POLITEKNIK
MALAYSIA

BAHAGIAN PEPERIKSAAN DAN PENILAIAN
JABATAN PENDIDIKAN POLITEKNIK DAN KOLEJ KOMUNITI
KEMENTERIAN PENGAJIAN TINGGI

JABATAN KEJURUTERAAN AWAM

PEPERIKSAAN AKHIR

SESI I : 2022/2023

DCB40153: AIR CONDITIONING SYSTEM TECHNOLOGY

TARIKH   : 14 DISEMBER 2022
MASA   : 8.30 AM – 10.30 AM (2 JAM)

Kertas ini mengandungi **SEMBILAN (9)** halaman bercetak.

Bahagian A: Esei (2 soalan)
Bahagian B: Esei (4 soalan)

Dokumen sokongan yang disertakan : Formula, Appendix

JANGAN BUKA KERTAS SOALAN INI SEHINGGA DIARAHKAN

(CLO yang tertera hanya sebagai rujukan)

SECTION A: 50 MARKS

BAHAGIAN A: 50 MARKAH

INSTRUCTION:

This section consists of **TWO (2)** essay questions. Answer **ALL** questions.

ARAHAN:

Bahagian ini mengandungi DUA (2) soalan esei. Jawab SEMUA soalan.

QUESTION 1

SOALAN 1

CLO2
C2

(a)   Identify **FIVE (5)** Psychrometric processes.

Kenalpasti LIMA (5) proses Psikometrik.

[5 marks]

[*5 markah*]

CLO2
C3

(b)   Explain **FIVE (5)** factors that affect the cooling loads in a room.

Terangkan LIMA (5) faktor yang mempengaruhi beban penyejukan dalam bangunan

[10 marks]

[*10 markah*]

CLO2
C3

(c)   A 180 m^3/min of air is having an inlet condition of 40°C DBT, 15% RH with an outlet condition of 25°C DBT and 20°C WBT is passed through an adiabatic humidifier. By using the psycrometric chart **(Appendix A1)**, determine the **amount of water vapour** added to the air per minute, (kg/min).

180 m^3/min udara mempunyai keadaan salur masukan 40°C DBT, 15% RH dan keadaan salur keluar 25°C DBT dan 20°C WBT telah disalurkan melalui pelembap adiabatik. Dengan menggunakan carta psikrometrik (Lampiran A1), tentukan jumlah wap air yang ditambahkan ke udara seminit, (kg/min).

[10 marks]

[*10 markah*]

QUESTION 2

SOALAN 2

CLO2
C2

(a)   Describe a centrifugal fan.

       Jelaskan kipas empar.

[5 marks]

[*5 markah*]

CLO2
C3

(b)   With the aid of a diagram, explain the vane axial fan of axial-flow fan.

       Dengan bantuan gambarajah, terangkan 'vane axial fan' bagi kipas alir paksi.

[10 marks]

[*10 markah*]

CLO2
C3

(c)   The following data are available for designing an air-conditioning system for a
       restaurant. Using the data below, determine the appropriate type of air
       conditioning system by referring to **Table A1 (Appendix A2).**

       *Data berikut tersedia untuk mereka bentuk sistem penghawa dingin untuk
       restoran. Dengan menggunakan data di bawah, tentukan jenis sistem penyaman
       udara yang sesuai dengan merujuk **Jadual A1 (Lampiran A2).***

       Data/ *data:*

Seating chair for dining/ *kerusi tempat duduk untuk makan*	45 people
Employees serving the meals/ *pekerja yang menghidang makanan*	5 people
Sensible heat gain per person/ *beban haba deria per orang*	60 W
Latent heat gain per sitting person/ *beban haba pendam bagi setiap orang yang duduk*	45 W
Latent heat gain per employee / *beban haba pendam bagi pekerja*	75 W
Sensible heat added from meals/ *haba deria dari makanan*	0.16 kW
Latent heat added from meals/ *haba pendam dari makanan*	0.28 kW
Total heat flow through the walls, roof and floor/ *jumlah aliran haba dari dinding, bumbung dan lantai.*	5.9 kW
Solar heat gain through glass / *beban haba solar melalui tingkap*	1.9 kW
Equipment sensible heat gain/ *beban haba deria peralatan*	2.75 kW
Equipment latent heat gain/ *beban haba pendam peralatan*	0.65 kW

[10 marks]

[*10 markah*]

SECTION B: 50 MARKS

BAHAGIAN B: 50 MARKAH

INSTRUCTION:

This section consists of **FOUR (4)** essay questions. Answer **TWO** questions.

ARAHAN:

*Bahagian ini mengandungi **EMPAT (4)** soalan esei. Jawab **DUA** soalan sahaja.*

QUESTION 1

SOALAN 1

CLO1
C2

(a)   Identify **FOUR (4)** factors that affect the sensible heat load in building.

*Kenalpasti **EMPAT (4)** faktor kesan haba deria di dalam bangunan*

[5 marks]

[*5 markah*]

CLO1
C3

(b)   Illustrate the plant load process line in psychometric chart.

Gambarkan garisan proses beban loji dalam carta psikometrik.

[10 marks]

[*10 markah*]

CLO1
C4

(c)   A 450 m^3/min of air is recirculated at dry bulb temperature 35 ^{O}C and dew point temperature 20 ^{O}C is to be mixed with 180 m^3/min. of fresh air at dry bulb temperature 20 ^{O}C and relative humidity 65%. By using the psycrometric chart **(Appendix B1)**, determine the enthalpy, specific volume, humidity ratio and dew point temperature of the mixture.

*450 m^3/min udara dikitar semula pada suhu bebuli kering 35 ^{O}C dan suhu takat embun 20 ^{O}C dicampur dengan 180m^3/min. udara segar pada suhu bebuli kering 20 ^{O}C dan kelembapan relatif 65%. Dengan menggunakan carta psikrometrik **(Lampiran B1)**, tentukan entalpi, isipadu tertentu, nisbah kelembapan dan suhu takat embun campuran tersebut.*

[10 marks]

[*10 markah*]

QUESTION 2

SOALAN 2

CLO1
C2

(a)   Describe the meaning of heating load.

     Jelaskan maksud haba pemanasan.

[5 marks]

[*5 markah*]

CLO1
C3

(b)   Sketch a complete diagram of the winter air conditioning system.

     Lakarkan gambarajah lengkap sistem penyamanan udara musim sejuk.

[10 marks]

[*10 markah*]

CLO1
C4

(c)   The cumulative external heat load for an Auto CADD laboratory is 3500 watts which is occupied by 40 students. The constant environment temperature is 24°C and the outside temperature is 32°C. The laboratory area is 120 m^2 and operates 9 hours per day. Based on the data given below, calculate the cooling load for the Auto CADD laboratory in tons unit.

Data:

24 unit fluoresent lamp, 15 w/m^2

40-unit desktop computer, 200 watts

1 unit projector, 300 watts

1-unit wi-fi router, 20 watts

40 students, sensible heat 75 watt/ student and latent heat 45 watt/ student

Beban haba luaran kumulatif untuk makmal Auto CADD ialah 3500 watt yang diduduki oleh 40 pelajar. Suhu persekitaran malar ialah 24°C dan suhu luar ialah 32°C. Kawasan makmal adalah 120 m2 dan beroperasi dalam 9 jam sehari. Berdasarkan data yang diberikan di bawah, hitung beban penyejukan untuk makmal Auto CADD dalam unit ton.

Data:

24 unit lampu fluoresent, 15 w/m^2

40-unit computer desktop, 200 watts

1-unit projektor, 300 watts

1-unit penghala wi-fi , 20 watts

40 pelajar, haba deria 75 watt/ pelajar and haba pendam 45 watt/ pelajar

[10 marks]

[*10 markah*]

QUESTION 3

SOALAN 3

A lecture's office at Lagenda College has internal dimensions of 15.6 m × 8.7 m × 3 m. This lecture's office will have its air conditioning system changed from a split unit to a plant unit. In order to supply 0.9 m³/s cold air into this office space later, the supply duct system needs to be designed and installed based on Figure B3 and in compliance with ASHRAE standards.

*Sebuah pejabat pensyarah di Kolej Lagenda mempunyai ukuran dalaman 15.6 m × 8.7 m × 3 m. Pejabat pensyarah ini akan ditukarkan sistem penyamanan udaranya daripada unit pisah kepada unit loji. Bagi menyalurkan 0.9 m³/s udara sejuk ke dalam ruang pejabat ini nanti, sistem sesalur udara bekalan perlu direkabentuk dan dipasang berdasarkan **Rajah B3** dan dengan mematuhi piawai ASHRAE.*

Statement B3 / Penyataan B3

Figure B3 / Rajah B3
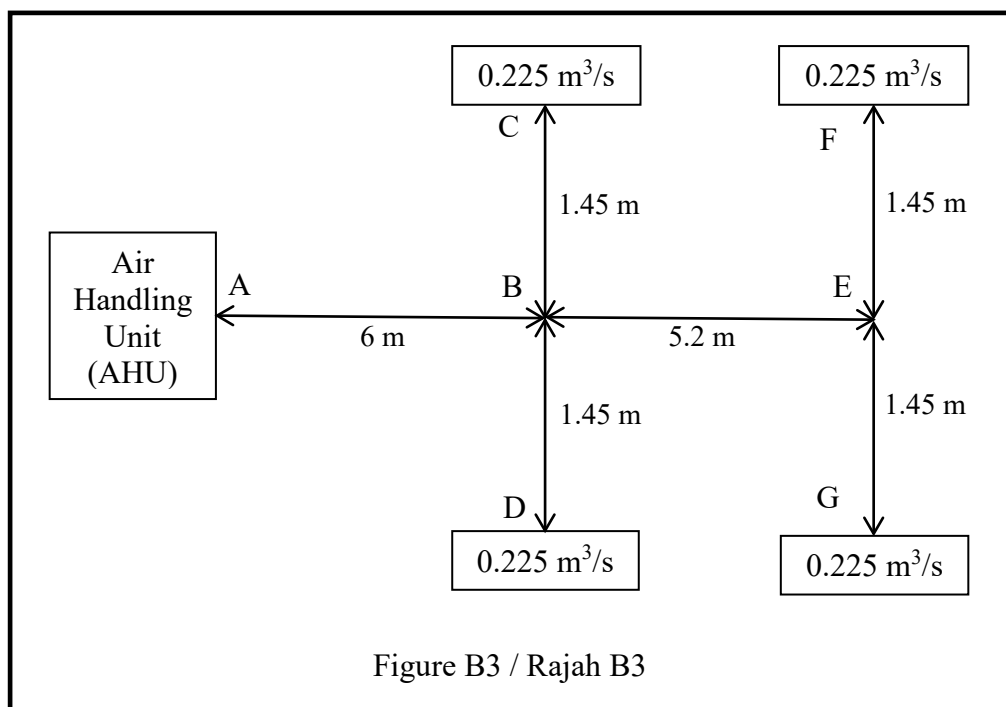
CLO1
C2

(a) From **Statement B3**, estimate the air change rate (ACH) for the lecturer office.

*Daripada **Penyataan B3**, anggarkan kadar pertukaran udara (ACH) untuk pejabat pensyarah.*

[5 marks]

[*5 markah*]

CLO1
C3

(b) According to **Figure B3** and **Chart 4.33 (Appendix B2)**, determine the circular duct size for duct AB, BC, BD, BE, EF and EG by using equal friction method. Assume that the air velocity at duct AB is 5 m/s.

*Berdasarkan kepada **Rajah B3** dan **Carta 4.33 (Lampiran B2)**, tentukan saiz sesalur bulat bagi sesalur AB, BC, BD, BE, EF dan EG dengan menggunakan kaedah geseran sama. Anggapkan bahawa halaju udara pada sesalur AB adalah 5 m/s.*

[10 marks]

[*10 markah*]

CLO1
C4

(c) Referring to **Q3(b)** and **Chart 4.19 (Appendix B3)**, estimate the rectangular duct size for duct AB, BC, BD, BE, EF and EG. Given duct dimension ratio is 2:1.

*Merujuk kepada **S3(b)** dan **Carta 4.19 (Lampiran B3)**, anggarkan saiz sesalur segiempat bagi sesalur AB, BC, BD, BE, EF dan EG. Diberi nisbah dimensi sesalur ialah 2:1.*

[10 marks]

[*10 markah*]

QUESTION 4

SOALAN 4

CLO1
C2

(a) Describe propeller fans.

Jelaskan kipas pendorong.

[5 marks]

[*5 markah*]

CLO1
C3

(b) **Figure B4** shows the cafeteria layout plan that includes the kitchen, the toilet and the store. The ceiling height is 3.5 m. Assuming that the air change per hour (ACH) for the kitchen is 10, toilet 15 and store 8, calculate the air volume flow rate in CFM for each space.

Rajah B4, *menunjukkan pelan susun atur kafeteria yang merangkumi dapur, tandas dan stor. Ketinggian siling ialah 3.5 m. Dengan mengandaikan kadar pertukaran udara sejam (ACH) untuk dapur ialah 10, tandas 15 dan stor 8, hitung aliran udara dalam CFM bagi setiap ruang tersebut.*
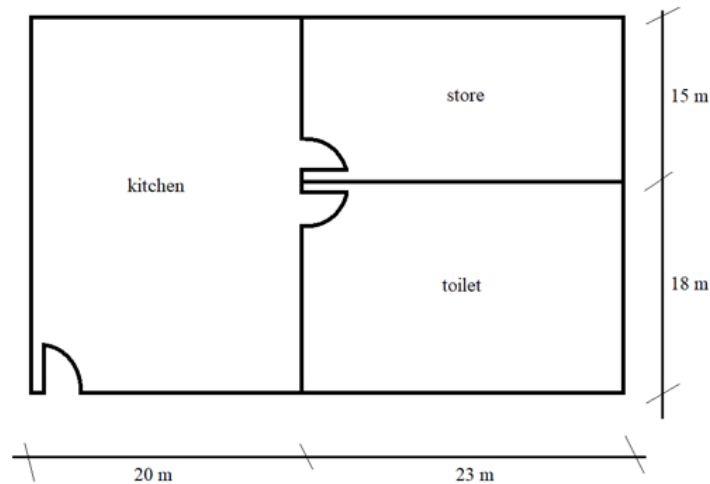

Figure B4/ Rajah B4

[10 marks]

[*10 markah*]

CLO1

C4

(c) A fan of 650 mm in diameter is running at 1200 r.p.m, delivering 120 m³/min of air at 14°C against 72 mm of water of total pressure. If its total efficiency is 82 per cent, estimate the volume of air delivered, the total pressure developed and the power consumed, if the fan speed is increased to 1500 r.p.m.

Sebuah kipas berdiameter 650 mm berputar pada kelajuan 1200 r.p.m, menghantar 120 m3/min udara pada 14°C melawan 72 mm air jumlah tekanan.. Jika jumlah kecekapan ialah 82 peratus, anggarkan isipadu udara yang dihantar, jumlah tekanan yang dihasilkan dan kuasa yang digunakan, jika kelajuan kipas dinaikkan kepada 1500 r.p.m.

[10 marks]

Note

[*10 markah*]

Assessment items for this course have covered elements of the Dublin Problem: DP 1, DP3 DP4 and DP5 as mentioned in FEIST.

SOALAN TAMAT

FORMULA

$$R = \frac{I}{k}$$

$$U = \frac{1}{R}$$

$$Q = A\,U\,T_D$$

$$Q = A\,U\,T_D\,F_S$$

$$Q_{si} = \frac{N\,V\,(t_0 - t_r)}{3}$$

$$Q_{LH} = 0.8\,N\,V(m_{so} - m_{Sr})$$

$$Q = \frac{nos\ x\ power\ x\ hours}{24}$$

$$Q_p = \frac{no\ of\ people\ x\ (SH + LH)xhours}{24hours}$$

$$Q_T = Q_{internal} + Q_{external}$$

$$SH = m_a(h_3 - h_2)$$

$$LH = m_a(h_1 - h_3)$$

$$SHF = \frac{SH}{SH+LH}$$

TOTAL HEAT GAIN = SHG+LHG

TOTAL HEAT=SHL+LHG

$$\frac{m_1}{m_2} = \frac{h_3 - h_2}{h_1 - h_3}$$

$$m_a = \frac{V}{v_s}$$

$$H_S = m_a\ x\ C_p(t_r - t_s)$$

$$H_c = m_a\ x\ (h_m - h_{ADP})$$

$$Q = m_C(h_d - h_c)$$

$$Q = m_a(W_2 - W_1)$$

$$m = \frac{H}{C_p\ (t_r - t_s)}$$

$$Supply\ Air\ Rate = \frac{Volume\ Flow\ Rate}{Room\ volume}$$

$$Recirculation\ Air\ Rate = Supply\ air\ rate - Fresh\ air\ rate$$

$$Q = \frac{mass\ flow\ rate\ \left(\frac{kg}{s}\right)}{density\ of\ air\ \left(\frac{kg}{m^3}\right)}$$

$$p_f = \frac{fL}{m}\left(\frac{v}{4.04}\right)^2$$

$$Q = AV$$

$$Q = \frac{Room\ volume\ x\ ACH}{3600}$$

$$Q = \frac{Room\ volume\ x\ ACH}{60}$$

$$m = \frac{A}{p}$$

$$P = \pi D$$

$$\frac{Q_1}{Q_2} = \frac{N_1}{N_2}$$

$$\frac{P_1}{P_2} = \left[\frac{N_1}{N_2}\right]^2$$

$$\frac{kW_1}{kW_2} = \left[\frac{N_1}{N_2}\right]^3$$

W =(Q × P)/ μ

1 kW = 0.2843451 tons

1 tons = 12000 BtuH

PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS
Barometric Pressure 101,325 kPa
SEA LEVEL

Carrier

Dry Bulb Temperature °C

Volume m³/kg dry air

Below 0°C, Properties and Enthalpy Deviation Lines Are For Ice

Moisture content kg/kg Dry Air

Sensible Heat Factor

Wet Bulb or Saturation Temperature °C

Enthalpy at saturation kJ/kg Dry Air

Relative Humidity

Enthalpy deviation kJ/kg dry air
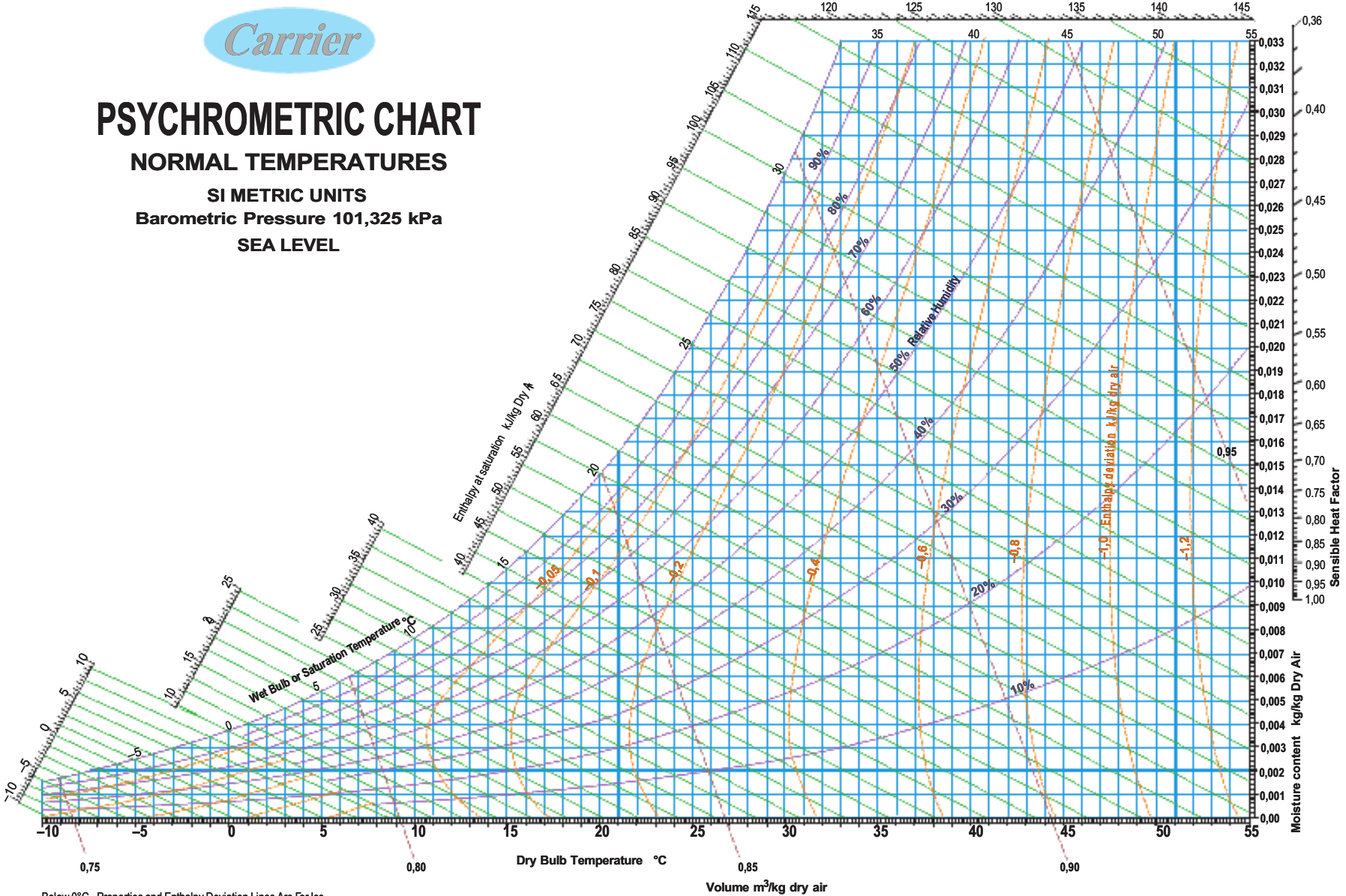
Table A1/ Jadual A1

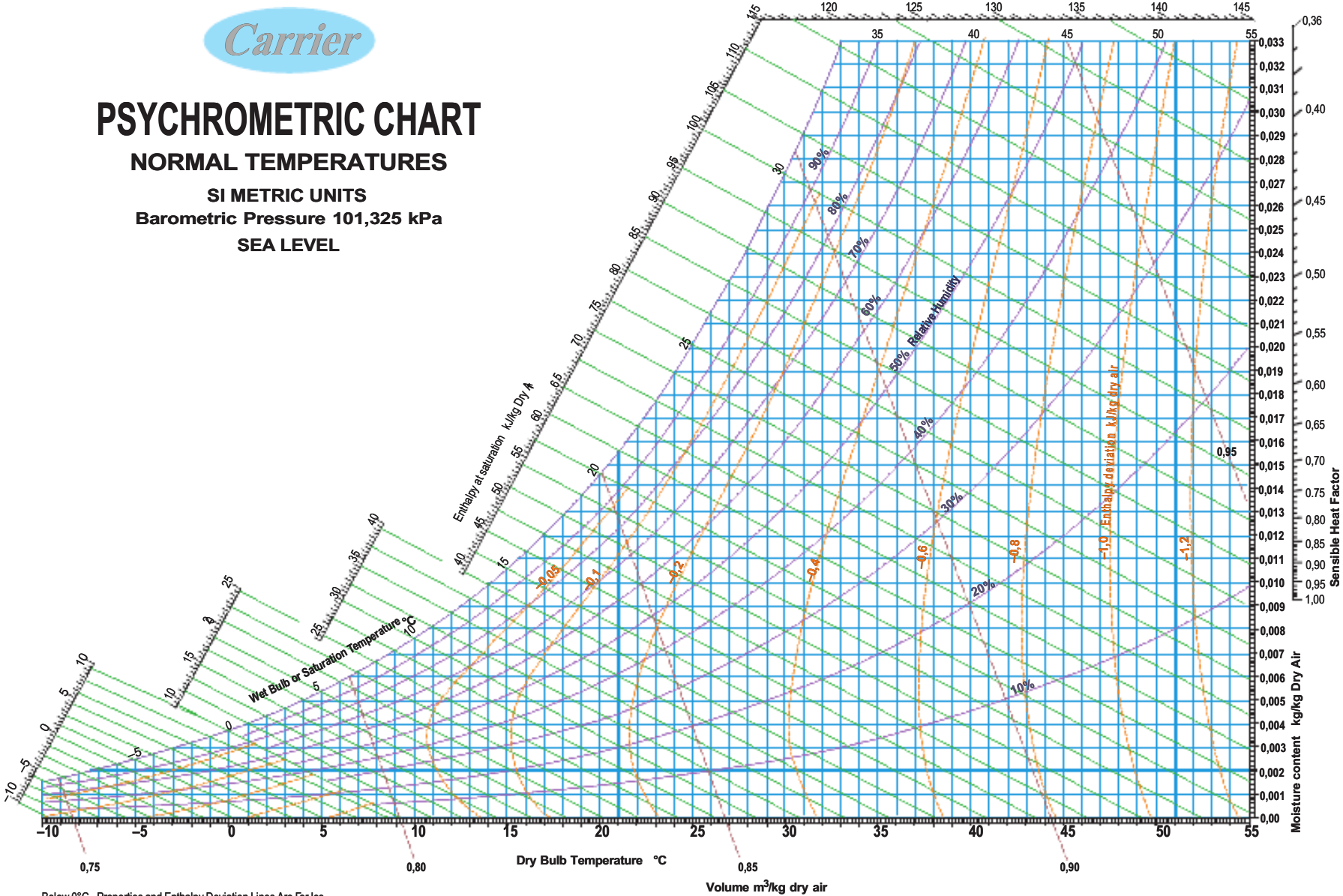| TYPE OF EQUIPMENT	USUAL TONNAGE
Air-cooled Package	up to 15 tons
Water Cooled Package	up to 60 tons
DX Central System	30 to 120 tons
Chiller water	100 tons to above

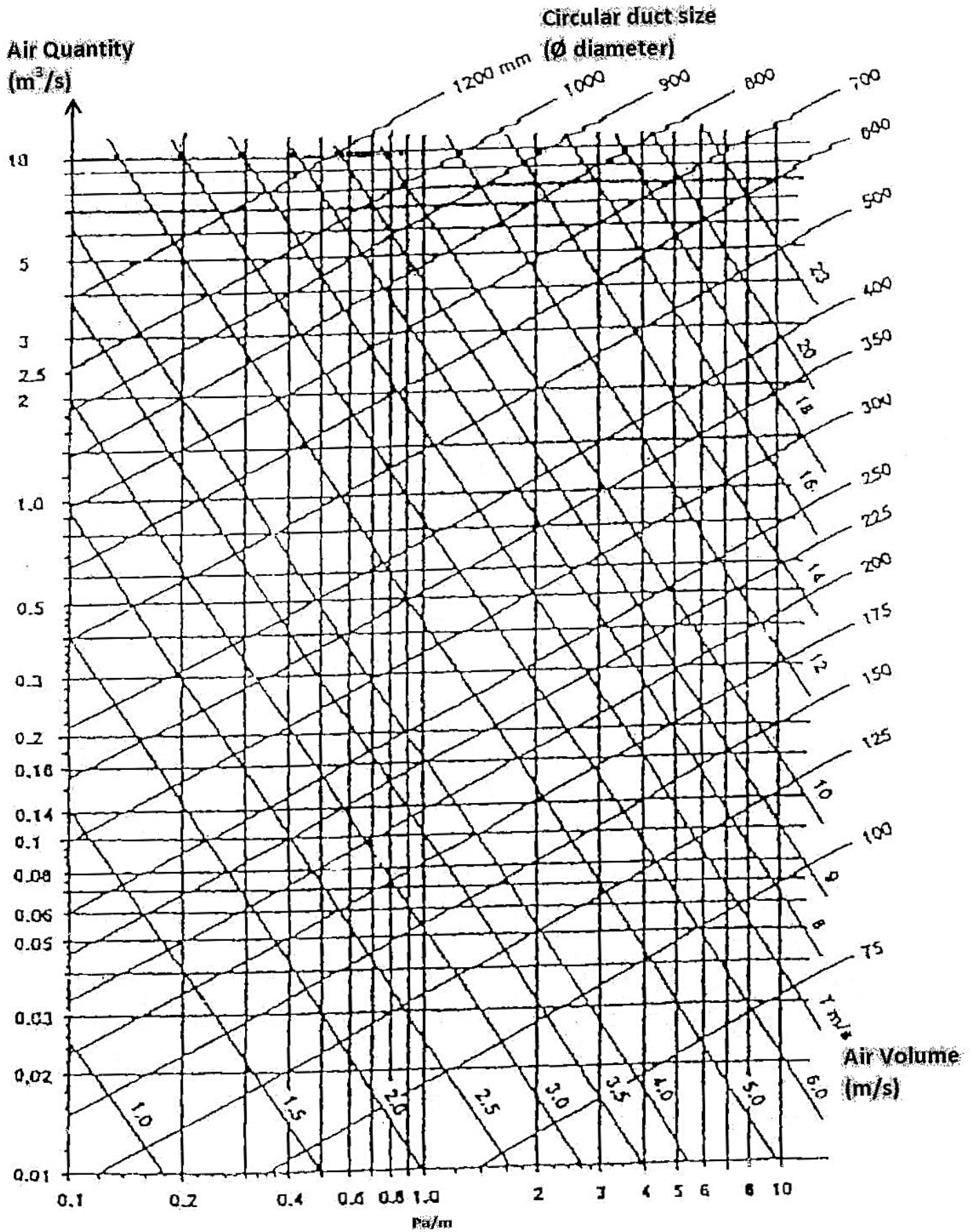# PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS
Barometric Pressure 101,325 kPa
SEA LEVEL

Dry Bulb Temperature °C

Volume m³/kg dry air

Below 0°C, Properties and Enthalpy Deviation Lines Are For Ice
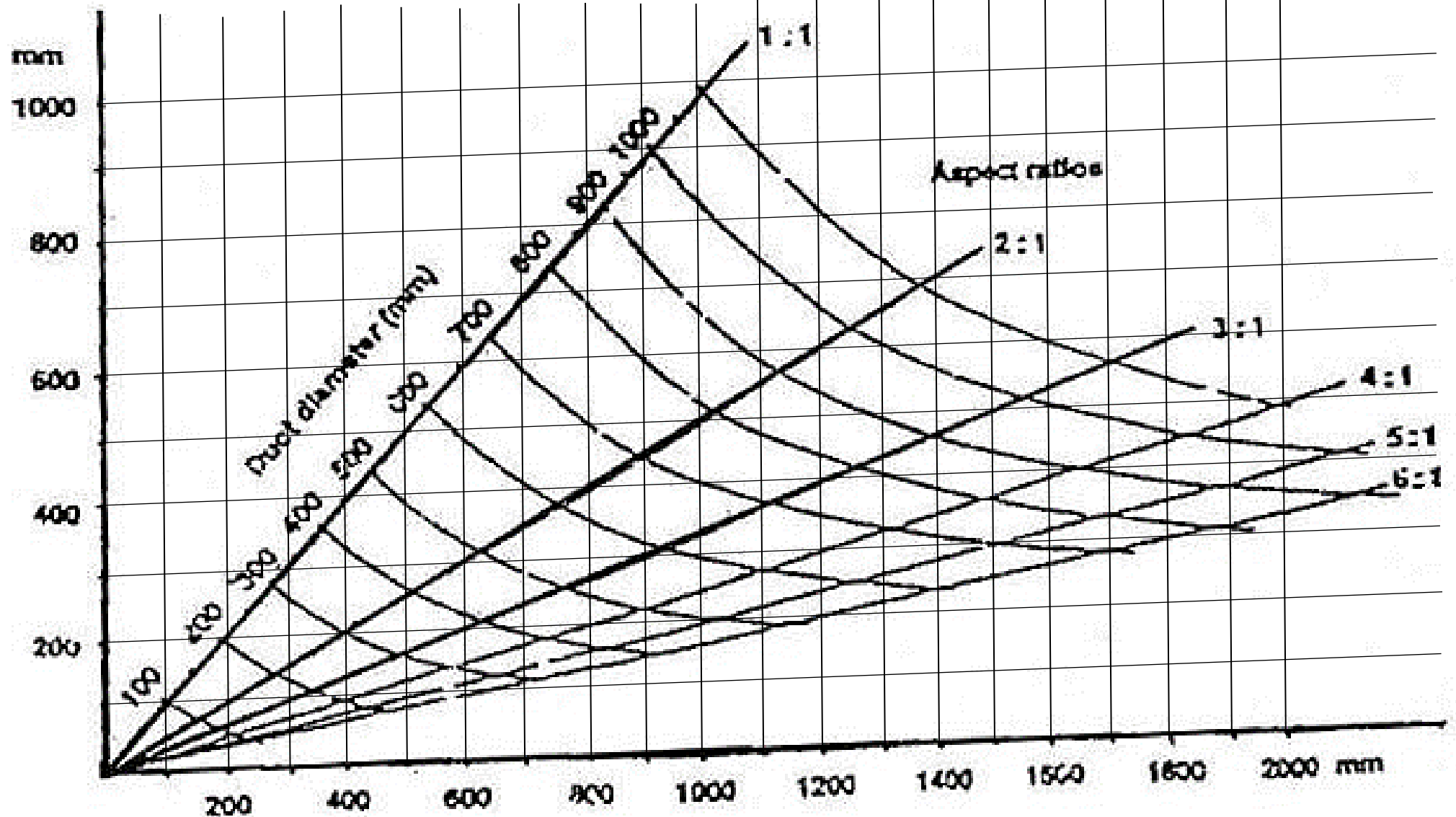
Chart 4.33: Determination of Air Duct Sizing

Chart 4.19: Circular to Rectangular Ductwork Conversion Chart