COOLING LOAD CALCULATION

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Terminology

Space – is either a volume or a site without a partition or a partitioned room or group of rooms.
Room – is an enclosed or partitioned space that is usually treated as single load.
Zone – is a space or group of spaces within a building with heating and/or cooling requirements sufficiently similar so that comfort conditions can be maintained throughout by a single controlling device.
British Thermal Unit (BTU) –is the approximate heat required to raise 1 lb. of water by 1 deg Fahrenheit. Air conditioners are rated by the number of British Thermal Units (Btu) of heat they can remove per hour. Another common rating term for air conditioning size is the "ton," which is 12,000 Btu per hour and Watts.
Ton –

1 ton = 12,000 BTU/hr
1 ton = 3.516 kW

Terminology

Cooling Load temperature Difference (CLTD)–an equivalent temperature difference used for calculating the instantaneous external cooling load across a wall or roof.

Sensible Heat Gain –is the energy added to the space by conduction, convection and/or radiation.

Latent Heat Gain –is the energy added to the space when moisture is added to the space by means of vapor emitted by the occupants, generated by a process or through air infiltration from outside or adjacent areas.

Radiant Heat Gain –the rate at which heat is absorbed by the surfaces enclosing the space and the objects within the space.

Space Heat Gain –is the rate at which heat enters into and/or is generated within the conditioned space during a given time interval.

Space Cooling Load –is the rate at which energy must be removed from a space to maintain a constant space air temperature.

Space Heat Extraction Rate –the rate at which heat is removed from the conditioned space and is equal to the space cooling load if the room temperature remains constant.

Dry Bulb Temperature –is the temperature of air indicated by a regular thermometer.

Terminology

Wet bulb Temperature –is the temperature measured by a thermometer that has a bulb wrapped in wet cloth. The evaporation of water from the thermometer has a cooling effect, so the temperature indicated by the wet bulb thermometer is less than the temperature indicated by a dry-bulb (normal, unmodified) thermometer. The rate of evaporation from the wet-bulb thermometer depends on the humidity of the air. Evaporation is slower when the air is already full of water vapor. For this reason, the difference in the temperatures indicated by ordinary dry bulb and wet bulb thermometers gives a measure of atmospheric humidity.

Dew Point Temperature –is the temperature to which air must be cooled in order to reach saturation or at which the condensation of water vapor in a space begins for a given state of humidity and pressure.

Relative Humidity - describes how far the air is from saturation. It is a useful term for expressing the amount of water vapor when discussing the amount and rate of evaporation. One way to approach saturation, a relative humidity of 100%, is to cool the air. It is therefore useful to know how much the air needs to be cooled to reach saturation.

Terminology

Thermal Transmittance/ Heat Transfer Coefficient (U-Factor)-is the rate of heat flow through a unit area of building envelope material or assembly, including its boundary films, per unit of temperature difference between the inside and outside air. The U-factor is expressed in Btu/ (hr 0R ft2) or in KW/ (m2 K).

Thermal Resistance / Thermal Resistivity (R) –is the reciprocal of a heat transfer coefficient and is expressed in (hr ^{0}R ft^{2})/Btu.

AIRCONDITIONING SYSTEM DESIGN

AIRCONDITIONING SYSTEM DESIGN

- Direct Expansion System
  - Package Terminal Air Conditioners (PTAC)/ Window Type
  - Package Roof-top Unit (RTU)
  - Split System
- Chilled Water System
  - Air-cooled
  - Water-cooled
- Evaporative Cooling System

AIR DISTRIBUTION SYSTEMS

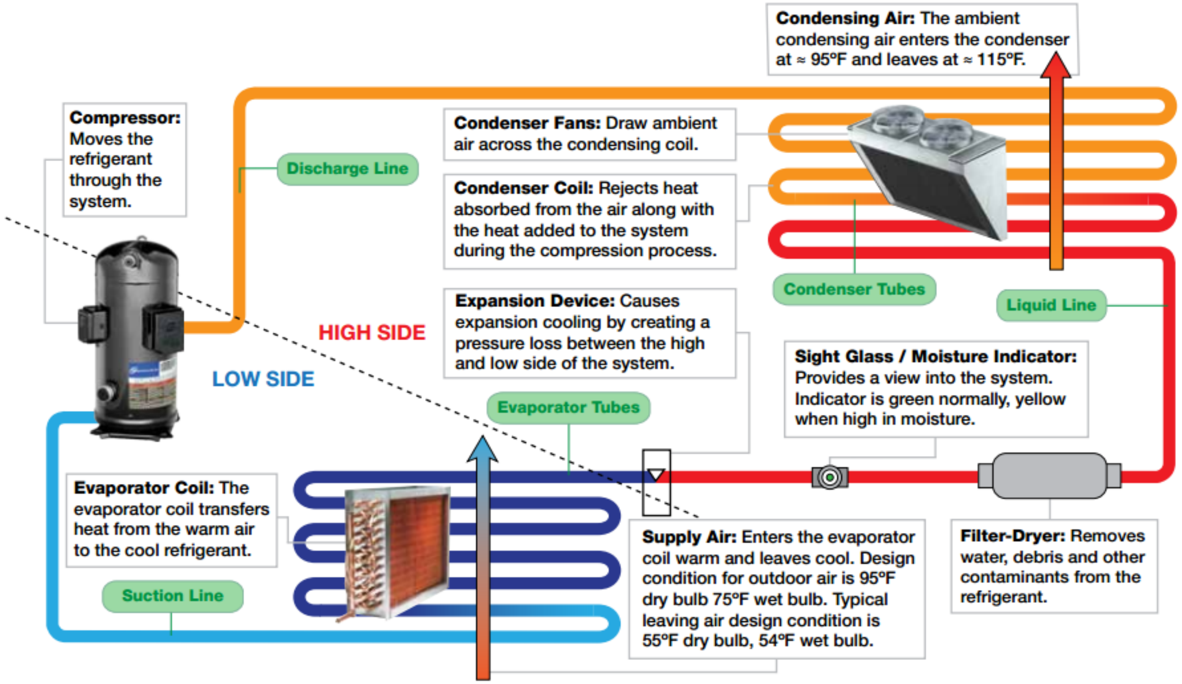
- Variable Air Volume (VAV) System
- Constant Volume System

DX (Direct Expansion) AC System

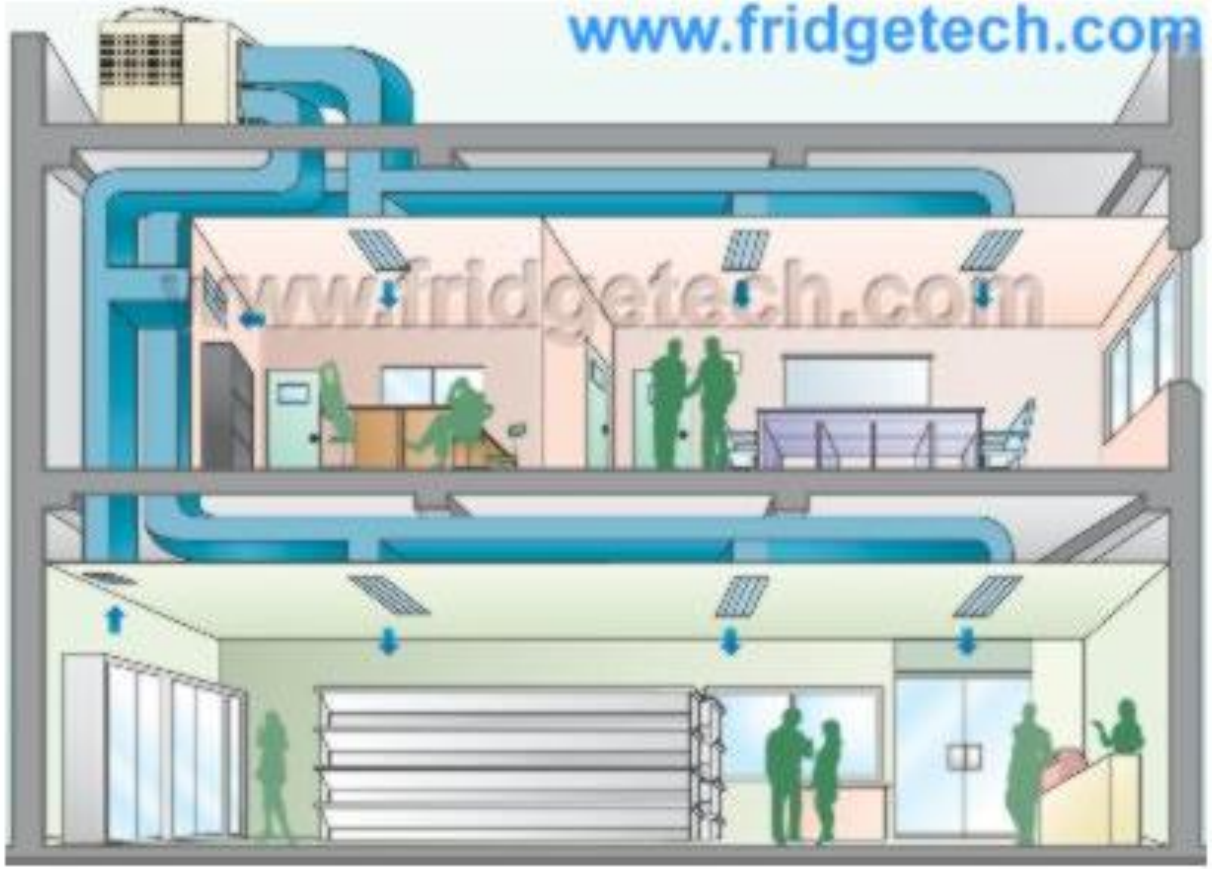
A direct expansion air conditioning (DX) system uses a refrigerant vapor expansion/compression (RVEC) cycle to directly cool the supply air to an occupied space.

DX systems (both packaged and split) directly cools the air supplied to the building because the evaporator is in direct contact with the supply air.

DX (Direct Expansion) AC System



Package Rooftop Unit

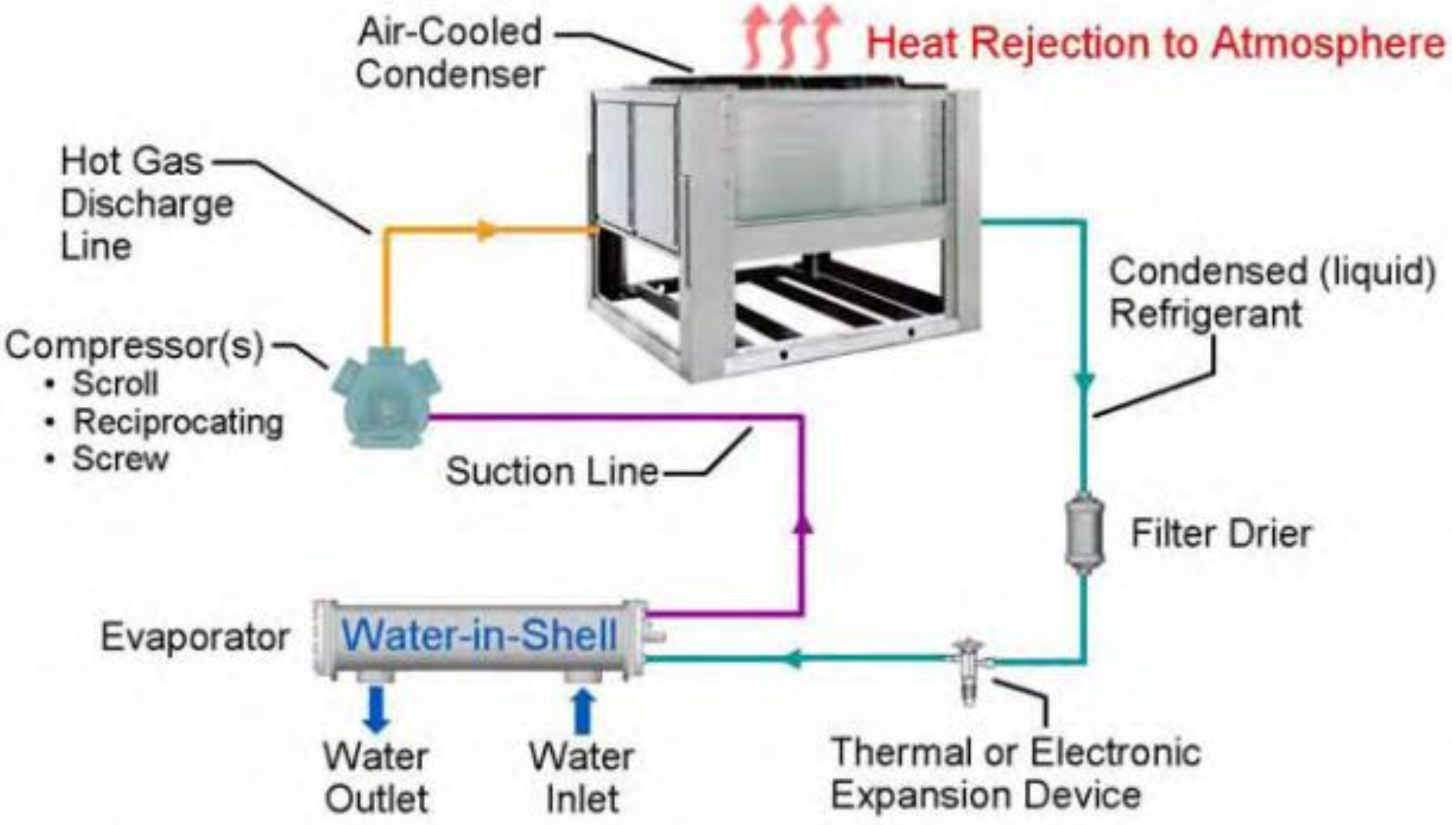


Chilled Water AC System

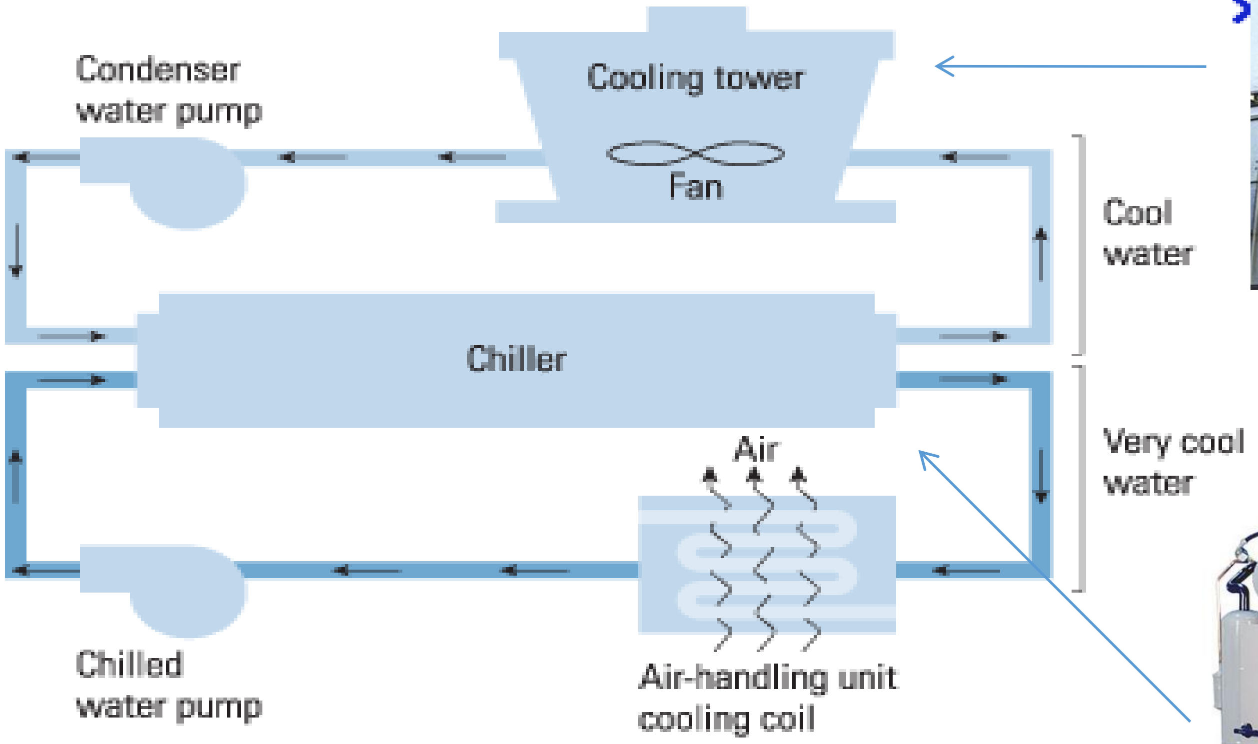
A chilled water system also use the basic refrigeration cycle but instead cooling the air directly, chilled water system cools water which in turn use to cool the air.

The condenser side of the chilled water system can be air-cooled or water cooled.

Air-Cooled Chilled Water AC System



Water-Cooled Chilled Water AC System



Air-cooled vs Water-cooled Chiller

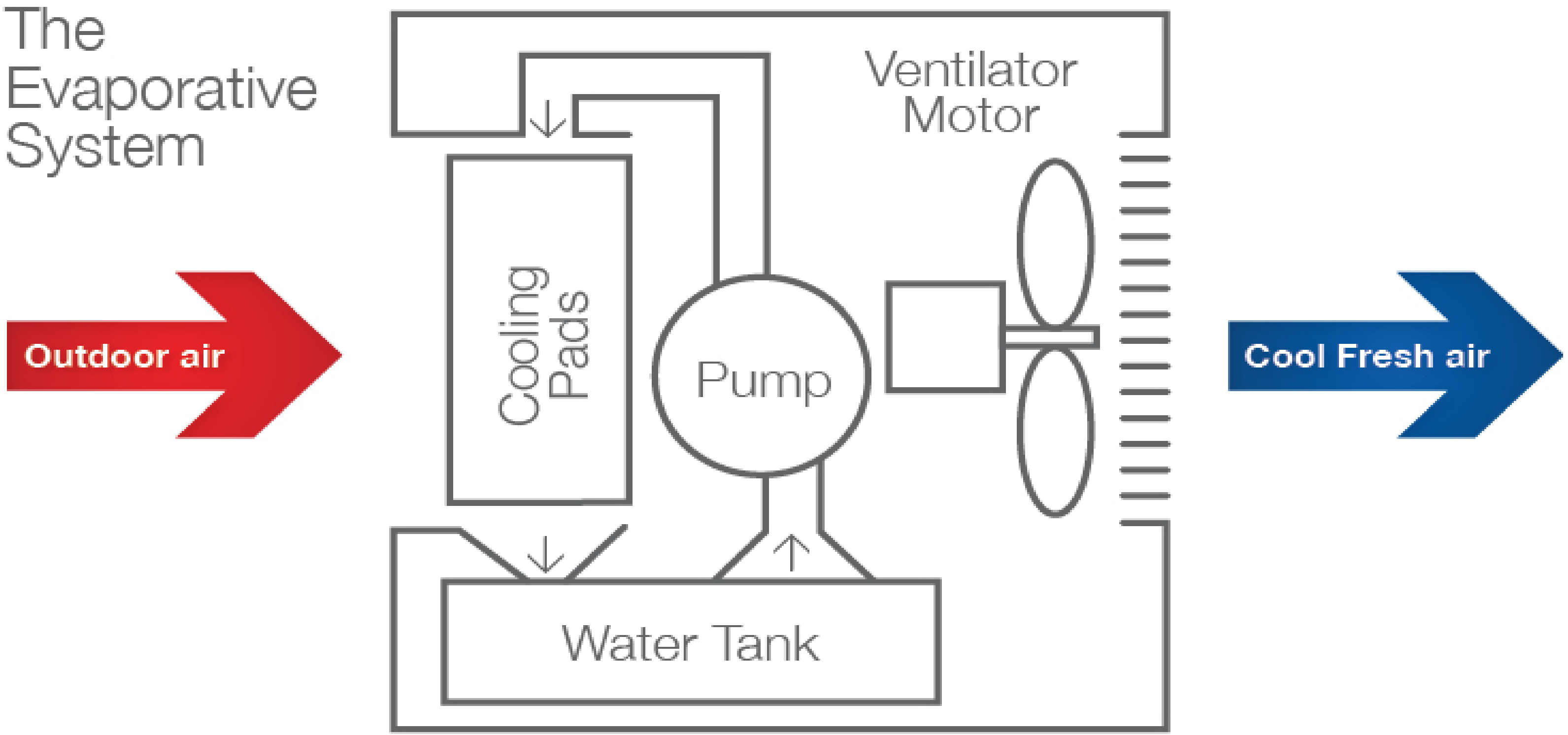
Air-Cooled Chiller Advantages

- Lower installed cost
- Quicker availability
- No cooling tower or condenser pumps required
- Less maintenance
- No mechanical room required

Water-Cooled Chiller Advantages

- Higher efficiency
- Custom selections in larger sizes
- Large tonnage capabilities
- Indoor chiller location
- Longer life

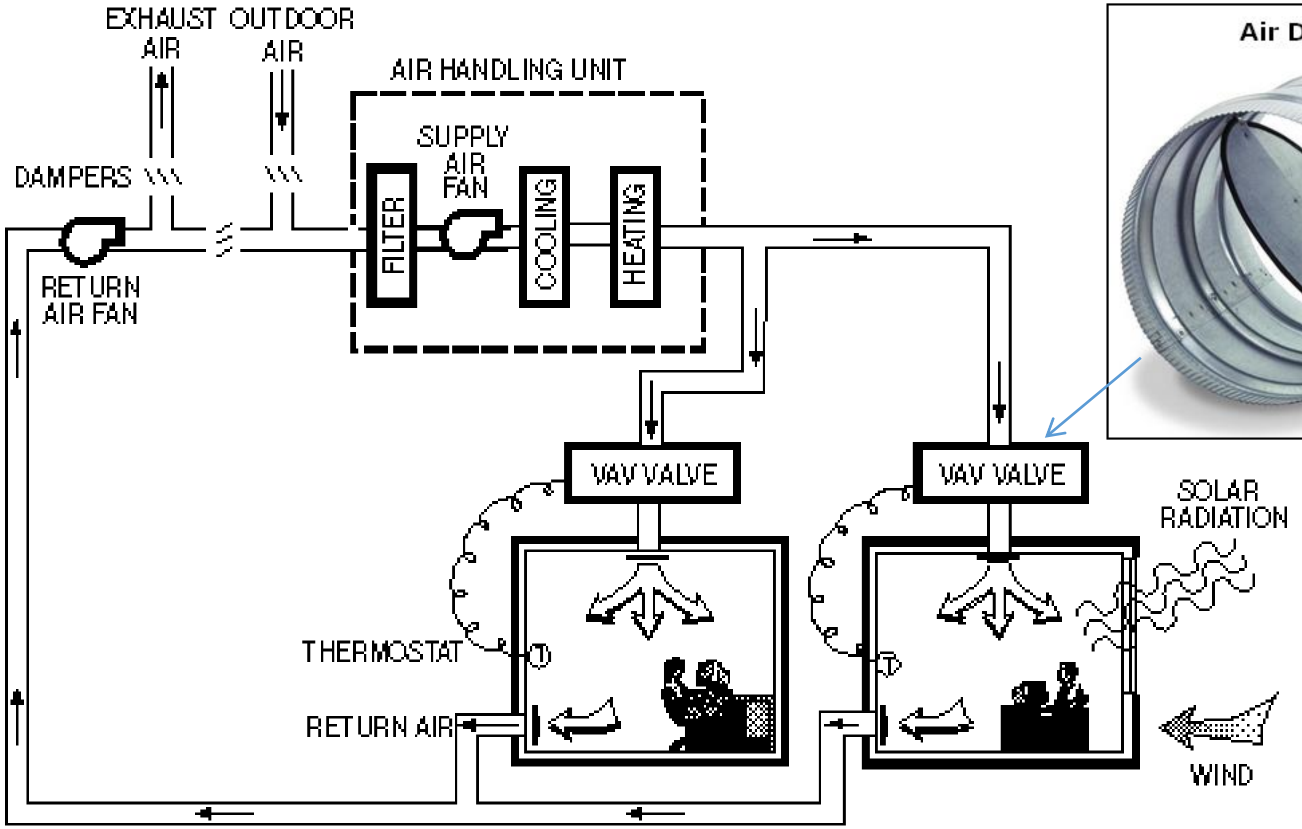
Evaporative Cooling System



Evaporative air conditioning uses evaporation to cool the air. In an evaporative cooler, a pump circulates water from the reservoir on to a cooling pad, which in turn becomes very wet. A fan draws air from outside the unit through the moistened pad. As it passes through the pad the air is cooled by evaporation.

Variable Air Volume System

- Type of air distribution system which varies the volume of air-conditioned air deliver to the space. The volume is based on the temperature sensor in the room.



Types of AC Clients

- Important factor in choosing appropriate HVAC System.

- ➢Developer – choose HVAC system mainly by its first Cost (Capital Cost)
- ➢Owner - prefer HVAC system that is energy efficient, easy to maintain and that will last a long time.

Project Size

- Another indicator of determining right HVAC System.

- ➢ DX System – smaller projects (low first cost and low maintenance)
- ➢ Air-cooled Chilled Water System – 100 to 250 tons of cooling capacity; energy savings outweigh the first cost and maintenance cost of DX system.
- ➢ Water-cooled Chilled Water System – more than 250 tons.

Project Type

- Has significant bearing in HVAC design.

➢ Office buildings – uses VAV system (varying occupant thermal comfort)

➢ Retailer store – uses constant volume distribution system (same thermal loading all throughout)

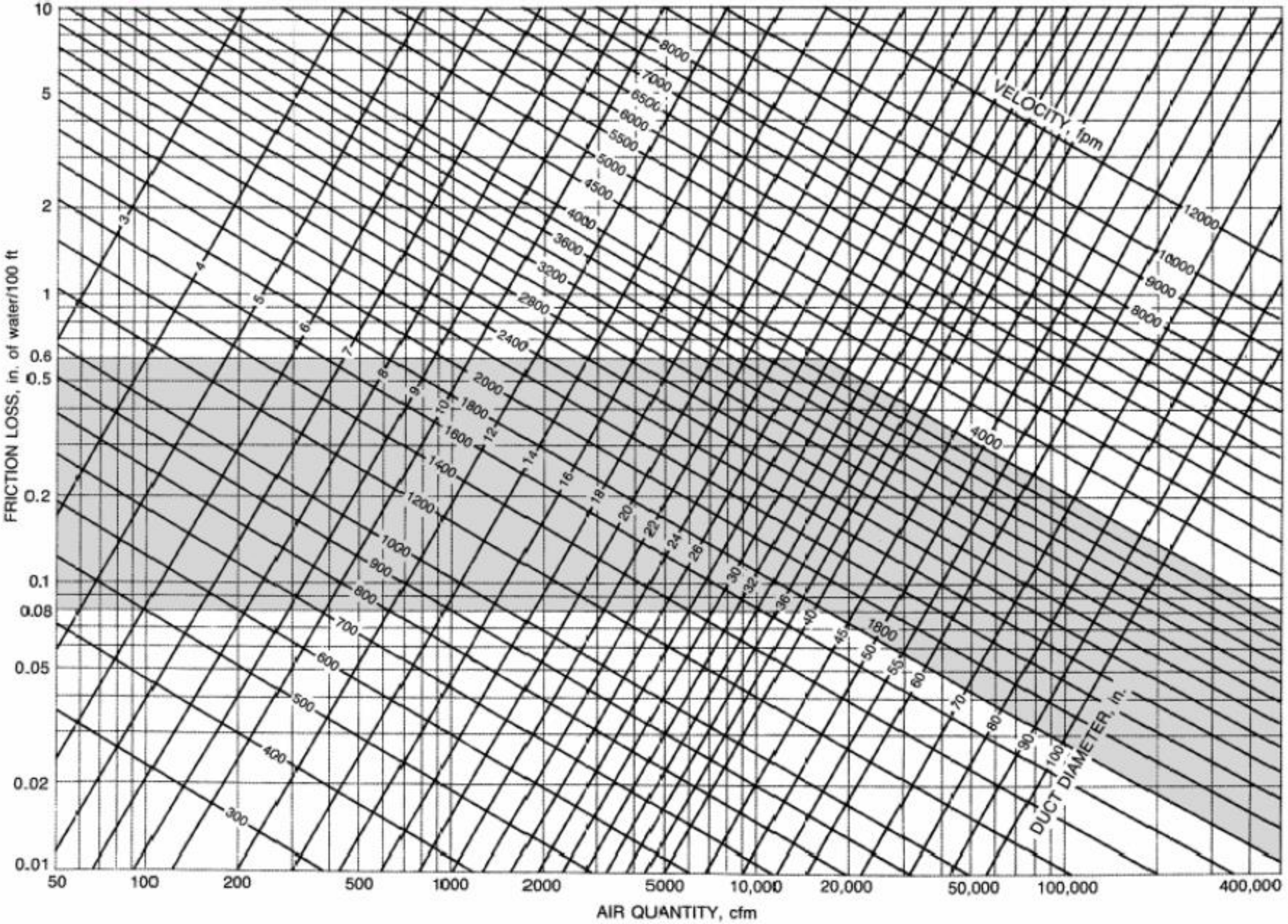
HVAC System Selection Guide

PROJECT TYPE	UNDER 100 TONS	100 - 250 TONS	OVER 250 TONS
TABLE 1: HVAC SYSTEM SELECTION GUIDE - DEVELOPER PROJECTS			
Medical Office Building	DX Rooftop VAV	DX Rooftop VAV	DX Rooftop VAV
Office Building	DX Rooftop VAV	Air-Cooled Chiller, VAV	Air-Cooled Chiller, VAV
Residential	DX Split System CV	N/A	N/A
Retail Strip Mall	DX Split System CV	N/A	N/A

HVAC System Selection Guide

PROJECT TYPE	UNDER 100 TONS	100 - 250 TONS	OVER 250 TONS
TABLE 2: HVAC SYSTEM SELECTION GUIDE - OWNER PROJECTS			
Airport Terminal	DX Rooftop VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Apartment Units	DX Split System CV	N/A	N/A
Bank	DX Rooftop VAV	N/A	N/A
Church	DX Split System CV	Air-Cooled Chiller, VAV	Air-Cooled Chiller, VAV
Computer Room	Computer Room Unit	Computer Room Unit	Computer Room Unit
Courthouse Building	DX Rooftop VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Hospital	Air-Cooled Chiller, CV	Air-Cooled Chiller, CV	Water-Cooled Chiller, CV
Hotel Guest Rooms	PTAC	N/A	N/A
Jail	DX Rooftop CV	Air-Cooled Chiller, CV	Water-Cooled Chiller, CV
K-12 Classroom	DX CV	N/A	N/A
Laboratory Building	Air-Cooled Chiller, VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Library	DX Rooftop VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Manufacturing Plant	Evaporative Cooling	Evaporative Cooling	Evaporative Cooling
Police Station	DX Rooftop VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Restaurant	DX Rooftop VAV	Air-Cooled Chiller, VAV	Air-Cooled Chiller, VAV
Retail Big Box Store	DX Rooftop CV	DX Rooftop CV	DX Rooftop CV
Supermarket	DX Rooftop CV	DX Rooftop CV	DX Rooftop CV
Theater	DX Rooftop VAV	Air-Cooled Chiller, VAV	Air-Cooled Chiller, VAV
University Building	DX Rooftop VAV	Air-Cooled Chiller, VAV	Water-Cooled Chiller, VAV
Warehouse	Ventilation at 3 ACH	N/A	N/A

Equal Friction Chart



Sizing Air Conditioning System

- Based on heat gain in a building.

Heat Gain depends on the following:

1. Temperature Difference between outside and the desired inside temperature – hot vs hotter
2. Type of construction of building envelope (walls, and ceilings) – Brick vs Glass
3. Orientation to the sun – East/West vs North/South
4. Room size – Big vs small
5. Infiltration
6. Occupants
7. Room Activities
8. Lighting – LED vs Incandescent
9. Appliances, equipments

Two Groups publish calculation procedures for sizing central air conditioners.

- Air Conditioning Contractors of America (ACCA)
- American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE)

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Residential Features

1. Occupied 24/7
2. Loads are imposed by heat gain through structural components and by air leakage or ventilation. Internal loads, particularly those from occupants and lights, are small in comparison to those in commercial or industrial structures.
3. Residence is considered 1 zone
4. Small capacity, up to 18kW cooling

Categories of Residences

- **Single-Family Detached**
- **Multifamily buildings**

Single-Family Detached

- A house in this category usually has exposed walls in four directions, often more than one story, and a roof. The cooling system is a single-zone, unitary system with a single thermostat.

Multifamily buildings

- Unlike single-family detached units, multifamily units by definition do not have exposed surfaces facing in all directions. Rather, each unit has only one or two exposed surfaces and possibly a roof. Two exposed walls will be at right angles, and both east and west walls will not be exposed in a given living unit.

Load Components

(1) through structural components (walls, floors, and ceilings).

(2) through windows;

(3) caused by infiltration and ventilation; and

(4) due to occupancy.

Summary of Cooling Loads

- Roof
- Walls
- Doors
- Glass Windows
- People
- Appliances
- Infiltration
- Ducting (if any; usually 10% of total sensible loads)
- Compute total power and flow requirements.

Non-Residential Cooling Load Calculation

Cooling Load Calculation Procedure

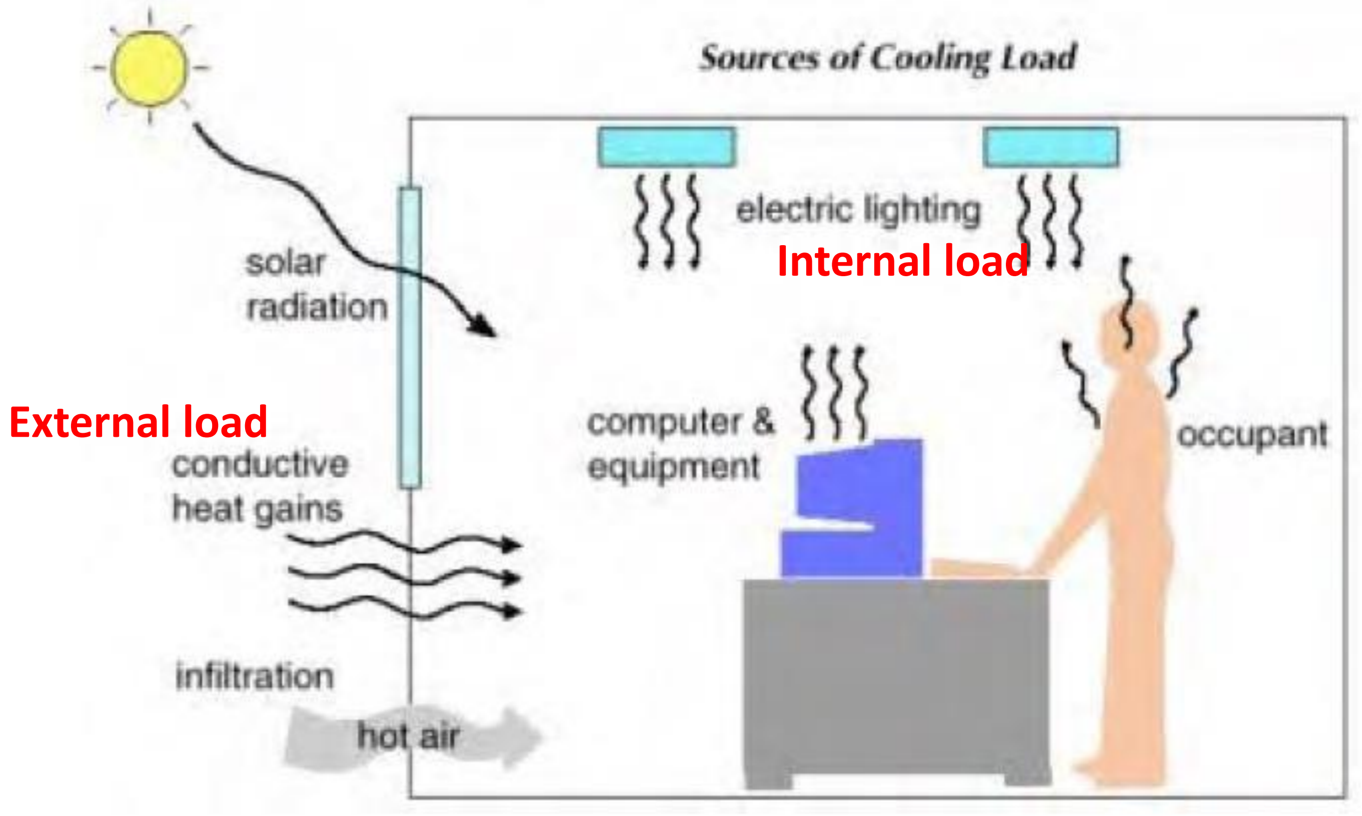
The cooling load calculation is divided into 3 parts:

1. **External load**. Includes heat conduction through the roof, floor, walls, ceiling, partitions and windows and radiation through glass windows.

2. **Internal load**. Covers the occupant's sensible and latent heat loads, lightings, equipment cooling load requirements.

3. **Ventilation Cooling Load**

Sources of Cooling Load



Externally loaded building vs internally Loaded building

Load Components

- External Cooling Load
  - *Roofs, walls, and conduction through glass*
  - *Solar load through glass*
  - *Cooling load from partitions, ceilings, floors*
- Internal Cooling Load
  - *People*
  - *Lights*
  - *Equipment*
  - *Appliances*
- Ventilation and Infiltration Air

Cooling Load Calculation Method

CLTD/ SCL/ CLF Method

CLTD (Cooling Load Temperature Difference)

- Theoretical temperature difference that accounts for the combined effects of inside and outside air difference, daily temperature range, solar radiation and heat storage in building mass.

-It is affected by orientation, tilt, month, day, hour, latitude, etc. *CLTD factors are used for adjustment to conductive heat gains from walls, roof, floor and glass.*

CLF (Cooling Load Factor)

- accounts for the fact that all the radiant energy that enters the conditioned space at a particular time does not become a part of the cooling load instantly. The CLF values for various surfaces have been calculated as functions of solar time and orientation and are available in the form of tables in ASHRAE Handbooks.

- used for adjustment to heat gains from internal loads such as lights, occupants and power appliances

SCL (Solar Cooling Load Factor)

- used for adjustment to transmission heat gains from glass

Cooling Load Calculation Procedure

- 1. Obtain Building Characteristics
- 2. Select outdoor design weather conditions
- 3. Select indoor design temperature to be maintained in space.
- 4. Estimate temperatures in un-conditioned spaces.
- 5. Select and/or compute U-values for walls, roof, windows, doors, partitions, etc.
- 6. Determine area of walls, windows, floors, doors, partitions, etc.
- 7. Compute conduction heat gains for all walls, windows, floors, doors, partitions, skylights, etc.

Cooling Load Calculation Procedure

- 8. Compute solar heat gains for all walls, windows, floors, doors, partitions, skylights, etc.
- 9. Infiltration heat gains are generally ignored unless space temperature and humidity tolerance are critical.
- 10. Compute ventilation heat gain required.
- 11. Compute internal heat gains from lights, people, and equipment.

DESIGN INFORMATION

The following information were gathered to effectively calculate the space cooling load:

1. Outdoor Design Conditions

- Dry bulb temperature
- Wet-bulb temperature
- Humidity Ratio
- Mean daily range (DR)

DESIGN INFORMATION

Table 3B Cooling and Dehumidification Design Conditions—World Locations

Station	DB/MWB						WB/MDB						DP/MDB and HR									Range of DB
	0.4%		1%		2%		0.4%		1%		2%		0.4%			1%			2%			
	DB	MWB	DB	MWB	DB	MWB	WB	MDB	WB	MDB	WB	MDB	DP	HR	MDB	DP	HR	MDB	DP	HR	MDB	
PHILLIPPINES																						
Angeles, Clark AFB	36.0	25.3	34.9	25.0	34.0	25.0	28.0	31.8	27.5	31.6	27.0	30.8	27.1	23.4	30.2	26.8	23.0	30.0	26.1	22.0	29.3	9.8
Baguio	27.7	21.6	26.2	21.1	25.2	20.7	23.2	25.8	22.2	24.8	21.6	24.2	22.5	20.7	25.1	21.4	19.3	24.1	20.7	18.5	23.6	8.2
Cebu/Mandaue	33.8	27.1	33.1	27.0	32.8	26.9	27.8	32.4	27.6	32.3	27.3	31.8	26.4	21.9	30.6	26.2	21.7	30.5	26.1	21.5	30.4	6.9
Olongapo	36.4	25.0	35.7	25.1	34.9	25.3	28.1	32.7	27.6	32.0	27.1	31.9	27.1	22.9	30.9	26.2	21.7	30.0	26.1	21.5	29.8	9.5
Manila, Aquino Apt	35.0	27.0	34.1	26.5	33.4	26.3	28.4	32.8	27.9	32.3	27.5	31.9	27.2	23.0	31.5	26.8	22.5	31.1	26.2	21.7	30.4	8.8
POLAND																						
Bialystok	27.2	19.0	25.5	18.5	23.9	17.5	20.6	25.5	19.3	23.9	18.4	22.8	18.8	13.9	23.3	17.7	12.9	21.6	16.6	12.0	20.4	10.6
Gdansk	26.8	18.6	24.8	17.4	22.9	16.5	19.5	24.9	18.3	22.8	17.2	21.6	17.8	13.0	21.0	16.2	11.7	20.1	15.2	11.0	19.3	9.7
Katowice	28.5	19.5	26.7	18.1	25.0	17.5	20.2	26.8	19.2	25.1	18.3	23.4	18.0	13.4	22.1	17.1	12.6	21.4	16.4	12.1	20.8	10.2
Kielce	28.2	19.2	26.4	18.4	24.6	17.5	20.2	26.3	19.2	24.7	18.4	23.3	18.1	13.4	22.7	17.3	12.8	21.5	16.4	12.0	20.6	11.2
Kolobrzeg	26.4	18.3	23.8	17.3	21.8	17.1	19.4	23.3	18.6	22.5	17.7	21.1	18.0	12.9	21.1	17.1	12.2	20.1	16.2	11.5	19.5	6.7

MDB = mean coincident dry-bulb temp., °C MWS = mean coincident wind speed, m/s StdD = standard deviation, °C HR = humidity ratio, g (water) / kg (dry air)
MWB = mean coincident wet-bulb temp., °C MWD = mean coincident wind direction, ° A = airport DP = dew-point temperature, °C

- Reference: 1997 ASHRAE Fundamentals Handbook (SI); pp.567 pdf file

DESIGN INFORMATION

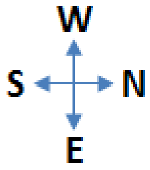
The following information were gathered to effectively calculate the space cooling load:

2. Indoor Design Conditions

- Indoor air temperature: *21°C +/-3°C*
- Relative Humidity: *50% +/- 5%*
- Humidity Ratio: *7.73 g_v/kg_{da} (values taken from Psychrometric chart given DB & RH values above)*

3. Building Characteristics

- Building Dimensions
  - Total Bldg. Area: 1,423.18 m^2
- Building Orientation
- External or Internal Shading
- Materials of Construction



DESIGN INFORMATION

The following information were gathered to effectively calculate the space cooling load:

4. Internal Loads

- Occupants
  - 8 persons
  - 24 hrs/day, 7 days/week operation
  - activity is categorized as light machine work
- Lightings
  - 764 LED lights
  - 17 Watts per light
  - 24 hrs/day, 7 days/week operation
- Equipment
  - 4 Computers
  - 100 Watts per computer
  - 24 hrs/day, 7 days/week operation

External Load Calculation

Roof and Wall calculation

$$q = U*A*(CLTD_{Corr})$$

where:

q = heat gain through the roof, Watts

U = design heat transfer coefficient for roof, W/m^2-K or W/m^2°C

$U = 1 / R_T$ (k & R Values are taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.471to 474 pdf file)

R_T = thermal resistance, m^2-K/ W, m^2-°C/ W

$$R_T = 1/h_i + x_1/k_1 + x_2/k_2 + \ldots + x_n/k_n + 1/h_o$$

h_i = inside surface conductance, W/m^2-K or W/m^2°C; Values are taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.469 pdf file

h_o = outside surface conductance, W/m^2-K or W/m^2°C

x = thickness of the roof material, m

External Load Calculation

Roof and Wall calculation

$$CLTD_{corr} = CLTD + (25.5 – Tr) + (Tm – 29.4)$$

CLTD = cooling load temperature difference for roofs, K or °C; CLTD for Roofs and Roof Numbers taken from 1997 ASHRAE Fundamentals Handbook (SI) pp.628 pdf file; CLTD for walls is taken from pp. 629 to 631 and Wall types is taken from pp.632 to 634.

Tr = inside design temperature = 21°C

Tm = (maximum outdoor temperature) – (Daily Range / 2)

Tm = mean Outdoor temperature, °C

Maximum Outdoor temperature = 36°C

Daily Range = 9.8°C

$t_m = DB – DR/2$

External Load Calculation

Fenestration

$$q_{cond} = UA(CLTD_{corr})$$

$$q_{rad} = A(SC)(SCL)$$

where:

q_{cond} = *heat gain through conduction by the fenestration, Watts*

q_{rad} = *cooling load caused by solar radiation, Watts*

U = design heat transfer coefficient for fenestration, W/m^2-K or W/m^2°C; values taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.659 to 660 pdf file

A = net glass area of fenestration

CLTD = cooling load temperature difference for fenestration, K or °C, values taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.635 pdf file

CLTDcorr = corrected cooling load temperature difference for glass, K or °C

External Load Calculation

Fenestration

SC = Shading coefficient, for combination of fenestration and shading device; values taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.676 to 677 pdf file

SCL = Solar cooling load; values taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.635 (for Zone Type) and 636 (for SCL) pdf file

Internal Load Calculation

<u>Occupants</u>

Sensible Cooling Load, $Q_{s:}$ $q_s = N*(SHG_p)*(CLF_p)$

Latent Cooling Load, $Q_{l:}$ $q_l = N*(LHG_p)$

<u>Lighting</u>

$$q_{el} = W*F_{ul}*F_{sa}*(CLF)$$

<u>Equipment</u>

$$q_s = (\text{Watt Rating})*(CLF)$$

Internal Load Calculation

Ventilation

$$\boldsymbol{q_{sensible} = 1.23\,(Q)\,(t_o - t_i)}$$
$$\boldsymbol{q_{latent} = 3010\,(Q)\,(w_o - w_i)}$$

Q = ventilation rate requirement taken from ASHRAE Standard 62, L/s

t_o, t_i = outside, insaide air temperature, ^oC

w_o, w_i = outside, inside air humidity ratio, kg (water)/kg(dry air)

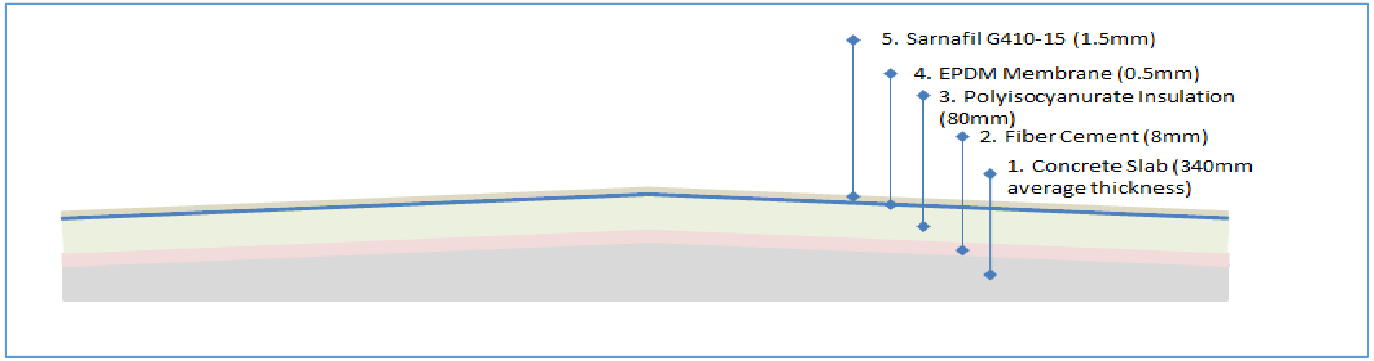
Qpeople = (Number of people) * (Air Rate/Person), L/s

Qarea = (Floor Area) *(Air Rate/Floor Area), L/s

COOLING LOAD CALCULATION RESULTS AND DISCUSSION

Roof

Roof Material Cross Section



Roof Material Thermal Coefficient

	Material	Thickness, x, (mm)	Thermal conductivity, k, (W/m-K)	Thermal Resistance, R (m^2-K/W)
1	Concrete Slab	340	1.731	0.1964
2	Fiber Cement	8	0.17	0.0471
3	Polyisocyanurate Insulation	80	0.023	3.4783
4	EPDM Membrane	0.5	0.2	0.0025
5	Sarnafil G410-15	1.5	0.029	0.0517
	Total Thermal Resistance			3.7760

$$R = x_1/k_1$$

Table 4 Typical Thermal Properties of Common Building and Insulating Materials—Design Values[a]

Description	Density, kg/m³	Conductivity[b] (*k*), W/(m·K)	Conductance (*C*), W/(m²·K)	Resistance[c] (*R*) 1/*k*, K·m/W	Resistance[c] (*R*) For Thickness Listed (1/*C*), K·m²/W	Specific Heat, kJ/(kg·K)
BUILDING BOARD						
Asbestos-cement board	1900	0.58	—	1.73	—	1.00
Asbestos-cement board 3.2 mm	1900	—	187.4	—	0.005	—
Asbestos-cement board 6.4 mm	1900	—	93.7	—	0.011	—
Gypsum or plaster board 9.5 mm	800	—	17.6	—	0.056	1.09
Gypsum or plaster board 12.7 mm	800	—	12.6	—	0.079	—
Gypsum or plaster board 15.9 mm	800	—	10.1	—	0.099	—
Plywood (Douglas Fir)[d]	540	0.12	—	8.66	—	1.21
Plywood (Douglas Fir) 6.4 mm	540	—	18.2	—	0.055	—
Plywood (Douglas Fir) 9.5 mm	540	—	12.1	—	0.083	—
Plywood (Douglas Fir) 12.7 mm	540	—	9.1	—	0.11	—
Plywood (Douglas Fir) 15.9 mm	540	—	7.3	—	0.14	—
Plywood or wood panels 19.0 mm	540	—	6.1	—	0.16	1.21
Vegetable fiber board						
Sheathing, regular density[e] 12.7 mm	290	—	4.3	—	0.23	1.30
19.8 mm	290	—	2.8	—	0.36	—
Sheathing intermediate density[e] 12.7 mm	350	—	5.2	—	0.19	1.30
Nail-base sheathing[e] 12.7 mm	400	—	5.3	—	0.19	1.30
Shingle backer 9.5 mm	290	—	6.0	—	0.17	1.30
Shingle backer 7.9 mm	290	—	7.3	—	0.14	—
Sound deadening board 12.7 mm	240	—	4.2	—	0.24	1.26
Tile and lay-in panels, plain or acoustic	290	0.058	—	17.	—	0.59
12.7 mm	290	—	4.5	—	0.22	—
19.0 mm	290	—	3.0	—	0.33	—
Laminated paperboard	480	0.072	—	13.9	—	1.38
Homogeneous board from repulped paper	480	0.072	—	13.9	—	1.17
Hardboard[e]						
Medium density	800	0.105	—	9.50	—	1.30
High density, service-tempered grade and service grade	880	0.82	—	8.46	—	1.34
High density, standard-tempered grade	1010	0.144	—	6.93	—	1.34
Particleboard[e]						
Low density	590	0.102	—	9.77	—	1.30
Medium density	800	0.135	—	7.35	—	1.30
High density	1000	0.170	—	5.90	—	1.30
Underlayment 15.9 mm	640	—	6.9	—	0.14	1.21
Waferboard	590	0.01	—	11.0	—	—
Wood subfloor 19.0 mm	—	—	6.0	—	0.17	1.38

Table 4 Typical Thermal Properties of Common Building and Insulating Materials—Design Values[a]

Description	Density, kg/m³	Conductivity[b] (*k*), W/(m·K)	Conductance (*C*), W/(m²·K)	Resistance[c] (*R*): 1/*k*, K·m/W	Resistance[c] (*R*): For Thickness Listed (1/*C*), K·m²/W	Specific Heat, kJ/(kg·K)
BUILDING MEMBRANE						
Vapor—permeable felt	—	—	94.9	—	0.011	
Vapor—seal, 2 layers of mopped 0.73 kg/m² felt	—	—	47.4	—	0.21	
Vapor—seal, plastic film	—	—	—	—	Negl.	
FINISH FLOORING MATERIALS						
Carpet and fibrous pad	—	—	2.73	—	0.37	1.42
Carpet and rubber pad	—	—	4.60	—	0.22	1.38
Cork tile 3.2 mm	—	—	20.4	—	0.049	2.01
Terrazzo 25 mm	—	—	71.0	—	0.014	0.80
Tile—asphalt, linoleum, vinyl, rubber	—	—	113.6	—	0.009	1.26
vinyl asbestos						1.01
ceramic						0.80
Wood, hardwood finish 19 mm	—		8.35	—	0.12	
INSULATING MATERIALS						
Blanket and Batt[f,g]						
Mineral fiber, fibrous form processed from rock, slag, or glass						
approx. 75-100 mm	6.4-32	—	0.52	—	1.94	
approx. 90 mm	6.4-32	—	0.44	—	2.29	
approx. 90 mm	19-26	—	0.38	—	2.63	
approx. 140-165 mm	6.4-32	—	0.30	—	3.32	
approx. 140 mm	10-16	—	0.27	—	3.67	
approx. 150-190 mm	6.4-32	—	0.26	—	3.91	
approx. 210-250 mm	6.4-32	—	0.19	—	5.34	
approx. 250-330 mm	6.4-32	—	0.15	—	6.77	
Board and Slabs						
Cellular glass	136	0.050	—	19.8	—	0.75
Glass fiber, organic bonded	64-140	0.036	—	27.7	—	0.96
Expanded perlite, organic bonded	16	0.052	—	19.3	—	1.26
Expanded rubber (rigid)	72	0.032	—	31.6	—	1.68
Expanded polystyrene, extruded (smooth skin surface) (CFC-12 exp.)	29-56					

Thermal Conductivity

Table 1 Properties of Vapor

Material	Relative Molecular Mass	Normal Boiling Point, °C	Critical Temperature, °C	Critical Pressure, kPa	Density, kg/m^3	Specific Heat, J/(kg·K)	Thermal Conductivity, W/(m·K)	Viscosity, μPa·s
Alcohol, Ethyl	46.07[a]	78.6[a]	243.2[b]	6 394[b]		1520[j]	0.013[a]	14.2[j] (289)
Alcohol, Methyl	32.04[a]	65.0[a]	240.1[b]	7 977[b]		1350[j]	0.0301[r]	14.8[j] (272)
Ammonia	17.03[a]	−33.2[a]	132.6[b]	11 300[b]	7.72[b]	2200[aa]	0.0221[b]	9.30[aa]
Argon	39.948[a]	−185.9*	−122.5*	4 860[b]	1.785[b]	523[c]	0.016[a]	21.0[a]
Acetylene	26.04[a]	−83.7[a]	36.1[b]	6 280[b]	1.17[b]	1580[a]	0.0187[b]	9.34[a]
Benzene	78.11[a]	80.2[a]	289.6[d]	4 924[d]	2.68[e] (80)	1300[e] (80)	0.0071[e]	7.0[a]
Bromine	159.82[a]	58.8[a]	58.8[d]	10 340[d]	6.1[f] (59)	230[f] (100)	0.0061[a]	17[a]
Butane	58.12[a]	−0.5[a]	152.1[d]	3 797[d]	2.69[g]	1580[aa]	0.014[a]	7.0[a]
Carbon dioxide	44.01[a]	−78.5[a]	31.1[d]	7 384[d]	1.97[g]	840[g]	0.015[a]	14[h]
Carbon disulfide	76.13[h]	46.3[h]	278.9[h]	7 212[h]		599.0[p] (27)		
Carbon monoxide	28.01[a]	−191.5[a]	−140.3[d]	3 500[d]	1.25[d]	1100[f]	0.0230[a]	17[a]
Carbon tetrachloride	153.84[g]	76.6[h]	283.3[h]	4 560[h]		862[q] (27)		16.0[j]
Chlorine	70.91[a]	−34.7[a]	144.1[d]	7 710[d]	3.22[d]	490[a]	0.0080[a]	12[a]
Chloroform	119.39[h]	61.8[h]	263.4[h]	5 470[h]		528[j]	0.014[r]	16[j]
Ethyl chloride	64.52[h]	12.4[h]	187.3[h]	5 270[h]	2.872[b]	1780[r]	0.00872[j]	16.0[q]
Ethylene	28.03[h]	−103.7[h]	10.0[h]	5 120[h]	1.25[b]	1470[aa]	0.0176[aa]	9.60[aa]
Ethyl ether	74.12[h]	34.7[h]	192.7[h]	3 610[h]		2470[h] (35)		11.3[q]
Fluorine	38.00[h]	−187.0[h]	−129.2[h]	5 580[h]	1.637[b]	812[j]	0.0254[j]	37[j]
Helium	4.0026[a]	−269.0[i]	−267.9[h]	229[i]	0.178[i]	5192[aa]	0.142[aa]	19.0[aa]
Hydrogen	2.0159[a]	−253.1[i]	−240.0[i]	1 316[i]	0.0900[i]	14 200[j]	0.168[aa]	8.40[aa]
Hydrogen chloride	36.461[a]	−84.9[a]	51.4[d]	8 260[d]	1.640[b]	800[j]	0.0131[j]	13.3[j]
Hydrogen sulfide	34.080[a]	−60.8[a]	100.4[d]	9 012[d]	1.54[b]	996[j]	0.0130[j]	11.6[j]
Heptane (m)	100.21[a]	98.5[a]	266.8[b]	2 720[b]	3.4[k]	1990[j]	0.0185[j]	7.00[j]
Hexane (m)	86.18[a]	66.9[a]	234.8[d]	3 030[d]	3.4[k]	1880[j]	0.0168[j]	7.52[j]
Isobutane	58.12[f]	−11.6*	135.1[j]	3 648[j]	2.47[a] (21)	1570[aa]	0.014[aa]	6.94[aa]
Methane	16.04[a]	−164.0[a]	−81.8[j]	4 641[b]	0.718[b]	2180[aa]	0.0310[aa]	10.3[aa]
Methyl chloride	50.49[a]	−24.3[a]	143.2[j]	6 678[b]	2.307[b]	770[aa]	0.0093[aa]	10.1[aa]
Naphthalene	128.19[a]	218.0*	469.1[j]	3 972[j]		1310[q] (25)		
Neon	20.183[a]	−247.0[a]	−228.8[j]	2 698[j]		1030[aa]	0.0464[aa]	30.0[aa]
Nitric oxide	30.01[a]	−152.0[a]	−92.9[j]	6 546[j]		996[j]		29.4[j]
Nitrogen	28.01[a]	−195.8[a]	−146.9[j]	3 394[b]		1040[j]	0.0240[aa]	16.6[aa]
Nitrous oxide	44.01[a]	−88.5[a]	36.4[j]	7 235[j]		850[j]	0.01731[j] (26.8)	22.4[j]
Nitrogen tetroxide	92.02[a]		158.3[j]	10 133[j]		842[p] (27)	0.0401[r] (55)	
Oxygen	31.9977*	−183.0[a]	−118.6*	5 043*		913[j]	0.0244[aa]	19.1[aa]
n-Pentane	72.53[a]	36.1*	196.7[j]	3 375[j]		1680[a] (27)	0.0152[j] (26.8)	11.7[j]
Phenol	74.11[b]	181.4[b]	418.9[b]	6 130[b]	2.6[k]	1400[k]	0.017[k]	12[k]
Propane	44.09[g]	−42.1[g]	96.7*	4 248*	2.02[g]	1571[j] (4.5)	0.015[j]	7.40[j]
Propylene	42.08[b]	−47.7[l]	91.8[l]	4 622[l]	1.92[l]	1460[aa]	0.014[aa]	8.06[aa]
Sulfur dioxide	64.06[b]	−10.0[b]	156.9[b]	7 874[b]	2.93[b]	607[l]	0.0085[j]	11.6[j]
Water vapor	18.02[b]	100.0[m]	374.0*	22 064*	0.598[m]	2050[aa]	0.0247[m]	12.1[aa]

*Data source unknown.

Notes: 1. Properties at 101.325 kPa and 0°C, or the saturation temperature if higher than 0°C, unless otherwise noted in parentheses.
2. Superscript letters indicate data source from the section on References.

Note: for k of air, see N2 k-value

Thermal Conductivity

Table 3 Properties of Solids

Material Description	Specific Heat, J/(kg·K)	Density, kg/m^3	Thermal Conductivity, W/(m·K)	Emissivity	
				Ratio	Surface Condition
Aluminum (alloy 1100)	896[b]	2 740[u]	221[u]	0.09[u]	Commercial sheet
				0.20[u]	Heavily oxidized
Aluminum bronze (76% Cu, 22% Zn, 2% Al)	400[u]	8 280[u]	100[u]		
Asbestos: Fiber	1050[b]	2 400[u]	0.170[u]		
Asbestos: Insulation	800[t]	580[b]	0.16[b]	0.93[b]	"Paper"
Ashes, wood	800[t]	640[b]	0.071[b] (50)		
Asphalt	920[b]	2 110[b]	0.74[b]		
Bakelite	1500[b]	1 300[u]	17[u]		
Bell metal	360[t] (50)				
Bismuth tin	170*		65.0*		
Brick, building	800[b]	1 970[u]	0.7[b]	0.93*	
Brass: Red (85% Cu, 15% Zn)	400[u]	8 780[u]	150[u]	0.030[b]	Highly polished
Brass: Yellow (65% Cu, 35% Zn)	400[u]	8 310[u]	120[u]	0.033[b]	Highly polished
Bronze	435[t]	8 490[t]	29[d] (0)		
Cadmium	230[a]	8 650[f]	92.9[b]	0.02[d]	
Carbon (gas retort)	710[a]		0.35[b] (–17)	0.81[a]	
Cardboard			0.07[b]		
Cellulose	1300[b]	54[t]	0.057[t]		
Cement (Portland clinker)	670[b]	1 920[i]	0.029[i]		
Chalk	900[t]	2 290[t]	0.83*	0.34*	About 120°C
Charcoal (wood)	840[t]	240[a]	0.05[a] (200)		
Chrome brick	710[b]	3 200[b]	1.2[b]		
Clay	920[b]	1 000[t]			
Coal	1000[b]	1 400[t]	0.17[f] (0)		
Coal tars	1500[b] (40)	1 200[b]	0.1[b]		
Coke (petroleum, powdered)	1500[b] (400)	990[b]	0.95[b] (400)		
Concrete (stone)	653[b] (200)	2 300[b]	0.93[b]		
Copper (electrolytic)	390[u]	8 910[u]	393[u]	0.072[u]	commercial, shiny
Cork (granulated)	2030[t]	86[t]	0.048[t] (–5)		
Cotton (fiber)	1340[u]	1 500[u]	0.042[u]		
Cryolite ($AlF_3 \cdot 3NaF$)	1060[b]	2 900[b]			
Diamond	616[b]	2 420[t]	47[t]		

Table 3 Properties of Solids

Material Description	Specific Heat, J/(kg·K)	Density, kg/m³	Thermal Conductivity, W/(m·K)	Emissivity Ratio	Emissivity Surface Condition
Earth (dry and packed)		1 500[t]	0.064*	0.41*	
Felt		330[b]	0.05[b]		
Fireclay brick	829[b] (100)	1 790[t]	1[b] (200)	0.75[a]	At 1000°C
Fluorspar (CaF_2)	880[b]	3 190[v]	1.1[v]		
German silver (nickel silver)	400[u]	8 730[u]	33[u]	0.135[a]	Polished
Glass: Crown (soda-lime)	750[b]	2 470[u]	1.0[t] (93)	0.94[a]	Smooth
Flint (lead)	490[b]	4 280[u]	1.4[r]		
Heat-resistant	840[b]	2 230[t]	1.0[t] (93)		
"Wool"	657[b]	52.0[t]	0.038[t]		
Gold	131[u]	19 350[u]	297[t]	0.02[a]	Highly polished
Graphite: Powder	691*		0.183*		
Impervious	670[u]	1 870[u]	130[u]	0.75[a]	
Gypsum	1080[b]	1 200[b]	0.43[b]	0.903[b]	On a smooth plate
Hemp (fiber)	1352.3[u]	1 500[u]			
Ice: 0°C	2040[t]	921[b]	2.24[b]	0.95*	
–20°C	1950[t]		2.44*		
Iron: Cast	500[v] (100)	7 210[t]	47.7[b] (54)	0.435[b]	Freshly turned
Wrought		7 700[b]	60.4[b]	0.94[b]	Dull, oxidized
Lead	129[u]	11 300[u]	34.8[u]	0.28[a]	Gray, oxidized
Leather (sole)		1 000[b]	0.16[b]		
Limestone	909[b]	1 650[b]	0.93[b]	0.36* to 0.90	At 63 to 193°C
Linen			0.09[b]		
Litharge (lead monoxide)	230[b]	7 850[b]			
Magnesia: Powdered	980[b] (100)	796[b]	0.61[b] (47)		
Light carbonate		210[b]	0.059[b]		
Magnesite brick	930[b] (100)	2 530[b]	3.8[b] (204)		
Magnesium	1000[b]	1 730[u]	160[u]	0.55[a]	Oxidized
Marble	880[b]	2 600[b]	2.6[b]	0.931[b]	Light gray, polished
Nickel, polished	440[u]	8 890[u]	59.5[u]	0.045[a]	Electroplated
Paints: White lacquer				0.80[a]	
White enamel				0.91[a]	On rough plate
Black lacquer				0.80[a]	
Black shellac		1 000[u]	0.26[u]	0.91[a]	"Matte" finish
Flat black lacquer				0.96[a]	
Aluminum lacquer				0.39[a]	On rough plate

Thermal Conductivity

Table 3 Properties of Solids (*Concluded*)

Material Description	Specific Heat, J/(kg·K)	Density, kg/m³	Thermal Conductivity, W/(m·K)	Emissivity: Ratio	Emissivity: Surface Condition
Paper	1300*	930[b]	0.13[b]	0.92[b]	Pasted on tinned plate
Paraffin	1670[bb]	749[bb]	0.24[b] (0)		
Plaster		2 110[b]	0.74[b] (75)	0.91[b]	Rough
Platinum	130[u]	21 470[u]	69.0[u]	0.054[b]	Polished
Porcelain	750*	260[u]	2.2[u]	0.92[b]	Glazed
Pyrites (copper)	549[b]	4 200[b]			
Pyrites (iron)	569[b] (69)	4 970[v]			
Rock Salt	917[u]	2 180[u]			
Rubber, vulcanized: Soft	2000*	1 100[t]	0.1[t]	0.86[b]	Rough
Hard		1 190[t]	0.16[t]	0.95[b]	Glossy
Sand	800[b]	1 520[b]	0.33[b]		
Sawdust		190[b]	0.05[b]		
Silica	1320[b]	2 240[v]	1.4[t] (93)		
Silver	235[u]	10 500[u]	424[u]	0.02[u]	Polished and at 227°C
Snow: Freshly fallen		100[y]	0.598[t]		
At 0°C		500[t]	2.2[t]		
Steel (mild)	500[b]	7 830[b]	45.3[b]	0.12[u]	Cleaned
Stone (quarried)	800[b]	1 500[t]			
Tar: Pitch	2500[v]	1 100[u]	0.88[v]		
Bituminous		1 200[t]	0.71[u]		
Tin	233[u]	7 290[u]	64.9[u]	0.06[h]	Bright and at 50°C
Tungsten	130[u]	19 400[u]	201[u]	0.032[u]	Filament at 27°C
Wood: Hardwoods—	1900/2700[b]	370/1100[z]	0.11/0.255[z]		
Ash, white		690[z]	0.172[z]		
Elm, American		580[z]	0.153[z]		
Hickory		800[z]			
Mahogany		550[u]	0.13[u]		
Maple, sugar		720[z]	0.187[z]		
Oak, white	2390[b]	750[z]	0.176[z]	0.90[u]	Planed
Walnut, black		630[z]			
Softwoods—	See Table 4,	350/740[z]	0.11/0.16[z]		
Fir, white	Chapter 24	430[z]	0.12[z]		
Pine, white		430[z]	0.11[z]		
Spruce		420[z]	0.11[z]		
Wool: Fiber	1360[u]	1 300[u]			
Fabric		110/330[u]	0.036/0.063[u]		
Zinc: Cast	390[u]	7 130[u]	110[u]	0.05[u]	Polished
Hot-rolled	390[b]	7 130[b]	110[b]		
Galvanizing				0.23[u]	Fairly bright

*Data source unknown.

Notes: 1. Values are for room temperature unless otherwise noted in parentheses.

2. Superscript letters indicate data source from the section on References.

Parameters for Air

Table 1 Surface Conductances and Resistances for Air

Position of Surface	Direction of Heat Flow	Non-reflective ε = 0.90 h_i	Non-reflective ε = 0.90 R	Reflective ε = 0.20 h_i	Reflective ε = 0.20 R	Reflective ε = 0.05 h_i	Reflective ε = 0.05 R
STILL AIR							
Horizontal	Upward	9.26	0.11	5.17	0.19	4.32	0.23
Sloping—45°	Upward	9.09	0.11	5.00	0.20	4.15	0.24
Vertical	Horizontal	8.29	0.12	4.20	0.24	3.35	0.30
Sloping—45°	Downward	7.50	0.13	3.41	0.29	2.56	0.39
Horizontal	Downward	6.13	0.16	2.10	0.48	1.25	0.80
MOVING AIR (Any position)		h_o	R				
Wind (for winter) 6.7 m/s (24 km/h)	Any	34.0	0.030	—	—	—	—
Wind (for summer) 3.4 m/s (12 km/h)	Any	22.7	0.044	—	—	—	—

Table 2 Emittance Values of Various Surfaces and Effective Emittances of Air Spaces[a]

Surface	Average Emittance ε	Effective Emittance ε_{eff} of Air Space: One Surface Emittance ε; Other, 0.9	Effective Emittance ε_{eff} of Air Space: Both Surfaces Emittance ε
Aluminum foil, bright	0.05	0.05	0.03
Aluminum foil, with condensate just visible (> 0.5 g/m^2)	0.30[b]	0.29	—
Aluminum foil, with condensate clearly visible (> 2.0 g/m^2)	0.70[b]	0.65	—
Aluminum sheet	0.12	0.12	0.06
Aluminum coated paper, polished	0.20	0.20	0.11
Steel, galvanized, bright	0.25	0.24	0.15
Aluminum paint	0.50	0.47	0.35
Building materials: wood, paper, masonry, nonmetallic paints	0.90	0.82	0.82
Regular glass	0.84	0.77	0.72

Roof Thermal Coefficient Summary

Description	Value	Unit
Thermal resistance of the Roof material, R	3.7760	m^2-K/W
Internal Surface Conductance of Air, h_i	9.2600	W/m^2K
External Surface Conductance of Air, h_o	22.7000	W/m^2K
Total Thermal Resistance, R_T	3.9280	m^2-K/W
Overall Heat Transfer Coefficient, U	0.2546	W/m^2K

$$R_T = 1/h_i + x_1/k_1 + x_2/k_2 + \ldots + x_n/k_n + 1/h_o$$

h_i = inside surface conductance, W/m^2-K or W/m^2°C; Values are taken from 1997 ASHRAE Fundamentals Handbook (SI); pp.469 pdf file

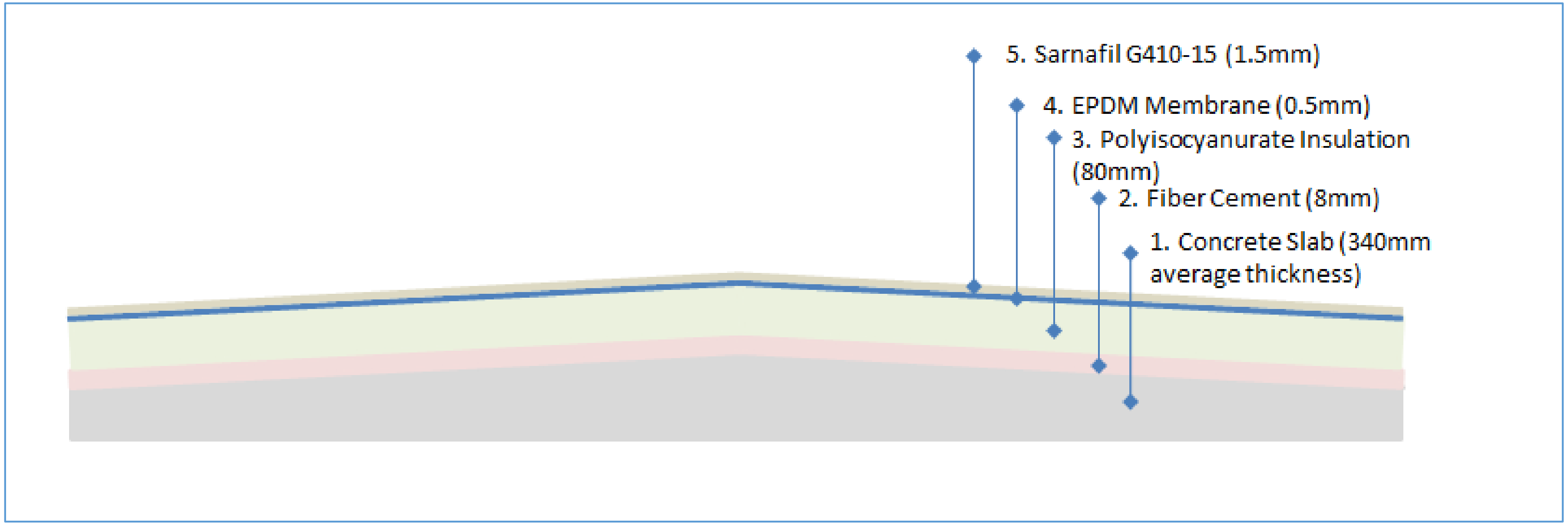
h_o = outside surface conductance, W/m^2-K or W/m^2°C

x = thickness of the roof material, m

COOLING LOAD CALCULATION RESULTS AND DISCUSSION

Roof

Roof Material Cross Section



Roof Numbers

Table 31 Roof Numbers Used in Table 30

Mass Location**	Suspended Ceiling	R-Value, $m^2 \cdot K/W$	B7, Wood 25 mm	C12, HW Concrete 50 mm	A3, Steel Deck	Attic-Ceiling Combination
Mass inside the insulation	Without	0 to 0.9	*	2	*	*
		0.9 to 1.8	*	2	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	4	*	*
		3.5 to 4.4	*	5	*	*
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	5	*	*
		0.9 to 1.8	*	8	*	*
		1.8 to 2.6	*	13	*	*
		2.6 to 3.5	*	13	*	*
		3.5 to 4.4	*	14	*	*
		4.4 to 5.3	*	*	*	*
Mass evenly placed	Without	0 to 0.9	1	2	1	1
		0.9 to 1.8	2	*	1	2
		1.8 to 2.6	2	*	1	2
		2.6 to 3.5	4	*	2	2
		3.5 to 4.4	4	*	2	4
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	3	1	*
		0.9 to 1.8	4	*	1	*
		1.8 to 2.6	5	*	2	*
		2.6 to 3.5	9	*	2	*
		3.5 to 4.4	10	*	4	*
		4.4 to 5.3	10	*	*	*
Mass outside the insulation	Without	0 to 0.9	*	2	*	*
		0.9 to 1.8	*	3	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	5	*	*
		3.5 to 4.4	*	5	*	*
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	3	*	*
		0.9 to 1.8	*	3	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	5	*	*
		3.5 to 4.4	*	*	*	*
		4.4 to 5.3	*	*	*	*

*Denotes a roof that is not possible with the chosen parameters.

**The 50-mm concrete is considered massive and the others nonmassive.

Roof Numbers

Table 31 Roof Numbers Used in Table 30

Mass Location**	Suspended Ceiling	R-Value, $m^2 \cdot K/W$	B7, Wood 25 mm	C12, HW Concrete 50 mm	A3, Steel Deck	Attic-Ceiling Combination
Mass inside the insulation	Without	0 to 0.9	*	2	*	*
		0.9 to 1.8	*	2	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	4	*	*
		3.5 to 4.4	*	5	*	*
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	5	*	*
		0.9 to 1.8	*	8	*	*
		1.8 to 2.6	*	13	*	*
		2.6 to 3.5	*	13	*	*
		3.5 to 4.4	*	14	*	*
		4.4 to 5.3	*	*	*	*
Mass evenly placed	Without	0 to 0.9	1	2	1	1
		0.9 to 1.8	2	*	1	2
		1.8 to 2.6	2	*	1	2
		2.6 to 3.5	4	*	2	2
		3.5 to 4.4	4	*	2	4
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	3	1	*
		0.9 to 1.8	4	*	1	*
		1.8 to 2.6	5	*	2	*
		2.6 to 3.5	9	*	2	*
		3.5 to 4.4	10	*	4	*
		4.4 to 5.3	10	*	*	*
Mass outside the insulation	Without	0 to 0.9	*	2	*	*
		0.9 to 1.8	*	3	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	5	*	*
		3.5 to 4.4	*	5	*	*
		4.4 to 5.3	*	*	*	*
	With	0 to 0.9	*	3	*	*
		0.9 to 1.8	*	3	*	*
		1.8 to 2.6	*	4	*	*
		2.6 to 3.5	*	5	*	*
		3.5 to 4.4	*	*	*	*
		4.4 to 5.3	*	*	*	*

*Denotes a roof that is not possible with the chosen parameters.

**The 50-mm concrete is considered massive and the others nonmassive.

CLTD for Roofs

Roof No.	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1	0	−1	−2	−3	−3	−3	0	7	16	25	33	41	46	49	49	46	41	33	24	14	8	5	3	1
2	1	0	−1	−2	−3	−3	−2	2	9	18	27	34	41	46	48	47	44	39	31	22	14	8	5	3
3	7	4	3	1	0	−1	0	3	7	13	19	26	32	37	40	41	41	37	33	27	21	17	13	9
4	9	6	4	2	1	−1	−2	−2	0	4	9	16	23	30	36	41	43	43	41	37	31	25	19	13
5	12	9	7	4	3	2	1	1	3	7	12	17	23	28	33	37	38	38	36	33	28	23	19	15
8	16	13	12	9	8	7	6	6	7	9	12	16	19	23	27	29	31	32	31	29	27	24	21	18
9	18	14	12	9	7	5	3	2	2	4	7	11	15	20	25	29	33	35	36	35	32	29	25	21
10	21	18	15	13	11	8	7	6	5	6	7	9	13	17	21	24	28	31	32	32	31	29	26	23
13	19	17	16	14	12	11	10	9	9	9	11	13	16	18	21	23	26	27	27	27	26	24	22	21
14	19	18	17	15	14	13	12	11	11	11	12	13	16	18	20	22	23	24	25	25	24	23	22	21

$$q = U*A*(CLTD_{Corr})$$

$$CLTD_{corr} = CLTD + (25.5 - Tr) + (Tm - 29.4)$$

Roof Cooling Load Requirement Summary

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Roof Area, m^2	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423
U, W/m^2-K	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
CLTD, °C	1	3	7	12	17	23	28	33	37	38	38	36	33
Corr.CLTD, °C	7.2	9.2	13.2	18.2	23.2	29.2	34.2	39.2	43.2	44.2	44.2	42.2	39.2
Q, kW	2.61	3.33	4.78	6.59	8.41	10.58	12.39	14.20	15.65	16.01	16.01	15.29	14.20

External Cooling Load
(Walls)

$$q = UA(\text{CLTD})$$

U = design heat transfer coefficient for roof or wall from Chapter 24, Table 4; or for glass, Table 5, Chapter 29

A = area of roof, wall, or glass, calculated from building plans

CLTD = cooling load temperature difference, roof, wall, or glass

Design temperatures : Corr. CLTD = CLTD + $(25.5 - t_r) + (t_m - 29.4)$

where

t_r = inside temperature and t_m = mean outdoor temperature

t_m = maximum outdoor temperature – (daily range)/2

At Clark: T_{max}= 35degC; T_{dr}= 9.8K or 9.8degC

t_m= 35 – 9.8/2 = 30.1

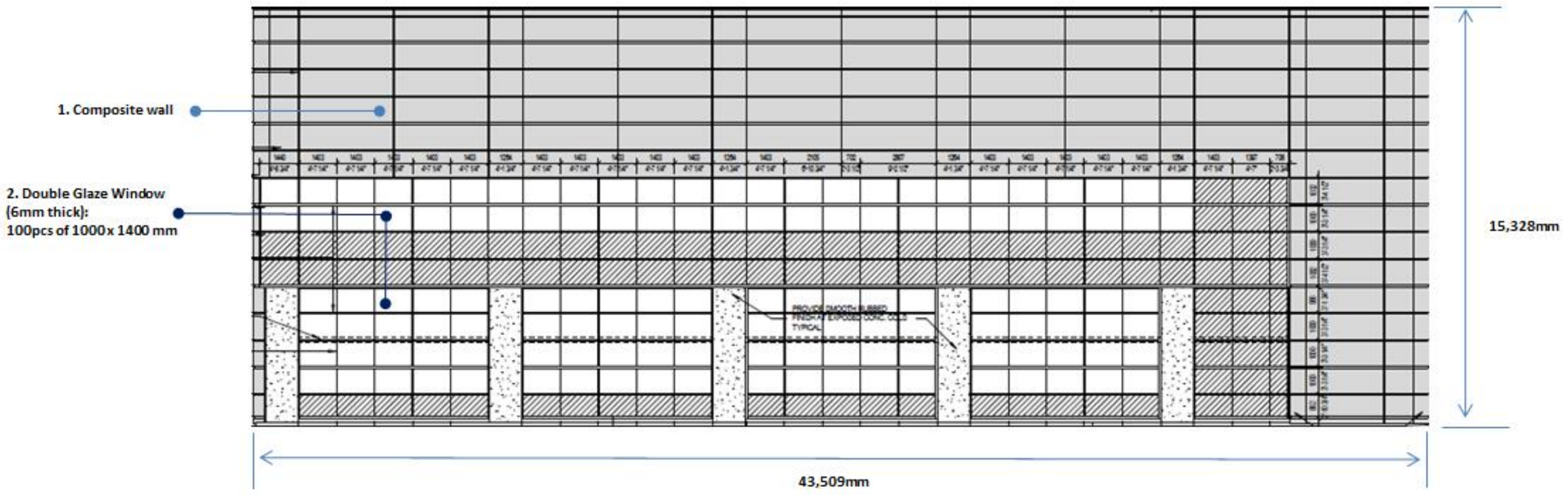
North Wall

The cooling load calculation in the North wall is divided into 2:

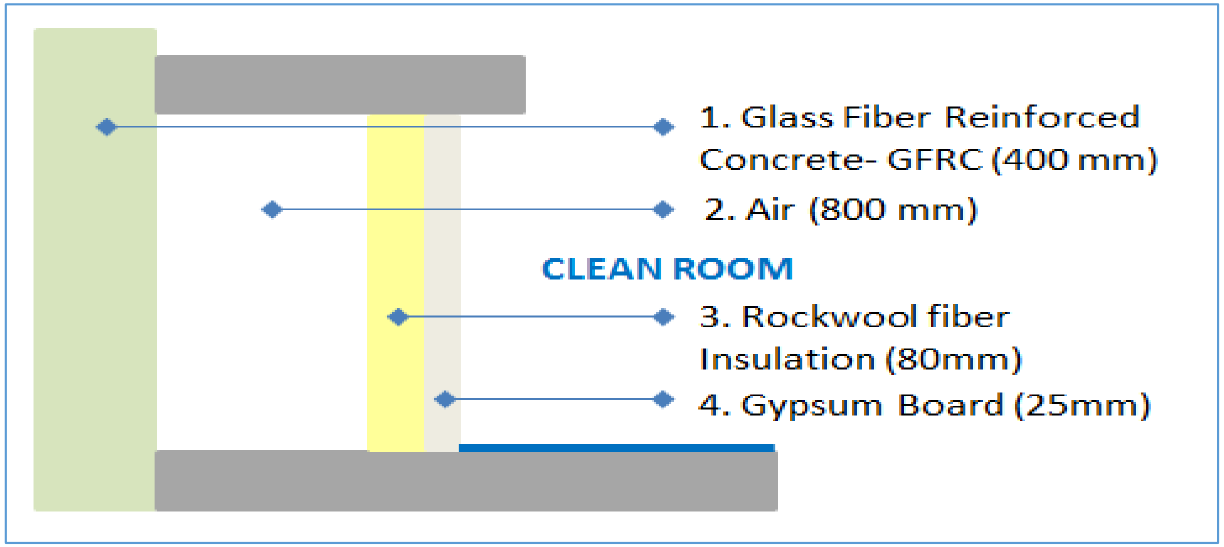
1. Heat load through the composite wall which is exposed to the outside environment.
2. Heat load through fenestration. This covers both conduction and radiation heat loads through the glass window.

North Wall - Composite Wall

North Wall Front View



North Wall Cross Section



Composite Wall Material Thermal Coefficient for North Wall

Material	Thickness; mm	Thermal Conductivity; W/m. K	Thermal Resistance; m². K/W
GFRC*	400	1.04	0.385
Air	800	0.25	3.2
Rockwool Fiber Insulation	80	0.04	2
Gypsum Board	25	0.17	0.147
Total Thermal Resistance			**5.732**

$$R = x_1/k_1$$

Air Surface Conductance

Table 1 Surface Conductances and Resistances for Air

Position of Surface	Direction of Heat Flow	Surface Emittance, ε: Non-reflective ε = 0.90 h_i	R	Reflective ε = 0.20 h_i	R	Reflective ε = 0.05 h_i	R
STILL AIR							
Horizontal	Upward	9.26	0.11	5.17	0.19	4.32	0.23
Sloping—45°	Upward	9.09	0.11	5.00	0.20	4.15	0.24
Vertical	Horizontal	8.29	0.12	4.20	0.24	3.35	0.30
Sloping—45°	Downward	7.50	0.13	3.41	0.29	2.56	0.39
Horizontal	Downward	6.13	0.16	2.10	0.48	1.25	0.80
MOVING AIR (Any position)		h_o	R				
Wind (for winter) 6.7 m/s (24 km/h)	Any	34.0	0.030	—	—	—	—
Wind (for summer) 3.4 m/s (12 km/h)	Any	22.7	0.044	—	—	—	—

Notes:
1. Surface conductance h_i and h_o measured in W/(m²·K); resistance R in m²·K/W.
2. No surface has both an air space resistance value and a surface resistance value.
3. For ventilated attics or spaces above ceilings under summer conditions (heat flow down), see Table 5.
4. Conductances are for surfaces of the stated emittance facing virtual blackbody surroundings at the same temperature as the ambient air. Values are based on a surface-air temperature difference of 5.5°C and for surface temperatures of 21°C.
5. See Chapter 3 for more detailed information, especially Tables 5 and 6, and see Figure 1 for additional data.
6. Condensate can have a significant impact on surface emittance (see Table 2).

Internal surface conductance of air, hi = 8.29 m². K/W

External surface conductance of air, ho = 22.7 m². K/W

Total thermal resistance

Using equation 3, we have:

$R_T = 1/22.7 + 5.732 + 1/8.29$

$R_T = 5.897\ m^2.\ K/W$

$$R_T = 1/h_i + x_1/k_1 + x_2/k_2 + ... + x_n/k_n + 1/h_o$$

Therefore, the Overall heat transfer coefficient (U);

$U = 1/\ R_T$ Equation 2

$U = 1/5.897$

$U = 0.17\ W/m^2.K$

Using table 33C of the ASHRAE Fundamentals 1997 and considering a secondary material of stucco and/or plaster which is same as the GFRC with 100 mm of high density concrete (C5) of thermal resistance 0.385 $m^2.K/W$, the equivalent Wall number is 5.

Table 11 Thermal Properties and Code Numbers of Layers Used in Wall and Roof Descriptions for Tables 12 and 13					
Code Number	Description	R, m2-K/W	k, W/mK	x, mm	Rnew
A1	25 mm Stucco	0.037	0.692	25	0.0361
A2	100 mm Face brick	0.076	1.333	100	0.0750
B7	25 mm Wood	0.207	0.121	25	0.2066
B9	100 mm Wood	0.837	0.121	100	0.8264
B10	50 mm Wood	0.42	0.121	50	0.4132
C1	100 mm Clay tile	0.178	0.571	100	0.1751
C2	100 mm low density concrete block	0.266	0.381	100	0.2625
C3	100 mm high density concrete block	0.125	0.813	100	0.1230
C4	100 mm Common brick	0.14	0.727	100	0.1376
C5	100 mm high density concrete	0.059	1.731	100	0.0578
C6	200 mm Clay tile	0.352	0.571	200	0.3503
C7	200 mm low density concrete block	0.352	0.571	200	0.3503
C8	200 mm high density concrete block	0.196	1.038	200	0.1927
C17	200 mm low density concrete block (filled)	1.467	0.138	150	1.0870
C18	200 mm high density concrete block (filled)	0.345	0.558	200	0.3584

Table 33C Wall Types, Mass Located Outside Insulation, for Use with Table 32

Secondary Material	R-Value, $m^2 \cdot K/W$	Principal Wall Material**														
		A1	A2	B7	B10	B9	C1	C2	C3	C4	C5	C6	C7	C8	C17	C18
Stucco and/or plaster	0 to 0.35	*	*	*	*	*	*	*	*	*	*	*	*	*	*	*
	0.35 to 0.44	*	3	*	*	*	*	*	2	3	5	*	*	*	*	*
	0.44 to 0.53	*	3	*	*	*	2	*	2	4	5	*	*	5	*	*
	0.53 to 0.62	*	3	*	*	*	2	2	2	5	5	*	*	5	*	*
	0.62 to 0.70	*	3	*	*	*	2	2	2	5	5	10	4	6	*	5
	0.70 to 0.84	*	4	*	*	*	4	2	2	5	5	10	4	6	*	9
	0.84 to 0.97	*	4	*	*	*	4	2	2	5	6	11	5	10	*	10
	0.97 to 1.14	*	5	*	*	*	4	2	2	5	6	11	5	10	*	10
	1.14 to 1.36	*	5	*	*	*	4	2	2	5	6	11	5	10	*	10
	1.36 to 1.59	*	5	*	*	*	5	2	4	5	6	16	10	10	*	10
	1.59 to 1.89	*	5	*	*	*	5	4	4	5	6	16	10	10	4	11
	1.89 to 2.24	*	5	*	*	*	5	4	4	10	6	16	10	10	9	11
	2.24 to 2.64	*	5	*	*	*	5	4	4	10	10	*	10	11	9	11
	2.64 to 3.08	*	5	*	*	*	5	4	4	10	10	*	10	11	10	16
	3.08 to 3.52	*	5	*	*	*	9	4	4	10	10	*	10	15	10	16
	3.52 to 4.05	*	9	*	*	*	9	9	9	15	10	*	10	15	15	16
	4.05 to 4.76	*	*	*	*	*	*	*	*	*	*	*	15	*	15	16

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40°North Latitude

Wall Number 1

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	1	0	−1	−1	−2	−1	4	6	6	7	9	12	14	15	16	16	16	16	15	9	6	4	3	2
NE	1	0	−1	−1	−2	1	13	23	26	24	19	16	15	16	16	16	15	13	11	8	6	4	3	2
E	1	0	−1	−1	−1	1	16	28	34	36	33	27	20	17	17	17	16	14	11	8	6	4	3	2
SE	1	0	−1	−1	−2	0	8	18	26	31	32	31	27	22	18	17	16	14	11	8	6	4	3	2
S	1	0	−1	−1	−2	−1	0	2	6	12	18	24	28	29	28	24	19	15	11	8	6	4	3	2
SW	1	0	−1	−1	−1	−1	0	2	4	7	9	14	22	29	36	39	38	34	25	13	7	4	3	2
W	1	1	−1	−1	−1	−1	1	2	4	7	9	12	15	23	33	41	44	44	34	18	9	5	3	2
NW	1	0	−1	−1	−1	−1	0	2	4	7	9	12	14	16	21	28	34	36	31	16	8	5	3	2

Wall Number 2

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	3	2	1	0	−1	−1	−1	2	4	5	6	8	10	12	13	14	15	16	16	15	12	9	7	4
NE	3	2	1	0	−1	−1	1	7	14	20	22	21	18	17	16	16	16	16	14	13	10	8	6	4
E	3	2	1	0	−1	−1	1	8	18	26	31	32	29	24	21	19	18	17	15	13	11	8	6	4
SE	3	2	1	0	−1	−1	0	4	11	18	24	28	29	28	25	22	19	17	16	13	11	8	6	4
S	3	2	1	0	−1	−1	−1	−1	1	4	8	13	18	23	26	27	26	22	18	15	12	8	6	4
SW	4	2	1	1	0	−1	−1	0	1	3	5	7	11	17	23	29	34	36	34	29	22	15	9	6
W	4	3	2	1	0	−1	−1	0	1	3	5	7	9	13	18	26	33	38	41	37	28	19	12	8
NW	4	2	1	1	−1	−1	−1	−1	1	3	5	7	9	12	14	18	23	28	32	30	23	16	11	7

Wall Number 3

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	4	3	2	1	1	0	1	3	4	4	6	8	9	11	13	13	14	14	15	13	11	9	7	6
NE	4	3	2	1	0	0	4	9	14	17	18	17	17	16	16	16	16	16	14	12	10	8	7	5
E	4	3	2	1	1	1	4	12	18	23	26	26	24	22	21	19	18	17	16	13	11	9	7	6
SE	4	3	2	1	1	0	2	7	12	18	22	24	26	24	23	21	19	18	16	13	11	9	7	6
S	4	3	2	1	1	0	0	1	2	5	9	13	17	21	23	23	22	20	17	14	12	9	8	6
SW	7	5	3	2	1	1	1	1	2	3	5	8	12	17	22	27	31	32	30	25	20	16	12	9
W	8	6	4	3	2	1	1	1	2	3	5	7	9	13	19	25	31	35	35	30	24	18	14	11
NW	7	4	3	2	1	1	0	1	2	3	5	7	9	11	14	18	22	27	28	24	19	15	12	9

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40 °North Latitude (*Continued*)

Wall Number 4

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	6	4	3	2	1	0	0	1	2	3	4	6	7	9	11	12	13	14	15	15	14	12	11	8
NE	6	4	3	2	1	0	0	2	7	12	16	18	18	18	17	17	17	16	16	14	13	11	9	7
E	6	4	3	2	1	1	1	3	8	15	21	25	27	26	24	22	21	19	18	16	14	12	9	8
SE	6	4	3	2	1	1	0	1	4	9	15	20	24	26	26	24	23	21	19	17	14	12	10	8
S	6	4	3	2	1	1	0	1	0	1	3	7	11	16	19	23	24	23	22	19	17	13	11	8
SW	10	7	5	3	2	1	0	0	0	1	3	4	7	10	15	20	26	29	32	32	28	23	18	14
W	12	8	6	4	2	1	1	0	1	1	3	4	6	8	12	17	22	28	33	36	33	28	22	17
NW	10	7	5	3	2	1	0	0	0	1	2	4	6	8	11	13	17	21	25	27	27	23	18	14

Wall Number 5

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	7	6	4	3	3	2	1	2	3	3	4	5	7	8	9	11	12	13	13	13	13	12	10	8
NE	7	6	4	3	3	2	2	4	8	11	14	15	16	16	16	16	16	16	15	14	13	12	10	8
E	8	6	5	4	3	2	2	4	9	14	18	22	22	22	21	21	19	19	18	16	14	13	11	9
SE	8	7	5	4	3	2	2	3	6	10	14	18	21	22	22	21	21	19	18	17	15	13	11	9
S	8	7	5	4	3	2	2	1	2	2	4	7	11	14	17	19	20	20	19	18	16	13	12	10
SW	12	10	8	6	4	3	3	2	2	3	3	5	7	9	14	18	22	26	27	27	24	21	18	14
W	14	11	9	7	6	4	3	2	2	3	4	5	6	8	11	16	21	25	29	30	28	24	21	17
NW	12	9	7	6	4	3	2	2	2	2	3	4	6	8	9	12	15	19	22	23	22	19	17	14

Wall Number 6

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	7	6	5	4	3	3	2	3	3	4	4	6	7	8	9	10	11	12	12	13	12	11	9	8
NE	8	7	6	4	3	3	3	6	8	11	13	14	14	14	14	15	15	15	14	14	13	12	10	9
E	9	7	6	5	4	3	4	6	10	14	17	19	20	20	19	19	19	18	17	16	14	13	12	10
SE	9	8	6	5	4	3	3	4	7	10	13	16	18	19	20	19	19	18	18	16	15	13	12	10
S	9	7	6	5	4	3	3	2	2	3	5	7	10	13	16	17	18	18	17	16	15	13	12	10
SW	13	11	9	8	6	5	4	3	3	4	4	6	7	10	13	17	21	23	24	24	22	19	17	15
W	14	12	10	8	7	6	4	4	4	4	4	6	7	8	11	15	19	23	26	27	25	22	19	17
NW	12	10	8	7	6	4	4	3	3	3	4	5	6	8	9	12	14	18	20	21	20	18	16	14

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40 °North Latitude (*Continued*)

Wall Number 7

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	7	7	6	5	4	3	3	4	4	4	5	6	7	8	9	9	10	11	11	11	11	10	9	8
NE	8	7	6	6	5	4	5	7	9	11	12	13	13	13	13	14	14	14	13	13	12	11	10	9
E	9	8	7	7	6	5	6	9	12	14	17	18	18	18	18	18	17	17	16	15	14	13	12	11
SE	9	8	7	7	6	5	5	7	9	12	14	16	17	18	18	18	17	17	16	15	14	13	12	11
S	9	8	7	6	6	4	4	4	4	5	7	8	11	13	14	16	16	16	16	14	13	12	11	10
SW	13	11	10	9	7	7	6	6	6	6	6	7	8	11	14	17	19	21	22	21	19	17	16	14
W	14	12	11	9	8	7	7	6	6	6	7	7	8	9	12	16	19	22	23	23	21	19	17	16
NW	11	10	9	8	7	6	5	5	5	5	6	6	7	8	9	12	14	17	18	18	17	16	14	13

Wall Number 9

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	9	8	7	6	5	4	3	2	2	2	3	4	4	6	7	8	9	11	12	12	13	13	12	11
NE	10	8	7	6	5	4	3	3	3	6	9	11	13	14	14	15	15	16	16	15	14	14	13	11
E	11	9	8	7	6	4	3	3	4	7	11	14	18	20	21	21	21	20	19	18	17	16	14	13
SE	11	9	8	7	6	4	3	3	3	5	7	11	14	17	19	20	21	20	19	19	18	16	14	13
S	12	10	8	7	6	4	3	3	2	2	2	3	6	8	11	14	16	18	19	19	18	17	15	13
SW	17	14	12	10	8	7	5	4	3	3	3	3	4	6	8	11	14	18	22	24	25	24	22	20
W	19	17	14	12	9	8	6	4	4	3	3	4	4	6	7	9	12	17	21	24	27	27	25	23
NW	16	14	12	9	8	6	5	4	3	3	3	3	4	5	6	8	10	12	16	19	21	21	20	18

Wall Number 10

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	9	8	7	6	5	4	3	3	3	3	3	4	4	6	7	8	9	10	11	12	12	12	12	11
NE	10	9	7	6	5	4	3	3	4	7	9	11	12	13	14	14	15	15	15	15	14	13	12	11
E	11	9	8	7	6	4	4	4	6	8	11	14	17	19	19	20	20	19	19	18	17	16	14	13
SE	12	10	8	7	6	4	4	3	4	6	8	11	14	17	18	19	19	19	19	18	17	16	14	13
S	12	10	8	7	6	5	4	3	2	2	3	4	6	8	11	13	16	17	18	18	17	16	14	13
SW	17	15	13	11	9	7	6	4	4	3	3	4	4	6	8	11	14	18	21	23	23	23	21	19
W	19	17	14	12	10	8	7	5	4	4	4	4	4	6	7	9	13	17	21	23	25	25	23	22
NW	16	13	12	10	8	7	6	4	3	3	3	3	4	6	7	8	10	13	16	18	19	20	19	17

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40°North Latitude (*Continued*)

Wall Number 11

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	9	8	7	7	6	5	4	4	4	4	4	5	6	6	7	8	8	9	10	11	11	11	10	9
NE	10	9	8	7	7	6	5	5	6	8	9	11	12	12	13	13	13	13	14	14	13	13	12	11
E	12	11	9	9	8	7	6	6	7	9	12	14	16	17	17	17	17	17	17	17	16	15	14	13
SE	12	11	9	9	8	7	6	6	6	8	9	12	13	15	16	17	17	17	17	17	16	15	14	13
S	11	10	9	8	7	6	6	5	4	4	4	6	7	9	11	13	14	15	16	16	15	14	13	12
SW	16	14	13	11	10	9	8	7	6	6	6	6	7	8	9	12	14	17	18	20	20	19	18	17
W	17	16	14	12	11	10	9	8	7	7	6	7	7	7	8	11	13	16	18	21	22	21	20	18
NW	14	13	11	10	9	8	7	6	6	5	5	6	6	7	7	8	10	12	14	16	17	17	16	15

Wall Number 12

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	9	8	7	7	6	6	4	4	4	4	4	5	6	6	7	8	8	9	9	10	11	11	10	9
NE	10	9	8	8	7	6	6	6	7	8	9	11	12	12	12	13	13	13	13	13	13	12	12	11
E	12	11	10	9	8	7	7	7	8	9	12	14	16	16	17	17	17	17	17	16	16	15	14	13
SE	12	11	10	9	8	7	7	6	7	8	9	12	13	14	16	16	17	17	17	16	16	15	14	13
S	11	11	9	8	8	7	6	6	5	5	5	6	7	9	11	12	13	14	14	14	14	14	13	12
SW	15	14	13	12	11	9	8	8	7	7	7	7	7	8	9	11	13	16	18	19	19	19	18	17
W	17	16	14	13	12	11	9	8	8	7	7	7	7	8	9	11	13	15	18	19	21	20	19	18
NW	13	12	11	11	9	8	7	7	6	6	6	6	6	7	7	8	10	12	14	16	16	16	16	14

Wall Number 13

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	9	8	7	7	6	6	4	4	4	4	4	5	6	6	7	8	8	9	9	10	11	11	10	9
NE	10	9	8	8	7	6	6	6	7	8	9	11	12	12	12	13	13	13	13	13	13	12	12	11
E	12	11	10	9	8	7	7	7	8	9	12	14	16	16	17	17	17	17	17	16	16	15	14	13
SE	12	11	10	9	8	7	7	6	7	8	9	12	13	14	16	16	17	17	17	16	16	15	14	13
S	11	11	9	8	8	7	6	6	5	5	5	6	7	9	11	12	13	14	14	14	14	14	13	12
SW	15	14	13	12	11	9	8	8	7	7	7	7	7	8	9	11	13	16	18	19	19	19	18	17
W	17	16	14	13	12	11	9	8	8	7	7	7	7	8	9	11	13	15	18	19	21	20	19	18
NW	13	12	11	11	9	8	7	7	6	6	6	6	6	7	7	8	10	12	14	16	16	16	16	14

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40°North Latitude (*Concluded*)

Wall Number 14

Wall Face	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	8	8	8	7	7	6	6	6	6	6	6	6	6	6	7	7	8	8	8	9	9	9	9	9
NE	11	10	9	9	8	8	7	7	8	8	9	10	11	11	11	12	12	12	12	12	12	12	12	11
E	13	12	12	11	10	9	9	8	9	10	12	13	14	14	15	15	16	16	16	16	15	14	14	13
SE	13	12	11	11	10	9	8	8	8	9	10	11	12	13	14	14	15	15	15	15	14	14	14	13
S	11	11	10	9	9	8	8	7	7	7	7	7	8	8	9	11	12	12	13	13	13	13	12	12
SW	14	14	13	12	12	11	10	9	9	8	8	8	8	9	9	11	12	14	15	16	17	17	16	16
W	16	15	14	13	13	12	11	10	9	9	9	9	9	9	9	11	12	13	15	17	18	18	17	17
NW	13	12	12	11	10	9	9	8	8	7	7	7	7	8	8	8	9	11	12	13	14	14	14	13

Wall Number 15

Wall Face	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	11	10	9	8	7	6	5	4	3	3	3	3	4	4	5	6	7	8	9	11	11	12	12	11
NE	12	11	9	8	7	6	5	4	4	5	6	8	10	11	12	13	14	14	14	14	14	14	14	13
E	14	12	11	9	8	7	6	5	5	6	8	10	13	15	17	18	19	19	19	18	18	17	16	15
SE	14	12	11	9	8	7	6	5	4	4	6	8	10	12	14	17	18	18	19	18	18	17	17	15
S	14	12	11	9	8	7	6	5	4	3	3	3	4	6	7	9	12	14	16	17	17	17	16	15
SW	19	18	16	14	12	10	9	7	6	5	4	4	4	5	6	8	10	13	16	18	21	22	22	21
W	22	19	18	16	13	12	10	8	7	6	5	4	4	5	6	7	9	12	14	18	21	23	23	23
NW	17	16	14	13	11	9	8	7	6	4	4	4	4	4	5	6	7	9	11	14	16	18	18	18

Wall Number 16

Wall Face	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	10	9	9	8	7	6	6	5	4	4	4	4	4	5	6	6	7	8	9	9	10	11	11	11
NE	12	11	10	9	8	7	6	6	6	6	7	8	9	11	12	12	13	13	13	14	14	13	13	13
E	14	13	12	11	9	8	7	6	6	7	8	11	12	14	16	17	17	17	18	18	17	17	16	15
SE	14	13	12	11	9	8	7	6	6	6	7	8	10	12	14	15	16	17	17	17	17	17	16	15
S	13	12	11	10	9	8	7	6	5	4	4	4	5	6	8	9	11	13	14	15	15	15	15	14
SW	18	17	16	14	13	11	10	8	7	7	6	6	6	6	7	8	10	12	15	17	18	19	19	19
W	20	18	17	16	14	12	11	9	8	7	7	6	6	6	7	8	9	11	14	17	19	21	21	21
NW	16	15	14	13	11	10	9	8	7	6	6	5	5	6	6	7	8	9	11	13	15	16	17	17

Corrected Cooling Load Temperature Difference

CLTDcorr = CLTD + (25.5 – tr) + (tm – 29.4)   Equation 4

Wall Number 5

Wall Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
N	7	6	4	3	3	2	1	2	3	3	4	5	7	8	9	11	12	13	13	13	13	12	10	8
NE	7	6	4	3	3	2	2	4	8	11	14	15	16	16	16	16	16	16	15	14	13	12	10	8
E	8	6	5	4	3	2	2	4	9	14	18	22	22	22	21	21	19	19	18	16	14	13	11	9
SE	8	7	5	4	3	2	2	3	6	10	14	18	21	22	22	21	21	19	18	17	15	13	11	9
S	8	7	5	4	3	2	2	1	2	2	4	7	11	14	17	19	20	20	19	18	16	13	12	10
SW	12	10	8	6	4	3	3	2	2	3	3	5	7	9	14	18	22	26	27	27	24	21	18	14
W	14	11	9	7	6	4	3	2	2	3	4	5	6	8	11	16	21	25	29	30	28	24	21	17
NW	12	9	7	6	4	3	2	2	2	2	3	4	6	8	9	12	15	19	22	23	22	19	17	14

Table 32 July Cooling Load Temperature Differences for Calculating Cooling Load from Sunlit Walls 40°North Latitude

Where:

tr = inside temperature

tm = maximum outdoor temperature – (daily range)/2

Thus,

tm = 36 °C – (9.8 °C/2)

tm = 31.1 C

With CLTD at 0800H using Wall no. 5 is 2;

Thus CLTDcorr = 2 + (25.5 – 21) + (31.1 – 29.4)

CLTDcorr = 8.2 °C

Thus the heat load from conduction through the composite wall at 0800H using equation 1 is equivalent to:

$$Q = U \times A \times CLTDcorr$$

$$= 0.17 \times 526.91 \times 8.2$$

$$= 732.72 \text{ Watts}$$

Cooling Load Summary of the North Composite Wall (0800H to 2000H)

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Wall Area, m^2	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91	526.91
R (material), m^2-K/W	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73	5.73
hi, W/m2K	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29	8.29
ho, W/m2K	22.70	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00
R_T, m^2K/W	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90	5.90
U, W/m^2-K	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
CLTD, °C	2.00	3.00	3.00	4.00	5.00	7.00	8.00	9.00	11.00	12.00	13.00	13.00	13.00
Corr.CLTD, °C	8.20	9.20	9.20	10.20	11.20	13.20	14.20	15.20	17.20	18.20	19.20	19.20	19.20
Q, kW	0.73	0.82	0.82	0.91	1.00	1.18	1.27	1.36	1.54	1.63	1.72	1.72	1.72

Space Cooling Load from Fenestration

$$q_{cond} = UA(\text{CLTD}) \quad (42)$$

$$q_{rad} = A(\text{SC})(\text{SCL}) \quad (43)$$

where

q_{rad} = cooling load caused by solar radiation, W
A = net glass area of fenestration, m^2
SC = shading coefficient, for combination of fenestration and shading device, obtained from Chapter 29
SCL = solar cooling load from Table 36, W/m^2

North Glass Window

Conduction through the glass window

Q = U x A x CLTDcorr

Where;
Glass material: 6 mm thick tempered tinted double glaze fixed panel
The overall heat transfer coefficient can be taken from table 5 Chapter 29 of the ASHRAE Fundamentals 1997.
U = 3.56 W/m^2. K
A = 140 m^2

Table 5 U-Factors for Various Fenestration Products in $W/(m^2 \cdot K)$

Product Type	Glass Only		Vertical Installation									
			Operable (including sliding and swinging glass doors)					Fixed				
Frame Type ID Glazing Type	Center of Glass	Edge of Glass	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl
Single Glazing												
1 3.2 mm glass	*5.91*	*5.91*	7.24	6.12	5.14	5.05	4.61	6.42	6.07	5.55	5.55	5.35
2 6.4 mm acrylic/polycarb	*5.00*	*5.00*	6.49	5.43	4.51	4.42	4.01	5.60	5.25	4.75	4.75	4.58
3 3.2 mm acrylic/polycarb	*5.45*	*5.45*	6.87	5.77	4.82	4.73	4.31	6.01	5.66	5.15	5.15	4.97
Double Glazing												
4 6.4 mm airspace	*3.12*	*3.63*	4.93	3.70	3.25	3.13	2.77	3.94	3.56	3.19	3.17	3.04
5 12.7 mm airspace	*2.73*	*3.36*	4.62	3.42	3.00	2.87	2.53	3.61	3.22	2.86	2.84	2.72
6 6.4 mm argon space	*2.90*	*3.48*	4.75	3.54	3.11	2.98	2.63	3.75	3.37	3.00	2.98	2.85
7 12.7 mm argon space	*2.56*	*3.24*	4.49	3.30	2.89	2.76	2.42	3.47	3.08	2.73	2.70	2.58
Double Glazing, *e* = 0.60 on surface 2 or 3												
8 6.4 mm airspace	*2.95*	*3.52*	4.80	3.58	3.14	3.02	2.67	3.80	3.41	3.05	3.03	2.90
9 12.7 mm airspace	*2.50*	*3.20*	4.45	3.26	2.85	2.73	2.39	3.42	3.03	2.68	2.66	2.54
10 6.4 mm argon space	*2.67*	*3.32*	4.58	3.38	2.96	2.84	2.49	3.56	3.17	2.82	2.80	2.67
11 12.7 mm argon space	*2.33*	*3.08*	4.31	3.13	2.74	2.62	2.28	3.28	2.89	2.54	2.52	2.40
Double Glazing, *e* = 0.40 on surface 2 or 3												
12 6.4 mm airspace	*2.78*	*3.40*	4.66	3.46	3.03	2.91	2.56	3.66	3.27	2.91	2.89	2.76
13 12.7 mm airspace	*2.27*	*3.04*	4.27	3.09	2.70	2.58	2.25	3.23	2.84	2.49	2.47	2.35
14 6.4 mm argon space	*2.44*	*3.16*	4.40	3.21	2.81	2.69	2.35	3.37	2.98	2.63	2.61	2.49
15 12.7 mm argon space	*2.04*	*2.88*	4.09	2.93	2.55	2.43	2.10	3.04	2.65	2.31	2.29	2.17
Double Glazing, *e* = 0.20 on surface 2 or 3												
16 6.4 mm airspace	*2.56*	*3.24*	4.49	3.30	2.89	2.76	2.42	3.47	3.08	2.73	2.70	2.58
17 12.7 mm airspace	*1.99*	*2.83*	4.05	2.89	2.52	2.39	2.07	2.99	2.60	2.26	2.24	2.13
18 6.4 mm argon space	*2.16*	*2.96*	4.18	3.01	2.63	2.51	2.17	3.13	2.74	2.40	2.38	2.26
19 12.7 mm argon space	*1.70*	*2.62*	3.83	2.68	2.33	2.21	1.89	2.75	2.36	2.03	2.01	1.90
Double Glazing, *e* = 0.10 on surface 2 or 3												
20 6.4 mm airspace	*2.39*	*3.12*	4.36	3.17	2.78	2.65	2.32	3.32	2.93	2.59	2.56	2.45
21 12.7 mm airspace	*1.82*	*2.71*	3.92	2.77	2.41	2.28	1.96	2.84	2.45	2.12	2.10	1.99
22 6.4 mm argon space	*1.99*	*2.83*	4.05	2.89	2.52	2.39	2.07	2.99	2.60	2.26	2.24	2.13
23 12.7 mm argon space	*1.53*	*2.49*	3.70	2.56	2.22	2.10	1.79	2.60	2.21	1.89	1.86	1.76

Table 5 U-Factors for Various Fenestration Products in W/(m^2·K)

Product Type	Glass Only		Vertical Installation									
			Operable (including sliding and swinging glass doors)					Fixed				
Frame Type / ID Glazing Type	Center of Glass	Edge of Glass	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Insulated Fiberglass/ Vinyl
Double Glazing, *e* = 0.05 on surface 2 or 3												
24 6.4 mm airspace	*2.33*	*3.08*	4.31	3.13	2.74	2.62	2.28	3.28	2.89	2.54	2.52	2.40
25 12.7 mm airspace	*1.70*	*2.62*	3.83	2.68	2.33	2.21	1.89	2.75	2.36	2.03	2.01	1.90
26 6.4 mm argon space	*1.87*	*2.75*	3.96	2.81	2.44	2.32	2.00	2.89	2.50	2.17	2.15	2.03
27 12.7 mm argon space	*1.42*	*2.41*	3.61	2.48	2.15	2.02	1.71	2.50	2.11	1.79	1.77	1.67
Triple Glazing												
28 6.4 mm airspace	*2.16*	*2.96*	4.11	2.89	2.51	2.45	2.16	3.10	2.73	2.38	2.33	2.25
29 12.7 mm airspace	*1.76*	*2.67*	3.80	2.60	2.25	2.19	1.91	2.76	2.39	2.05	2.01	1.93
30 6.4 mm argon space	*1.93*	*2.79*	3.94	2.73	2.36	2.30	2.01	2.90	2.54	2.19	2.15	2.07
31 12.7 mm argon space	*1.65*	*2.58*	3.71	2.52	2.17	2.12	1.84	2.66	2.30	1.96	1.91	1.84
Triple Glazing, *e* = 0.20 on surface 2,3,4, or 5												
32 6.4 mm airspace	*1.87*	*2.75*	3.89	2.69	2.32	2.27	1.98	2.86	2.49	2.15	2.10	2.03
33 12.7 mm airspace	*1.42*	*2.41*	3.54	2.36	2.02	1.97	1.70	2.47	2.10	1.77	1.73	1.66
34 6.4 mm argon space	*1.59*	*2.54*	3.67	2.48	2.13	2.08	1.80	2.61	2.25	1.91	1.87	1.80
35 12.7 mm argon space	*1.25*	*2.28*	3.40	2.23	1.91	1.86	1.59	2.32	1.96	1.63	1.59	1.52
Triple Glazing, *e* = 0.20 on surfaces 2 or 3 and 4 or 5												
36 6.4 mm airspace	*1.65*	*2.58*	3.71	2.52	2.17	2.12	1.84	2.66	2.30	1.96	1.91	1.84
37 12.7 mm airspace	*1.14*	*2.19*	3.31	2.15	1.84	1.78	1.52	2.23	1.86	1.54	1.49	1.43
38 6.4 mm argon space	*1.31*	*2.32*	3.45	2.27	1.95	1.90	1.62	2.37	2.01	1.68	1.63	1.56
39 12.7 mm argon space	*0.97*	*2.05*	3.18	2.03	1.72	1.67	1.41	2.08	1.71	1.39	1.35	1.29
Triple Glazing, *e* = 0.10 on surfaces 2 or 3 and 4 or 5												
40 6.4 mm airspace	*1.53*	*2.49*	3.63	2.44	2.10	2.05	1.77	2.57	2.20	1.86	1.82	1.75
41 12.7 mm airspace	*1.02*	*2.10*	3.22	2.07	1.76	1.71	1.45	2.13	1.76	1.44	1.40	1.33
42 6.4 mm argon space	*1.19*	*2.23*	3.36	2.19	1.87	1.82	1.55	2.27	1.91	1.58	1.54	1.47
43 12.7 mm argon space	*0.80*	*1.92*	3.05	1.90	1.61	1.56	1.30	1.93	1.57	1.25	1.21	1.15
Quadruple Glazing, *e* = 0.10 on surfaces 2 or 3 and 4 or 5												
44 6.4 mm airspaces	*1.25*	*2.28*	3.40	2.23	1.91	1.86	1.59	2.32	1.96	1.63	1.59	1.52
45 12.7 mm airspaces	*0.85*	*1.96*	3.09	1.94	1.65	1.60	1.34	1.98	1.62	1.30	1.26	1.19
46 6.4 mm argon spaces	*0.97*	*2.05*	3.18	2.03	1.72	1.67	1.41	2.08	1.71	1.39	1.35	1.29
47 12.7 mm argon spaces	*0.68*	*1.83*	2.96	1.82	1.54	1.48	1.23	1.84	1.47	1.16	1.11	1.05
48 6.4 mm krypton spaces	*0.68*	*1.83*	2.96	1.82	1.54	1.48	1.23	1.84	1.47	1.16	1.11	1.05

Table 5 U-Factors for Various Fenestration Products in W/(m^2·K) (*Concluded*)

Product Type	Vertical Installation					Sloped Installation								
	Garden Windows		Curtainwall			Glass Only (Skylights)		Manufactured Skylight				Site-Assembled Sloped/Overhead Glazing		
Frame Type / ID Glazing Type	Aluminum without Thermal Break	Wood/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing	Center of Glass	Edge of Glass	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing
Single Glazing														
1 3.2 mm glass	14.76	13.13	6.93	6.30	6.30	*6.76*	*6.76*	11.24	10.73	9.96	8.34	7.73	7.09	7.09
2 6.4 mm acrylic/polycarb	13.23	11.71	6.11	5.48	5.48	*5.85*	*5.85*	10.33	9.82	9.07	7.45	6.90	6.26	6.26
3 3.2 mm acrylic/polycarb	14.00	12.42	6.52	5.89	5.89	*6.30*	*6.30*	10.79	10.27	9.52	7.89	7.31	6.67	6.67
Double Glazing														
4 6.4 mm airspace	10.30	9.16	4.47	3.84	3.59	*3.29*	*3.75*	7.44	6.32	5.94	4.79	4.64	3.99	3.74
5 12.7 mm airspace	9.72	8.68	4.14	3.51	3.26	*3.24*	*3.71*	7.39	6.27	5.90	4.74	4.59	3.95	3.70
6 6.4 mm argon space	9.97	8.88	4.28	3.65	3.40	*3.01*	*3.56*	7.19	6.06	5.70	4.54	4.40	3.75	3.50
7 12.7 mm argon space	9.47	8.47	3.99	3.36	3.11	*3.01*	*3.56*	7.19	6.06	5.70	4.54	4.40	3.75	3.50
Double Glazing, e = 0.60 on surface 2 or 3														
8 6.4 mm airspace	10.05	8.95	4.33	3.70	3.45	*3.07*	*3.60*	7.24	6.11	5.75	4.59	4.45	3.80	3.55
9 12.7 mm airspace	9.38	8.40	3.94	3.31	3.06	*3.01*	*3.56*	7.19	6.06	5.70	4.54	4.40	3.75	3.50
10 6.4 mm argon space	9.63	8.61	4.09	3.46	3.21	*2.78*	*3.40*	6.98	5.86	5.49	4.34	4.20	3.56	3.31
11 12.7 mm argon space	9.13	8.19	3.80	3.17	2.92	*2.78*	*3.40*	6.98	5.86	5.49	4.34	4.20	3.56	3.31
Double Glazing, e = 0.40 on surface 2 or 3														
12 6.4 mm airspace	9.80	8.75	4.18	3.55	3.30	*2.90*	*3.48*	7.09	5.96	5.59	4.44	4.30	3.66	3.41
13 12.7 mm airspace	9.05	8.12	3.75	3.12	2.87	*2.84*	*3.44*	7.03	5.91	5.54	4.39	4.25	3.61	3.36
14 6.4 mm argon space	9.30	8.33	3.89	3.26	3.01	*2.50*	*3.20*	6.73	5.60	5.24	4.09	3.96	3.32	3.07
15 12.7 mm argon space	8.71	7.83	3.55	2.92	2.67	*2.61*	*3.28*	6.83	5.70	5.34	4.19	4.06	3.41	3.16
Double Glazing, e = 0.20 on surface 2 or 3														
16 6.4 mm airspace	9.47	8.47	3.99	3.36	3.11	*2.61*	*3.28*	6.83	5.70	5.34	4.19	4.06	3.41	3.16
17 12.7 mm airspace	8.62	7.76	3.50	2.87	2.63	*2.61*	*3.28*	6.83	5.70	5.34	4.19	4.06	3.41	3.16
18 6.4 mm argon space	8.88	7.98	3.65	3.02	2.77	*2.22*	*3.00*	6.47	5.34	4.99	3.84	3.72	3.07	2.83
19 12.7 mm argon space	8.19	7.40	3.26	2.63	2.38	*2.27*	*3.04*	6.52	5.39	5.04	3.89	3.77	3.12	2.87
Double Glazing, e = 0.10 on surface 2 or 3														
20 6.4 mm airspace	9.21	8.26	3.84	3.22	2.97	*2.50*	*3.20*	6.73	5.60	5.24	4.09	3.96	3.32	3.07
21 12.7 mm airspace	8.36	7.55	3.36	2.73	2.48	*2.50*	*3.20*	6.73	5.60	5.24	4.09	3.96	3.32	3.07
22 6.4 mm argon space	8.62	7.76	3.50	2.87	2.63	*2.04*	*2.88*	6.31	5.18	4.84	3.69	3.57	2.93	2.68
23 12.7 mm argon space	7.94	7.18	3.11	2.48	2.23	*2.16*	*2.96*	6.41	5.29	4.94	3.79	3.67	3.03	2.78

Table 5 U-Factors for Various Fenestration Products in $W/(m^2 \cdot K)$ (*Concluded*)

Product Type	Vertical Installation					Sloped Installation								
	Garden Windows		Curtainwall			Glass Only (Skylights)		Manufactured Skylight				Site-Assembled Sloped/Overhead Glazing		
Frame Type / ID Glazing Type	Aluminum without Thermal Break	Wood/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing	Center of Glass	Edge of Glass	Aluminum without Thermal Break	Aluminum with Thermal Break	Reinforced Vinyl/ Aluminum Clad Wood	Wood/ Vinyl	Aluminum without Thermal Break	Aluminum with Thermal Break	Structural Glazing
Double Glazing, *e* = 0.05 on surface 2														
24 6.4 mm airspace		8.19	3.80	3.17	2.92	*2.39*	*3.12*	6.62	5.50	5.14	3.99	3.87	3.22	2.97
25 12.7 mm airspace		7.40	3.26	2.63	2.38	*2.44*	*3.16*	6.67	5.55	5.19	4.04	3.91	3.27	3.02
26 6.4 mm argon space		7.62	3.41	2.78	2.53	*1.93*	*2.79*	6.21	5.08	4.73	3.58	3.48	2.83	2.58
27 12.7 mm argon space		7.04	3.01	2.39	2.14	*2.04*	*2.88*	6.31	5.18	4.84	3.69	3.57	2.93	2.68
Triple Glazing														
28 6.4 mm airspace			3.58	2.97	2.65	*2.22*	*3.00*	6.38	5.07	4.77	3.63	3.65	3.02	2.71
29 12.7 mm airspace			3.24	2.63	2.31	*2.04*	*2.88*	6.22	4.92	4.62	3.48	3.51	2.88	2.56
30 6.4 mm argon space			3.39	2.77	2.46	*1.99*	*2.83*	6.17	4.86	4.56	3.43	3.46	2.83	2.51
31 12.7 mm argon space			3.14	2.53	2.21	*1.87*	*2.75*	6.07	4.76	4.46	3.33	3.36	2.73	2.41
Triple Glazing, *e* = 0.20 on surface 2,3,4, or 5														
32 6.4 mm airspace			3.34	2.73	2.41	*1.93*	*2.79*	6.12	4.81	4.51	3.38	3.41	2.78	2.46
33 12.7 mm airspace			2.95	2.33	2.02	*1.76*	*2.67*	5.96	4.65	4.36	3.22	3.26	2.63	2.32
34 6.4 mm argon space			3.09	2.48	2.16	*1.59*	*2.54*	5.81	4.50	4.21	3.07	3.11	2.49	2.17
35 12.7 mm argon space			2.80	2.19	1.87	*1.53*	*2.49*	5.75	4.44	4.15	3.02	3.07	2.44	2.12
Triple Glazing, *e* = 0.20 on surfaces 2 or 3 and 4 or 5														
36 6.4 mm airspace			3.14	2.53	2.21	*1.65*	*2.58*	5.86	4.55	4.26	3.12	3.16	2.53	2.22
37 12.7 mm airspace			2.70	2.09	1.77	*1.53*	*2.49*	5.75	4.44	4.15	3.02	3.07	2.44	2.12
38 6.4 mm argon space			2.85	2.24	1.92	*1.36*	*2.36*	5.60	4.29	4.00	2.86	2.92	2.29	1.97
39 12.7 mm argon space			2.55	1.94	1.62	*1.25*	*2.28*	5.49	4.18	3.90	2.76	2.82	2.19	1.87
Triple Glazing, *e* = 0.10 on surfaces 2 or 3 and 4 or 5														
40 6.4 mm airspace			3.05	2.43	2.11	*1.53*	*2.49*	5.75	4.44	4.15	3.02	3.07	2.44	2.12
41 12.7 mm airspace			2.60	1.99	1.67	*1.42*	*2.41*	5.65	4.34	4.05	2.91	2.97	2.34	2.02
42 6.4 mm argon space			2.75	2.14	1.82	*1.19*	*2.23*	5.44	4.13	3.84	2.71	2.77	2.14	1.82
43 12.7 mm argon space			2.40	1.79	1.47	*1.14*	*2.19*	5.38	4.07	3.79	2.66	2.72	2.09	1.78
Quadruple Glazing, *e* = 0.10 on surfaces 2 or 3 and 4 or 5														
44 6.4 mm airspaces			2.80	2.19	1.87	*1.25*	*2.28*	5.49	4.18	3.90	2.76	2.82	2.19	1.87
45 12.7 mm airspaces			2.45	1.84	1.52	*1.08*	*2.14*	5.33	4.02	3.74	2.60	2.67	2.04	1.73
46 6.4 mm argon spaces			2.55	1.94	1.62	*1.02*	*2.10*	5.28	3.97	3.69	2.55	2.62	1.99	1.68
47 12.7 mm argon spaces			2.31	1.69	1.38	*0.91*	*2.01*	5.17	3.86	3.59	2.45	2.52	1.90	1.58
48 6.4 mm krypton spaces			2.31	1.69	1.38	*0.74*	*1.87*	5.01	3.70	3.43	2.29	2.38	1.75	1.43

Table 34 Cooling Load Temperature Differences (CLTD) for Conduction through Glass

Solar Time, h	CLTD, °C	Solar Time, h	CLTD, °C
0100	1	1300	7
0200	0	1400	7
0300	–1	1500	8
0400	–1	1600	8
0500	–1	1700	7
0600	–1	1800	7
0700	–1	1900	6
0800	0	2000	4
0900	1	2100	3
1000	2	2200	2
1100	4	2300	2
1200	5	2400	1

CLTD for the glass can be taken from table 34 of the ASHRAE Fundamentals 1997

CLTD at 0800H = 0 °C
Thus;
CLTDcorr = 0 + (25.5 – 21) + (31.1 – 29.4)
CLTDcorr = 6.2 °C

Therefore, using equation 1:
Q = 3.56 x 140 x 6.2
Q = 3,090.08 Watts

Table 34 Cooling Load Temperature Differences (CLTD) for Conduction through Glass

Solar Time, h	CLTD, °C	Solar Time, h	CLTD, °C
0100	1	1300	7
0200	0	1400	7
0300	–1	1500	8
0400	–1	1600	8
0500	–1	1700	7
0600	–1	1800	7
0700	–1	1900	6
0800	0	2000	4
0900	1	2100	3
1000	2	2200	2
1100	4	2300	2
1200	5	2400	1

North Glass Window

Cooling Load Summary of the North Glass Window (0800H to 2000H)

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Area	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00
CLTD	0.00	1.00	2.00	4.00	5.00	7.00	7.00	8.00	8.00	7.00	7.00	6.00	4.00
CLTDcorr	6.20	7.20	8.20	10.20	11.20	13.20	13.20	14.20	14.20	13.20	13.20	12.20	10.20
U; W/m².K	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56	3.56
Q, W	3090.08	3588.48	4086.88	5083.68	5582.08	6578.88	6578.88	7077.28	7077.28	6578.88	6578.88	6080.48	5083.68

North Glass Window
(Fenestration through the glass window)

Q = A x SC x SCL – Equation 5

Where:
A = Area of the glass window = 140 m^2
SC = Shading coefficient; Chapter 29 Table 11 ASHRAE Fundamentals
SC = SHGC/0.87
SHGC = Solar Heat Gain Coefficient

*The solar heat gain coefficient for the tinted double glaze glass on this project is taken from table 11 of chapter 29 ASHRAE Fundamentals using **high performance green tinted glass with low emissivity.**

Table 11 Visible Transmission (VT), Shading Coefficient (SC), and Solar Heat Gain Coefficient (SHGC) at Normal Incidence for Single Pane Glass and Insulating Glass

Glazing System					Glazing SHGC at Specified Incidence Angles						Total Window SHGC at Normal Incidence				Total Window VT at Normal Incidence	
					Normal						Aluminum		Other Frames		All Frames	
ID	Glass Thick, mm		Center Glazing VT	Center Glazing SC	0°	40°	50°	60°	70°	Hemis. (Diffuse)	Operable	Fixed	Operable	Fixed	Operable	Fixed
	Uncoated Single Glazing															
1a	3.2	Clear	0.90	1.00	0.86	0.85	0.83	0.78	0.67	0.78	0.75	0.78	0.63	0.75	0.65	0.78
1b	6.4	Clear	0.89	0.94	0.81	0.80	0.77	0.73	0.62	0.73	0.71	0.74	0.60	0.71	0.65	0.78
1c	3.2	Bronze	0.68	0.85	0.73	0.71	0.69	0.64	0.55	0.65	0.64	0.67	0.54	0.64	0.49	0.59
1d	6.4	Bronze	0.55	0.73	0.62	0.60	0.58	0.54	0.46	0.55	0.55	0.57	0.46	0.54	0.40	0.48
1e	3.2	Green	0.82	0.82	0.71	0.68	0.66	0.62	0.53	0.63	0.62	0.65	0.53	0.62	0.60	0.71
1f	6.4	Green	0.74	0.68	0.58	0.56	0.54	0.51	0.44	0.52	0.51	0.53	0.43	0.51	0.54	0.64
1g	3.2	Gray	0.62	0.82	0.70	0.68	0.66	0.61	0.53	0.63	0.61	0.64	0.52	0.61	0.45	0.54
1h	6.4	Gray	0.43	0.65	0.56	0.53	0.51	0.48	0.41	0.49	0.50	0.51	0.42	0.49	0.31	0.37
1i	6.4	Bluegreen	0.75	0.72	0.62	0.59	0.57	0.54	0.46	0.55	0.55	0.57	0.46	0.54	0.54	0.65
	Reflective Single Glazing															
1j	6.4	SS on CLR 8%	0.08	0.22	0.19	0.19	0.18	0.17	0.15	0.17	0.18	0.18	0.15	0.17	0.06	0.07
1k	6.4	SS on CLR 14%	0.14	0.29	0.25	0.25	0.24	0.23	0.20	0.23	0.23	0.24	0.19	0.22	0.10	0.12
1l	6.4	SS on CLR 20%	0.20	0.36	0.31	0.30	0.30	0.28	0.24	0.28	0.28	0.29	0.24	0.27	0.15	0.17
1m	6.4	SS on GRN 14%	0.12	0.29	0.25	0.25	0.24	0.23	0.20	0.23	0.23	0.24	0.19	0.22	0.09	0.10
1n	6.4	TI on CLR 20%	0.20	0.34	0.29	0.29	0.28	0.26	0.23	0.27	0.27	0.27	0.22	0.26	0.15	0.17
1o	6.4	TI on CLR 30%	0.30	0.45	0.39	0.38	0.37	0.35	0.30	0.35	0.35	0.36	0.29	0.34	0.22	0.26
	Uncoated Double Glazing															
5a	3.2	CLR CLR	0.81	0.87	0.75	0.73	0.70	0.63	0.49	0.65	0.66	0.68	0.55	0.66	0.59	0.71
5b	6.4	CLR CLR	0.78	0.81	0.70	0.68	0.65	0.58	0.45	0.60	0.61	0.64	0.52	0.61	0.57	0.68
5c	3.2	BRZ CLR	0.62	0.72	0.62	0.59	0.57	0.51	0.39	0.53	0.55	0.57	0.46	0.54	0.45	0.54
5d	6.4	BRZ CLR	0.48	0.59	0.50	0.47	0.45	0.40	0.31	0.42	0.45	0.46	0.37	0.44	0.35	0.42
5e	3.2	GRN CLR	0.74	0.70	0.60	0.57	0.55	0.49	0.38	0.51	0.53	0.55	0.45	0.53	0.54	0.64
5f	6.4	GRN CLR	0.66	0.54	0.47	0.44	0.42	0.38	0.30	0.40	0.42	0.43	0.35	0.41	0.48	0.57
5g	3.2	GRY CLR	0.56	0.69	0.59	0.57	0.54	0.48	0.37	0.50	0.52	0.54	0.44	0.52	0.41	0.49
5h	6.4	GRY CLR	0.40	0.51	0.44	0.42	0.40	0.35	0.28	0.38	0.39	0.41	0.33	0.39	0.29	0.35
5i	6.4	BLUGRN CLR	0.67	0.58	0.50	0.47	0.45	0.40	0.32	0.43	0.45	0.46	0.37	0.44	0.49	0.58
5j	6.4	HI-P GRN CLR	0.59	0.46	0.39	0.37	0.35	0.31	0.25	0.33	0.35	0.36	0.29	0.34	0.43	0.51
	Reflective Double Glazing															
5k	6.4	SS on CLR 8%,CLR	0.07	0.15	0.13	0.13	0.12	0.12	0.10	0.12	0.13	0.13	0.10	0.12	0.05	0.06
5l	6.4	SS on CLR 14%, CLR	0.13	0.20	0.17	0.17	0.16	0.15	0.12	0.15	0.17	0.16	0.13	0.15	0.09	0.11
5m	6.4	SS on CLR 20%, CLR	0.18	0.26	0.22	0.21	0.21	0.19	0.16	0.19	0.21	0.21	0.17	0.20	0.13	0.16
5n	6.4	SS on GRN 14%, CLR	0.11	0.18	0.16	0.16	0.15	0.14	0.12	0.14	0.16	0.16	0.13	0.14	0.08	0.10
5o	6.4	TI on CLR 20%, CLR	0.18	0.24	0.21	0.20	0.20	0.18	0.15	0.19	0.20	0.20	0.16	0.19	0.13	0.16
5p	6.4	TI on CLR 30%, CLR	0.27	0.33	0.29	0.28	0.27	0.25	0.20	0.25	0.27	0.27	0.22	0.26	0.20	0.24

KEY:

CLR = clear, GRN = green, GRY = gray, SS = stainless steel reflective coating, TI = titanium reflective coating

Reflective coating descriptors include percent visible transmittance as x%.

Hi-P GRN = high performance green tinted glass, LE = glass with a low-emissivity coating with an emittance of *e* = 0.xx

Low-e coating with an emittance of 0.2 is a pyrolytic coating. Other low-e coatings are sputtered coatings.

VT is Visible Transmittance, SC is Shading Coefficient, SHGC, is Solar Heat Gain Coefficient, and HEMIS is the hemispherical SHGC.

ID numbers refer to U-factors in Table 5

SHGC at 90° is 0.

Table 11 Visible Transmission (VT), Shading Coefficient (SC), and Solar Heat Gain Coefficient (SHGC) at Normal Incidence for Single Pane Glass and Insulating Glass

Glazing System: ID	Glass Thick, mm	Glazing	Center Glazing VT	Center Glazing SC	Glazing SHGC at Specified Incidence Angles: Normal 0°	Normal 40°	50°	60°	70°	Hemis. (Diffuse)	Total Window SHGC at Normal Incidence: Aluminum Operable	Aluminum Fixed	Other Frames Operable	Other Frames Fixed	Total Window VT at Normal Incidence: All Frames Operable	All Frames Fixed
Low-e Double Glazing, e = 0.2 on Surface 2																
17a	3.2	LE CLR	0.76	0.76	0.65	0.63	0.61	0.55	0.43	0.57	0.57	0.59	0.48	0.57	0.55	0.66
17b	6.4	LE CLR	0.73	0.70	0.60	0.58	0.56	0.51	0.40	0.52	0.53	0.55	0.45	0.53	0.53	0.64
Low-e Double Glazing, e = 0.2 on Surface 3																
17c	3.2	CLR LE	0.76	0.81	0.70	0.68	0.65	0.59	0.46	0.61	0.61	0.64	0.52	0.61	0.55	0.66
17d	6.4	CLR LE	0.73	0.75	0.65	0.63	0.60	0.54	0.42	0.56	0.57	0.59	0.48	0.57	0.53	0.64
17e	3.2	BRZ LE	0.58	0.66	0.57	0.54	0.52	0.46	0.36	0.48	0.50	0.52	0.42	0.50	0.42	0.51
17f	6.4	BRZ LE	0.45	0.52	0.45	0.42	0.40	0.35	0.27	0.37	0.40	0.41	0.34	0.40	0.33	0.39
17g	3.2	GRN LE	0.70	0.63	0.55	0.52	0.50	0.44	0.34	0.46	0.49	0.50	0.41	0.48	0.51	0.61
17h	6.4	GRN LE	0.61	0.48	0.42	0.39	0.37	0.33	0.25	0.35	0.38	0.39	0.32	0.37	0.44	0.53
17i	3.2	GRY LE	0.53	0.63	0.54	0.51	0.49	0.43	0.33	0.46	0.48	0.50	0.40	0.47	0.38	0.46
17j	6.4	GRY LE	0.37	0.46	0.39	0.36	0.34	0.31	0.24	0.33	0.35	0.36	0.29	0.34	0.27	0.32
17k	6.4	BLUGRN LE	0.62	0.52	0.45	0.42	0.40	0.35	0.27	0.37	0.40	0.41	0.34	0.40	0.45	0.54
17l	6.4	HI-P GRN LE	0.55	0.40	0.34	0.31	0.29	0.26	0.20	0.28	0.31	0.32	0.26	0.30	0.40	0.48
Low-e Double Glazing, e = 0.1 on Surface 2																
21a	3.2	LE CLR	0.75	0.62	0.54	0.52	0.49	0.44	0.34	0.46	0.48	0.50	0.40	0.47	0.54	0.65
21b	6.4	LE CLR	0.72	0.59	0.51	0.49	0.47	0.42	0.32	0.44	0.45	0.47	0.38	0.45	0.52	0.63
21l	6.4	HI-P GRN W/LE CLR	0.57	0.36	0.31	0.30	0.29	0.26	0.21	0.27	0.28	0.29	0.24	0.27	0.41	0.50
Low-e Double Glazing, e = 0.1 on Surface 3																
21c	3.2	CLR LE	0.75	0.69	0.60	0.58	0.56	0.51	0.41	0.53	0.53	0.55	0.45	0.53	0.54	0.65
21d	6.4	CLR LE	0.72	0.66	0.56	0.54	0.52	0.47	0.38	0.49	0.50	0.51	0.42	0.49	0.52	0.63
21e	3.2	BRZ LE	0.57	0.56	0.48	0.46	0.43	0.39	0.31	0.41	0.43	0.44	0.36	0.42	0.41	0.50
21f	6.4	BRZ LE	0.45	0.45	0.39	0.37	0.34	0.31	0.24	0.33	0.35	0.36	0.29	0.34	0.33	0.39
21g	3.2	GRN LE	0.68	0.57	0.49	0.47	0.44	0.40	0.31	0.42	0.44	0.45	0.37	0.43	0.49	0.59
21h	6.4	GRN LE	0.61	0.45	0.39	0.36	0.34	0.30	0.24	0.33	0.35	0.36	0.29	0.34	0.44	0.53
21i	3.2	GRY LE	0.52	0.53	0.46	0.44	0.41	0.37	0.29	0.39	0.41	0.42	0.34	0.41	0.38	0.45
21j	6.4	GRY LE	0.37	0.40	0.35	0.33	0.31	0.28	0.22	0.29	0.32	0.33	0.26	0.31	0.27	0.32
21k	6.4	BLUGRN LE	0.62	0.48	0.42	0.39	0.37	0.33	0.26	0.35	0.38	0.39	0.32	0.37	0.45	0.54

KEY:

CLR = clear, GRN = green, GRY = gray, SS = stainless steel reflective coating, TI = titanium reflective coating

Reflective coating descriptors include percent visible transmittance as x%.

Hi-P GRN = high performance green tinted glass, LE = glass with a low-emissivity coating with an emittance of *e* = 0.xx

Low-e coating with an emittance of 0.2 is a pyrolytic coating. Other low-e coatings are sputtered coatings.

VT is Visible Transmittance, SC is Shading Coefficient, SHGC, is Solar Heat Gain Coefficient, and HEMIS is the hemispherical SHGC.

ID numbers refer to U-factors in Table 5.

SHGC at 90° is 0.

Table 11 Visible Transmission (VT), Shading Coefficient (SC), and Solar Heat Gain Coefficient (SHGC) at Normal Incidence for Single Pane Glass and Insulating Glass (*Continued*)

Glazing System					Glazing SHGC at Specified Incidence Angles						Total Window SHGC at Normal Incidence				Total Window VT at Normal Incidence	
					Normal					Hemis.	Aluminum		Other Frames		All Frames	
ID	Glass Thick, mm		Center Glazing VT	Center Glazing SC	0°	40°	50°	60°	70°	(Diffuse)	Operable	Fixed	Operable	Fixed	Operable	Fixed
Low-e Double Glazing, e = 0.05 on Surface 2																
25a	3.2	LE CLR	0.72	0.48	0.41	0.38	0.34	0.26	0.14	0.35	0.37	0.38	0.31	0.36	0.52	0.63
25b	6.4	LE CLR	0.70	0.43	0.37	0.34	0.31	0.24	0.13	0.32	0.33	0.34	0.28	0.33	0.51	0.61
25c	6.4	BRZ W/LE CLR	0.42	0.30	0.26	0.24	0.22	0.18	0.10	0.23	0.24	0.24	0.20	0.23	0.31	0.37
25d	6.4	GRN W/LE CLR	0.60	0.35	0.30	0.28	0.25	0.20	0.11	0.26	0.28	0.28	0.23	0.27	0.44	0.52
25e	6.4	GRY W/LE CLR	0.35	0.27	0.24	0.22	0.20	0.16	0.10	0.20	0.22	0.23	0.18	0.21	0.25	0.30
25f	6.4	BLUE W/LE CLR	0.45	0.32	0.27	0.25	0.23	0.18	0.10	0.23	0.25	0.25	0.21	0.24	0.33	0.39
25g	6.4	HI-P GRN W/LE CLR	0.53	0.31	0.27	0.26	0.25	0.23	0.18	0.24	0.00	0.00	0.22	0.25	0.38	0.46
Triple Glazing																
29a	3.2	CLR CLR CLR	0.74	0.78	0.67	0.65	0.61	0.53	0.39	0.57	0.59	0.61	0.50	0.59	0.54	0.64
29b	6.4	CLR CLR CLR	0.70	0.71	0.61	0.58	0.55	0.48	0.35	0.51	0.54	0.56	0.45	0.54	0.51	0.61
29c	6.4	HI-P GRN CLR CLR	0.53	0.39	0.34	0.31	0.29	0.25	0.19	0.27	0.31	0.32	0.26	0.30	0.38	0.46
Triple Glazing, e = 0.2 on Surface 2																
32a	3.2	LE CLR CLR	0.68	0.69	0.60	0.58	0.55	0.48	0.35	0.51	0.53	0.55	0.45	0.53	0.49	0.59
32b	6.4	LE CLR CLR	0.64	0.62	0.53	0.50	0.47	0.41	0.30	0.44	0.47	0.49	0.39	0.47	0.46	0.56
Triple Glazing, e = 0.2 on Surface 5														0.00	0.00	
32c	3.2	CLR CLR LE	0.68	0.72	0.62	0.60	0.56	0.49	0.36	0.52	0.55	0.57	0.46	0.54	0.49	0.59
32d	6.4	CLR CLR LE	0.64	0.65	0.56	0.53	0.50	0.44	0.32	0.47	0.50	0.51	0.42	0.49	0.46	0.56
Triple Glazing, e = 0.1 on Surface 2 and 5																
40a	3.2	LE CLR LE	0.62	0.52	0.45	0.43	0.40	0.36	0.26	0.38	0.40	0.41	0.34	0.40	0.45	0.54
40b	6.4	LE CLR LE	0.59	0.47	0.41	0.39	0.37	0.32	0.24	0.34	0.37	0.38	0.31	0.36	0.43	0.51
Triple Glazing, e = 0.05 on Surface 2 and 4								0.00	0.00							
40c	3.2	LE LE CLR	0.58	0.37	0.32	0.30	0.29	0.26	0.19	0.27	0.29	0.30	0.24	0.28	0.42	0.51
40d	6.4	LE LE CLR	0.55	0.36	0.31	0.29	0.28	0.25	0.19	0.26	0.28	0.29	0.24	0.27	0.40	0.48

KEY:

CLR = clear, GRN = green, GRY = gray, SS = stainless steel reflective coating, TI = titanium reflective coating

Reflective coating descriptors include percent visible transmittance as x%.

Hi-P GRN = high performance green tinted glass, LE = glass with a low-emissivity coating with an emittance of e = 0.xx

Low-e coating with an emittance of 0.2 is a pyrolytic coating. Other low-e coatings are sputtered coatings.

VT is Visible Transmittance, SC is Shading Coefficient, SHGC, is Solar Heat Gain Coefficient, and HEMIS is the hemispherical SHGC.

ID numbers refer to U-factors in Table 5.

SHGC at 90° is 0.

North Glass Window
(Fenestration through the glass window)

SHGC = 0.32
SC = 0.32/0.87 = 0.368

SCL = Solar cooling load factor with no internal shade or with shade;

*Using table 35B, the glass solar can be taken as **zone type D** and with this known the solar cooling load can be derived from table 36 of the ASHRAE Fundamentals 1997.

Table 35B Zone Types for Use with SCL and CLF Tables, Single-Story Building

Zone Parameters[a]				Zone Type			Error Band	
No. Walls	Floor Covering	Partition Type	Inside Shade	Glass Solar	People and Equipment	Lights	Plus	Minus
1 or 2	Carpet	Gypsum	b	A	B	B	9	2
1 or 2	Carpet	Concrete block	b	B	C	C	9	0
1 or 2	Vinyl	Gypsum	Full	B	C	C	9	0
1 or 2	Vinyl	Gypsum	Half to None	C	C	C	16	0
1 or 2	Vinyl	Concrete block	Full	C	D	D	8	0
1 or 2	Vinyl	Concrete block	Half to None	D	D	D	10	6
3	Carpet	Gypsum	b	A	B	B	9	2
3	Carpet	Concrete block	Full	A	B	B	9	2
3	Carpet	Concrete block	Half to None	B	B	B	9	0
3	Vinyl	Gypsum	Full	B	C	C	9	0
3	Vinyl	Gypsum	Half to None	C	C	C	16	0
3	Vinyl	Concrete block	Full	B	C	C	9	0
3	Vinyl	Concrete block	Half to None	C	C	C	16	0
4	Carpet	Gypsum	b	A	B	B	6	3
4	Vinyl	Gypsum	Full	B	C	C	11	6
4	Vinyl	Gypsum	Half to None	C	C	C	19	–1

[a]A total of 14 zone parameters is fully defined in Table 20. Those not shown in this table were selected to achieve the minimum error band shown in the righthand column for Solar Cooling Load (SCL). The error band for Lights and People and Equipment is approximately 10%.
[b]The effect of inside shade is negligible in this case.

walls

Table 36 July Solar Cooling Load For Sunlit Glass 40°North Latitude

Zone Type A

Glass Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Solar Time																							
N	0	0	0	0	3	79	85	88	101	110	120	126	126	123	113	98	98	113	38	19	9	3	3	0
NE	0	0	0	0	6	268	406	422	353	236	173	151	139	126	117	101	82	57	22	9	6	3	0	0
E	0	0	0	0	6	293	495	583	576	485	334	211	167	142	123	104	82	57	22	9	6	3	0	0
SE	0	0	0	0	3	148	299	413	473	473	413	306	198	154	129	107	85	57	22	9	6	3	0	0
S	0	0	0	0	0	28	54	79	129	202	268	306	302	265	198	132	98	63	25	13	6	3	0	0
SW	0	0	0	0	0	28	54	76	95	110	123	202	318	419	476	479	419	293	110	54	25	13	6	3
W	3	0	0	0	0	28	54	76	95	110	120	126	205	359	498	589	605	491	180	85	41	19	9	6
NW	3	0	0	0	0	28	54	76	95	110	120	126	126	158	265	381	450	410	145	69	35	16	9	3
Hor	0	0	0	0	0	76	217	378	532	665	759	810	816	772	684	554	394	221	91	44	22	9	6	3

Zone Type B

Glass Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Solar Time																							
N	6	6	3	3	3	69	72	76	88	101	110	117	120	117	110	101	98	110	50	32	22	16	13	9
NE	6	3	3	3	6	230	343	365	318	230	183	164	151	142	129	113	95	72	41	28	19	16	9	9
E	6	6	3	3	6	252	419	501	510	450	331	233	198	173	151	129	107	79	47	32	22	16	13	9
SE	6	6	3	3	3	126	255	353	413	422	384	302	217	183	154	132	110	82	47	32	25	19	13	9
S	6	6	3	3	3	25	47	66	113	176	233	271	274	249	198	145	117	85	50	35	25	19	13	9
SW	19	16	13	9	6	28	50	69	85	98	113	183	280	369	425	435	397	296	145	98	66	47	35	25
W	25	19	16	13	9	28	50	69	85	98	110	117	186	318	438	523	545	463	208	135	95	66	47	35
NW	19	16	13	9	6	28	50	69	85	98	107	117	117	145	239	340	403	375	161	104	69	50	35	25
Hor	25	19	16	13	9	69	189	328	463	583	674	734	753	731	668	567	432	284	167	117	85	60	44	35

Notes:
1. Values are in W/m^2.
2. Apply data directly to standard double strength glass with no inside shade.
3. Data applies to 21st day of July.
4. For other types of glass and internal shade, use shading coefficients as multiplier. See text. For externally shaded glass, use north orientation. See text.

Table 36 July Solar Cooling Load For Sunlit Glass 40 °North Latitude

Zone Type C

Glass Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Solar Time																							
N	16	16	13	13	13	76	72	76	85	95	104	107	110	107	101	91	91	107	44	32	25	22	19	19
NE	22	19	19	16	19	236	334	337	277	192	154	148	142	135	126	113	98	79	50	41	35	32	28	25
E	28	25	25	22	25	261	410	466	457	391	280	195	176	164	148	135	117	95	63	54	47	41	38	35
SE	28	25	22	19	19	142	258	337	381	381	337	258	186	161	148	132	113	91	60	50	44	41	35	32
S	22	22	19	16	16	38	57	72	113	170	221	249	249	221	170	126	104	82	50	41	38	32	28	25
SW	44	38	35	32	28	47	66	82	91	104	113	180	271	347	391	394	350	252	117	88	72	63	54	47
W	54	47	41	38	35	54	69	85	98	107	113	117	186	309	416	482	491	403	158	110	88	76	66	60
NW	38	35	32	28	25	44	63	79	91	101	107	113	113	139	230	321	372	337	123	82	66	54	47	41
Hor	76	66	60	54	50	107	214	337	454	551	627	668	677	652	595	504	387	261	167	139	120	107	95	85

Zone Type D

Glass Face	Hour 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	Solar Time																							
N	25	22	19	19	19	66	66	66	76	85	91	98	101	98	95	88	91	101	54	44	38	35	32	28
NE	35	32	28	25	28	198	274	284	243	183	154	151	145	139	132	123	110	91	69	60	54	47	44	38
E	47	41	38	35	35	221	337	387	391	347	268	205	189	180	167	151	135	117	91	79	69	63	57	50
SE	44	41	35	32	32	123	214	284	321	328	299	246	189	173	161	148	132	110	85	76	66	60	54	50
S	35	32	28	25	22	38	54	66	101	145	186	211	217	198	164	129	113	95	69	60	54	47	44	38
SW	66	60	54	47	44	57	69	79	88	98	107	161	233	296	334	343	315	246	142	117	104	91	82	72
W	79	72	63	57	54	66	76	88	95	104	107	110	167	265	353	410	425	365	180	145	123	110	98	88
NW	57	50	47	41	38	54	66	76	85	95	101	104	107	129	202	274	318	296	132	104	91	79	69	63
Hor	117	104	95	85	76	120	202	299	391	473	539	583	602	592	554	491	403	302	227	198	176	158	142	129

Notes:

1. Values are in W/m^2.
2. Apply data directly to standard double strength glass with no inside shade.
3. Data applies to 21st day of July.
4. For other types of glass and internal shade, use shading coefficients as multiplier. See text. For externally shaded glass, use north orientation. See text.

Zone Type D

Glass Face	Hour											Solar Time												
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**
N	25	22	19	19	19	66	66	66	76	85	91	98	101	98	95	88	91	101	54	44	38	35	32	28
NE	35	32	28	25	28	198	274	284	243	183	154	151	145	139	132	123	110	91	69	60	54	47	44	38
E	47	41	38	35	35	221	337	387	391	347	268	205	189	180	167	151	135	117	91	79	69	63	57	50
SE	44	41	35	32	32	123	214	284	321	328	299	246	189	173	161	148	132	110	85	76	66	60	54	50
S	35	32	28	25	22	38	54	66	101	145	186	211	217	198	164	129	113	95	69	60	54	47	44	38
SW	66	60	54	47	44	57	69	79	88	98	107	161	233	296	334	343	315	246	142	117	104	91	82	72
W	79	72	63	57	54	66	76	88	95	104	107	110	167	265	353	410	425	365	180	145	123	110	98	88
NW	57	50	47	41	38	54	66	76	85	95	101	104	107	129	202	274	318	296	132	104	91	79	69	63
Hor	117	104	95	85	76	120	202	299	391	473	539	583	602	592	554	491	403	302	227	198	176	158	142	129

Table 36 July Solar Cooling Load For Sunlit Glass 40°North Latitude

Thus, with SCL = 66 W/m² at 0800H then

Q_f = 140 m² x 0.368 x 66 W/m²

Q_f = 3398.62 W

North Glass Window

Summary of Load from the Fenestration through the glass (0800H to 2000H)

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Area;m²	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00	140.00
SC	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368	0.368
SCL; W/m²	66	76	85	91	98	101	98	95	88	91	101	54	44
Q; Watts	3398.621	3913.563	4377.011	4685.977	5046.437	5200.92	5046.437	4891.954	4531.494	4685.977	5200.92	2780.69	2265.747

Same process for South, East, and West

Internal Load
(People)

Sensible Cooling Load, Qs

$$q_s = N(\mathrm{SHG}_p)(\mathrm{CLF}_p)$$

Latent Cooling Load, Q_l

$$q_l = N(\mathrm{LHG}_p)$$

where

q_s = sensible cooling load due to people
N = number of people
SHG_p = sensible heat gain per person (Table 3)
CLF_p = cooling load factor for people (Table 37)
q_l = latent cooling load due to people
LHG_p = latent heat gain per person (Table 3)

Internal Loads

Occupants

Number of occupants = 8

Sensible heat gain
Qsensible = N (Sensible Heat Gain) CLF
Qlatent = N (Latent Heat Gain)

Considering Light machine work for all of the above personnel and from table 3 chapter 28 of the 1997 ASHRAE Fundamentals handbook, the sensible and latent heat gain may be derived as:
Sensible Heat Gain = **110 Watts**
Latent Heat Gain = **185 Watts**

The Cooling Load Factor will be equal to 1 since the factory is in 24 hour non-stop operation.

People Sensible & Latent Heat Gains

Table 3 Rates of Heat Gain from Occupants of Conditioned Spaces

		Total Heat, W		Sensible Heat, W	Latent Heat, W	% Sensible Heat that is Radiant[b]	
Degree of Activity		**Adult Male**	**Adjusted, M/F[a]**			**Low V**	**High V**
Seated at theater	Theater, matinee	115	95	65	30		
Seated at theater, night	Theater, night	115	105	70	35	60	27
Seated, very light work	Offices, hotels, apartments	130	115	70	45		
Moderately active office work	Offices, hotels, apartments	140	130	75	55		
Standing, light work; walking	Department store; retail store	160	130	75	55	58	38
Walking, standing	Drug store, bank	160	145	75	70		
Sedentary work	Restaurant[c]	145	160	80	80		
Light bench work	Factory	235	220	80	140		
Moderate dancing	Dance hall	265	250	90	160	49	35
Walking 4.8 km/h; light machine work	Factory	295	295	110	185		
Bowling[d]	Bowling alley	440	425	170	255		
Heavy work	Factory	440	425	170	255	54	19
Heavy machine work; lifting	Factory	470	470	185	285		
Athletics	Gymnasium	585	525	210	315		

Therefore the sensible and latent heat load will be calculated as follows:

Qsensible = 8 x 110 Watts = 880 Watts

Qlatent = 8 x 185 = 1480 Watts

Summary of Heat Load from the Occupants

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
No. of Occupants	8	8	8	8	8	8	8	8	8	8	8	8	8
Sensible Heat Gain, W	110	110	110	110	110	110	110	110	110	110	110	110	110
Latent Heat Gean, W	185	185	185	185	185	185	185	185	185	185	185	185	185
CLF	1	1	1	1	1	1	1	1	1	1	1	1	1
Qsensible, W	880	880	880	880	880	880	880	880	880	880	880	880	880
Qlatent, W	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480	1480
Q, W	2360	16225	16225	16225	16225	16225	16225	16225	16225	16225	16225	16225	16225

Internal Load
(Lighting)

$$q_{el} = W F_{ul} F_{sa} \text{ (CLF)} \qquad (9)(46)$$

W = watts input from electrical plans or lighting fixture data
F_{ul} = lighting use factor, as appropriate
F_{sa} = special allowance factor, as appropriate
CLF = cooling load factor, by hour of occupancy, Table 38

Note: CLF = 1.0 with 24-h light usage and/or if cooling off at night or during weekends.

Lighting Fixtures

*The light fixture n PDC is 764 LED Lights. The Light Use factor, F_{UL}, used is 1 for commercial application while the Special Allowance factor, F_{SA}, is 1.2 for general application. The plant is in a 24 hour non-stop operation that is why we will use a cooling load factor of 1.

Calculation for the loading from the lighting fixtures yields to:

Qel = W x Ful x Fsa x CLF

Where:

W = input from lighting fixture data = 17 watts rating

Wtotal = 17 x 764 = 12,988 Watts

Thus at 0800H:
Qel = 12,988 Watts x 1 x 1.2 x 1 = 15585.6Watts

Table 35A Zone Types for Use with CLF Tables, Interior Rooms

Zone Parameters[a]				Zone Type	
Room Location	Middle Floor	Ceiling Type	Floor Covering	People and Equipment	Lights
Single story	N/A	N/A	Carpet	C	B
	N/A	N/A	Vinyl	D	C
Top floor	65 mm Concrete	With	Carpet	D	C
	65 mm Concrete	With	Vinyl	D	D
	65 mm Concrete	Without	b	D	B
	25 mm Wood	b	b	D	B
Bottom floor	65 mm Concrete	With	Carpet	D	C
	65 mm Concrete	b	Vinyl	D	D
	65 mm Concrete	Without	Carpet	D	D
	25 mm Wood	b	Carpet	D	C
	25 mm Wood	b	Vinyl	D	D
Mid-floor	65 mm Concrete	N/A	Carpet	D	C
	65 mm Concrete	N/A	Vinyl	D	D
	25 mm Wood	N/A	b	C	B

[a] A total of 14 zone parameters is fully defined in Table 20. Those not shown in this table were selected to achieve an error band of approximately 10%.
[b] The effect of this parameter is negligible in this case.

Table 35B Zone Types for Use with SCL and CLF Tables, Single-Story Building

Zone Parameters[a]				Zone Type			Error Band	
No. Walls	Floor Covering	Partition Type	Inside Shade	Glass Solar	People and Equipment	Lights	Plus	Minus
1 or 2	Carpet	Gypsum	b	A	B	B	9	2
1 or 2	Carpet	Concrete block	b	B	C	C	9	0
1 or 2	Vinyl	Gypsum	Full	B	C	C	9	0
1 or 2	Vinyl	Gypsum	Half to None	C	C	C	16	0
1 or 2	Vinyl	Concrete block	Full	C	D	D	8	0
1 or 2	Vinyl	Concrete block	Half to None	D	D	D	10	6
3	Carpet	Gypsum	b	A	B	B	9	2
3	Carpet	Concrete block	Full	A	B	B	9	2
3	Carpet	Concrete block	Half to None	B	B	B	9	0
3	Vinyl	Gypsum	Full	B	C	C	9	0
3	Vinyl	Gypsum	Half to None	C	C	C	16	0
3	Vinyl	Concrete block	Full	B	C	C	9	0
3	Vinyl	Concrete block	Half to None	C	C	C	16	0
4	Carpet	Gypsum	b	A	B	B	6	3
4	Vinyl	Gypsum	Full	B	C	C	11	6
4	Vinyl	Gypsum	Half to None	C	C	C	19	–1

[a]A total of 14 zone parameters is fully defined in Table 20. Those not shown in this table were selected to achieve the minimum error band shown in the righthand column for Solar Cooling Load (SCL). The error band for Lights and People and Equipment is approximately 10%.
[b]The effect of inside shade is negligible in this case.

walls

Table 38 Cooling Load Factors for Lights

Lights On For	Number of Hours after Lights Turned On																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Zone Type A																								
8	0.85	0.92	0.95	0.96	0.97	0.97	0.97	0.98	0.13	0.06	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
10	0.85	0.93	0.95	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.14	0.07	0.04	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01
12	0.86	0.93	0.96	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.14	0.07	0.04	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.02
14	0.86	0.93	0.96	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.15	0.07	0.05	0.03	0.03	0.03	0.02	0.02	0.02	0.02
16	0.87	0.94	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.15	0.08	0.05	0.04	0.03	0.03	0.03	0.02
Zone Type B																								
8	0.75	0.85	0.90	0.93	0.94	0.95	0.95	0.96	0.23	0.12	0.08	0.05	0.04	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.02	0.02	0.02	0.01
10	0.75	0.86	0.91	0.93	0.94	0.95	0.95	0.96	0.96	0.97	0.24	0.13	0.08	0.06	0.05	0.04	0.04	0.03	0.03	0.03	0.03	0.02	0.02	0.02
12	0.76	0.86	0.91	0.93	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.24	0.14	0.09	0.07	0.05	0.05	0.04	0.04	0.03	0.03	0.03	0.03
14	0.76	0.87	0.92	0.94	0.95	0.96	0.96	0.97	0.97	0.97	0.97	0.98	0.98	0.98	0.25	0.14	0.09	0.07	0.06	0.05	0.05	0.04	0.04	0.03
16	0.77	0.88	0.92	0.95	0.96	0.96	0.97	0.97	0.97	0.98	0.98	0.98	0.98	0.98	0.98	0.99	0.25	0.15	0.10	0.07	0.06	0.05	0.05	0.04
Zone Type C																								
8	0.72	0.80	0.84	0.87	0.88	0.89	0.90	0.91	0.23	0.15	0.11	0.09	0.08	0.07	0.07	0.06	0.05	0.05	0.05	0.04	0.04	0.03	0.03	0.03
10	0.73	0.81	0.85	0.87	0.89	0.90	0.91	0.92	0.92	0.93	0.25	0.16	0.13	0.11	0.09	0.08	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04
12	0.74	0.82	0.86	0.88	0.90	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.26	0.18	0.14	0.12	0.10	0.09	0.08	0.08	0.07	0.06	0.06	0.05
14	0.75	0.84	0.87	0.89	0.91	0.92	0.92	0.93	0.94	0.94	0.95	0.95	0.96	0.96	0.27	0.19	0.15	0.13	0.11	0.10	0.09	0.08	0.08	0.07
16	0.77	0.85	0.89	0.91	0.92	0.93	0.93	0.94	0.95	0.95	0.95	0.96	0.96	0.97	0.97	0.97	0.28	0.20	0.16	0.13	0.12	0.11	0.10	0.09
Zone Type D																								
8	0.66	0.72	0.76	0.79	0.81	0.83	0.85	0.86	0.25	0.20	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06	0.05	0.04	0.04
10	0.68	0.74	0.77	0.80	0.82	0.84	0.86	0.87	0.88	0.90	0.28	0.23	0.19	0.17	0.15	0.14	0.12	0.11	0.10	0.09	0.08	0.07	0.06	0.06
12	0.70	0.75	0.79	0.81	0.83	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.30	0.25	0.21	0.19	0.17	0.15	0.13	0.12	0.11	0.10	0.09	0.08
14	0.72	0.77	0.81	0.83	0.85	0.86	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.32	0.26	0.23	0.20	0.18	0.16	0.14	0.13	0.12	0.10
16	0.75	0.80	0.83	0.85	0.87	0.88	0.89	0.90	0.91	0.92	0.93	0.94	0.94	0.95	0.96	0.96	0.34	0.28	0.24	0.21	0.19	0.17	0.15	0.14

Summary of Heat Load due to Lights

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
# of Lights	764	764	764	764	764	764	764	764	764	764	764	764	764
Rating, (W)	17	17	17	17	17	17	17	17	17	17	17	17	17
F_{UL}	1	1	1	1	1	1	1	1	1	1	1	1	1
F_{SA}	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
CLF	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Heat Load, Q, (kW)	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586	15.586

Internal Load
(Appliance/ Equipment)

$$Qs = (\text{Watt Rating})^* \ (\text{CLF})$$

Table 35A Zone Types for Use with CLF Tables, Interior Rooms

Zone Parameters[a]				Zone Type	
Room Location	Middle Floor	Ceiling Type	Floor Covering	People and Equipment	Lights
Single story	N/A	N/A	Carpet	C	B
	N/A	N/A	Vinyl	D	C
Top floor	65 mm Concrete	With	Carpet	D	C
	65 mm Concrete	With	Vinyl	D	D
	65 mm Concrete	Without	b	D	B
	25 mm Wood	b	b	D	B
Bottom floor	65 mm Concrete	With	Carpet	D	C
	65 mm Concrete	b	Vinyl	D	D
	65 mm Concrete	Without	Carpet	D	D
	25 mm Wood	b	Carpet	D	C
	25 mm Wood	b	Vinyl	D	D
Mid-floor	65 mm Concrete	N/A	Carpet	D	C
	65 mm Concrete	N/A	Vinyl	D	D
	25 mm Wood	N/A	b	C	B

[a] A total of 14 zone parameters is fully defined in Table 20. Those not shown in this table were selected to achieve an error band of approximately 10%.
[b] The effect of this parameter is negligible in this case.

Table 37 Cooling Load Factors for People and Unhooded Equipment

Hours in Space	Number of Hours after Entry into Space or Equipment Turned On																							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Zone Type A																								
2	0.75	0.88	0.18	0.08	0.04	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.75	0.88	0.93	0.95	0.22	0.10	0.05	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.75	0.88	0.93	0.95	0.97	0.97	0.23	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.75	0.88	0.93	0.95	0.97	0.97	0.98	0.98	0.24	0.11	0.06	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
10	0.75	0.88	0.93	0.95	0.97	0.97	0.98	0.98	0.99	0.99	0.24	0.12	0.07	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
12	0.75	0.88	0.93	0.96	0.97	0.98	0.98	0.98	0.99	0.99	0.99	0.99	0.25	0.12	0.07	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01
14	0.76	0.88	0.93	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03	0.02	0.02	0.01	0.01
16	0.76	0.89	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03	0.02	0.02
18	0.77	0.89	0.94	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.25	0.12	0.07	0.05	0.03	0.03
Zone Type B																								
2	0.65	0.74	0.16	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.65	0.75	0.81	0.85	0.24	0.17	0.13	0.10	0.07	0.06	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
6	0.65	0.75	0.81	0.85	0.89	0.91	0.29	0.20	0.15	0.12	0.09	0.07	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.00	0.00
8	0.65	0.75	0.81	0.85	0.89	0.91	0.93	0.95	0.31	0.22	0.17	0.13	0.10	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01	0.01	0.01
10	0.65	0.75	0.81	0.85	0.89	0.91	0.93	0.95	0.96	0.97	0.33	0.24	0.18	0.14	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.01
12	0.66	0.76	0.81	0.86	0.89	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.34	0.24	0.19	0.14	0.11	0.08	0.06	0.05	0.04	0.03	0.02	0.02
14	0.67	0.76	0.82	0.86	0.89	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.35	0.25	0.19	0.15	0.11	0.09	0.07	0.05	0.04	0.03
16	0.69	0.78	0.83	0.87	0.90	0.92	0.94	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.35	0.25	0.19	0.15	0.11	0.09	0.07	0.05
18	0.71	0.80	0.85	0.88	0.91	0.93	0.95	0.96	0.97	0.98	0.98	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.35	0.25	0.19	0.15	0.11	0.09
Zone Type C																								
2	0.60	0.68	0.14	0.11	0.09	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
4	0.60	0.68	0.74	0.79	0.23	0.18	0.14	0.12	0.10	0.08	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01
6	0.61	0.69	0.74	0.79	0.83	0.86	0.28	0.22	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01	0.01	0.01
8	0.61	0.69	0.75	0.79	0.83	0.86	0.89	0.91	0.32	0.26	0.21	0.17	0.14	0.11	0.09	0.08	0.06	0.05	0.04	0.04	0.03	0.02	0.02	0.02
10	0.62	0.70	0.75	0.80	0.83	0.86	0.89	0.91	0.92	0.94	0.35	0.28	0.23	0.18	0.15	0.12	0.10	0.08	0.07	0.06	0.05	0.04	0.03	0.03
12	0.63	0.71	0.76	0.81	0.84	0.87	0.89	0.91	0.93	0.94	0.95	0.96	0.37	0.29	0.24	0.19	0.16	0.13	0.11	0.09	0.07	0.06	0.05	0.04
14	0.65	0.72	0.77	0.82	0.85	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.38	0.30	0.25	0.20	0.17	0.14	0.11	0.09	0.08	0.06
16	0.68	0.74	0.79	0.83	0.86	0.89	0.91	0.92	0.94	0.95	0.96	0.96	0.97	0.98	0.98	0.98	0.39	0.31	0.25	0.21	0.17	0.14	0.11	0.09
18	0.72	0.78	0.82	0.85	0.88	0.90	0.92	0.93	0.94	0.95	0.96	0.97	0.97	0.98	0.98	0.99	0.99	0.99	0.39	0.31	0.26	0.21	0.17	0.14
Zone Type D																								
2	0.59	0.67	0.13	0.09	0.08	0.06	0.05	0.05	0.04	0.04	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00
4	0.60	0.67	0.72	0.76	0.20	0.16	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02	0.02	0.01	0.01	0.01
6	0.61	0.68	0.73	0.77	0.80	0.83	0.26	0.20	0.17	0.15	0.13	0.11	0.09	0.08	0.07	0.06	0.05	0.05	0.04	0.03	0.03	0.03	0.02	0.02
8	0.62	0.69	0.74	0.77	0.80	0.83	0.85	0.87	0.30	0.24	0.20	0.17	0.15	0.13	0.11	0.10	0.08	0.07	0.06	0.05	0.05	0.04	0.04	0.03
10	0.63	0.70	0.75	0.78	0.81	0.84	0.86	0.88	0.89	0.91	0.33	0.27	0.22	0.19	0.17	0.14	0.12	0.11	0.09	0.08	0.07	0.06	0.05	0.05
12	0.65	0.71	0.76	0.79	0.82	0.84	0.87	0.88	0.90	0.91	0.92	0.93	0.35	0.29	0.24	0.21	0.18	0.16	0.13	0.12	0.10	0.09	0.08	0.07
14	0.67	0.73	0.78	0.81	0.83	0.86	0.88	0.89	0.91	0.92	0.93	0.94	0.95	0.95	0.37	0.30	0.25	0.22	0.19	0.16	0.14	0.12	0.11	0.09
16	0.70	0.76	0.80	0.83	0.85	0.87	0.89	0.90	0.92	0.93	0.94	0.95	0.95	0.96	0.96	0.97	0.38	0.31	0.26	0.23	0.20	0.17	0.15	0.13
18	0.74	0.80	0.83	0.85	0.87	0.89	0.91	0.92	0.93	0.94	0.95	0.95	0.96	0.97	0.97	0.97	0.98	0.98	0.39	0.32	0.27	0.23	0.20	0.17

Table 39 Cooling Load Factors for Hooded Equipment

Hours in	Number of Hours after Equipment Turned On																							
Operation	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Zone Type A																								
2	0.64	0.83	0.26	0.11	0.06	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.64	0.83	0.90	0.93	0.31	0.14	0.07	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6	0.64	0.83	0.90	0.93	0.96	0.96	0.33	0.16	0.09	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8	0.64	0.83	0.90	0.93	0.96	0.96	0.97	0.97	0.34	0.16	0.09	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00
10	0.64	0.83	0.90	0.93	0.96	0.96	0.97	0.97	0.99	0.99	0.34	0.17	0.10	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00
12	0.64	0.83	0.90	0.94	0.96	0.97	0.97	0.97	0.99	0.99	0.99	0.99	0.36	0.17	0.10	0.06	0.04	0.03	0.03	0.03	0.01	0.01	0.01	0.01
14	0.66	0.83	0.90	0.94	0.96	0.97	0.97	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.36	0.17	0.10	0.07	0.04	0.04	0.03	0.03	0.03	0.01
16	0.66	0.84	0.91	0.94	0.96	0.97	0.97	0.99	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	0.36	0.17	0.10	0.07	0.04	0.04	0.04	0.03
18	0.67	0.84	0.91	0.94	0.96	0.97	0.97	0.99	0.99	0.99	0.99	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.36	0.17	0.10	0.08	0.07	0.04
Zone Type B																								
2	0.50	0.63	0.23	0.16	0.11	0.09	0.07	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4	0.50	0.64	0.73	0.79	0.34	0.24	0.19	0.14	0.10	0.09	0.06	0.04	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
6	0.50	0.64	0.73	0.79	0.84	0.87	0.41	0.29	0.21	0.17	0.13	0.10	0.07	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00
8	0.50	0.64	0.73	0.79	0.84	0.87	0.90	0.93	0.44	0.31	0.24	0.19	0.14	0.11	0.09	0.07	0.06	0.04	0.03	0.03	0.01	0.01	0.01	0.01
10	0.50	0.64	0.73	0.79	0.84	0.87	0.90	0.93	0.94	0.96	0.47	0.34	0.26	0.20	0.16	0.11	0.09	0.07	0.06	0.04	0.03	0.03	0.03	0.01
12	0.51	0.66	0.73	0.80	0.84	0.89	0.91	0.93	0.94	0.96	0.97	0.97	0.49	0.34	0.27	0.20	0.16	0.11	0.09	0.07	0.06	0.05	0.04	0.03
14	0.53	0.66	0.74	0.80	0.84	0.89	0.91	0.93	0.94	0.96	0.97	0.97	0.99	0.99	0.50	0.36	0.27	0.21	0.16	0.13	0.10	0.08	0.07	0.06
16	0.56	0.69	0.76	0.81	0.86	0.89	0.91	0.93	0.94	0.96	0.97	0.97	0.99	0.99	0.99	0.99	0.50	0.36	0.27	0.21	0.16	0.14	0.13	0.10
18	0.59	0.71	0.79	0.83	0.87	0.90	0.93	0.94	0.96	0.97	0.97	0.99	0.99	0.99	0.99	0.99	1.00	1.00	0.50	0.36	0.27	0.23	0.21	0.16
Zone Type C																								
2	0.43	0.54	0.20	0.16	0.13	0.10	0.09	0.07	0.06	0.04	0.04	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
4	0.43	0.54	0.63	0.70	0.33	0.26	0.20	0.17	0.14	0.11	0.09	0.07	0.06	0.06	0.04	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01
6	0.44	0.56	0.63	0.70	0.76	0.80	0.40	0.31	0.26	0.21	0.17	0.14	0.11	0.10	0.09	0.07	0.06	0.04	0.04	0.03	0.03	0.02	0.01	0.01
8	0.44	0.56	0.64	0.70	0.76	0.80	0.84	0.87	0.46	0.37	0.30	0.24	0.20	0.16	0.13	0.11	0.09	0.07	0.06	0.06	0.04	0.03	0.03	0.03
10	0.46	0.57	0.64	0.71	0.76	0.80	0.84	0.87	0.89	0.91	0.50	0.40	0.33	0.26	0.21	0.17	0.14	0.11	0.10	0.09	0.07	0.06	0.06	0.04
12	0.47	0.59	0.66	0.73	0.77	0.81	0.84	0.87	0.90	0.91	0.93	0.94	0.53	0.41	0.34	0.27	0.23	0.19	0.16	0.13	0.10	0.09	0.09	0.07
14	0.50	0.60	0.67	0.74	0.79	0.83	0.86	0.89	0.90	0.91	0.93	0.94	0.96	0.96	0.54	0.43	0.36	0.29	0.24	0.20	0.16	0.14	0.13	0.11
16	0.54	0.63	0.70	0.76	0.80	0.84	0.87	0.89	0.91	0.93	0.94	0.94	0.96	0.97	0.97	0.97	0.56	0.44	0.36	0.30	0.24	0.22	0.20	0.16
18	0.60	0.69	0.74	0.79	0.83	0.86	0.89	0.90	0.91	0.93	0.94	0.96	0.96	0.97	0.97	0.99	0.99	0.99	0.56	0.44	0.37	0.33	0.30	0.24
Zone Type D																								
2	0.41	0.53	0.19	0.13	0.11	0.09	0.07	0.07	0.06	0.06	0.04	0.04	0.03	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
4	0.43	0.53	0.60	0.66	0.29	0.23	0.19	0.16	0.14	0.11	0.10	0.09	0.07	0.07	0.06	0.04	0.04	0.04	0.03	0.03	0.03	0.02	0.01	0.01
6	0.44	0.54	0.61	0.67	0.71	0.76	0.37	0.29	0.24	0.21	0.19	0.16	0.13	0.11	0.10	0.09	0.07	0.07	0.06	0.04	0.04	0.04	0.04	0.03
8	0.46	0.56	0.63	0.67	0.71	0.76	0.79	0.81	0.43	0.34	0.29	0.24	0.21	0.19	0.16	0.14	0.11	0.10	0.09	0.07	0.07	0.06	0.06	0.06
10	0.47	0.57	0.64	0.69	0.73	0.77	0.80	0.83	0.84	0.87	0.47	0.39	0.31	0.27	0.24	0.20	0.17	0.16	0.13	0.11	0.10	0.09	0.09	0.07
12	0.50	0.59	0.66	0.70	0.74	0.77	0.81	0.83	0.86	0.87	0.89	0.90	0.50	0.41	0.34	0.30	0.26	0.23	0.19	0.17	0.14	0.13	0.13	0.11
14	0.53	0.61	0.69	0.73	0.76	0.80	0.83	0.84	0.87	0.89	0.90	0.91	0.93	0.93	0.53	0.43	0.36	0.31	0.27	0.23	0.20	0.18	0.17	0.16
16	0.57	0.66	0.71	0.76	0.79	0.81	0.84	0.86	0.89	0.90	0.91	0.93	0.93	0.94	0.94	0.96	0.54	0.44	0.37	0.33	0.29	0.26	0.24	0.21
18	0.63	0.71	0.76	0.79	0.81	0.84	0.87	0.89	0.90	0.91	0.93	0.93	0.94	0.96	0.96	0.96	0.97	0.97	0.56	0.46	0.39	0.35	0.33	0.29

Equipment

The PDC have 4 Computers each with 100 watts operates 24hrs per day, 7 days a week.

CLF = 1; For 24 hour continuous plant operation

Q = Pe x CLF x N

Where:

Pe = equipment power rating from manufacturer data

N = Number of Computers

Thus, calculating the power load at 0800H:

Q = 100 x 1 x 4

Q = 400 Watts

Summary of Heat Load due to Equipment

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Computers Qty	4	4	4	4	4	4	4	4	4	4	4	4	4
Computers Rating, (W)	100	100	100	100	100	100	100	100	100	100	100	100	100
CLF	1	1	1	1	1	1	1	1	1	1	1	1	1
Total Heat Load, Q, (kW)	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4

Ventilation Load

$$q_{sensible} = 1.23\ (Q)\ (t_o - t_i)$$
$$q_{latent} = 3010\ (Q)\ (w_o - w_i)$$

Q = ventilation rate requirement taken from ASHRAE Standard 62, L/s
t_o, t_i = outside, insaide air temperature, ^oC
w_o, w_i = outside, inside air humidity ratio, kg (water)/kg(dry air)

Qpeople = (Number of people) * (Air Rate/Person), L/s
Qarea = (Floor Area) *(Air Rate/Floor Area), L/s

Ventilation Load

Ventilation Load Requirement Summary

Parameters	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
# of Occupant	8	8	8	8	8	8	8	8	8	8	8	8	8
Outdoor Air Rate of People, Rp, (L/s-person)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5
Air Requirement per Person, Q(p), (L/s)	20	20	20	20	20	20	20	20	20	20	20	20	20
Room Area, m^2	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423	1423
Area Outdoor Air Rate , R_A, (L/s-m^2)	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9	0.9
Air Requirement per Area, Q(p), (L/s)	1281	1281	1281	1281	1281	1281	1281	1281	1281	1281	1281	1281	1281
Max Outside Temperature, To	36	36	36	36	36	36	36	36	36	36	36	36	36
Inside Temperature, Ti	21	21	21	21	21	21	21	21	21	21	21	21	21
Qsensible, kW	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**	**23.6**
Outside Humidity Ratio, Wo, (kg_V/kg_{DA})	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023	0.023
Inside Humidity Ratio, Wi, (kg_V/kg_{DA})	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773	0.00773
Qlatent, kW	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**	**58.87**
Q_{TOTAL}, kW	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50	82.50

Minimum Ventilation Rates In Breathing Zone

(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_A		Notes	Default Values		
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)	
	cfm/person	L/s•person	cfm/ft^2	L/s•m^2		#/1000 ft^2 (#/100 m^2)	cfm/person	L/s•person
Correctional Facilities								
Cell	5	2.5	0.12	0.6		25	10	4.9
Day room	5	2.5	0.06	0.3		30	7	3.5
Guard stations	5	2.5	0.06	0.3		15	9	4.5
Booking/waiting	7.5	3.8	0.06	0.3		50	9	4.4
Educational Facilities								
Daycare (through age 4)	10	5	0.18	0.9		25	17	8.6
Classrooms (ages 5-8)	10	5	0.12	0.6		25	15	7.4
Classrooms (age 9 plus)	10	5	0.12	0.6		35	13	6.7
Lecture classroom	7.5	3.8	0.06	0.3		65	8	4.3
Lecture hall (fixed seats)	7.5	3.8	0.06	0.3		150	8	4.0
Art classroom	10	5.0	0.18	0.9		20	19	9.5
Science laboratories	10	5.0	0.18	0.9		25	17	8.6
Wood/metal shop	10	5	0.18	0.9		20	19	9.5
Computer lab	10	5	0.12	0.6		25	15	7.4
Media center	10	5	0.12	0.6	A	25	15	7.4
Music/theater/dance	10	5.0	0.06	0.3		35	12	5.9

Minimum Ventilation Rates In Breathing Zone

(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Multi-use assembly	7.5	3.8	0.06	0.3		100	8	4.1
Food and Beverage Service								
Restaurant dining rooms	7.5	3.8	0.18	0.9		70	10	5.1
Cafeteria/fast food dining	7.5	3.8	0.18	0.9		100	9	4.7
Bars, cocktail lounges	7.5	3.8	0.18	0.9		100	9	4.7
General								
Conference/meeting	5	2.5	0.06	0.3		50	6	3.1
Corridors	-	-	0.06	0.3		-		
Storage rooms	-	-	0.12	0.6	B	-		
Hotels, Motels, Resorts, Dormitories								
Bedroom/living room	5	2.5	0.06	0.3		10	11	5.5
Barracks sleeping areas	5	2.5	0.06	0.3		20	8	4.0
Lobbies/prefunction	7.5	3.8	0.06	0.3		30	10	4.8
Multi-purpose assembly	5	2.5	0.06	0.3		120	6	2.8
Office Buildings								
Office space	5	2.5	0.06	0.3		5	17	8.5
Reception areas	5	2.5	0.06	0.3		30	7	3.5
Telephone/data entry	5	2.5	0.06	0.3		60	6	3.0
Main entry lobbies	5	2.5	0.06	0.3		10	11	5.5
Miscellaneous spaces								
Bank vaults/safe deposit	5	2.5	0.06	0.3		5	17	8.5
Computer (not printing)	5	2.5	0.06	0.3		4	20	10.0
Pharmacy (prep. area)	5	2.5	0.18	0.9		10	23	11.5
Photo studios	5	2.5	0.12	0.6		10	17	8.5

TABLE 6.1 *(Continued)*
Minimum Ventilation Rates In Breathing Zone
(This table is not valid in isolation; it must be used in conjunction with the accompanying notes.)

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_A		Notes	Default Values		
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)	
	cfm/person	L/s•person	cfm/ft^2	L/s•m^2		#/1000 ft^2 (#/100 m^2)	cfm/person	L/s•person
Shipping/receiving	-	-	0.12	0.6	B	-		
Transportation waiting	7.5	3.8	0.06	0.3		100	8	4.1
Warehouses	-	-	0.06	0.3	B	-		
Public Assembly Spaces								
Auditorium seating area	5.0	2.5	0.06	0.3		150	5	2.7
Places of religious worship	5.0	2.5	0.06	0.3		120	6	2.8
Courtrooms	5.0	2.5	0.06	0.3		70	6	2.9
Legislative chambers	5.0	2.5	0.06	0.3		50	6	3.1
Libraries	5.0	2.5	0.12	0.6		10	17	8.5
Lobbies	5.0	2.5	0.06	0.3		150	5	2.7
Museums (children's)	7.5	3.8	0.12	0.6		40	11	5.3
Museums/galleries	7.5	3.8	0.06	0.3		40	9	4.6
Retail								
Sales (except as below)	7.5	3.8	0.12	0.6		15	16	7.8
Mall common areas	7.5	3.8	0.06	0.3		40	9	4.6
Barber shop	7.5	3.8	0.06	0.3		25	10	5.0

Occupancy Category	People Outdoor Air Rate R_p		Area Outdoor Air Rate R_A		Notes	Default Values		
						Occupant Density (see Note 4)	Combined Outdoor Air Rate (see Note 5)	
	cfm/person	L/s•person	cfm/ft^2	L/s•m^2		#/1000 ft^2 (#/100 m^2)	cfm/person	L/s•person
Barber shop	7.5	3.8	0.06	0.3		25	10	5.0
Beauty and nail salons	20	10	0.12	0.6		25	25	12.4
Pet shops (animal areas)	7.5	3.8	0.18	0.9		10	26	12.8
Supermarket	7.5	3.8	0.06	0.3		8	15	7.6
Coin-operated laundries	7.5	3.8	0.06	0.3		20	11	5.3
Sports and Entertainment								
Sports arena (play area)	-	-	0.30	1.5		-		
Gym, stadium (play area)	-	-	0.30	1.5		30		
Spectator areas	7.5	3.8	0.06	0.3		150	8	4.0
Swimming (pool and deck)	-	-	0.48	2.4	C	-		
Disco/dance floors	20	10	0.06	0.3		100	21	10.3
Health club/aerobics room	20	10	0.06	0.3		40	22	10.8
Health club/weight rooms	20	10	0.06	0.3		10	26	13.0
Bowling alley (seating)	10	5.0	0.12	0.6		40	13	6.5
Gambling casinos	7.5	3.8	0.18	0.9		120	9	4.6
Game arcades	7.5	3.8	0.18	0.9		20	17	8.3
Stages, studios	10	5.0	0.06	0.3	D	70	11	5.4

GENERAL NOTES FOR TABLE 6.1

1 **Related Requirements:** The rates in this table are based on all other applicable requirements of this standard being met.

2 **Smoking:** This table applies to no-smoking areas. Rates for smoking-permitted spaces must be determined using other methods.

3 **Air Density:** Volumetric airflow rates are based on an air density of 1.2 kg_{da}/m^3 (0.075 lb_{da}/ft^3), which corresponds to dry air at a barometric pressure of 101.3 kPa (1 atm) and an air temperature of 21 °C (70 °F). Rates may be adjusted for actual density, but such adjustment is not required for compliance with this standard.

4 **Default Occupant Density**: The default occupant density shall be used when actual occupant density is not known.

5 **Default Combined Outdoor Air Rate (per person)**: This rate is based on the default occupant density.

6 **Unlisted Occupancies:** If the occupancy category for a proposed space or zone is not listed, the requirements for the listed occupancy category that is most similar in terms of occupant density, activities, and building construction shall be used.

7 **Residential facilities, Health care facilities, and Vehicles:** Rates shall be determined in accordance with Appendix E.

ITEM-SPECIFIC NOTES FOR TABLE 6.1

A For high school and college libraries, use values shown for *Public Spaces – Libraries*.

B Rate may not be sufficient when stored materials include those having potentially harmful emissions.

C Rate does not allow for humidity control. Additional ventilation or dehumidification may be required to remove moisture.

D Rate does not include special exhaust for stage effects, e.g., dry ice vapors, smoke.

Overall Cooling Load Summary

Time	0800h	0900h	1000h	1100h	1200h	1300h	1400h	1500h	1600h	1700h	1800h	1900h	2000h
Roof Walls													
Conduction Load thru roof; kW	2.61	3.33	4.78	6.59	8.41	10.58	12.39	14.20	15.65	16.01	16.01	15.29	14.20
East Walls													
Conduction Load thru composite wall; kW	0.78	1.16	1.54	1.85	2.16	2.16	2.16	2.08	2.08	1.93	1.93	1.85	1.70
Conduction Load thru the window; kW	1.11	1.29	1.47	1.83	2.01	2.37	2.37	2.55	2.55	2.37	2.37	2.19	1.83
Fenestration Load	7.17	7.25	6.43	4.97	3.80	3.50	3.34	3.10	2.80	2.50	2.17	1.69	1.46
South Wall													
Conduction Load thru the glass window, W	17.67	20.12	20.12	25.03	32.39	42.21	49.57	56.93	61.84	64.29	64.29	61.84	59.38
North Wall													
Conduction Load thru composite wall; kW	0.73	0.82	0.82	0.91	1.00	1.18	1.27	1.36	1.54	1.63	1.72	1.72	1.72
Conduction Load thru the window; kW	3.09	3.59	4.09	5.08	5.58	6.58	6.58	7.08	7.08	6.58	6.58	6.08	5.08
Fenestration Load	3.40	3.91	4.38	4.69	5.05	5.20	5.05	4.89	4.53	4.69	5.20	2.78	2.27
Floor													
Conduction Load thru floor; kW	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792	34.63861792
Load from Occupants													
Sensible Load, kW	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Latent Load, kW	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48	1.48
Load from Lights													
Lighting Load, kW	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59	15.59
Equipments													
Equipment Cooling Load, kW	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40
Ventilation & Infiltration													
Qsensible, kW	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63	23.63
Qlatent, kW	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87	58.87
Total Cooling Load, KW	**172.05**	**176.97**	**179.13**	**186.44**	**195.88**	**209.26**	**218.20**	**227.67**	**233.55**	**235.48**	**235.75**	**228.92**	**223.13**

AIR CONDITIONING SYSTEM

- PER AREA METHOD OF AIR CONDITIONING DESIGN

- ASSUME: ONE (1) TOR FOR EVERY 15 SQ. METERS AREA
- WHERE ONE (1) TOR = 1 TON OF REFRIGERATION
- TO CALCULATE THE HP RATING OF AN AIRCONDITIONER:
- 1 TOR = 1.2HP
- HP OF AIRCON UNIT = 1 TOR X 1.2 HP/TOR

EXAMPLE OF SIZING HP OF AIRCON UNIT:

- OFFICE ROOM IS 6 MTRS LONG BY 5 METERS WIDE
- CALCULATE THE TONNAGE AND THE HP RATING OF THE AIRCON UNIT
- TOR = (6 MTRS X 5 MTRS) / 15 SQ.MTRS PER TON
- TOR = 2 TONS
- TO TAL HP = 2.4 HP
- SAY USE 1 UNIT OF 2.5 HP WINDOW TYPE ACU
- OR USE 1 UNIT OF 3-TONNER SPLIT TYPE ACU

- OFFICE ROOM IS 12 MTRS LONG BY 6 METERS WIDE
- CALCULATE THE TONNAGE AND THE HP RATING OF THE AIRCON UNITS
- TOR = (12MTRS X 6 MTRS) / 15 SQ.MTRS PER TON
- TOR = 4.8 TONS
- TO TAL HP =5.76 HP
- SAY USE 2 UNITS OF 3-TONNER SPLIT TYPE ACU

OFFICE ROOM IS 24 MTRS LONG BY 8 METERS WIDE

- CALCULATE THE TONNAGE AND THE HP RATING OF THE AIRCON UNITS
- TOR = (10.12MTRS X 6.2 MTRS) / 15 SQ.MTRS PER TON
- TOR = 4.18 TONS
- TOTAL HP = 5.02 HP
- SAY USE 2 UNITS OF 2.5 HP WINDOW TYPE ACU
- OR USE 2 UNITS OF 3-TONNER SPLIT TYPE ACU