UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 6 Examination in Engineering: November 2016

Module Number: CE6251 **Module Name: Building Services Engineering**

[Three Hours]

[Answer **all questions**, each question carries twelve marks]

Q1.

a) Efficient means of movement inside buildings are very essential to achieve the intended purpose of the building. Discuss means of movement that can be used in different types of buildings.

[3.0 Marks]

b) Escalators are used in public places as a means of circulation inside buildings. Determine the carrying capacity of the escalator whose step width is 1 *m*. You may assume that the speed of the escalator is 0.8 *m/s*, two passengers per step and the angle of inclination is 30^0.

[3.0 Marks]

c) A company has been awarded to design a lift system for a hotel complex having 25 storeys. Ground floor is proposed to be used as a Vehicle Park. The first 14 storeys are proposed to function as 3- star or less hotels while other above 10 storeys are to function as 4 and 5- star hotels. Consider each floor has 20 rooms on average. As the service engineer of that company you are asked to undertake this job. Design a suitable lift system for this hotel complex allowing zoning arrangement if required. Your answer should contain the number of lifts, the size of a lift and shaft and the capacity of a lift. Use the information given in Data Sheets 1, 2 and 3. Floor to floor height is 3.6 *m*. Any assumption made should be clearly mentioned and justified.

[6.0 Marks]

Q2.

a) What are the factors that you have to consider when designing a pipe network to supply hot or cold water to a building?

[2.0 Marks]

b) Explain the terms, equivalent pipe length and effective pipe length.

[2.0 Marks]

c) Consider the following project description for a three-storey building which is proposed to be used as a students' hostel. Each floor contains separate toilets and bathrooms. It is proposed that main distribution pipe from the overhead tank is located centrally outside the building. From the main distribution pipe two branch pipes at either side are served at each floor. One branch pipe consists of four water closets, 4 wash basins and 3 showers. Showers are considered as having high peak demands. The distance to the remote appliance in each floor and each side is 10 *m*. Floor to floor height is 4 *m* and every appliance is located 1 *m* above the floor level.

i Draw a schematic diagram of the proposed pipe network.

ii Determine the diameters of main distribution pipe and two branch pipes at 2nd floor. PVC pipes are to be used for the entire pipe network. Information given in Data Sheets 4 and 5 can be used when answering the question.

[8.0 Marks]

Q3.

a) Describe the factors you should consider during the design phase to ensure fire precaution of a building.

[2.0 Marks]

b) As protection against fire, what are the advantages of providing proper means of escape?

[2.0 Marks]

c) "As a fire protection mean, Sprinkler system is more effective compared to other means like Risers, Extinguishers, Hose reels etc." Do you agree with this statement? Give reasons to support your answer.

[2.0 Marks]

d) You are required to design an automatic sprinkler system for a two-storey commercial building. The ground floor of the building is proposed to be used as departmental stores while the top floor is to be used as restaurants. Inside the building, the dimensions are 60 *m* x 40 *m*. The distribution pipe has to be arranged such a way that it is parallel to the long side of the building and range pipe are arranged only to a one direction from the distribution pipe. Design a suitable sprinkler system. You may assume that there are no obstructions like columns and beams inside the building. Use the information given in Data Sheet 6 when answering.

[4.0 Marks]

e) To ensure the efficiency of a sprinkler system, what are the factors you should consider when supplying water for the system?

[2.0 Marks]

Q4. Three-storey building is to be constructed to provide space for a garment factory. The layout of a typical floor is shown in Figure Q4. Building consists of steel framed glass windows. It is decided to have natural ventilation for the ground floor and the first floor while the second floor is to be artificially ventilated.

a) Select a suitable orientation for this building (assuming the North direction by yourself, and wind direction is not necessary to consider) to minimize the external thermal gains so that it will be possible to provide thermal comfort without air conditioning at the ground floor and the first floor. Give reasons for your selection.

[2.0 Marks]

b) Once the orientation is selected, what are the other measures that can be taken to minimize the thermal gains inside the building?

[2.0 Marks]

c) Explain the importance of humidification and dehumidification process in a cooling or heating system using the psychrometric chart. Psychrometric chart is in the Data Sheet 7.

[3.0 Marks]

d) During a summer season atmospheric temperature is 30^0C with relative humidity 20%. A building is to be cooled to 20^0 C with relative humidity 60%. What is the amount of moisture that should be added in to the building through an Air Conditioning machine? Show all the corresponding points and data on the psychrometric chart given in Data Sheet 7.

[5.0Marks]

Q5. a) What are the material properties and design aspects that should be ensured in choosing sanitary appliances?

[3.0 Marks]

b) Explain the situations where we use single stack system and fully ventilated one pipe system.

[3.0 Marks]

c) Loss of water seal in traps create unpleasant and unhygienic situation. Analyse this statement.

[3.0 Marks]

d) Discuss the techniques that can be applied for waste separation in chutes.

[3.0 Marks]

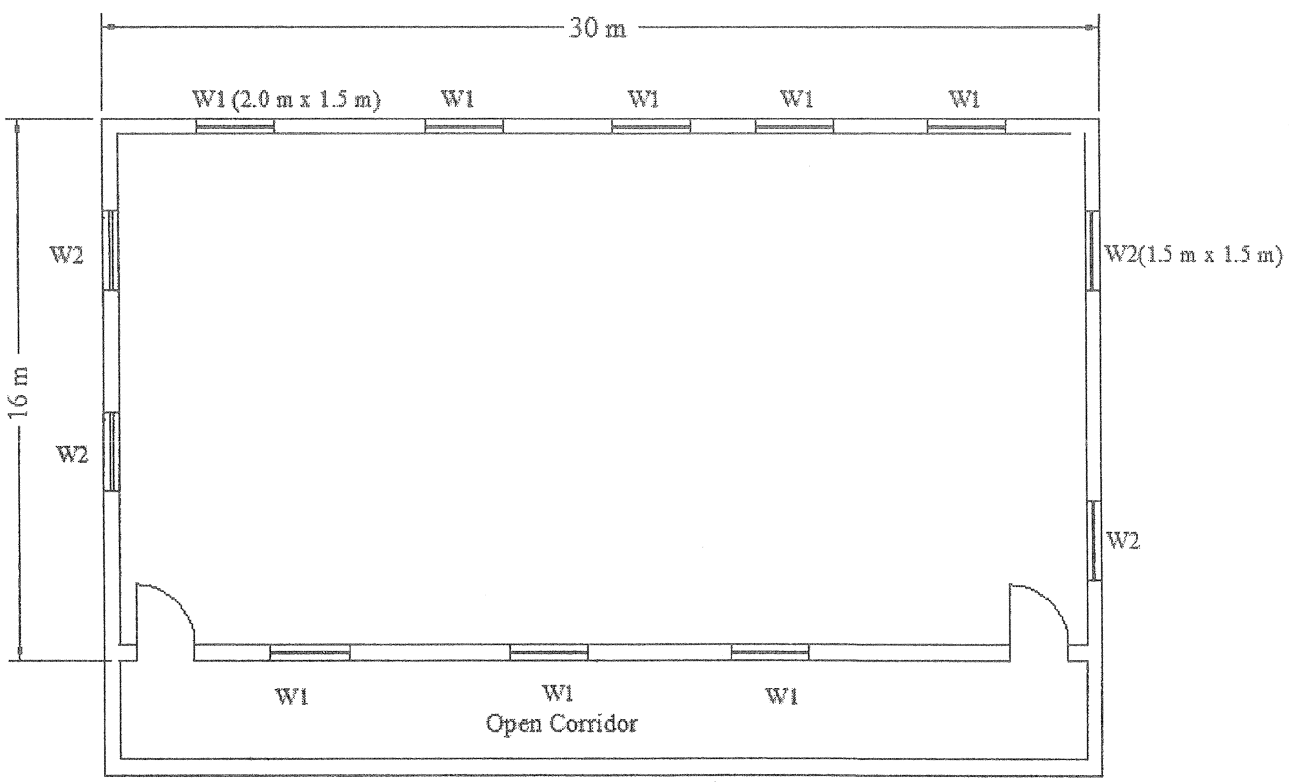


Figure Q4: Layout of a Typical Floor

Data Sheet 1

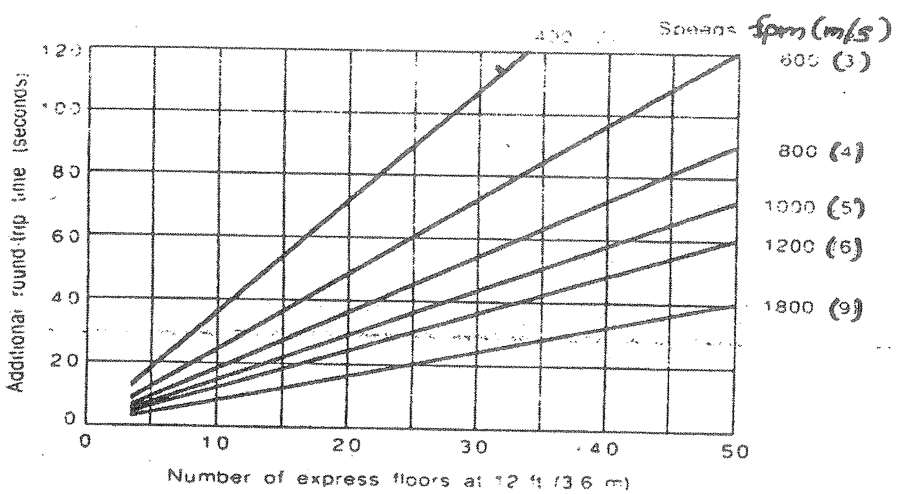
Elevator Speeds for Various Occupancies

Travel Distance		*Offices and Hotels*		*Retail Stores*		*Apartments*	
ft	*m*	*fpm*	*m/s*	*fpm*	*m/s*	*fpm*	*m/s*
0-60	0-20	200-400	1-2	200	1	100	0.5
60-120	20-36	300-400	1.5-2	200-300	1-1.5	200	1
120-240	36-72	500-600	2.5-3	200-400	1-2	200-400	1-2
240-500	72-150	800-1000	4-5				

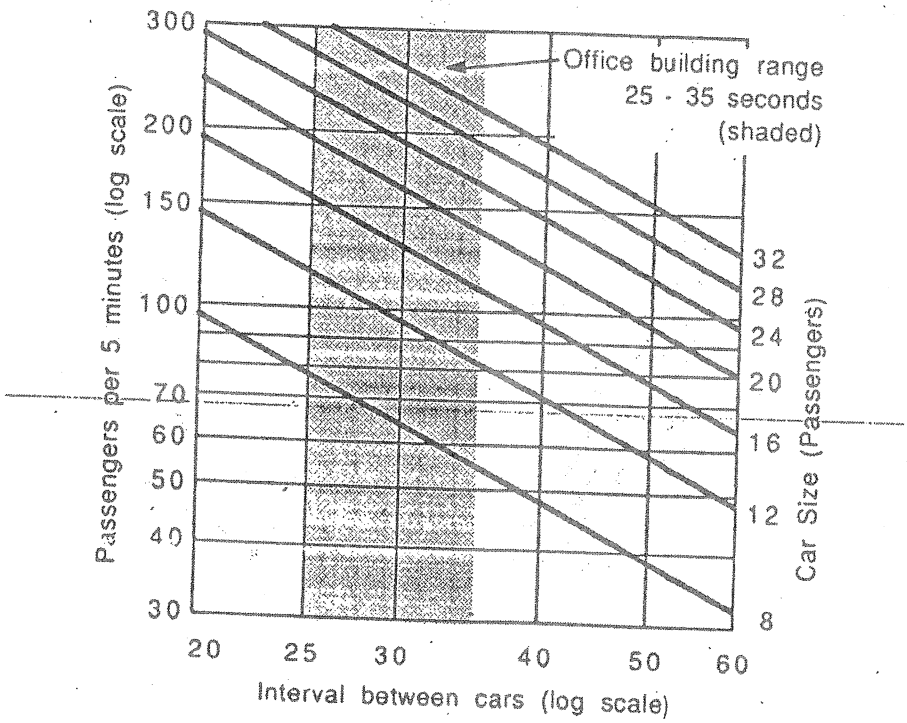
fpm: feet per minute

Design Parameters for Elevators

Building type	*Population Density*		*% Population Handled in 5 minutes*	*Average Interval Seconds*
	ft^2/person	*m^2/person*		
Offices				
Prestige, single tenant	300	12	12-17	25-30
Investment downtown	100-110	9-10	12-14	30-35
Investment suburban	90-100	8-9	12-14	30-45
Apartment				
Prestige	1.5 per bedroom		5-7	50-70
Midrange	2 per bedroom		6-8	60-80
Low rental	2-3 per bedroom		6-8	80-120
Hotels				
4-5 star	1.5-2 per room		12-15	40-60
3 and less star	1.5-2 per room		10-12	50-70



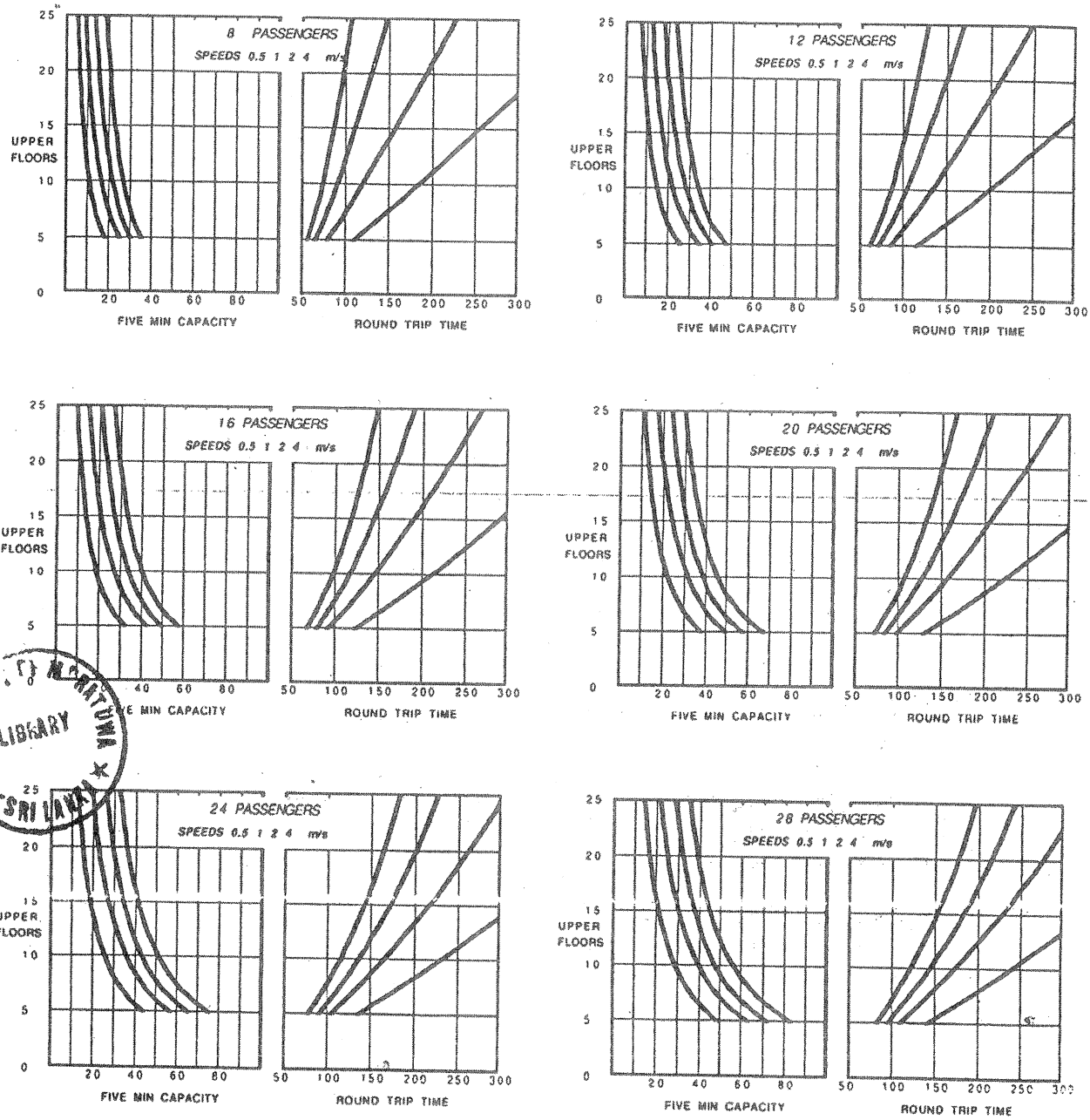
Additional time to be added to the round-trip time when a car operates express through the lower floors of a building. The additional time is calculated as twice the distance divided by the speed, and therefore allows for both the up and down travel through the express zone at rated car speed.



The five-minute handling capacity of sets of various sized elevator cars, plotted against the interval between them. First determine the required handling capacity of the group. Enter the graph from the left, and continue across to find the intersection of an acceptable car size and interval. If the required capacity is too high for an acceptable solution, try zoning. If it is too low, then the building is less than optimum size for elevatoring. Once a size and interval is determined, refer to Fig. 25.7.2 to determine the round-trip time of cars of various speeds. The number of cars required in the group is the round-trip time divided by the required interval.

Approximate Sizes and ratings of Elevator Cars

Capacity		*Passengers*		*Inside W x D*		*Shaft W x D*	
lb	*kg*	*Max*	*Average*	*in*	*mm*	*in*	*Mm*
2000	900	12	10	68 x 51	1700 x 1300	89 x 83	2200 x 2100
2500	1150	16	13	82 x 51	2100 x 1300	102 x 83	2550 x 2100
3000	1350	20	16	82 x 55	2100 x 1400	102 x 88	2550 x 2200
3500	1600	24	19	82 x 66	2100 x 1650	102 x 96	2550 x 2400
4000	1800	28	22	92 x 66	2300 x 1650	114 x 96	2850 x 2400



The round trip time, and five-minute carrying capacity, for single elevator cars from 8 to 28 passenger nameplate capacity, and speeds from 100 to 800 fpm (0.5 to 4 m/s). All upper floors are assumed to have equal attraction. Figures are based on up peak conditions. Assumptions made about door operations and landing dwell times are intended to reflect good conditions. Slight to moderate downgrading is likely with nonstandard conditions such as extended door-open times and narrow or deep car shape.

Loading units

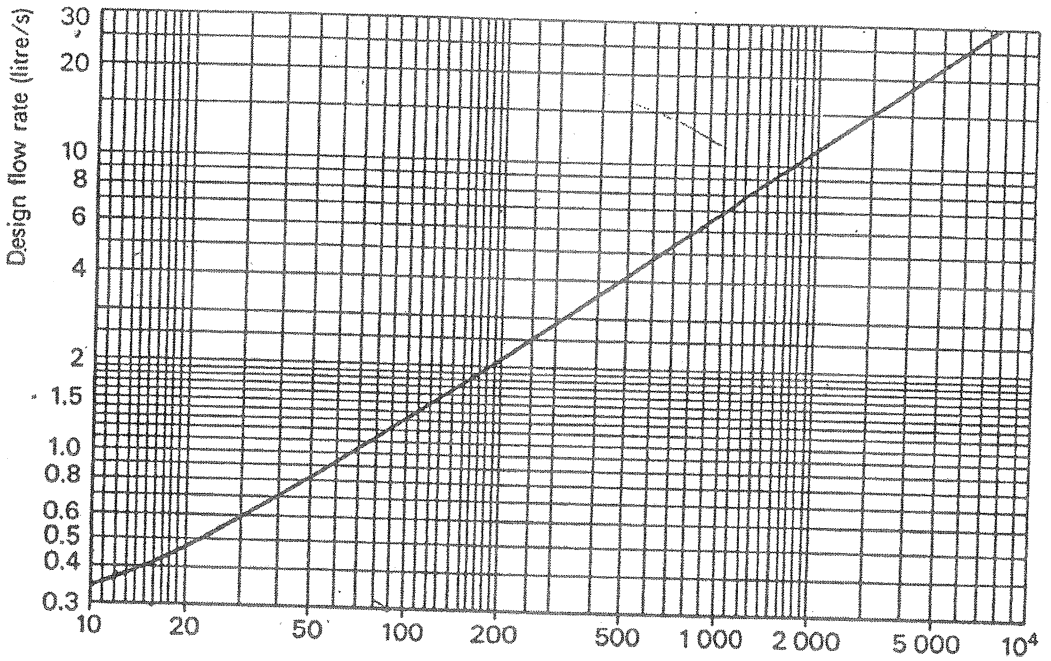
	Loading unit rating
Dwellings and flats	
W.C. flushing cistern	2
Wash basin	1 ½
Bath	10
Sink	3-5
Offices	
W.C. flushing cistern	2
Wash basin(distributed use)	1 ½
Wash basin (concentrated use)	3
Schools and industrial buildings	
W.C. flushing cistern	2
Wash basin	3
Shower	3
Public bath	22

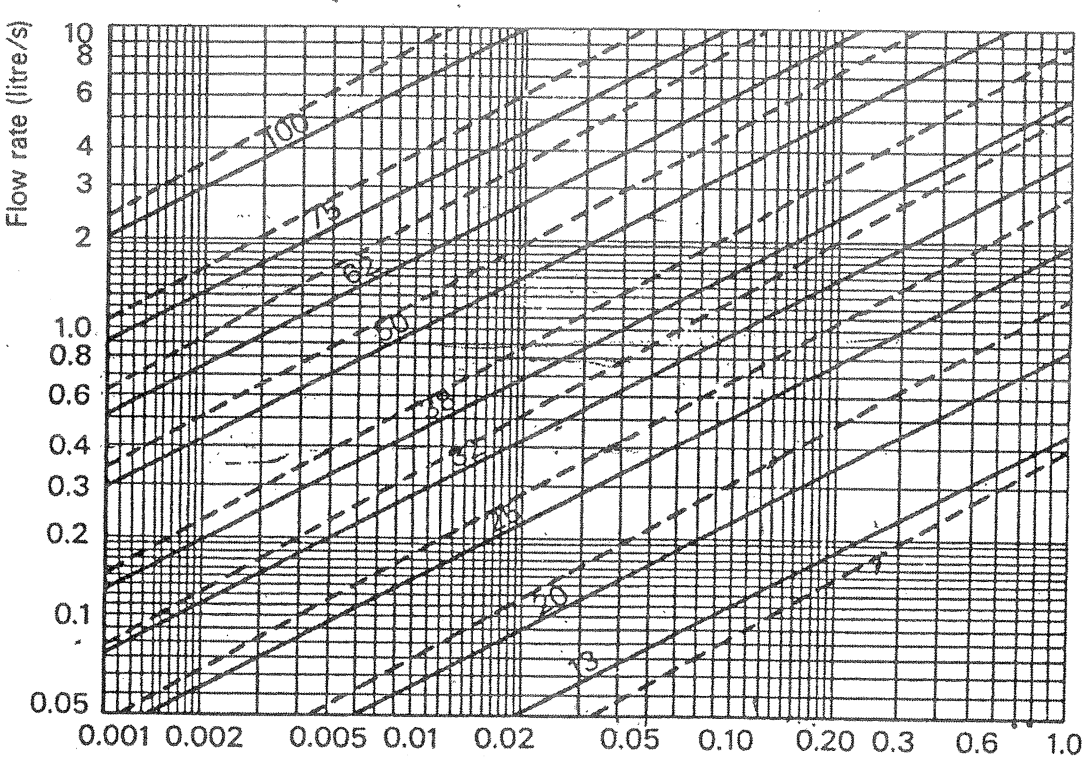
Minimum flow rate with high peak demand

Type of appliances	Rate of flow (*l*/s)
W.C. flushing cistern	0.12
Wash basin	0.15
Wash basin with spray taps	0.04
Bath (private)	0.30
Bath (public)	0.60
Shower	0.12
Sink with 13mm taps	0.20
Sink with 19mm taps	0.30
Sink with 25mm taps	0.60

Equivalent length for frictional resistance

Copper/Plastic			**Galvanized steel**			
Nominal outside diameter (mm)	Meter run of pipe		Nominal outside diameter (mm)	Meter run of pipe		
	Elbow	Tee		Elbow	Bend	Tee
15	0.5	0.6	15	0.5	0.4	1.2
22	0.8	1.0	20	0.6	0.5	1.4
28	1.0	1.5	25	0.7	0.6	1.8
35	1.4	2.0	32	1.0	0.7	2.3
42	1.7	2.5	40	1.2	1.0	2.7
54	2.3	3.5	50	1.4	1.2	3.4
62	3.0	4.5	65	1.7	1.3	4.2
76	3.4	5.8	80	2.0	1.6	5.3
108	4.5	8.0	100	2.7	2.0	6.8





copper lead and plastics – – – – galvanised steel. ————

Pipe-sizing chart

Loss of Heads in Pipes

Sprinkler arrangements

S= design spacing of sprinkler on range pipes
- Max. 4.6 m extra light hazard
- Max. 4.0 m ordinary hazard
- Max. 3.7 m extra high hazard

D= distance between rows of sprinklers

S x D =
- 21 m^2 or less, extra light hazard
- 12 m^2 or less, ordinary hazard
- 9 m^2 or less, extra high hazard

Classification of occupancies

Extra light hazard
Hospitals, hotels, libraries, museums, nursing homes, offices, prisons, schools, colleges

Ordinary hazard (Group I)
Butchers, breweries, cement works, cafes

Ordinary hazard (Group II)
Bakeries, chemical works (ordinary), engineering works, laundries, garages, potteries, shops

Ordinary hazard (Group III)
Aircraft factories (excluding hangars), boot and shoe factories, carpet factories, clothing factories, departmental stores, plastic factories, printing rooms, saw mills, warehouses

Group III (Special)
Cotton mills, distillers, film and television studios, match factories

Extra high hazard
Celluloid works, foam plastics and rubber factories, paint and varnish factories, wood and wood works, high piled storage risks, oil flammable liquid hazard

PSYCHROMETRIC CHART

NORMAL TEMPERATURES

SI METRIC UNITS

Barometric Pressure 101,325 kPa

SEA LEVEL

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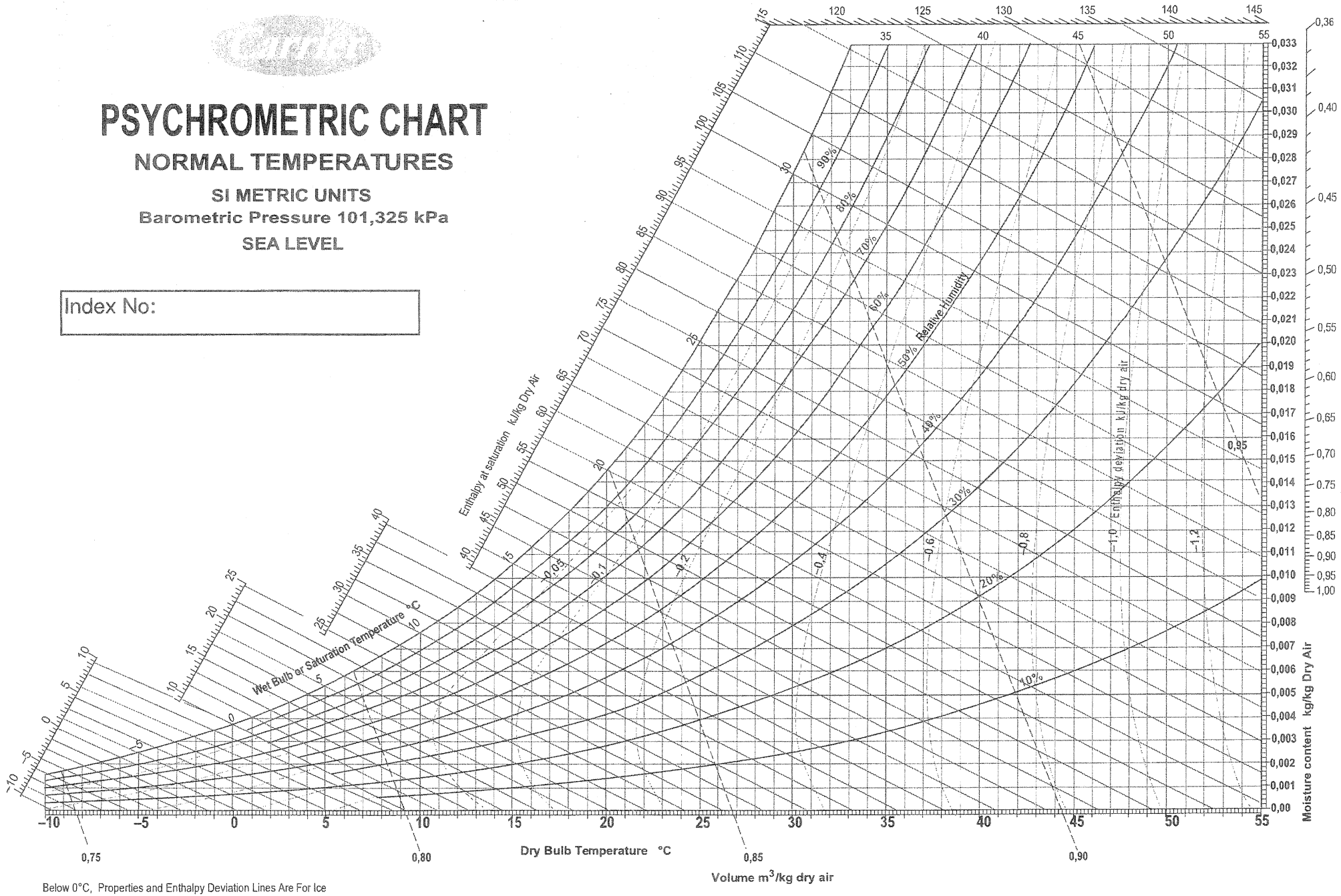

Below 0°C, Properties and Enthalpy Deviation Lines Are For Ice