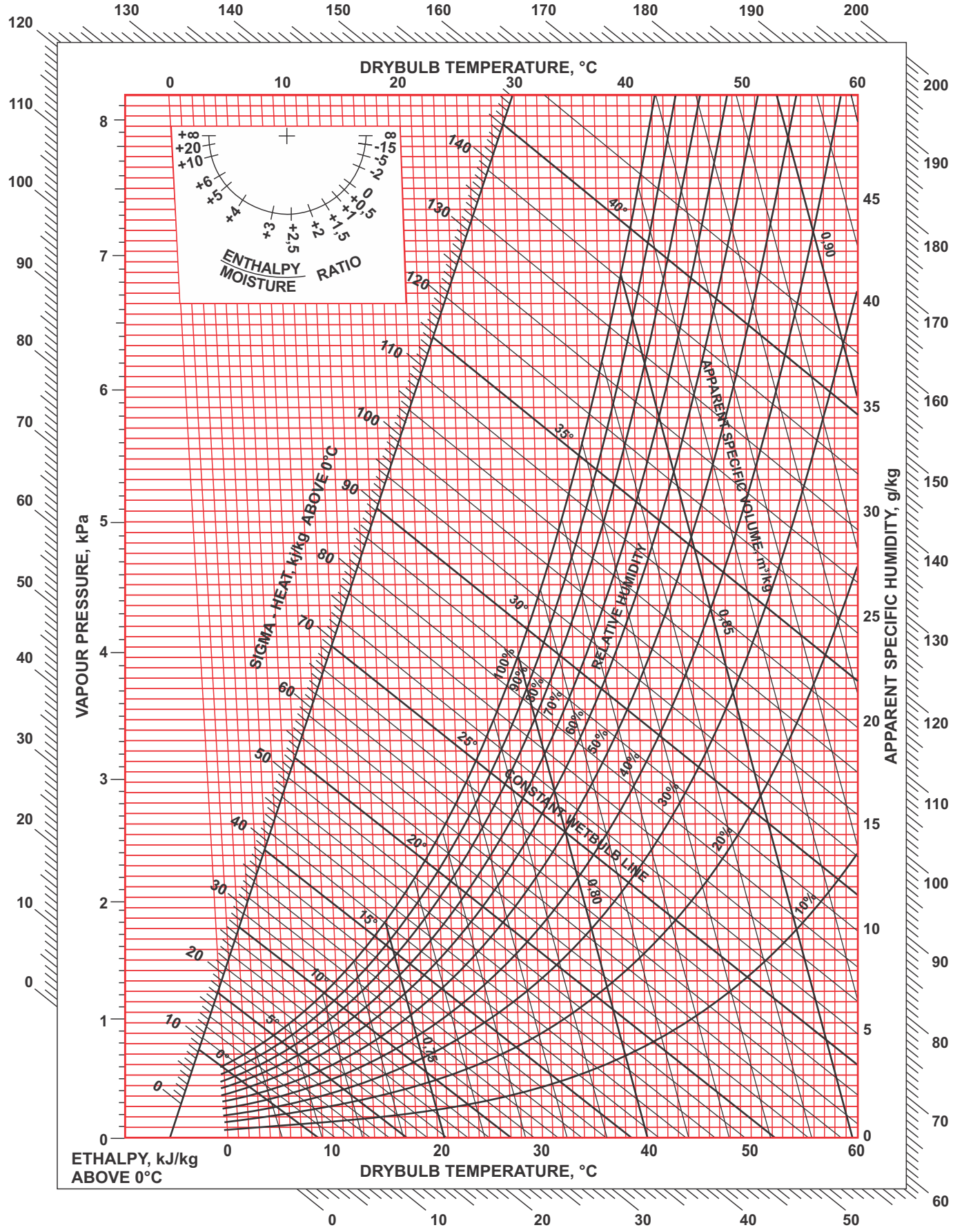


A.W.T.B.

CHART NO 12
105,0 kPa

ANNEXURE F

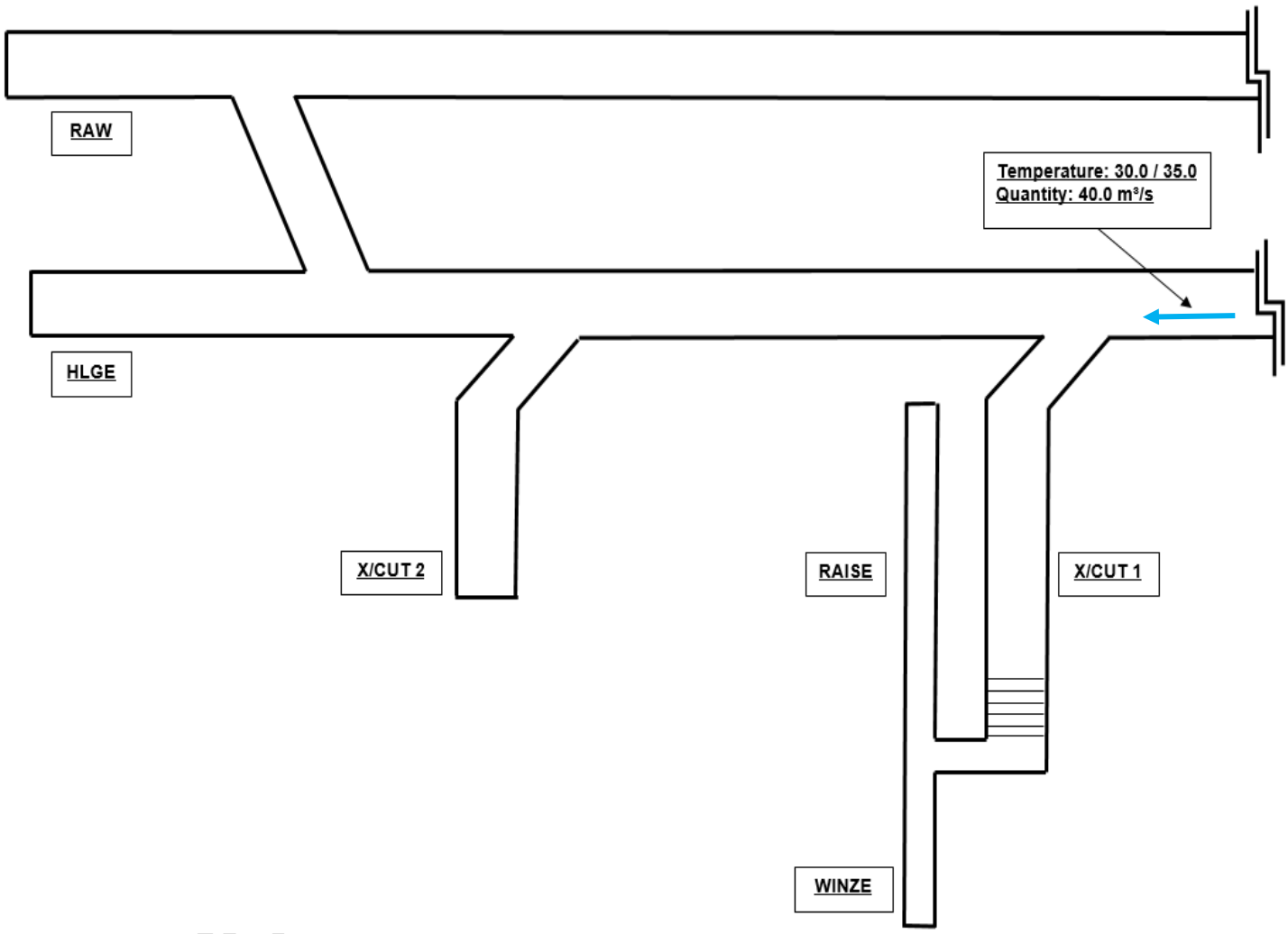
PSYCHROMETRIC CHART
112,5 kPa



A.W.T.B.

CHART NO 15
112,5 kPa

ANNEXURE G


RAW
Temperature: 30.0 / 35.0
Quantity: 40.0 m³/s
HLGE
X/CUT 2
RAISE
X/CUT 1
WINZE