UNIVERSITY OF RUHUNA

Faculty of Engineering

End-Semester 4 Examination in Engineering: January 2022

Module Number: CE4251 **Module Name: Building Services Engineering**

[Three Hours]

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

Q1.

a) List four major components of a lift (elevator) system and briefly discuss their functions.

[2.0 Marks]

b) List any four safety features available in modern elevators.

[2.0 Marks]

c) Briefly discuss functions of the building core in a high-rise building. From the functional context, what are the factors to be considered in designing the building core?

[2.0 Marks]

d) You are required to design a lift (elevator) system for a 35-storey (including the ground floor) prestige type apartment building. The first three floors (ground floor, 1st floor and the 2nd floor) are designed as shopping spaces and the vertical movement is facilitated only using escalators and staircases. The remaining thirty-two floors are designed for apartment living with a lift system starting from the groundfloor. Please note that any lift does not stop at the 1st floor and the 2nd floor. Each of the apartment floors contains four number of two-bedroom apartments. The floor to floor height of the building is 3.6 *m*. Client's objective is to maximize the passenger service using provided lifts. Design a suitable lift system for this building including a 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 information given in Data Sheets 1-3. Any assumption made should be clearly mentioned and justified.

[4.0 Marks]

e) Briefly discuss two challenges inherent in designing lift systems for skyscrapers.

[2.0 Marks]

Q2.

a) 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 supplies water to 5 water closets and 5 washbasins; the horizontal distance to the last appliance from the main distribution pipe is 8.5 m. Each

appliance is located 0.9 m above the floor level. Floor to floor height is 3.6 *m* and showers are located 1.8 *m* above the floor level.

i Draw a schematic diagram of the proposed pipe network.

[2.0 Marks]

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. State any assumptions made in your calculations.

[8.0 Marks]

b) Briefly describe one possible method that can be applied for indoor water conservation.

[2.0 Marks]

Q3.

a) Green building concept is intended to deliver improved sustainability in the construction sector. Explain giving examples the economic, environmental and social benefits that Green Building offers.

[3.0 Marks]

b) i Identify ONE Green Building assessment tool commonly used in the construction sector in Sri Lanka and/or abroad.

[1.0 Marks]

ii List all categories used to assess the sustainability of buildings in the above assessment tool.

[3.0 Marks]

iii Discuss in detail the design and construction approaches for improving energy efficiency recognized according to the above assessment tool.

[2.0 Marks]

c) Can the early involvement of all project stakeholders make a building design and construction sustainable? Discuss your rationale.

[3.0 Marks]

Q4.

Newly married two young professionals consider to purchase a housing unit of an attached four-unit apartment building situated in greater Colombo area. The building is in a convenient location closer to the workplace and other shopping centers. However, the unit is not air-conditioned at the moment and therefore it is required to investigate the power consumption for cooling, when units installed, before making the purchasing decision. Figure Q4(a) shows the plan view of the unit under consideration. Table Q4(a) and Table Q4(b) show the Window and Door schedule respectively. Floor to floor height of the building is 11 feet. The housing unit consists of a flat roof with no insulation. The adjacent units are not air-conditioned. Appliance and light load for the unit is estimated to be 640 W in total that is shared mainly between the kitchen, and Living/Dining room.

a) Determine the total cooling load for air-conditioning the house unit. Outside temperature can be assumed as 95° Fahrenheit. Use Data Sheet 6 as a guide in answering the question. State any assumptions made.

[6.0 Marks]

b) i Determine the number of Air conditioner units required, if the capacity of 15000 BTU/hr units are used.

[1.0 Mark]

ii If the Coefficient of Performance (COP) is 3.5, estimate the total power requirement for air-conditioning the office space.

[2.0 Marks]

c) Discuss the strategies you can adapt during the design and pre-construction stages to ensure "occupant thermal comfort" in buildings. Provide reference to the standards that are followed in the industry.

[3.0 Marks]

Q5.

a) List four factors to be considered in manufacturing high-quality sanitary fittings.

[2.0 Marks]

b) Graphically illustrate the pressure effects due to water flow in a discharge stack. Assume three basins are discharging simultaneously.

[3.0 Marks]

c) Discuss how the water seal of a sanitary appliance is lost due to self siphonage and induced siphonage. Mention an arrangement to prevent each of these issues.

[4.0 Marks]

d) Draw a diagram to illustrate a fully ventilated one pipe system for sanitary drainage. List two advantages of this system compared to a single stack system.

[3.0 Marks]

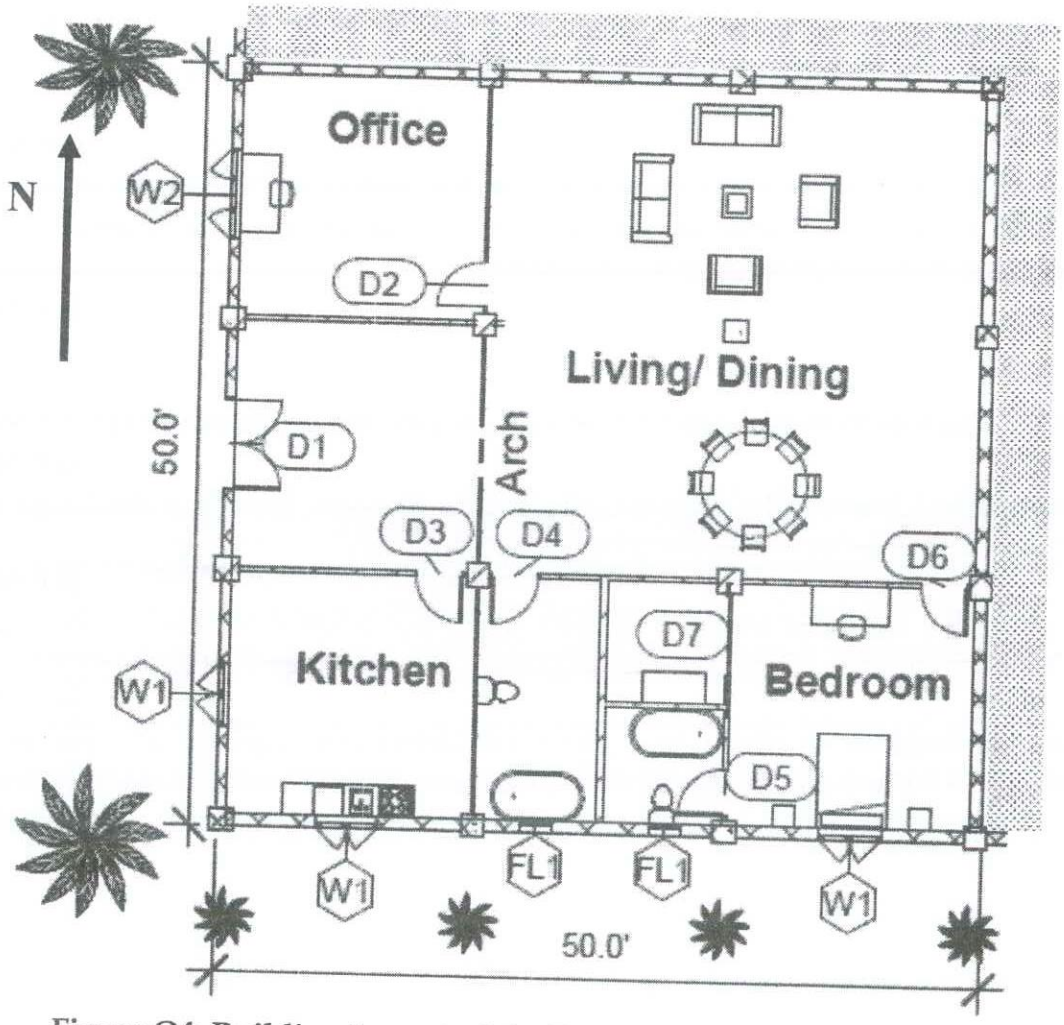


Figure Q4: Building Layout of the Executive Deluxe Small House Unit

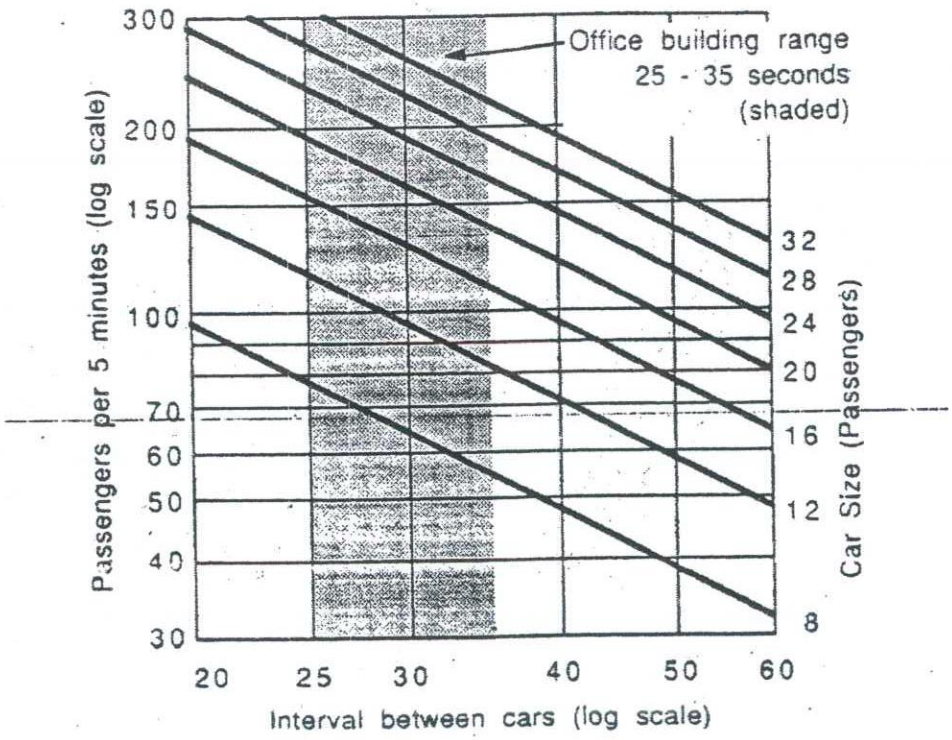
Table Q4(a). Window Schedule

Window Schedule				
Family	Tag	Width	Height	Count
Window-Double-Hung	FL1	2.0'	3.5'	2
Window-Casement-Double	W1	4.0'	5.0'	3
M_Window-Casement-Triple-Middle-Transom	W2	5.9'	4.4'	1

Table Q4(b). Door Schedule

Door Schedule				
Family	Tag	Width	Height	Count
Door-Interior-Single-Flush_Panel-Wood	D2, D3, D4, D5	3.0'	7.0'	4
M_Door-Exterior-Double-Full Glass-Wood_Clad	D1	5.9'	6.6'	1
M_Door-Interior-Double-Pocket-2_Panel-Wood	D7	5.2'	6.6'	1
M_Door-Interior-Single-Flush_Panel-Wood	D6	3.0'	6.6'	1

Data Sheet 2

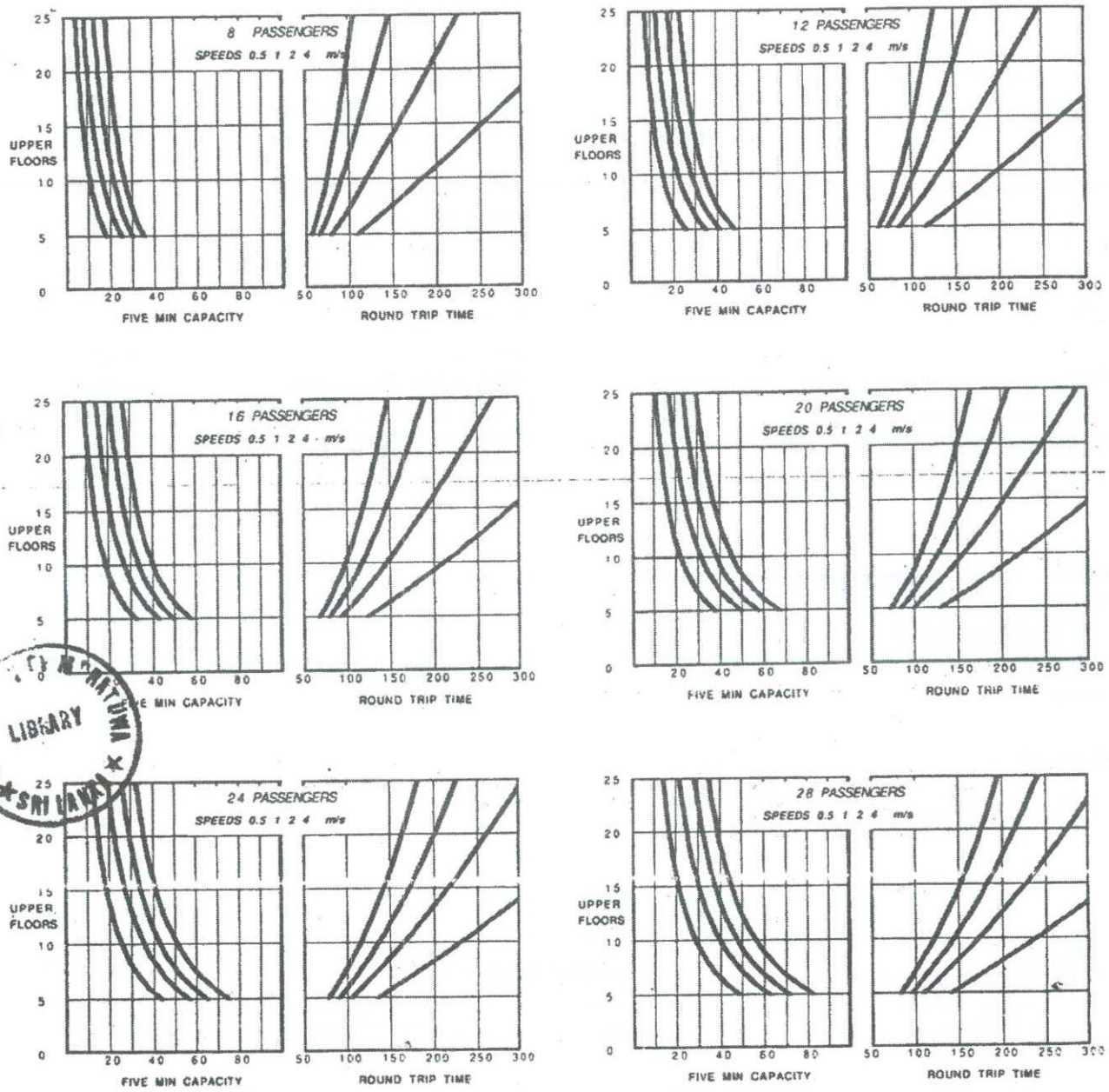


The five-minute handling capacity of sets of various sized elevator cars, plotted against the interval between them. First determine the required handling capacity of the group. Enter the graph from the left, and continue across to find the intersection of an acceptable car size and interval. If the 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

Data Sheet 3



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

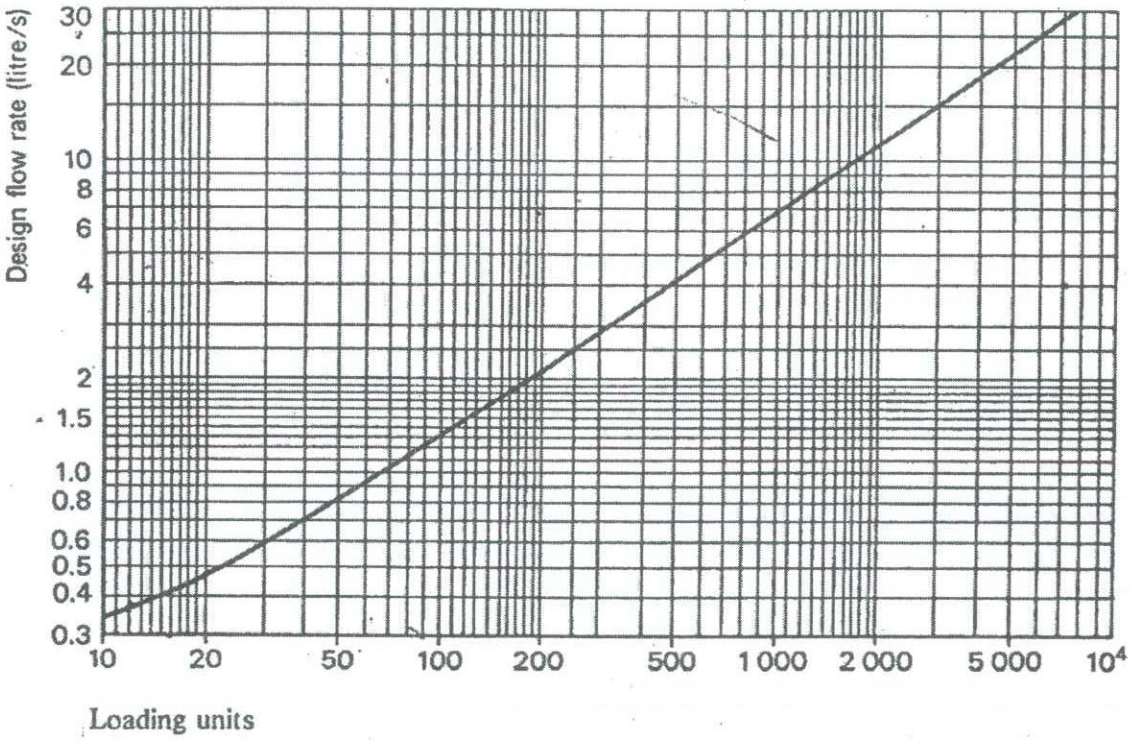
	Loading unit rating
Dwellings and flats	
W.C. flushing cistern	2
Wash basin	1 ½
Bath	10
Sink	3-5
Offices	
W.C. flushing cistern	2
Wash basin (distributed use)	1 ½
Wash basin (concentrated use)	3
Schools and industrial buildings	
W.C. flushing cistern	2
Wash basin	3
Shower	3
Public bath	22

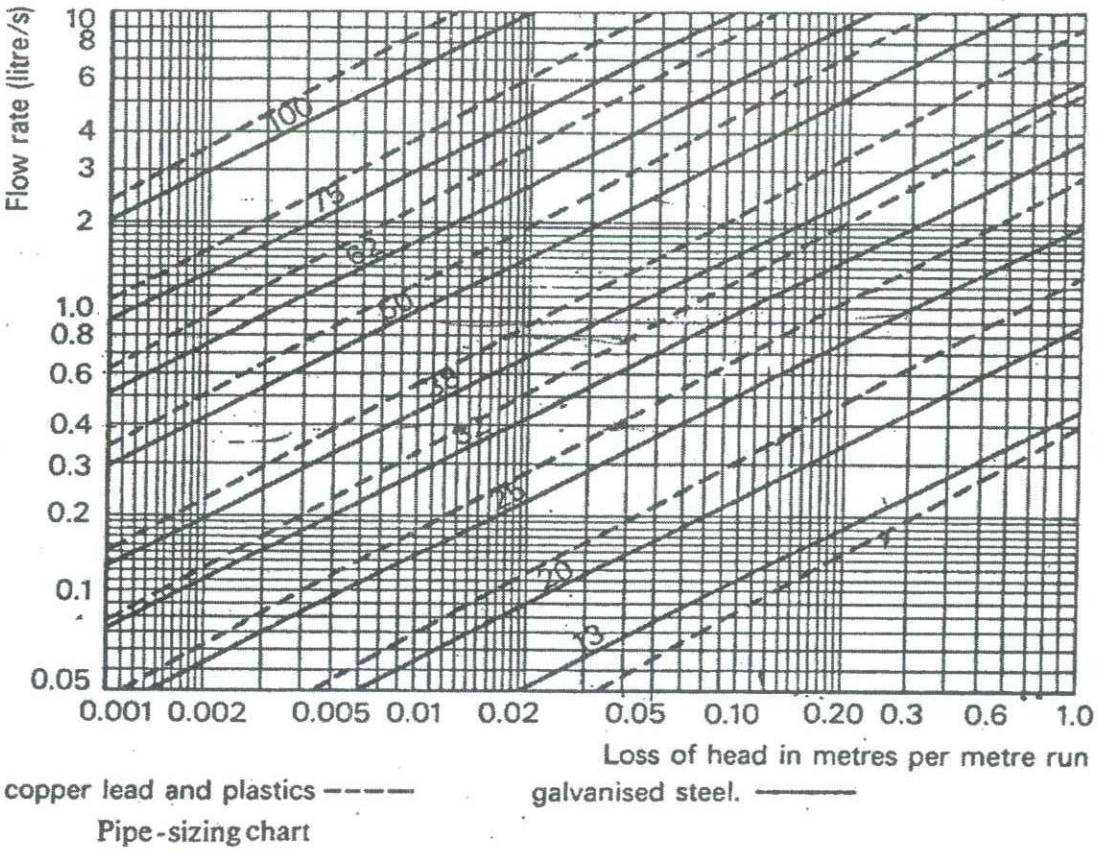
Minimum flow rate with high peak demand

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





Pipe-sizing chart

Data Sheet 6

	Item	Quantity		Factor		BTU/hr
				*90 **	*95**	
1	Window exposed to Sun	N or E NW W NE & SW	sqft sqft sqft sqft	42 77 85 57	47 80 100 60	=
2	All windows not included in item 1		sqft	20	25	=
3	Wall exposed to Sun (wall considered in item 1)	Light construction Heavy construction	lnft lnft	60 40	70 50	=
4	All exterior walls not included in item 3		lnft	22	27	=
5	Partitions	All interior walls adjacent to an unconditioned space	lnft	20	30	=
6	Ceiling or Roof (use only one)	Ceiling with unconditioned space Ceiling with no insulation Attic space with insulation Flat roof with no insulation Ceiling below with insulation Roof no insulation	sqft sqft sqft sqft sqft sqft	1 8 5 7 3 14	3 10 3 8 3 16	=
7	Floor	Over unconditioned space	sqft	2	3	=
8	People	Including allowances for ventilation through unit	No	..... x 1000		=
9	Light & Electrical equipment		W	..... x 3.41		=
10	Doors or Arches continuously open to unconditioned space		Nos	..... x 250		=
					Total cooling load	=

*:- outside design condition of

1 BTU (British Thermal Unit)/hr=0.2931 Watt