Design Of Mechanical Systems For The New Architect Building In Palestine Polytechnic University

By

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Submitted to the College of Engineering
in partial fulfillment of the requirements for the degree of
Bachelor degree in Refrigeration & Air Conditioning Engineering

Palestine Polytechnic University

May 2015

Abstract

يهدف هذا المشروع الى تصميم الخدمات الميكانيكية للمبنى الجديد لكلية العمارة في جامعة بوليتكنك فلسطين المكونة من اربعة طوابق. وتصميم هذا المشروع يشمل عمل الحسابات وتجهيز الرسومات واختيار المواد والمعدات وحساب جدول الكميات لنظام تزويد المياه ونظام الصرف الصحي ونظام التكييف والتبريد ونظام اطفاء الحريق.

This project aims to design the mechanical systems that will serve the architect building of Palestine Polytechnic University. The project is going to provide an integrating service to that building in regard to the air conditioning, fire fighting and plumbing systems. For the air conditioning, the Variable Refrigeration Volume system (VRV) is to be used, which is the most environmental friendly because of its efficiency in eliminating both sound and environmental pollution .Besides, this system is based on the principle of Variable frequency Drive (VFD), which reduces the consumption of the electrical energy.

Regarding the fire fighting system, the pump system that provides the water with the required pressure even in the case of the absence of electricity by using jockey, electrical and diesel pumps will be used. Finally, in the plumbing system the water is provided under an adequate pressure to each fixture unit inside the building and get rid of waste water in a safe and healthy manner.

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1 Chapter 1: Introduction :

In business, industry, schools, hospitals, hotels, theaters, restaurants and homes air conditioning is no longer auxiliary but an essential part of modern living. There are four atmospheric conditions. True air conditioning implies that all four of these atmospheric conditions for human comfort are being met.

The air conditioning system include much more than the control of the inside temperature of a given space. It include the controlling and maintaining of the following four atmospheric conditions that affect the human comfort :

1. Temperature of the inside space.
2. Humidity contents of the air.
3. Purity and quality of the inside air.
4. Air velocity and air circulation within the space .

The main goal of plumping design for building is to safely and reliably provide domestic water and water for fire fitting. And also to get rid of the waste water.

1.1. Project objectives:

The main objectives of this project are:

1. To calculate and design air conditioning, heating and plumbing systems.
2. To prepare the required drawings for the relevant systems.
3. To select the required equipment and parts.
4. Design a suitable firefighting system that covers the requirements of the building.

1.2. Time tables:

Table 1:Time table for the first semester:

Task \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Choosing the building plane															
Overview previous projects															
Overall heat transfer coefficient calculations for walls, ceiling, floor, doors, and windows															
Heating and cooling loads calculations															
Water supply system calculations															
Drainage system calculations															
Printing															

Table 2: Time table for the second semester:

Task \ Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Editing and modifying	■	■													
Design the VRV system			■	■	■	■									
Design the plumbing system							■	■	■						
Design the firefighting system										■	■				
Selection and drawing the relevant systems							■	■	■	■	■	■	■		
Doing bill of quantity tables													■	■	
Printing														■	■

1.3. Project content:

Chapter one: Introduction

Includes an overview, the project objectives and time table.

Chapter two: Cooling load

Includes a sample calculation for one room in details and the other rooms loads.

Chapter three: Heating load

Includes a sample calculation for one room in details and the other rooms loads.

Chapter four: Plumbing system

Includes the calculation of water supply system to determine the total required amount of water and the drainage system.

Chapter five: Firefighting system

Includes general introduction about each system, and the pipe size calculations for one branch.

Chapter six: Bill of quantity

This chapter includes the total number of quantity for each system and its cost.

2 Chapter 2: Cooling load

The main purpose of air conditioning is to provide a comfortable atmosphere for people inside a closed space. The parameters that govern this comfort are four parameters namely air temperature, humidity, air velocity and air purity. Therefore, cooling decreases the temperature of the surrounding air, and heating increases the temperature of the surrounding air, humidifying increases the moisture content in the surrounding air, dehumidifying decreases the moisture content in the surrounding air. Ventilation renew and clean the air inside the space.

Human body temperature is normally 37°C. We are comfortable when the heat level in our body is transferring to the surrounding air at comfort rate. The rate of this heat transfer depends on the properties of surrounding air, and these properties are temperature, humidity, air velocity, and other factors like the type of clothes the human put on .Therefore, to maintain the correct rate of heat transfer, the surrounding air must be conditioned (i.e. changing the properties of the air to suitable ones).

An air conditioner is an appliance or mechanism designed to extract heat from humanly occupied space air temperature using refrigeration cycle. When air conditioning is available it may be central air conditioning where all parts of the building including common areas are cooled or it may be provided only in the specific spaces. In general comfort occurs when body temperature is held within narrow ranges, skin moisture is low and physiological effort of regulation is minimized. Comfortable conditions result from a desirable combination of air temperature, humidity, air velocity, and air purity.

2.1 Data analysis:

Calculation of outside design temperature:

$$T_{sur} = \left(0.4 \times T_{a/m}\right) + \left(0.6 \times T_{m/hottest}\right) \quad (1.1)$$

Where:

T_{sur} : Is the surrounding temperature.

$T_{a/m}$:Is the absolute maximum temperature in the recent 20 years which is 40 °C. [1]

$T_{m/hottest}$:Is the mean temperature in the hottest month in year which is 33 °C. [1]

Substitute the values in the equation (1.1) :

$T_{sur} = (0.4 \times 40) + (0.6 \times 33) = 35.8$ °C.

Calculation of unconditioned space temperature:

$$T_{un/space} = T_{in} + \left(\frac{2}{3}\right) \times (T_{sur} - T_{in}) \quad (1.2)$$

Where:

$T_{un/space}$: Is the unconditioned space temperature.

T_{in} : Is the inside temperature.

T_{sur} : Is the surrounding temperature.

Then :

$T_{un/space} = 24 + \left(\frac{2}{3}\right) \times (35.8 - 24) = 31.9$ °C .

In the following equation the outdoor mean temperature will be determined :

$$T_{o,m} = T_o - \frac{DR}{2} \qquad (1.3)$$

Where:

DR : Is the daily range temperature which equals to the difference between the average maximum and average minimum daily temperatures for the warmest month of the summer season .It is equal to 12 °C.

$T_{o,m}$: Is the outdoor mean temperature.

T_o : Is the outdoor design temperature.

Then:

$$T_{o,m} = 31.9 - \frac{12}{2} = 25.9°C$$

$$CLTD_{corr.} = (CLTD + LM)k + (25.5 - T_i) + \left(T_{o,m} - 29.4\right)f \qquad (1.4)$$

Where:

CLTD: Is called cooling load temperature difference for medium wall construction.

LM: Latitude correction factor for horizontal and vertical surfaces .

K: Colors adjustment factor such that $k = 1.0$ for dark colored roofs, and $k = 0.65$ for Permanently Light colored walls.

T_i : Is the indoor design temperature.

f : The factor f is attic or roof fan factor such that $f = 1$ if there is no attic or roof fan, and the value of $f = 0.75$ if there is an attic or roof fan.

2.1.1 Data analysis:

The following table contains all the inside and outside design conditions needed for the next calculations:

Table 3:The inside and outside design conditions:

Outdoor temperature (T_o)	35.8 °C
Indoor temperature (T_i)	24 °C
Latitude	32° North
Day of calculations	21st day of July
Color of surfaces	light-colored surface
Inside design relative humidity(ϕ_i)	50%

In the following table is the corrected CLTD for walls and roof and it is tabulated as follows :

Table 4: CLTD for walls and roof:

Wall	CLTD	LM	$CLTD_{corr}$
N	6	0.5	5.83
NE	9	0.5	7.8
E	11	0.0	8.75
SE	10	-0.5	7.8
S	8	-1.6	5.8
SW	10	-0.5	7.8
W	11	0.0	8.75
NW	8	0.5	7.13
Roof	10	0.5	8.43

2.2 Calculation of the overall heat transfer coefficient:

2.2.1 Overall heat transfer coefficient for external walls:

The construction of the external walls explained in details in the following figure:

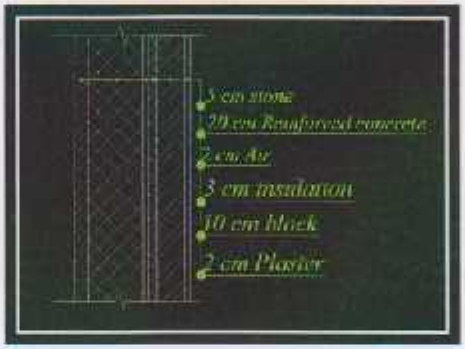


Figure 1: External wall

Table 5:External wall construction:

Material	Thickness (cm)	k (W/m.°C)
(1) Plaster	2	0.2
(2) Cement block	10	0.65
(3) Insulation	3	0.05
(4) Air	2	0.024
(5) Reinforced concrete	20	1.75
(6) Stone	5	2.25

Outside film resistance = 0.08 $m^2.^{o}C/W$. [3]
Inside film resistance =0.12 $m^2.^{o}C/W$. [3]

$$U_{ex,wall} = \frac{1}{\frac{1}{h_i} + \Sigma\frac{\Delta X}{k} + \frac{1}{h_o}} \tag{1.5}$$

Where:

$U_{ex,wall}$: Is the overall heat transfer coefficient for the external wall.

h_i : Is the inside film heat transfer coefficients.

h_o : Is the outside film heat transfer coefficients .

X : Is the thickness of wall layers.

k : Is the thermal conductivity.

Then:

$$U_{ex,wall} = \frac{1}{0.12 + \frac{0.02}{0.2} + \frac{0.1}{0.65} + \frac{0.03}{0.05} + \frac{0.02}{0.024} + \frac{0.2}{1.75} + \frac{0.05}{2.25} + 0.08}$$

$U_{ex,wall} = 0.494\ W/m^2.°C.$

2.2.2 Overall heat transfer coefficient for internal walls:

The construction of the internal walls explained in details in the following figure:

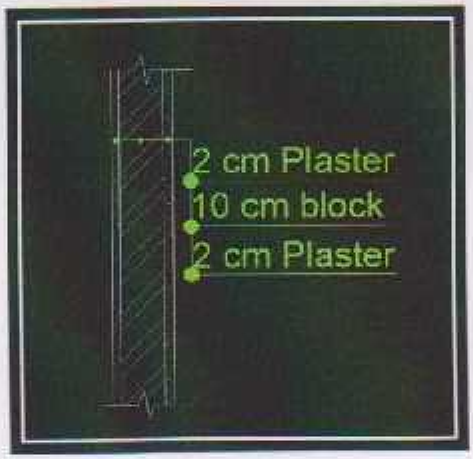


Figure 2: Internal wall

Table 6:Internal wall construction:

Material	Thickness (cm)	k (W/m.°C)
(1) Plaster	2	0.2
(2) Cement block	10	0.65
(4) Plaster	2	0.2

$$U_{in,wall} = \frac{1}{\frac{1}{h_i} + \Sigma\frac{\Delta X}{k} + \frac{1}{h_o}}$$

Then:

$$U_{in,wall} = \frac{1}{0.12 + \frac{0.02}{0.2} + \frac{0.10}{0.65} + \frac{0.02}{0.2} + 0.12}$$

$U_{in,wall} = 1.806\ W/m^2.°C$.

2.2.3 Overall heat transfer coefficient for ceiling:

The construction of ceiling described in details in the following figure:

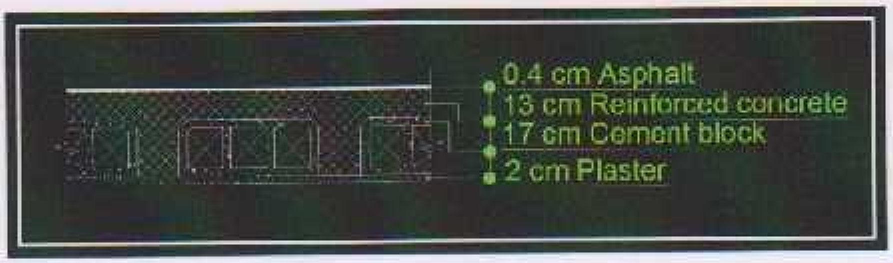


Figure 3: Ceiling construction

Table 7:Ceiling construction:

Material	Thickness (cm)	k (W/m.°C)
(1) Asphalt	0.4	0.80
(2) Reinforced Concrete	13	1.75
(3) Cement block	17	0.65
(4) Plaster	2	0.2

Outside film resistance = 0.07 m^2.°C/W .[3]
Inside film resistance =0.10 m^2.°C/W .[3]

$$U_{ceiling} = \frac{1}{\frac{1}{h_i} + \Sigma\frac{\Delta X}{k} + \frac{1}{h_o}}$$

There is two overall heat transfer coefficient for ceiling because of its construction.

The $U_{ceiling\,(1)}$:

$$U_{ceiling\,(1)} = \frac{1}{0.10 + \frac{0.004}{0.8} + \frac{0.13}{1.75} + \frac{0.17}{0.65} + \frac{0.02}{0.2} + 0.07}$$

$U_{ceiling\,(1)} = 1.637\ W/m^2.°C.$

The $U_{ceiling\,(2)}$:

$$U_{ceiling\,(2)} = \frac{1}{0.10 + \frac{0.004}{0.8} + \frac{0.30}{1.75} + \frac{0.02}{0.2} + 0.07}$$

$U_{ceiling\,(2)} = 2.240\ W/m^2.°C.$

2.2.4 Overall heat transfer coefficient for floor, doors and windows:

The doors assumed to be made from wood, and the windows assumed to be double glass Aluminum with a velocity ranges from 0.5 to 5 m/s.

* $U_{floor} = 0.9\ W/m^2.°C.$ * $U_{door} = 2.4\ W/m^2.°C.$ * $U_{window} = 3.2\ W/m^2.°C.$

2.3 Cooling load calculations:

The calculations were made for an arbitrary classroom in the third floor. In the following subsections the heat gain that comes from different resources is to be determined. And these resources are the walls, sun, occupants, infiltration, ventilation, and windows.

2.3.1 Heat gain from walls, ceiling and the sun:

The heat gain from walls, ceiling and the sun is to be determined by using the following equation:

$$Q = U \times A \times \Delta T \qquad (1.6)$$

Where:

Q : Is the heat gain through walls and ceiling.

The CLTD value is predetermined and taken from table 3, then substituting in the previous equation:

$Q = 0.48 \times 34 \times 5.8 = 95\ W.$

2.3.2 Heat gain from the solar transmitted through windows:

In the selected classroom the south wall is the only wall that exposed to the sun, and it is contain just one window. The following equation will be used to determine this heat gain:

$$Q_g = A \times (SHG) \times (SC) \times (CLF) \qquad (1.8)$$

Where:

Q_g : Is the heat gain due solar transmission through glass windows.

A : Is the area of the window.

SHG : Is the solar heat gain factor.

SC: Is the shading coefficients.

CLF : Is the cooling load factor.

Table 10:Heat gain from solar transmitted through the glass:

Surface	A (m^2)	SHG	SC	CLF
S-glass	7.2	227	0.57	0.59

Substituting in the previous equation:

$Q_g = 7.2 \times 227 \times 0.57 \times 0.59 = 485\ W.$

2.3.3 Sensible &latent heat gain from the occupants:

The heat gain from occupants depend on the number of occupants inside the classroom and on the type of activity inside this space. The following equation will use to calculate this heat gain.

$$Q_{oc} = \#\ of\ occupants \times CLF_{oc} \qquad (1.9)$$

Where:

Q_{oc} : is the heat gain from occupants.

CLF_{oc} : Is the cooling load factor for occupants, it is equal to 1 for the sensible heat and 0.64 for the latent heat. [3]

Then:

$$Q_{oc,sens} = 0.64 * 30 * \frac{70}{1000} = 1.3\ kW.$$

$$Q_{oc,latent} = 30 * \frac{30}{1000} = 0.9\ kW.$$

2.3.4 Heat gain from the lights:

There is eight lights inside this classroom, so:

$$Q_{lights} = N \times P \times CLF_{lights} \times Diversity\ factor \qquad (1.10)$$

Where:

N : Is the number of lights.

P : Is the power for the chose lights.

CLF_{lights} : Is the cooling load factor for the lights, and it is equal, $CLF_{lights} = 0.66$.

then:

$$Q_{lights} = 8 \times 60 \times 0.66 \times 0.4 = 0.127\ kW$$

2.3.5 Heat gain due to infiltration:

Infiltration is the leakage of the outside air through cracks or clearances around the windows and doors. The air change method used to calculate it as follow:

$$\dot{V}_{inf} = \text{No. Of ACH / h} \times \text{Room volume} \quad (1.11)$$

Where:

$\dot{V}_{inf}$: Is the volumetric flow rate due to infiltration.

No. of ACH/h : Is the number of air changed per hour.

Then:

$\dot{V}_{inf} = 2\times (3\times7.7\times6) = 277.2\ m^3/h$

$$\dot{m}_{inf} = \frac{\dot{V}_{inf}}{v_o} \quad (1.12)$$

Where:

$\dot{m}_{inf}$: Is the mass flow rate of air due to infiltration.

$\dot{V}_{inf}$: Is the volumetric flow rate of air due to infiltration.

v_o : Is the specific volume at outside condition.

Then:

$$\dot{m}_f = \frac{0.09}{0.86} = 0.105\ \text{kg/s}.$$

$$\dot{Q}_{infiltration} = \dot{m}_{inf} \times (h_o - h_i) \quad (1.13)$$

Where:

$\dot{Q}_{infiltration}$: Is the heat gain due to infiltration.

$\dot{m}_{inf}$: Is the mass flow rate of air due to infiltration.

Δh: Is the difference between the inlet and outlet enthalpy .

Then:

$$\dot{Q}_{infiltration} = 0.09 \times 1000 \times (63 - 48) = 1.35\ kW$$

2.3.6 Heat gain due to ventilation:

The ventilation is used for maintaining a healthy indoor air by introducing a fresh air from outside of the building. And this kind of heat gain can be calculated by using the following equations:

$$\dot{V}_v = \text{min. outside air requirements for mech. ventilation} \times \text{No.of persosn} \qquad (1.14)$$

Where:

$\dot{V}_v$: Is the volumetric flow rate due to ventilation.

Then:

$$\dot{V}_v = 3 \times 30 = 0.09\, m^3/s.$$

$$\dot{m}_v = \frac{\dot{V}_v}{v_o} \qquad (1.15)$$

Where:

$\dot{m}_v$: Is the mass flow rate of air due to ventilation.

$\dot{V}_v$: Is the volumetric flow rate of air due to ventilation.

v_o : Is the specific volume at outside condition.

Then:

$$\dot{m}_f = \frac{0.09}{0.86} = 0.105\ \text{kg/s}.$$

$$\dot{Q}_{ventilation} = \dot{m}_v \times (h_o - h_i) \qquad (1.16)$$

Where:

$\dot{Q}_{ventilation}$: Is the heat gain due to ventilation.

$\dot{m}_v$: Is the mass flow rate of air due to ventilation.

Δh: Is the difference between the inlet and outlet enthalpy .

Then:

$$\dot{Q}_{ventilation} = 0.105 \times 1000 \times (63 - 48) = 1.575 \text{ kW} .$$

The total load for this classroom without factor of safety is the summation of all the heat gain resources , then $\dot{Q}_{total} = 7.34$ kW .

Finally , the total load is the summation of all heat gain resources multiplying by a 15% factor of safety as follows:

$\dot{Q}_{total} = 7.34 \times 1.15 = 8.44\ kW$.

Table 11: The cooling load and the area for ground and first floor classrooms:

Ground floor			First floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(G_01)	98	17.5	**(F_01)**	98	13.5
(G_02)	70	11.5	**(F_02)**	70	10
(G_03)	68	11	**(F_03)**	68	9.6
(G_04)	162	25	**(F_04)**	162	22
(G_05)	92	15	**(F_05)**	92	12
(G_06)	95	17	**(F_06)**	95	12.9
(G_07)	90	12.5	**(F_07)**	90	10.8
(G_08)	92	15	**(F_08)**	92	12
(G_09)	44	7	**(F_09)**	44	5.4
(G_10)	34	5.5	**(F_10)**	34	4.6
(G_11)	34	5.5	**(F_11)**	34	4.6
(G_12)	44	7	**(F_12)**	44	5.4
(G_13)	44	7	**(F_13)**	44	5.4
(G_14)	90	12.5	**(F_14)**	34	4.6
(G_15)	44	7	**(F_15)**	34	4.6
(G_16)	10.7	2	**(F_16)**	44	5.4
(G_17)	183	32	**(F_17)**	36	5
			(F_18)	217	33.8
$Q_{total\ G.F}$		**210**	$Q_{total\ F.F}$		**181.6**

Table 12: The cooling load and the area for second and third floor classrooms:

Second floor			Third floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(S_01)	44	5.4	**(T_01)**	44	7
(S_02)	46	5.7	**(T_02)**	46	8.44
(S_03)	46	5.7	**(T_03)**	46	8.44
(S_04)	46	5.7	**(T_04)**	46	8.44
(S_05)	92	12	**(T_05)**	92	17
(S_06)	95	12.9	**(T_06)**	95	19.4
(S_07)	90	10.8	**(T_07)**	90	15.2
(S_08)	92	12	**(T_08)**	92	17
(S_09)	44	5.4	**(T_09)**	44	7
(S_10)	92	12	**(T_10)**	92	17
(S_11)	44	5.4	**(T_11)**	44	7
(S_12)	44	5.4	**(T_12)**	44	7
(S_13)	34	4.6	**(T_13)**	34	5.8
(S_14)	34	4.6	**(T_14)**	34	5.8
(S_15)	44	5.4	**(T_15)**	44	7
(S_16)	36	5			
(S_17)	217	33.8			
$Q_{total\ G.F}$		**151.8**	$Q_{total\ F.F}$		**157.52**

Table 11: The cooling load and the area for ground and first floor classrooms:

Ground floor			First floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(G_01)	98	17.5	**(F_01)**	98	13.5
(G_02)	70	11.5	**(F_02)**	70	10
(G_03)	68	11	**(F_03)**	68	9.6
(G_04)	162	25	**(F_04)**	162	22
(G_05)	92	15	**(F_05)**	92	12
(G_06)	95	17	**(F_06)**	95	12.9
(G_07)	90	12.5	**(F_07)**	90	10.8
(G_08)	92	15	**(F_08)**	92	12
(G_09)	44	7	**(F_09)**	44	5.4
(G_10)	34	5.5	**(F_10)**	34	4.6
(G_11)	34	5.5	**(F_11)**	34	4.6
(G_12)	44	7	**(F_12)**	44	5.4
(G_13)	44	7	**(F_13)**	44	5.4
(G_14)	90	12.5	**(F_14)**	34	4.6
(G_15)	44	7	**(F_15)**	34	4.6
(G_16)	10.7	2	**(F_16)**	44	5.4
(G_17)	183	32	**(F_17)**	36	5
			(F_18)	217	33.8
$Q_{total\ G.F}$		**210**	$Q_{total\ F.F}$		**181.6**

Table 12: The cooling load and the area for second and third floor classrooms:

Second floor			Third floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(S_01)	44	5.4	**(T_01)**	44	7
(S_02)	46	5.7	**(T_02)**	46	8.44
(S_03)	46	5.7	**(T_03)**	46	8.44
(S_04)	46	5.7	**(T_04)**	46	8.44
(S_05)	92	12	**(T_05)**	92	17
(S_06)	95	12.9	**(T_06)**	95	19.4
(S_07)	90	10.8	**(T_07)**	90	15.2
(S_08)	92	12	**(T_08)**	92	17
(S_09)	44	5.4	**(T_09)**	44	7
(S_10)	92	12	**(T_10)**	92	17
(S_11)	44	5.4	**(T_11)**	44	7
(S_12)	44	5.4	**(T_12)**	44	7
(S_13)	34	4.6	**(T_13)**	34	5.8
(S_14)	34	4.6	**(T_14)**	34	5.8
(S_15)	44	5.4	**(T_15)**	44	7
(S_16)	36	5			
(S_17)	217	33.8			
$Q_{total\ G.F}$		**151.8**	$Q_{total\ F.F}$		**157.52**

3 Chapter 3: Heating load

3.1 Outdoor and indoor design conditions:

These conditions include the dry bulb temperature, relative humidity, and the average air speed. These values were obtained from the Palestinian code and the psychometric chart.

Table 13: Outdoor design conditions:

Season	T_{out} (°C)	$\square_{out}$%	v_{out} $(m^3/kg\ dry\ air)$	h_{out} (kJ/kg)
Heating	5	65	0.78	14

Table 14:Indoor design conditions:

Season	T_{in} (°C)	$\square_{in}$%	h_{in} (kJ/kg)
Heating	24	50	48

3.2 Heat loss calculations:

The main resources of heat loss comes from the walls, floor, ceiling, doors, windows and also it comes from the infiltration and ventilation. To calculate each one of them the following equations are to be us:

$$\dot{Q} = A \times U \times (T_i - T_o) \tag{2.1}$$

Where:

$\dot{Q}$: Is the heat transfer rate.

A : Is the area of the layer which heat flow through it.

ΔT: Is the difference between the inside and outside temperatures .

U: Is the overall heat transfer coefficient.

3 Chapter 3: Heating load

3.1 Outdoor and indoor design conditions:

These conditions include the dry bulb temperature, relative humidity, and the average air speed. These values were obtained from the Palestinian code and the psychometric chart.

Table 13: Outdoor design conditions:

Season	T_{out} (°C)	$\square_{out}$%	v_{out} $(m^3/kg\ dry\ air)$	h_{out} (kJ/kg)
Heating	5	65	0.78	14

Table 14:Indoor design conditions:

Season	T_{in} (°C)	$\square_{in}$%	h_{in} (kJ/kg)
Heating	24	50	48

3.2 Heat loss calculations:

The main resources of heat loss comes from the walls, floor, ceiling, doors, windows and also if comes from the infiltration and ventilation. To calculate each one of them the following equations are to be us:

$$\dot{Q} = A \times U \times (T_i - T_o) \qquad (2.1)$$

Where:

$\dot{Q}$:Is the heat transfer rate.

A : Is the area of the layer which heat flow through it.

ΔT: Is the difference between the inside and outside temperatures .

U: Is the overall heat transfer coefficient.

3.2.1 Rate of heat transfer from the external walls:

The construction of the external walls From Table 5:External wall construction: and Figure 1: External wall is known, then by using the equation (2.1), we can determine the rate of heat transfer for the classroom (T-08) as follow:

$$Q_{ex.wall} = U_{ex.wall} \times A_{ex.wall} \times (T_{in} - T_{sur})$$

$$Q_{ex.wall} = 0.494 \times 34 \times (24 - 5) = 0.319 \text{ kW}.$$

3.2.2 Rate of heat transfer from the internal walls:

From Table 6 and Figure 2 we know the construction of the internal walls, then by using the equation (2.1), we can determine the rate of heat transfer for the classroom (T-08) from these walls as follow:

$$Q_{in.walls} = U_{in,walls} \times A_{in,walls} \times (T_{in} - T_{unR./space})$$

$$Q_{in.wall} = 1.806 \times 20.1 \times (24 - 20) = 0.145 \text{ kW}.$$

3.2.3 Rate of heat transfer from the ceiling:

From Table 7 and Figure 3 we know the construction of the ceiling, then by using the equation (2.1), we can determine the rate of heat transfer for the classroom (T-08) from the ceiling as follow:

$$Q_{ceiling} = Q_{ceiling(1)} + Q_{ceiling(2)}$$

Then:

$$Q_{ceiling(1)} = U_{ceiling(1)} \times A_{ceiling(1)} \times (T_{in} - T_{sur.})$$

$$Q_{ceiling(1)} = 1.637 \times 36.96 \times (24 - 5) = 1.149 \text{ kW}.$$

$Q_{ceiling(2)} = U_{ceiling(2)} \times A_{ceiling(2)} \times (T_{in} - T_{sur.})$

$Q_{ceiling(2)} = 2.24 \times 9.24 \times (24 - 5) = 0.393$ kW.

Then:

$Q_{ceiling} = 1.149 + 0.393 = 1.542$ kW.

3.2.4 Rate of heat transfer from the doors and windows:

By using the equation (2.1), the rate of heat transfer for the classroom (T-08) is determined from the doors and windows as follow:

windows:

$$Q_{window} = U_{window} \times A_{window} \times (T_{in} - T_{sur.}) .$$

The double glass Aluminum window was used with velocity ranges from 0.5 to 5 m/s, and $U_{window} = 3.2\ \ W/m^2.°C.$

$$Q_{window} = 3.2 \times 7.2 \times (24 - 5) = 0.437\ kW.$$

Doors:

$$Q_{door} = U_{door} \times A_{door} \times (T_{in} - T_{unit/space.}) .$$

The wood door with $U_{door} = 2.4\ \ W/m^2.°C$ is used.

$$Q_{door} = 2.4 \times 3 \times (24 - 20) = 0.0288 \text{ kW}.$$

3.2.5 Heat loss due to infiltration:

Infiltration is the leakage of the outside air through cracks or clearances around the windows and doors. The air change method was used to calculate it by using the equations 1-11, 1-12 and 1-13.

$\dot{V}_{inf} = 2\times(3\times7.7\times6) = 277.2\ m^3/h.$

$\dot{V}_{inf} = 0.077 m^3/s.$

$\dot{m}_{inf} = \frac{0.077}{0.78} = 0.099\ kg/s.$

$\dot{Q}_{infiltration} = 0.099 \times 1000 \times (48 - 14) = 3.366\ kW.$

3.2.6 Heat loss due to ventilation:

The ventilation is used for maintaining a healthy indoor air by introducing a fresh air from outside of the building. And the heat loss because of it can be calculated by using the equations 1-14, 1-15 and 1-16 as follow:

$\dot{V}_v = 3 \times 30 = 0.09\ m^3/s.$

$\dot{m}_v = \frac{0.09}{0.78} = 0.115 \frac{kg}{s}.$

$\dot{Q}_{ventilation} = 0.115 \times 1000 \times (48 - 14) = 3.91\ kW.$

The total load for this classroom without factor of safety is the summation of all the heat loss resources , then $\dot{Q}_{total} = 6.47\ kW$.

Finally , the total load is the summation of all heat gain resources multiplying by a 15% factor of safety as follows:

$\dot{Q}_{total} = 6.47 \times 1.15 = 7.44\ kW.$

Table 15: The heating load and the area for ground and first floor classrooms:

Ground floor			First floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(G_01)	98	16	(F_01)	98	12.5
(G_02)	70	10	(F_02)	70	9.3
(G_03)	68	9.6	(F_03)	68	8.6
(G_04)	162	22	(F_04)	162	20
(G_05)	92	13	(F_05)	92	10.5
(G_06)	95	15	(F_06)	95	11.9
(G_07)	90	11.5	(F_07)	90	9.8
(G_08)	92	13	(F_08)	92	10.5
(G_09)	44	5.5	(F_09)	44	4.4
(G_10)	34	3.6	(F_10)	34	3.5
(G_11)	34	3.6	(F_11)	34	3.5
(G_12)	44	5.5	(F_12)	44	4.4
(G_13)	44	5.5	(F_13)	44	4.4
(G_14)	90	11.5	(F_14)	34	3.5
(G_15)	44	5.5	(F_15)	34	3.5
(G_16)	10.7	1.5	(F_16)	44	4.4
(G_17)	183	28.8	(F_17)	36	3.8
			(F_18)	217	31.6
$Q_{total\ G.F}$		**181.1**	$Q_{total\ F.F}$		**160.1**

Table 16: The heating load and the area for second and third floor classrooms:

Second floor			Third floor		
Room #	Area (M^2)	$\dot{Q}_{total}$(kW)	Room #	Area (M^2)	$\dot{Q}_{total}$(kW)
(S_01)	44	4.4	(T_01)	44	6
(S_02)	46	4.7	(T_02)	46	7.44
(S_03)	46	4.7	(T_03)	46	7.44
(S_04)	46	4.7	(T_04)	46	7.44
(S_05)	92	10.5	(T_05)	92	16
(S_06)	95	11.9	(T_06)	95	18.4
(S_07)	90	9.8	(T_07)	90	14.2
(S_08)	92	10.5	(T_08)	92	16
(S_09)	44	4.4	(T_09)	44	6
(S_10)	92	10.5	(T_10)	92	16
(S_11)	44	4.4	(T_11)	44	6
(S_12)	44	4.4	(T_12)	44	6
(S_13)	34	3.5	(T_13)	34	4.8
(S_14)	34	3.5	(T_14)	34	4.8
(S_15)	44	4.4	(T_15)	44	6
(S_16)	36	3.8			
(S_17)	217	31.6			
$Q_{total\ G.F}$		131.7	$Q_{total\ F.F}$		**142.52**

3.3 The VRF system and its calculations:

3.3.1 VRF system:

The primary function of all air-conditioning systems is to provide thermal comfort for building occupants. There are a wide range of air conditioning systems available, starting from the basic window-fitted units to the small split systems, to the medium scale package units, to the large chilled water systems, and currently to the variable refrigerant flow (VRF) systems.

Variable refrigerant flow (VRF) is an air-condition system configuration where there is one outdoor condensing unit and multiple indoor units. The term variable refrigerant flow refers to the ability of the system to control the amount of refrigerant flowing to the multiple evaporators (indoor units), enabling the use of many evaporators of differing capacities and configurations connected to a single condensing unit. The arrangement provides an individualized comfort control, and simultaneous heating and cooling in different zones.

The term VRF refers to the ability of the system to control the amount of refrigerant flowing to each of the evaporators, enabling the use of many evaporators of differing capacities and configurations, individualized comfort control, simultaneous heating and cooling in different zones, and heat recovery from one zone to another. VRF systems operate on the direct expansion (DX) principle meaning that heat is transferred to or from the space directly by circulating refrigerant to evaporators located near or within the conditioned space. Refrigerant flow control is the key to many advantages as well as the major technical challenge of VRF systems.

3.3.2 The VRF calculations:

After the heating and cooling loads are calculated for all rooms in the building, the risers and the indoor units are distributed inside the building to deliver the required amount of refrigerant with the minimum pipe length, as follows in the next sub sections.

3.3.2.1 Total load calculations:

Rooms are carried to riser 1:

[T(0-1)+ T(0-2)+ T(0-3)+ T(0-4) +S(0-1) +S(0-2) +S(0-3) +S(0-4)+ F(0-1)+ F(0-2)+ F(0-3)+ G(0-1)+ G(0-2)+ G(0-3)]

The total load of indoor units that carried to riser 1:

$Total\ load = \sum load\ for\ each\ room$

$$Total\ load = 7 + 8.44 + 8.44 + 8.44 + 5.4 + 5.7 + 5.7 + 5.7 + 13.5 + 10 + 9.6 + 17.5 + 11.5 + 11 = 127.92\ kw$$

Related to the calculated load the outdoor unit model is chose from Samsung VRF catalog with model name (DVMS AM520FXVAGH), this outdoor unit has a capacity equal to 145.6 kW (note that the chosen unit has a capacity more than the load to be in the safety side).

The four way cassette indoor unit is chose . For example, room number (T(0-1)) has a 7kw load, the load for this room is divided to 2 indoor units, then these indoor units are selected from the catalog with a capacity equal to 3.6 kW.

3.3.2.2 Pipe sizing:

In this step the pipe size will be calculated manually and then check by using Samsung program (DVMS-PRO PROGRAM).

Continuing with riser 1, according to the catalog and outdoor unit the diameter of liquid line for the riser equal to 3/4" . Then we used the refrigerant piping works and technical data sheet from Samsung to calculate the size of all pipes for each branch.

First branch it is called branch B, from the loads that carried to this branch the diameter is determined from table B in refrigerant piping works to be 1/2" .

Finally, table C is used to calculate the size of the last branch before the indoor unit, and it is determined for room T(0-1) to be 1/4".

4 Chapter 4: Plumping system

4.1 Water supply system:

4.1.1 Fixture unit load calculations:

In this section the total amount of water that required for the building is to be calculated. By using the water supply fixture unit technique. This technique used because there are a great number of fixture units and that's make this technique more accurate.

4.1.1.1 Fixture unit load for the first riser:

Table 17:Fixture units for the first riser:

Floor \ Fixture type	General water closet	General lavatory
Ground floor	8	6
First floor	8	6
Second floor	8	6
Third floor	8	6
Total	32	24

Table 18:The fixture units load:

Fixture Type	No. of Fixture unit	Load per Fixture unit	Total load
Water closet General	32	10	320
Lavatory General	24	2	48

4.1.1.2 Fixture unit load for the second riser:

Table 19:Fixture units for the second riser:

Floor \ Fixture type	Kitchen sink
Ground floor	3
First floor	0
Second floor	0
Third floor	0
Total	3

Table 20:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Kitchen Sink	3	4	12

4.1.1.3 Fixture unit load for the third riser:

Table 21:Fixture units for the third riser:

Floor \ Fixture type	General water closet	General lavatory
Ground floor	6	4
First floor	6	4
Second floor	4	4
Third floor	4	4
Total	20	16

Table 22:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Water closet General	20	10	200
Lavatory General	16	2	32

4.1.1.4 Fixture unit load for the fourth riser:

Table 23:Fixture units for the second riser:

Floor \ Fixture type	Kitchen sink
Ground floor	1
First floor	1
Second floor	1
Third floor	1
Total	4

Table 24:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Kitchen Sink	4	4	16

Table 20:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Kitchen Sink	3	4	12

4.1.1.3 Fixture unit load for the third riser:

Table 21:Fixture units for the third riser:

Fixture type / Floor	General water closet	General lavatory
Ground floor	6	4
First floor	6	4
Second floor	4	4
Third floor	4	4
Total	20	16

Table 22:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Water closet General	20	10	200
Lavatory General	16	2	32

4.1.1.4 Fixture unit load for the fourth riser:

Table 23:Fixture units for the second riser:

Fixture type / Floor	Kitchen sink
Ground floor	1
First floor	1
Second floor	1
Third floor	1
Total	4

Table 24:The fixture units load:

Fixture Type	#No. of Fixture	Load per Fixture	Total load
Kitchen Sink	4	4	16

Table 25 : The pipe sizing for cold and hot water:

Pipe section	Flow (gpm)	Equivalent length (ft)	Pipe size (in)	Friction (psi/100ft)	Velocity (fps)	Section friction (psi)	Cumulative friction (psi)
Service to hot water tap	158	15	2"	0.87	2.6	0.131	0.131
Hot water tap to collector	96.4	130	1 1/2"	1	3	1.3	1.431
Collector to general lavatory	27	136.4	3/4"	1.2	3.2	1.64	3.1

4.2 Drainage system:

The wastewater system should be designed, constructed, and maintained to guard against fouling, deposit of solids, and clogging. And the foul air in the wastewater system should be exhausted to the outside, through vent pipes.

The calculations were made by using the table of drainage fixture unit values for various plumbing fixture units to find the amount of drainage fixture unit. Then we use the table of horizontal fixture branch and stuck to determine the diameters of the pipes.

Table 26:Sizing of stack 1:

Stack 1	Total dfu value	Diameter (inch)
From ground floor **(branch)**	6	2
From ground floor to building drain **(stack)**	6	4

Table 27:Sizing of stack 2:

Stack 2	Total dfu value	Diameter (inch)
From third floor **(branch)**	14	4
From third to second floor **(stack)**	14	4
From second floor **(branch)**	14	4
From second floor to first floor **(stack)**	28	4
From first floor **(branch)**	20	4
From first floor to ground floor **(stack)**	48	4
From ground floor **(branch)**	20	4
From ground floor to building drain **(stack)**	68	4

Table 28:Sizing of stack 3:

Stack 3	Total dfu value	Diameter (inch)
From third floor **(branch)**	14	4
From third to second floor **(stack)**	14	4
From second floor **(branch)**	14	4
From second floor to first floor **(stack)**	28	4
From first floor **(branch)**	20	4
from first floor to ground floor **(stack)**	48	4
From ground floor **(branch)**	20	4
from ground floor to building drain **(stack)**	68	4

Table 29:Sizing stack 4:

Stack 4	Total dfu value	Diameter (inch)
From third floor **(branch)**	2	2
From third to second floor **(stack)**	2	4
From second floor **(branch)**	2	2
From second floor to first floor **(stack)**	4	4
From first floor **(branch)**	2	2
from first floor to ground floor **(stack)**	6	4
From ground floor **(branch)**	2	2
from ground floor to building drain **(stack)**	8	4

Table 30:Sizing of stack 5:

Stack 5	Total dfu value	Diameter (inch)
From third floor**(branch)**	27	4
From third to second floor**(stack)**	27	4
From second floor**(branch)**	27	4
From second floor to first floor**(stack)**	54	4
From first floor**(branch)**	27	4
from first floor to ground floor**(stack)**	81	4
From ground floor**(branch)**	27	4
from ground floor to building drain**(stack)**	108	4

Table 31:Sizing of stack 6:

Stack 6	Total dfu value	Diameter (inch)
From third floor **(branch)**	27	4
From third to second floor **(stack)**	27	4
From second floor **(branch)**	27	4
From second floor to first floor **(stack)**	54	4
From first floor **(branch)**	27	4
from first floor to ground floor **(stack)**	81	4
From ground floor **(branch)**	27	4
from ground floor to building drain **(stack)**	108	4

Table 32:Building drain:

Branch of building drain from stack	Total dfu value from stacks	Diameter of building drain (inch)	Slope %	Velocity ft/s
Building drain from stack 1	6	4	¼	2.73
Building drain from stack 2	68	4	¼	2.73
Building drain from stack 3	68	4	¼	2.73
Building drain from stack 4	8	4	¼	1.72
Building drain from stack 5	108	4	¼	2.73
Building drain from stack 6	108	4	¼	2.73

4.2.1 Ventilation:

To calculate the vent for the bathroom (T-06), the volume of the bathroom shall be calculated by using the following equation:

$$V_{vent} = room\ volume \times\ No.of\ Air\ change/h$$

$V_{vent} = Area \times height \times No.of\ Air\ change/h$

Then:

$V_{vent} = 5.2 \times 3 \times 8 = 125\ m^3/h.$

$V_{vent} = \frac{125\times2.12}{3.6} = 75.7\ cfm.$

Then the duct will be dimensioned by using the duct sizer program.

5 Chapter 5: Firefighting system

Cultural property management is entrusted with the responsibility of protecting and preserving an institution's buildings, collections, operations and occupants. Constant attention is required to minimize adverse impact due to climate, pollution, theft, vandalism, insects, mold and fire. Because of the speed and totality of the destructive forces of fire, it constitutes one of the more serious threats. Vandalized or environmentally damaged structures can be repaired and stolen objects recovered. Items destroyed by fire, however, are gone forever. An uncontrolled fire can obliterate an entire room's contents within a few minutes and completely burn out a building in a couple hours.

The first step toward halting a fire is to properly identify the incident, raise the occupant alarm, and then notify emergency response professionals. This is often the function of the fire detection and alarm system. Several system types and options are available, depending on the specific characteristics of the protected space.

Fire fighting systems and equipment vary depending on the age, size, use and type of building construction. A building may contain some or all of the following features:

- Fire extinguishers.
- Fire hose reels.
- Fire hydrant systems.
- Automatic sprinkler systems.

In the following sections each feature is to be described.

5.1 Fire extinguisher:

Fire extinguishers are provided for a 'first attack' fire fighting measure generally undertaken by the occupants of the building before the fire service arrive. It is important that occupants are familiar with which extinguisher type to use on which fire. Most fires start as a small fire and may be extinguished if the correct type and amount of extinguishing agent is applied whilst the fire is small and controllable.

The following table shows the principle use for different extinguishing agent :

Figure 4: Fire extinguisher rating guide:

ID sign	Typical appearance	Extinguisher Type cylinder contains	**Class A** Wood, paper, textiles etc, normal combustibles	**Class B** Flammable liquids, petrol, paints	**Class E** Electrical fires	**Class F** Cooking oil, animal fats & vegetable oils
		Dry Chemical Powder	YES	YES	YES	NO
		Co2 Carbon Dioxide	NO	YES	YES	NO
		Water	YES	NO	NO	NO
		Foam	YES	YES	NO	NO
		Wet Chemical	YES	NO	NO	YES

Fire extinguisher locations must be clearly identified. Extinguishers are color coded according to the extinguishing agent. It is the policy of the Community Safety Department that fire extinguishers be logically grouped at exits from the building, so that occupants first go to the exit and then return to fight the fire, knowing that a safe exit lies behind them, away from the fire. In some instances this will be at odds with the prescriptive requirements of Australian Standard AS2444 Portable fire extinguishers and fire blankets - Selection and location which simply specifies a distance of travel to a fire extinguisher rather than their location in relation to escape paths.

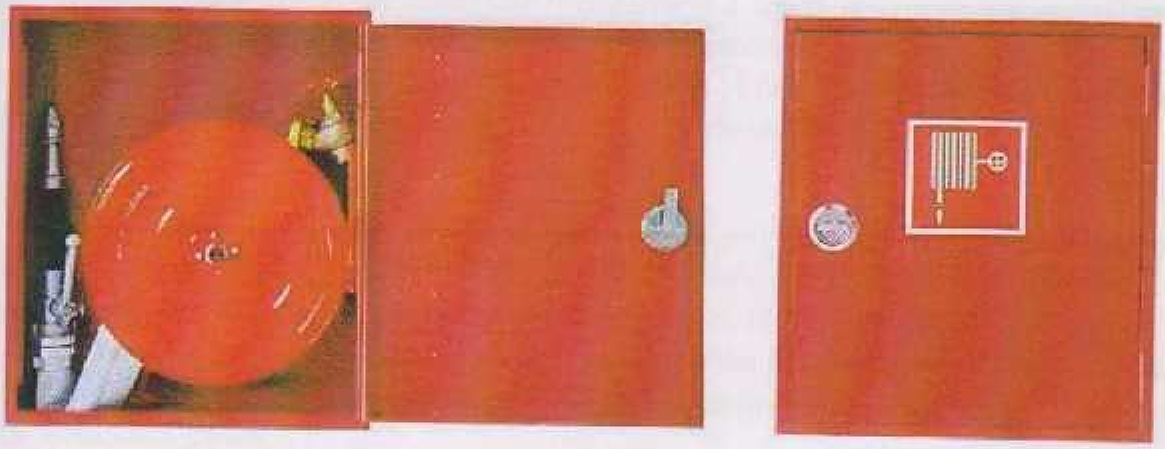
5.2 Fire hose reel:

Fire hose reels are provided for use by occupants as a 'first attack' firefighting measure but may in some instances be used by firefighters.

When stowing a fire hose reel, it is important to first attach the nozzle end to the hose reel valve, then close the hose reel valve, then open the nozzle to relieve any pressure in the wound hose, then close the nozzle. When the hose reel is next used, the operator will be forced to turn on the isolating valve, thus charging the hose reel with pressurized water supply, before being able to drag the hose to the fire. A potential danger exists if the operator reaches the fire and finds no water is available because the hose reel valve is still closed.

Because hose reels are generally located next to an exit, in an emergency it is possible to reach a safe place simply by following the hose.

Figure 5: Fire cabinet and hose reel:



5.3 Fire hydrant system:

Fire hydrant systems are installed in buildings to help firefighters quickly attack the fire. Essentially, a hydrant system is a water reticulation system used to transport water in order to limit the amount of hose that firefighters have to lay; thus speeding up the fire fighting process.

Fire hydrants are for the sole use of trained firefighters (which includes factory firefighting teams). Because of the high pressures available serious injury can occur if untrained persons attempt to operate the equipment connected to such installations.

Fire hydrant systems sometimes include ancillary parts essential to their effective operation such as pumps, tanks and fire service booster connections. These systems must be maintained and regularly tested if they are to be effective when needed.

5.4 Automatic sprinkler system:

Time is essential in the control of fire. Automatic sprinkler systems are one of the most reliable methods available for controlling fires. Today's automatic fire sprinkler systems offer state of the art protection of life and property from the effects of fire. Sprinkler heads are now available which are twenty times more sensitive to fire than they were ten years ago.

A sprinkler head is really an automatic (open once only) tap. The sprinkler head is connected to a pressurized water system. When the fire heats up the sprinkler head, it opens at a preset temperature, thus allowing pressurized water to be sprayed both down onto the fire and also up to cool the hot smoky layer and the building structure above the fire. This spray also wets combustible material in the vicinity of the fire, making it difficult to ignite, thereby slowing down or preventing fire spread and growth.

When a sprinkler head operates, the water pressure in the system drops, activating an alarm which often automatically calls the fire brigade via a telephone connection.

5.5 Pipe size calculation:

The fire hose reel system is to be used, so the pipe size for this system will be calculated as follows:

The minimum flow rate for single cabinet = 23 (l/min) . [2]

Then:

The total flow rate = min. flow rate × No. of cabinet

The total flow rate = 23 × 20 = 460 l/min

Table 33:Pipe schedule - standpipes and supply piping

Total Accumulated Flow		Total Distance of Piping from Farthest Outlet		
L/min	gpm	<15.2 m (<50 ft)	15.2–30.5 m (50–100 ft)	>30.5 m (>100 ft)
379	100	2	2½	3
382–1893	101–500	4	4	6
1896–2839	501–750	5	5	6
2843–4731	751–1250	6	6	6
4735	1251 and over	8	8	8

Note: For SI units, 3.785 L/min = 1 gpm; 0.3048 m = 1 ft.

Then the Table 33 is to be used to calculate the pipe size by follow the next procedure. First, the total flow rate is determined which is 460 l/min for our calculation sample. Then the total distance of piping from farthest outlet is to be chose. Finally, the intersection between the two values in Table 33 will give the size of pipe supply which is equal to 4".

Then to determine the outlet pipe size from pipe supply to hose connection the class of the building must be chose from the NFPA. For this building the class is chose to be class II. A class II referred to NFPA means: standpipe system provides (1½-in.) hose stations to supply water for use primarily by the building occupants or by the fire department during initial response. According to the NFPA 14 the pressure required for the (1½-in.) pipes is 6.9 bar.

6 Chapter 6: Bills of quantity:

Table 34:Bills of quantities for the new architect building in Palestine Polytechnic University

PLUMBING, SANITARY AND MECHANICAL WORKS					
BILL No. (1/01)	PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)				
No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	Preamble. Water Tanks, Sanitary Fixtures and sanitary fixture accessories shall all be measured per piece and paid for according to their unit rates. All pipes, whether domestic and fire fighting GI pipes, supply Pex. pipes, sewage drainage UPVC pipes from sanitary fixture to the final disposing point (including vent and stack pipes), storm water UPVC drain pipes, CPVC condensate pipes, or cooking gas copper tubes shall be measured at actual and paid for in linear meters according to the corresponding bill item. Floor drains and traps, roof drains, as well as, clean-outs, and the like, shall be measured per piece and paid for accordingly and in line with the corresponding unit rate. Manholes, gullies and the like shall be measured in numbers. Rates of all fitting, fixtures appliances, and pipe laying shall include supply of material; workmanship; installation; testing; adjusting; balancing and commissioning. Rates to include also all pieces and fittings including by-passes, floats, automatic vents, vent and stack mesh covers, and non-return valves, all needed to complete the works according to specifications and Engineer's satisfaction. This shall also bedding, backfilling and benching and all works connected with pipe laying: all ties, sleeves, joint, tie bolts and rods, hangers and brackets, and the like. All rates to include workshop drawings, coordinated sketches and as-built drawings, all pre-approved by the Engineer.				
12.1	Supply and Install porcelain wall mounted W.C white color European type or E.A. Price shall include all fixation and hanging bracket, 8-LT Capacity .(concealed) cistern ,valves ,fitting, hard solid seat and 13mm stop angle valve , chrome plated 13mm hose , and accessories , side 1 m length 13mm chrome plated hand shower for W.C (heavy duty) with spring nozzle outlet and all other required materials, including connection to drainage system and water system including 3/8" angle valve (European type or E.A) and paper holder. All to be done as per drawings, specifications and the approval of the Engineers.	NO.	37	٦٠٠	٢٢,٢٠٠
	Total for this page				٢٢,٢٠٠

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				22,200
12.2	Supply and install porcelain wall hung semi pedestal wash basin European type class A, size (45* 55) cm. Complete with all fittings, valves, waste pipes to nearest floor trap, taps (mixers) (Class A and approved by Palestine Standards Institution), connection to water distribution, traps, with soap holder and any other necessary parts as Specification and as directed by Eng. Price including supplying and installing 40*60cm Aluminum framed mirror.	NO.	40	400	١٦,٠٠٠
12.3	Supply and Install White Vitreous European Sink (30 cm. Deep) double bowl. (Class A and approved by Palestine Standards Institution). Complete with all necessary valves, Goose neck taps (mixer) (Class A and approved by Palestine Standards Institution), connection to water distribution, fittings, anti-chemical waste siphon, and any other necessary parts and accessories to complete works per specifications and as directed by Engineer.	NO.	7	450	٣,١٥٠
	Total for this page				19,150
	TOTAL CARRIED TO NEXT PAGE				41,150

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				41,150
12.4	a. Supply and Install 4" PVC Floor Trap. "With Quality approval Tag" Price to include siphon to be fixed in reinforced concrete, (20*20) cm double Chrome plated cover one grated and one-closed, the connection with 2" pipe) And all other fittings needed to comply with specifications and as directed by Engineer.	NO.	29	80	٢,٣٢٠

12.5	Supply and Install (Clean Out) UPVC 4'', of Drainage Network. "With Quality approval Tags" In size and location shown in the drawings and where necessary, including all needed to complete work as specification and directed by Eng.	NO.	78	70	٥,٤٦٠
12.6	UPVC Drainage Pipe and UPVC Fittings: Supply, installation, testing and commissioning of UPVC drainage and ventilation pipes down to manholes with all required fittings including excavation, back filling, incasing with concrete and roof vent caps, including connections as shown in drawings and in accordance to specifications.				
	a- Size 4-inch diameter.	MR	350	18	٦,٣٠٠
	a- Size 2-inch diameter.	MR	500	13	٦,٥٠٠
	b- Size 6-inch diameter	MR	220	30	٦,٦٠٠
	Total for this page				27,180
	TOTAL CARRIED TO NEXT PAGE				68,330

BILL No. (12/06) **PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)**

No.	Work Description	Unit	Qut.	Unit Price	Total Price
				US $	US $
	FORWARDED TOTAL				68,330
12.7	Roof Drains: Supply, installation and commissioning of U.P.V.C Rain water(Storm Water) roof drain (Class A and approved by Palestine Standards Institution) Rainwater drain size is: 20cm x 20cm.	NO.	6	80	٤٨٠
12.8	Rain Water pipes: - U.P.V.C rain(storm) water pipes down to a free discharge with wired mesh above ground level. with all required hanging accessories, fittings and vent caps, all as shown in drawings, specifications, and approval of supervisor engineer. U.P.V.C Pipe of 4 -inch diameter.	MR	240	15	٣,٦٠٠

12.9	Supply Materials for , and Construct Manholes In compliance with specifications and Drawings. Price to include excavation, concrete works, block works, back filling, cement plaster, benching, Cast Iron cover of weight not less than 50 kg. and bearing capacity load for the cover not less than 8 ton. And all necessary works to comply with drawings and specifications.				
	a. Manholes Ø 60 cm clear size	No.	5	٢٥٠	١,٧٥٠
	b. Manholes Ø 80 cm clear size	NO.	4	٤٥٠	١,٨٠٠
	c. Manholes Ø 100 cm clear size	NO.	5	٦٠٠	٣,٠٠٠
	d. Manholes Ø 120 cm clear size	NO.	4	٩٥٠	٣,٨٠٠
	d. Manholes Ø 150 cm clear size	NO.	5	٩٥٠	٤,٧٥٠
	Total for this page				19,180
	TOTAL CARRIED TO NEXT PAGE				87,510

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				87,510
12.10	**WATER METER:** Supply and install Water meter inside steel box, as per specification, drawings and supervisor engineer. Price includes all galvanized steel main water pipes (Ø ¾") or more, (Class A and approved by Palestine Standards Institution) with asphalt protection (factory covered), laid underground with all necessary fittings e.g. elbows, T's, unions, stop valves, non-return valves, automatic air vents, of best quality (Class A and approved by Palestine Standards Institution).	L.S	1	1000	1000
	Total for this page				1000
	TOTAL CARRIED TO NEXT PAGE				88,510

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				88,510

12.11	Supply and install of approved quality local made solar heating unit including 2 solar plates 0.90*1.90m and 200 Lit Cylindrical double jacket galvanized steel tank with glazed lining, the price also includes 1000Lit feeding tank located on the same stand, automatic air vent and all required fittings and connections.	NO.	6	١,٦٥٠	٩,٩٠٠
12.12	Galvanized cold & hot water supply pipes: Supply and installation of cold water distribution network of galvanized pipes of various diameters, (Seamless piping as per standard ASTM-A53schedule 40). From roof to sanitary fixture collectors and external water distribution network. Price includes all fittings, T's, elbows, insulation, etc., and all is needed to complete the works.				
	1- 3/4'' pipe size	MR	160	٢٠	٣,٢٠٠
	2- 1'' pipe size.	MR	180	٢٥	٤,٥٠٠
	3- 1, 1/4'' pipe size.	MR	140	٣٠	٤,٢٠٠
	4- 1, 1/2'' pipe size.	MR	110	٣٨	٤,١٨٠
	5- 2'' pipe size.	MR	70	٤٠	٢,٨٠٠
	6- 1/2'' pipe size	MR	80	١٥	١,٢٠٠
	Total for this page				29,980
	TOTAL CARRIED TO NEXT PAGE				118,490

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				118,490
12.13	Supply and install Hot and cold-water collectors with aluminum box price includes copper collectors, automatic air vent and with all necessary fittings (Italian made), all according to drawings specifications and Engineer's approval.				
	1- size 3/4''	EYES NO.	38	٢٥	٩٥٠
	2- size 1''	EYES NO.	94	٣٠	٢,٨٢٠

12.14	Supply and install the outlets for hot and cold water feeding lines to the sanitary fixture units (Class A and approved by Palestine Standards Institution). the price includes all needed Pex. Pipes of 16mm diameter and a 2.2mm thickness (type Vesbo or equivalent), with a network connection not less than 75% and a 10 bar pressure ,and isolated by a 1'' PVC pipe for protection , and that's from collector to the sanitary outlet, and copper bent16mm*1/2'' all with its plastic box, all according to drawings specifications and Engineer's approval.	NO.	132	٢٠	٢,٦٤٠
	Total for this page				6,410
	TOTAL CARRIED TO NEXT PAGE				124,900

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				124,900
12.15	Supply and install LIFFTING pump in the mechanical room of approved manufacture, including all valves, strainer, pressurized tank, electrical power supply complete with concrete base and connections to rising main, the price include all pipes from pump to roof tanks. All are according to drawings and specifications and approval of supervisor engineer. A 36m3/hr & 25m head. One duty and other stand by	NO.	1	2,585	٢,٥٨٥
12.16	Supply and Install PVC White Water Tank Two 2 Cubic meters in size for water system. Price to include well-painted steel stand, automatic float valves, valves, fittings, vents, watertight cover, lock and all necessary works to complete works as per Specifications and drawings.	NO.	6	٤٥٠	٢,٧٠٠
	Total for this page				5,285
	TOTAL CARRIED TO NEXT PAGE				130,185

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price	Total Price

				US $	US $
	FORWARDED TOTAL				130,185
12.17	Supply and install a fire hose cabinet , made of galvanized steel of thickness 1.5 mm , price includes hinges lock, pipes ,valves ,extinguisher Co2 , nozzles ,1''hose reel ,1'' linen hose ,and all necessary accessories to be exist inside this fire cabinet as details on drawings and all according to specification and Engineer's approval .	No.	20	٥٨٠	١١,٦٠٠
12.18	Supply, install, test and commission package type electric driven split case end suction multi-stage booster pump, LPC Approved, for fire fighting system. The set is composed of three pumps (one is electrical pump, the second one is a diesel pump, and the third one is a jockey pump), and control panel. The price includes all fittings needed for installation, such as but not limited to, strainers, stop valves, flexible joints, OS & Y valves, non-return valves, ... On addition to reinforced concrete bases, anti-vibration isolators, pressure switches, pressure gauges, electric floating valve installed inside well, 2X8" headers at both suction and discharge ports, test line with flow switch with all related accessories, and all needed pipes and fittings inside pumps room, supplying and installing 6" chimney for diesel pump, in addition to electrical and control cables and connections to MDB, as per detail drawing. The pumps specifications are: Electrical Pump 60m Head &460 L/s Water Flow Diesel Pump 60m Head & 460L/s Water Flow Rate Jockey Pump 65m Head &20 L/s Water Flow Rate	No.	2	٢٢,٠٠٠	٤٤,٠٠٠
12.19	Supply and install a Sch-40 fire water pipes (Seamless piping as per standard ASTM-A53 schedule 40). grooved or screwed connections, including all the requested fittings and supports UL/FM approved				
	1- 4'' Sch-40 fire pipes.	MR	80	٧٥	٦,٠٠٠
	2- 3'' Sch-40 fire pipes.	MR	50	٦٠	٣,٠٠٠
	3- 2'' Sch-40 fire pipes.	MR	110	٤٠	٤,٤٠٠
	3- 1 1/2'' Sch-40 fire pipes.	MR	140	٤٠	٥,٦٠٠

	3- 1'' Sch-40 fire pipes,	MR	40	٤٠	١,٦٠٠
12.20	Supply and install Portable Fire Extinguisher each in Location as decided by the Engineer.	No.	9	١٠٠	٩٠٠
	1- 3 kg HCFC and	No.	٢٤	150	3,600
	Total for this page				80,700
	TOTAL CARRIED TO NEXT PAGE				210,885

BILL No. (12/06) PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				210,885
2.21	**Duct Works:** Supply, install, test and commission galvanized air ducts of various thicknesses FOR ventilation as required in (ASHRAE) and as described and detailed on drawings, including hanging, digging, sleeves, and all fittings needed as drawings and supervision engineer approval.	L.S	1	٤,٥٠٠	٤,٥٠٠
.22	**Exhaust Grille**: Install and balance of white coated aluminum, Exhaust grille. Price includes connection to ducts with adapter if required, as shown in the drawings, and with right specifications and approval of supervisor engineer. The grilles size 6''* 6''	NO.	60	٥٥	٣,٣٠٠
23	a. Supply and install in-line centrifugal fans of approved manufacture (Vortices or equally approved). Price includes the connection with duct line and making necessary holes in glass and fixing, electrical connections. All is according to nearest power point and disconnect switch, drawings, specifications and approval of supervisor engineer.				
	* wall mounted Exhaust fan, capacity 100 cfm	No.	3	١٠٠	٣٠٠
	* wall mounted Exhaust fan, capacity 120 cfm	No.	4	١٢٥	٥٠٠
	*wall mounted Exhaust fan, capacity 170 cfm	No.	4	١٩٥	٧٨٠
	* wall mounted Exhaust fan, capacity 300 cfm	No.	8	٣٢٠	٢,٥٦٠

12.24	b. Supply and install wall-mounted kitchen hood of size 280cm*80cm*100cm. The hood should be made from 316 stainless steel sheets of gauge 14 and equipped with built-in 1000 CFM exhaust fan and gravity shutter.	NO.	2	٣,٠٠٠	٦,٠٠٠
	Total for this page				17,940
	TOTAL CARRIED TO NEXT PAGE				228,825

BILL No. (12/06) **PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)**

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				228,825
12.25	**VRF SYSTEM**Supply, install & commissioning for Heat pump VRF (variable refrigerant Flow) system ,of type Samsung or equivalent Korean brands . Refrigerant R410a.Complete with the outdoor and indoor units, piping & wiring network, control system and all necessary parts needed according to drawings and specifications.				
12.26	**Outdoor Units** Variable refrigerant flow outdoor unit, scroll compressor with invertors drive, refrigerant R 410 A, Outdoor design conditions 24C summer indoor temperature,35C summer outdoor temperature.				
	a- Outdoor unit size42 HP- for riser 5	No.	1	١٨,٤٣٥	١٨,٤٣٥
	b- Outdoor unit size 64 HP- for riser 1	No.	1	٣٧,٨١٢	٣٧,٨١٢
	c- Outdoor unit size 50 HP- for riser 2	No.	1	٣٢,٠٦٢	٣٢,٠٦٢
	d- Outdoor unit size 54 HP- for riser 4	No.	1	٣٥,٠٢٧	٣٥,٠٢٧
	e- Outdoor unit size 70 HP- for riser 5	No.	1	٤٢,٦٨٤	٤٢,٦٨٤
	Total for this page				166,020
	TOTAL CARRIED TO NEXT PAGE				394,845

BILL No. (12/06) **PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)**

No.	Work Description	Unit	Qut.	Unit Price US $	Total Price US $
	FORWARDED TOTAL				394,845

12.27	**Indoor Units** DVM S hydro water system with all valves ,and fittings the cost include water isolation tank with capacity 175L for each unit. cooling capacity 28 kW heating capacity 31 kW.	NO.	2	٤,٠٠٠	8,000
12.28	**Indoor Units** 4 way cassette type VRF indoor units with filter, Wall mounted thermostat including on-off, real time clock, schedule timer, fan control, Darin UPVC piping network2" to nearest floor trap, and temperature set and display. Indoor design conditions 24 C cooling, 50%relative humidity at high speed flow. According to the following capacities:				
	a-Cooling Capacity up to 2.8 kW 60cm x60cm	No.	18	١,٢٥٤	٢٢,٥٧٢
	b-Cooling Capacity up to 3.6 kW,60cm x60cm	No.	40	١,٣٠٠	٥٢,٠٠٠
	c-Cooling Capacity up to 4.5 kW,60cm x60cm	No.	65	١,٣٣٤	٨٦,٧١٠
	d-Cooling Capacity up to 5.6 kW,60cm x60cm	No.	27	١,٣٥٧	٣٦,٦٣٩
	e-Cooling Capacity up to 6 kW 60cm x60cm	No.	16	١,٠٠٠	١٦,٠٠٠
	f-Cooling Capacity up to 2 kW 60cm x60cm	No.	1	١,٠٣٥	١,٠٣٥
	Total for this page				222,956
	TOTAL CARRIED TO NEXT PAGE				617,801

BILL No. (12/06) **PLUMBING, SANITARY AND MECHANICAL WORKS (SEC - 06)**

No.	Work Description	Unit	Qut.	Unit Price	Total Price
				US $	US $
	FORWARDED TOTAL				617,801
2.29	**Centralized controller** Centralized controller for VRF system to control all indoor units set points, programmed on off operation, and alarms view, to be connected to 170 indoor units.	No.	1	١,٤٥٠	١,٤٥٠
2.30	**copper piping network** Supply, install & commissioning for copper valves on both liquid and gas lines	No.	200	٩٢	١٨,٤٠٠

12.31	Supply, install & commissioning copper pipes for refrigerant R410a between indoor units and outdoor unit according to manufacturer instructions and calculations. Price includes all required fittings, hanging, isolation and digging. According to manufacturer instructions	L.S	1	٥١,٩٢٣	٥١,٩٢٣
12.32	**Control & Wiring** All wiring between indoor and outdoor units inside electrical conduits	L.S	1	٢,٩٦٧	٢,٩٦٧
	Total for this page				74,740
	TOTAL CARRIED TO SUMMARY				692.541

References

[1] Palestinian code.

[2] Jordanian code.

[3] J. A. D. W. A.Beckman, *Solar Engineering of Thermal Processes*, John Wiley & Sons, 2006.

[4] M. A. A. M. A.Hammad, *Heating and Air Conditioning for Residantial Buildings*, National Library Department, Jordan, 2007.

[5] J. F. Kreider, *Handbook of Heating, Ventilation, and Air Conditioning*, Boca Raton, CRC Press LLC, Florida, 2001.

[6] B. Stein, *Building Technology Mechanical and Electrical Systems*, John Wiley & sons, Canada, 1997.

Appendix

A 1: Cooling load temperature differences (CLTD) for sunlit roofs,°C.

No.	Roof Description of Construction	U_m, W/m²·°C	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, h																							
			Without Suspended Ceiling																							
1	Steel sheet with 25.4 mm (or 50.8 mm) insulation	1.209 (0.704)	0	−1	−2	−2	−3	−2	3	11	19	27	34	40	43	44	43	39	33	25	17	10	7	5	3	1
2	25 mm wood with 25.4 mm insulation	0.963	3	2	0	−1	−2	−2	−1	2	8	15	22	29	35	39	41	41	39	35	29	21	15	11	8	5
3	101.6 mm L.W. concrete	1.209	5	3	1	0	−1	−2	−2	1	5	11	18	25	31	36	39	40	40	37	32	25	19	14	10	7
4	50.8 mm H.W. concrete 25.4 mm (or 50.8 mm) insulation	1.170 (0.693)	7	5	3	2	0	−1	0	2	6	11	17	23	28	33	36	37	37	34	30	25	20	16	12	10
5	25.4 mm wood with 50.8 insulation	0.619	2	0	−2	−3	−4	−4	−4	−2	3	9	15	22	27	32	35	36	35	32	27	20	14	10	6	3
6	152.4 mm L.W. concrete	0.897	12	10	7	5	3	2	1	0	2	4	8	13	18	24	29	33	35	36	35	32	28	24	19	16
7	63.5 mm wood with 25.4 mm insulation	0.738	16	13	11	9	7	6	4	3	4	5	8	11	15	19	23	27	29	31	31	30	27	25	22	19
8	203.4 mm L.W. concrete	0.715	20	17	14	12	10	8	6	5	4	4	5	7	11	14	18	22	25	28	30	30	29	27	25	22
9	101.6 mm H.W. concrete with 25.4 mm (or 50.8 mm) insulation	1.136 (0.681)	14	12	10	8	7	5	4	4	6	8	11	15	18	22	25	28	29	30	29	27	24	21	19	16
10	63.5 mm wood with insulation	0.528	18	15	13	11	9	8	6	5	5	5	7	10	13	17	21	24	27	28	29	29	27	25	23	20
11	Roof terrace system	0.602	19	17	15	14	12	11	9	8	7	8	8	10	12	15	18	20	22	24	25	26	25	24	22	21
12	152.4 mm H.W. concrete with 25.4 mm (or 50.8 mm) insulation	0.664	18	16	14	12	11	10	9	8	8	9	10	12	15	17	20	22	24	25	25	25	24	22	20	19
13	101.6 mm wood with 25.4 mm (or 50.8 mm) insulation	0.602 (0.443)	21	20	18	17	15	14	13	11	10	9	9	9	10	12	14	16	18	20	22	23	24	24	23	22

A 2: Latitude-Month correction factor LM, as applied to walls and horizontal roofs, north latitudes.

Lat.	Month	N	NNE NNW	NE NW	ENE WNW	E W	ESE WSW	SE SW	SSE SSW	S	Horizontal Roofs
16	December	-2.2	-3.3	-4.4	-4.4	-2.2	-0.5	2.2	5.0	7.2	-5.0
	Jan./Nov.	-2.2	-3.3	-3.8	-3.8	-2.2	-0.5	2.2	4.4	6.6	-3.8
	Feb./Oct.	-1.6	-2.7	-2.7	-2.2	-1.1	0.0	1.1	2.7	3.8	-2.2
	Mar/Sept.	-1.6	-1.6	-1.1	-1.1	-0.5	-0.5	0.0	0.0	0.0	-0.5
	Apr./Aug.	-0.5	0.0	-0.5	-0.5	-0.5	-1.6	-1.6	-2.7	-3.3	0.0
	May/July	2.2	1.6	1.6	0.0	-0.5	-2.2	-2.7	-3.8	-3.8	0.0
	June	3.3	2.2	2.2	0.5	-0.5	-2.2	-3.3	-4.4	-3.8	0.0
24	December	-2.7	-3.8	-5.5	-6.1	-4.4	-2.7	1.1	5.0	6.6	-9.4
	Jan./Nov.	-2.2	-3.3	-4.4	-5.0	-3.3	-1.6	-1.6	5.0	7.2	-6.1
	Feb./Oct.	-2.2	-2.7	-3.3	-3.3	-1.6	-0.5	1.6	3.8	5.5	-3.8
	Mar/Sept.	-1.6	-2.2	-1.6	-1.6	-0.5	-0.5	0.5	1.1	2.2	-1.6
	Apr./Aug.	-1.1	-0.5	0.0	-0.5	-0.5	-1.1	-0.5	-1.1	-1.6	0.0
	May/July	0.5	1.1	1.1	0.0	0.0	-1.6	-1.6	-2.7	-3.3	0.5
	June	1.6	1.6	1.6	0.5	0.0	-1.6	-2.2	-3.3	-3.3	0.5
32	December	-2.7	-3.8	-5.5	-6.1	-4.4	-2.7	1.1	5.0	6.6	-9.4
	Jan./Nov.	-2.7	-3.8	-5.0	-6.1	-4.4	-2.2	1.1	5.0	6.6	-8.3
	Feb./Oct.	-2.2	-3.3	-3.8	-4.4	-2.2	-1.1	2.2	4.4	6.1	-5.5
	Mar/Sept.	-1.6	-2.2	-2.2	-2.2	-1.1	-0.5	1.6	2.7	3.8	-2.7
	Apr./Aug.	-1.1	-1.1	-0.5	-1.1	0.0	-0.5	0.0	5.0	0.5	-0.5
	May/July	0.5	0.5	0.5	0.0	0.0	-0.5	-0.5	-1.6	-1.6	0.5
	June	0.5	1.1	1.1	0.5	0.0	-1.1	-1.1	-2.2	-2.2	1.1
40	December	-3.3	-4.4	-5.5	-7.2	-5.5	-3.8	0.0	3.8	5.5	-11.6
	Jan./Nov.	-2.7	-3.8	-5.5	-6.6	-5.0	-3.3	0.5	4.4	6.1	-10.5
	Feb./Oct.	-2.7	-3.8	-4.4	-5.0	-3.3	-1.6	1.6	4.4	6.6	-7.7
	Mar/Sept.	-2.2	-2.7	-2.7	-3.3	-1.6	0.5	2.2	3.8	5.5	-4.4
	Apr./Aug.	-1.1	-1.6	-1.6	-1.1	0.0	0.0	1.1	1.6	2.2	1.6
	May/July	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.5
	June	0.5	0.5	0.5	0.5	0.0	0.5	0.0	0.0	-0.5	1.1
48	December	-3.3	-4.4	-6.1	-7.7	-7.2	-5.5	-1.6	1.1	3.3	-13.8
	Jan./Nov.	-3.3	-4.4	-6.1	-7.2	-6.1	-4.4	-0.5	2.7	4.4	-13.3
	Feb./Oct.	-2.7	-3.8	-5.5	-6.1	-4.4	-2.7	0.5	4.4	6.1	-10.0
	Mar/Sept.	-2.2	-3.3	-3.3	-3.8	-2.2	-0.5	2.2	4.4	6.1	-6.1
	Apr./Aug.	-1.6	-1.6	-1.6	-1.6	-0.5	0.0	2.2	3.3	3.8	-2.7
	May/July	0.0	-0.5	0.0	0.0	0.5	0.5	1.6	1.6	2.2	0.0
	June	0.5	0.5	1.1	0.5	1.1	0.5	1.1	1.1	1.6	1.1

A 3: Cooling load temperature differences (CLTD) for various construction groups of sunlit walls, °C

North Latitude Wall Facing	Solar Time h: 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Hour of Max. CLTD	Min. CLTD	Max. CLTD	Difference CLTD
Group A Walls																												
N	8	8	8	7	7	7	7	6	6	6	6	6	6	6	6	6	6	6	7	7	7	7	8	8	2	6	8	2
NE	11	11	10	10	10	9	9	9	8	8	8	9	9	9	9	10	10	10	11	11	11	11	11	11	22	8	11	3
E	14	13	13	13	12	12	11	11	10	10	10	11	11	12	12	13	13	13	14	14	14	14	14	14	22	10	14	4
SE	13	13	13	12	12	11	11	10	10	10	10	10	10	11	11	12	12	13	13	13	13	13	13	13	22	10	13	3
S	11	11	11	11	10	10	9	9	9	8	8	8	8	8	8	8	9	9	10	10	11	11	11	11	23	8	11	3
SW	14	14	14	14	13	13	12	12	11	11	10	10	10	9	9	10	10	10	11	12	13	13	14	14	24	9	14	5
W	15	15	15	14	14	14	13	13	12	12	11	11	10	10	10	10	10	11	11	12	13	14	14	15	1	10	15	5
NW	12	12	11	11	11	11	10	10	10	9	9	8	8	8	8	8	8	8	9	9	10	11	11	11	1	8	12	4
Group B Walls																												
N	8	8	8	7	7	6	6	6	5	5	5	5	5	5	5	6	6	7	7	8	8	8	8	8	24	5	8	3
NE	11	10	10	9	9	8	7	7	7	7	8	8	9	9	10	10	11	11	11	12	12	12	11	11	21	7	12	5
E	13	13	12	11	10	10	9	8	8	9	9	10	12	13	13	14	14	15	15	15	15	15	14	14	20	8	15	7
SE	13	12	12	11	10	10	9	8	8	8	8	9	10	11	12	13	14	14	14	14	14	14	14	14	21	8	14	6
S	12	11	11	10	9	9	8	7	7	6	6	6	6	7	8	9	10	11	11	12	12	12	12	12	23	6	12	6
SW	15	15	14	13	13	12	11	10	9	9	8	8	7	7	8	9	10	11	13	14	15	15	16	16	24	7	16	9
W	16	16	15	14	14	13	12	11	10	9	9	8	8	8	8	8	9	11	12	14	15	16	16	17	24	8	17	9
NW	13	12	12	11	11	10	9	9	8	7	7	7	6	6	7	7	8	8	9	11	12	13	13	13	24	6	13	7
Group C Walls																												
N	9	8	7	7	6	5	5	4	4	4	4	4	5	5	6	6	7	8	9	9	9	10	9	9	22	4	10	6
NE	10	10	9	8	7	6	6	6	6	7	8	10	10	11	12	12	12	13	13	13	13	12	12	11	20	6	13	7
E	13	12	11	10	9	8	7	7	8	9	11	13	14	15	16	16	17	17	16	16	16	15	14	13	18	7	17	10
SE	13	12	11	10	9	8	7	6	7	7	9	10	12	14	15	16	16	16	16	16	16	15	14	13	19	6	16	10
S	12	11	10	9	8	7	6	6	5	5	5	5	6	8	9	11	12	13	14	14	14	14	13	12	20	5	14	9
SW	16	15	14	12	11	10	9	8	7	7	6	6	6	7	8	10	12	14	16	18	18	18	13	17	22	6	18	12
W	17	16	15	14	12	11	10	9	8	7	7	7	7	7	8	9	11	13	16	18	19	20	19	18	22	7	20	13

A 4: Description of wall construction groups.

Group No.	Description Of Construction	U_{∞} W/m²·°C
	101.6 mm Face Brick + (Brick)	
C	Air space + 101.6 mm face brick	2.033
D	101.6 mm common brick	2.356
C	25.4 mm insulation or air space + 101.6 mm common brick	0.987-1.709
B	50.6 mm insulation + 101.6 mm common brick	0.630
B	203.2 mm common brick	1.714
A	Insulation or air space + 203.2 mm common brick	0.874-1.379
	101.6 mm Face Brick + (H.W. Concrete)	
C	Air space + 50.8 mm concrete	1.987
B	50.8 mm insulation + 101.6 mm concrete	0.658
A	Air space or insulation + 203.2 mm or more concrete	0.625-0.636
	101.6 mm Face Brick + (L.W. or H.W Concrete Block)	
E	101.6 mm block	1.811
D	Air space or insulation + 101.60 mm block	0.868-1.397
D	203.2 mm block	1.555
C	Air space or 25.4 mm insulation + 152.4 mm or 203.2 mm block	1.255-1.561
B	50.8 insulation + 203.2 mm block	0.545-0.607
	101.6 mm Face Brick + (Clay Tile)	
D	101.6 mm tile	2.163
D	Air space + 101.6 mm tile	1.595
C	Insulation + 101.6 mm tile	0.959
C	203.2 mm tile	1.561
B	Air space or 25.4 mm insulation + 203.2 mm tile	0.806-1.255
A	50.8 mm insulation + 203.2 mm tile	0.551
	L.W. Concrete Wall + (Finish)	
E	101.5 mm concrete	3.321
D	101.6 mm concrete + 25.4 mm or 50.8 mm insulation	1.136 - 0.675
C	50.8 mm insulation+101.6 mm concrete	0.675
C	203.2 mm concrete	2.782
B	203.2 mm concrete + 25.4 mm or 50.8 mm insulation	1.061 - 0.653
A	203.2 mm concrete + 50.8 mm insulation	0.653
B	304.8 mm concrete	2.390
A	304.8 mm concrete + insulation	0.642
	L.W. and H.W. Concrete Block + (Finish)	
F	101.6 mm block + air space/insulation	0.914-1.493
E	50.8 mm insulation + 101.6 mm block	0.596-0.647
E	203.2 mm block	1.669-2.282
D	203.2 mm block + air space/insulation	0.846-0.982

A 5: Solar heat gain factor (SHG) for sunlit glass, W/m², for a latitude angle of 32 °N.

Month	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
N	76	85	101	114	120	139	126	117	104	88	76	69
NNE/NNW	76	85	117	252	350	385	350	249	110	88	76	69
NE/NW	91	205	338	461	536	555	527	445	325	199	91	69
ENE/WNW	331	470	577	631	656	656	643	615	546	451	325	265
E/W	552	647	716	716	694	675	678	691	678	615	546	511
ESE/WSW	722	764	748	691	628	596	612	663	716	738	710	688
SE/SW	786	782	716	590	489	439	473	571	688	754	773	776
SSE/SSW	789	732	615	445	213	262	303	429	596	710	776	795
S	776	697	555	363	233	189	227	350	540	678	767	795
Horizontal	555	685	795	855	874	871	861	836	770	672	552	498

A 6: Shading coefficient (SC) for glass windows without interior shading.

Type of Glass	Nominal Thickness, mm	Solar Trans.	Shading Coefficient, W/m²·K $h_o = 22.7$	Shading Coefficient, W/m²·K $h_o = 17.0$
Single Glass				
Clear	3	0.84	1.00	1.00
	6	0.78	0.94	0.95
	10	0.72	0.90	0.92
	12	0.67	0.87	0.88
Heat absorbing	3	0.64	0.83	0.85
	6	0.46	0.69	0.73
	10	0.33	0.60	0.64
	12	0.42	0.53	0.58
Double Glass				
Regular	3	—	0.90	—
Plate	6	—	0.83	—
Reflective	6	—	0.20-0.40	—
Insulating Glass				
Clear	3	0.71	0.88	0.88
	6	0.61	0.81	0.82
Heat absorbing*	6	0.36	0.55	0.58

A 7: Cooling load factors (CLF) *for glass windows without interior shading, north latitudes.*

Glass Facing	*Building* Construction	Solar Time, h																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
N Shaded	L	0.17	0.14	0.11	0.09	0.08	0.33	0.24	0.48	0.56	0.61	0.71	0.76	0.80	0.82	0.82	0.79	0.75
	M	0.23	0.20	0.18	0.16	0.14	0.34	0.14	0.46	0.53	0.59	0.65	0.70	0.73	0.75	0.76	0.74	0.75
	H	0.25	0.23	0.21	0.20	0.19	0.38	0.45	0.49	0.55	0.60	0.65	0.69	0.72	0.72	0.72	0.70	0.70
NNE	L	0.06	0.05	0.04	0.03	0.03	0.26	0.43	0.47	0.44	0.41	0.40	0.39	0.39	0.38	0.36	0.33	0.30
	M	0.09	0.08	0.07	0.06	0.06	0.24	0.38	0.42	0.39	0.37	0.37	0.36	0.36	0.36	0.34	0.33	0.30
	H	0.11	0.10	0.09	0.09	0.08	0.26	0.39	0.42	0.39	0.36	0.35	0.34	0.34	0.33	0.32	0.31	0.28
NE	L	0.04	0.04	0.03	0.02	0.02	0.23	0.41	0.51	0.51	0.45	0.39	0.36	0.33	0.31	0.28	0.26	0.23
	M	0.07	0.06	0.06	0.05	0.04	0.21	0.36	0.44	0.45	0.40	0.36	0.33	0.31	0.30	0.28	0.26	0.24
	H	0.09	0.08	0.08	0.07	0.07	0.23	0.37	0.44	0.44	0.39	0.34	0.31	0.29	0.27	0.26	0.24	0.22
ENE	L	0.04	0.03	0.03	0.02	0.02	0.21	0.40	0.52	0.57	0.53	0.45	0.39	0.34	0.31	0.28	0.25	0.22
	M	0.07	0.06	0.05	0.05	0.04	0.20	0.35	0.45	0.49	0.47	0.41	0.36	0.33	0.30	0.28	0.26	0.23
	H	0.09	0.09	0.08	0.07	0.07	0.22	0.36	0.46	0.49	0.45	0.38	0.31	0.30	0.27	0.25	0.23	0.21
E	L	0.04	0.03	0.03	0.02	0.02	0.19	0.37	0.51	0.57	0.57	0.50	0.42	0.37	0.32	0.29	0.25	0.22
	M	0.07	0.06	0.06	0.05	0.05	0.18	0.33	0.44	0.50	0.51	0.46	0.39	0.35	0.31	0.29	0.26	0.23
	H	0.09	0.09	0.08	0.08	0.07	0.20	0.34	0.45	0.49	0.49	0.43	0.39	0.32	0.29	0.26	0.24	0.22
ESE	L	0.05	0.04	0.03	0.03	0.02	0.17	0.34	0.49	0.58	0.61	0.57	0.48	0.41	0.36	0.32	0.28	0.24
	M	0.08	0.07	0.06	0.05	0.05	0.16	0.31	0.43	0.51	0.54	0.51	0.44	0.39	0.35	0.32	0.29	0.26
	H	0.10	0.09	0.09	0.08	0.08	0.19	0.32	0.43	0.50	0.52	0.49	0.41	0.36	0.32	0.29	0.26	0.24

	L	0.05	0.04	0.04	0.03	0.03	0.13	0.28	0.43	0.55	0.62	0.63	0.57	0.48	0.42	0.37	0.33	0.28
SE	M	0.09	0.08	0.07	0.06	0.05	0.14	0.26	0.38	0.48	0.54	0.56	0.51	0.45	0.40	0.36	0.33	0.29
	H	0.11	0.10	0.10	0.09	0.08	0.17	0.28	0.40	0.49	0.53	0.53	0.48	0.41	0.36	0.33	0.30	0.27
	L	0.07	0.05	0.04	0.04	0.03	0.06	0.15	0.29	0.43	0.55	0.63	0.64	0.60	0.25	0.45	0.40	0.35
SSE	M	0.11	0.09	0.08	0.07	0.06	0.08	0.16	0.26	0.38	0.58	0.55	0.57	0.54	0.48	0.43	0.39	0.35
	H	0.12	0.11	0.11	0.10	0.09	0.12	0.19	0.29	0.40	0.49	0.54	0.55	0.51	0.44	0.39	0.35	0.31
	L	0.08	0.07	0.05	0.04	0.04	0.06	0.09	0.14	0.22	0.34	0.48	0.59	0.65	0.65	0.59	0.50	0.43
S	M	0.12	0.11	0.09	0.08	0.07	0.08	0.11	0.14	0.21	0.31	0.42	0.52	0.57	0.58	0.53	0.47	0.41
	H	0.13	0.12	0.12	0.11	0.10	0.11	0.14	0.17	0.24	0.33	0.43	0.51	0.56	0.55	0.50	0.43	0.37
	L	0.10	0.08	0.07	0.06	0.05	0.06	0.09	0.11	0.15	0.19	0.27	0.39	0.52	0.62	0.67	0.65	0.58
SSW	M	0.14	0.12	0.11	0.09	0.08	0.09	0.11	0.13	0.15	0.18	0.25	0.35	0.46	0.55	0.59	0.59	0.53
	H	0.15	0.14	0.13	0.12	0.11	0.12	0.14	0.16	0.18	0.21	0.27	0.37	0.46	0.53	0.57	0.55	0.49
	L	0.12	0.10	0.08	0.06	0.05	0.06	0.08	0.10	0.12	0.14	0.16	0.24	0.36	0.49	0.60	0.66	0.66
SW	M	0.15	0.14	0.12	0.10	0.09	0.09	0.10	0.12	0.13	0.15	0.17	0.23	0.33	0.44	0.53	0.58	0.59
	H	0.15	0.14	0.13	0.12	0.11	0.12	0.13	0.14	0.16	0.17	0.19	0.25	0.34	0.44	0.52	0.56	0.56
	L	0.12	0.10	0.08	0.07	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.17	0.26	0.40	0.52	0.62	0.66
WSW	M	0.15	0.13	0.12	0.10	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.17	0.24	0.35	0.46	0.54	0.58
	H	0.15	0.14	0.13	0.12	0.11	0.11	0.12	0.13	0.14	0.15	0.16	0.19	0.26	0.36	0.46	0.53	0.56
	L	0.12	0.10	0.08	0.06	0.05	0.06	0.07	0.08	0.10	0.11	0.12	0.14	0.20	0.32	0.45	0.57	0.64

Glass Facing	Building Construction	Solar Time, h																
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
W	M	0.15	0.13	0.11	0.10	0.09	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.19	0.29	0.40	0.50	0.56
	H	0.14	0.13	0.12	0.11	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.21	0.30	0.40	0.49	0.54
WNW	L	0.12	0.10	0.08	0.06	0.05	0.06	0.07	0.09	0.10	0.12	0.13	0.15	0.17	0.26	0.40	0.53	0.63
	M	0.15	0.13	0.11	0.10	0.09	0.09	0.10	0.11	0.12	0.11	0.14	0.15	0.17	0.24	0.35	0.47	0.55
	H	0.14	0.13	0.12	0.11	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18	0.25	0.36	0.46	0.53
NW	L	0.11	0.09	0.08	0.06	0.05	0.06	0.08	0.10	0.12	0.14	0.16	0.17	0.19	0.23	0.33	0.47	0.59
	M	0.14	0.12	0.11	0.09	0.08	0.09	0.10	0.11	0.13	0.14	0.16	0.17	0.18	0.21	0.30	0.42	0.51
	H	0.14	0.12	0.11	0.10	0.10	0.10	0.12	0.13	0.15	0.16	0.18	0.18	0.19	0.22	0.30	0.41	0.50
NNW	L	0.12	0.09	0.08	0.06	0.05	0.07	0.11	0.14	0.18	0.22	0.25	0.27	0.29	0.30	0.33	0.44	0.57
	M	0.15	0.13	0.11	0.10	0.09	0.10	0.12	0.15	0.18	0.21	0.23	0.26	0.27	0.28	0.31	0.39	0.51
	H	0.14	0.13	0.12	0.11	0.10	0.12	0.15	0.17	0.20	0.23	0.25	0.26	0.28	0.28	0.31	0.38	0.49
HORIZ.	L	0.11	0.09	0.07	0.06	0.05	0.07	0.14	0.24	0.16	0.48	0.58	0.66	0.72	0.74	0.73	0.67	0.59
	M	0.16	0.14	0.12	0.11	0.11	0.11	0.16	0.24	0.13	0.43	0.52	0.59	0.64	0.67	0.66	0.62	0.56
	H	0.17	0.16	0.15	0.14	0.13	0.15	0.20	0.28	0.16	0.45	0.52	0.59	0.62	0.64	0.62	0.58	0.51

A 8: : Cooling load factors (CLF) for glass windows with interior shading, north latitudes.

Fenestration Facing	Solar Time, *h*																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
N	0.08	0.07	0.06	0.06	0.07	0.73	0.66	0.65	0.73	0.80	0.86	0.89	0.89	0.86	0.82	0.75	0.78
NNE	0.03	0.03	0.02	0.02	0.03	0.64	0.77	0.62	0.42	0.37	0.37	0.37	0.36	0.35	0.32	0.28	0.23
NE	0.03	0.02	0.02	0.02	0.02	0.56	0.76	0.74	0.58	0.37	0.29	0.27	0.26	0.24	0.22	0.20	0.16
ENE	0.03	0.02	0.02	0.02	0.02	0.52	0.76	0.80	0.71	0.52	0.31	0.26	0.24	0.22	0.20	0.18	0.15
E	0.03	0.02	0.02	0.02	0.02	0.47	0.72	0.80	0.76	0.62	0.41	0.27	0.24	0.22	0.20	0.17	0.14
ESE	0.03	0.03	0.02	0.02	0.02	0.41	0.67	0.79	0.80	0.72	0.54	0.34	0.27	0.24	0.21	0.19	0.15
SE	0.03	0.03	0.02	0.02	0.02	0.30	0.57	0.74	0.81	0.79	0.68	0.49	0.33	0.28	0.25	0.22	0.18
SSE	0.04	0.03	0.03	0.03	0.02	0.12	0.31	0.54	0.72	0.81	0.81	0.71	0.54	0.38	0.32	0.27	0.22
S	0.04	0.04	0.03	0.03	0.03	0.09	0.16	0.23	0.38	0.58	0.75	0.83	0.80	0.68	0.50	0.35	0.27
SSW	0.05	0.04	0.04	0.03	0.03	0.09	0.14	0.18	0.22	0.27	0.43	0.63	0.78	0.84	0.80	0.66	0.46
SW	0.05	0.05	0.04	0.04	0.03	0.07	0.11	0.14	0.16	0.19	0.22	0.38	0.59	0.75	0.83	0.81	0.69
WSW	0.05	0.05	0.04	0.04	0.03	0.07	0.10	0.12	0.14	0.16	0.17	0.23	0.44	0.64	0.78	0.84	0.78
W	0.05	0.05	0.04	0.04	0.03	0.06	0.09	0.11	0.13	0.15	0.16	0.17	0.31	0.53	0.72	0.82	0.81
WNW	0.05	0.05	0.04	0.03	0.03	0.07	0.10	0.12	0.14	0.16	0.17	0.18	0.22	0.43	0.65	0.80	0.84
NW	0.05	0.04	0.04	0.03	0.03	0.07	0.11	0.14	0.17	0.19	0.20	0.21	0.22	0.30	0.52	0.73	0.82
NNW	0.05	0.05	0.04	0.03	0.03	0.11	0.17	0.22	0.26	0.30	0.32	0.33	0.34	0.34	0.39	0.61	0.82
HORIZ.	0.06	0.05	0.04	0.04	0.03	0.12	0.27	0.44	0.59	0.72	0.81	0.85	0.85	0.81	0.71	0.58	0.42

A 9: Instantaneous heat gain from occupants in units of Watts.

Type of Activity	Typical Application	Total Heat Dissipation Adult Male	Total Adjusted[a] Heat Dissipation	Sensible Heat, W	Latent Heat, W
Seated at rest	*Theater*:				
	Matinee	111.5	94.0	64.0	30.0
	Evening	111.5	100.0	70.0	30.0
Seated, very light work	Offices, hotels, apartments, restaurants	128.5	114.0	70.0	44.0
Moderately active office work	Offices, hotels, apartments	135.5	128.5	71.5	57.0
Standing, light work, walking	Department store, retail store, supermarkets	157.0	143.0	71.5	71.5
Walking, seated	Drug store	157.0	143.0	71.5	71.5
Standing, walking slowly	Bank	157.0	143.0	71.5	71.5
Sedentary work	Restaurant	168.5	157.0	78.5	78.5
Light bench work	Factory	238.0	214.0	78.0	136.0
Moderate work	Small-Parts assembly	257.0	243.0	87.0	156.0
Moderate dancing	Dance halls	257.0	243.0	87.0	156.0
Walking at 1.5 m/s	Factory	286.0	285.0	107.0	178.0
Bowling (participant)	Bowling alley	428.5	414.0	166.0	248.0
Heavy work	Factory	428.5	414.0	166.0	248.0

senberg

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EKAD 200-4

07.05.2015

Operating data

Vol[cfm]	74
dp[inWG]	0,01

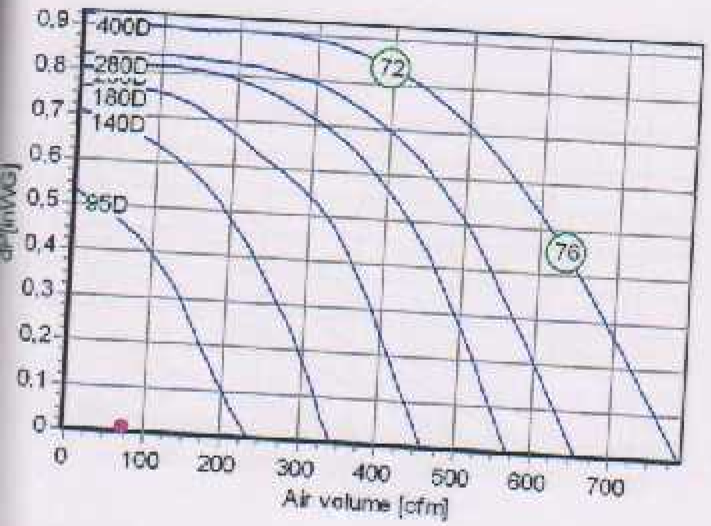
Requested operating point

Vol[cfm]	-
dp[inWG]	-
dp(dyn)[inWG]	-
U[V]	-
P[kW]	-
I[A]	-
n[1/min]	-
eta[%]	-
Lw[dBA]	-

Nominal data

Art.	D00-20050
U[V]	400 D
f[Hz]	50
P[kW]	0.33
I[A]	0.61
n[1/min]	1270
C[µF]	-
tR[°C]	60
Pst min[Pa]	-
Delta I[%]	-
Ia/In	2.0
Weight [kg]	13
Connection	01.006

rves:



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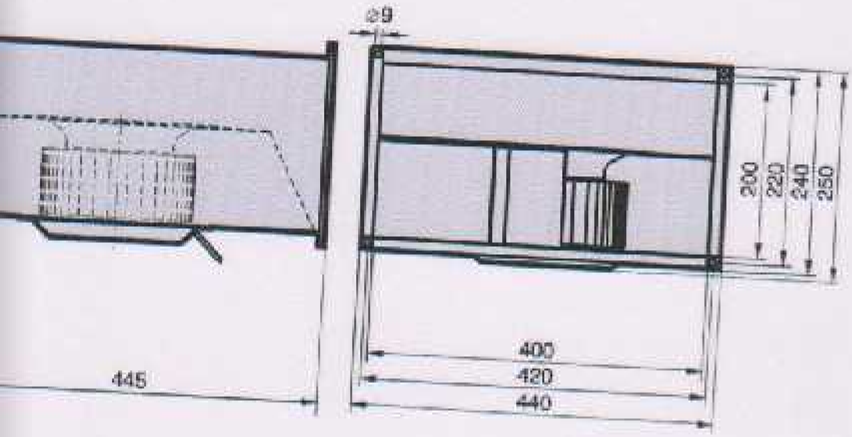

s [dBA]

125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	Total

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senberg

More information @
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EKAE 200-2

07.05.2015

Operating data

Vol[cfm]	300
dp[inWG]	0,01

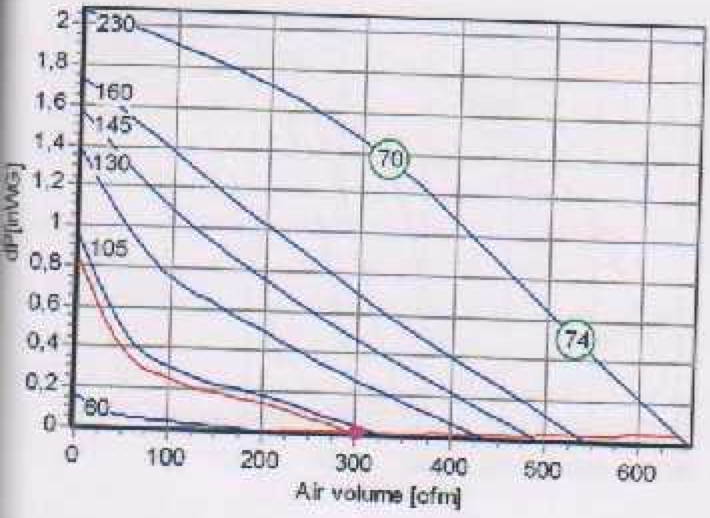
Requested operating point

Vol[cfm]	300
dp[inWG]	0,01
dp(dyn)[inWG]	0,01
U[V]	98
P[kW]	0,06
I[A]	0,56
n[1/min]	1226
eta[%]	0,0
Lw6[dBA]	57,5

Nominal data

Art.	D00-20003
U[V]	230
f[Hz]	50
P[kW]	0.17
I[A]	0.76
n[1/min]	2530
C[µF]	5
tR[°C]	60
Pst min[Pa]	-
Delta I[%]	-
Ia/In	1.8
Weight [kg]	9.4
Connection	01.024

rves:



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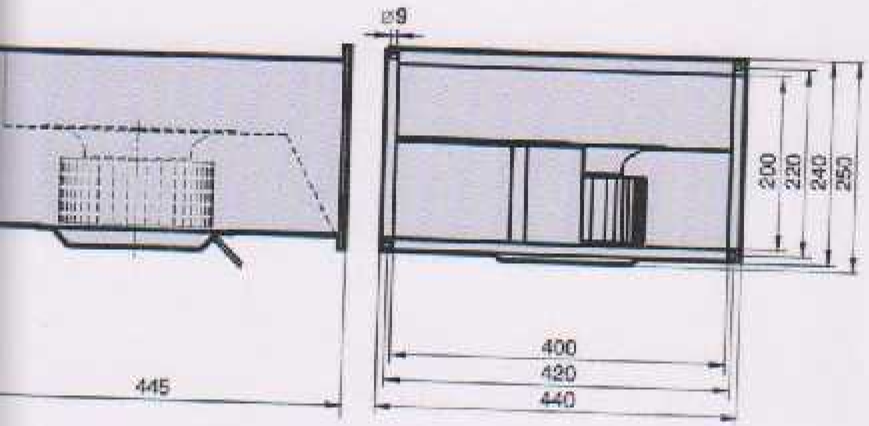


ves [dBA]

	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	Total
LwA6	42	44	50	53	52	51	41	57,5
LwA5	39	37	46	47	45	43	34	51,5
LwA2	36	34	32	34	29	24	17	40,5

LwA6: Free outlet sound power level
LwA5: Free inlet sound power level
LwA2: Casing radiated sound power level

enberg

More information @
www.rosenberg-gmbh.com

EKAE 200-4

ErP

07.05.2015

Operating data

Vol[cfm]	120
dp[inWG]	0,01

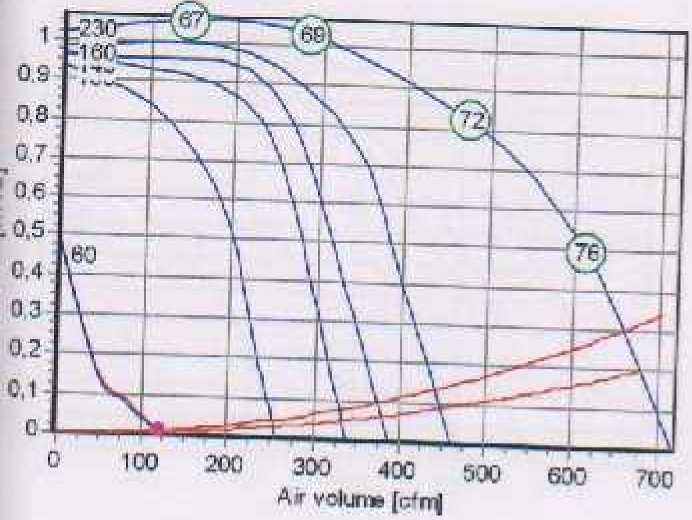
Requested operating point

Vol[cfm]	120
dp[inWG]	0,01
dp(dyn)[inWG]	0,00
U[V]	60
P[kW]	0,03
I[A]	0,51
n[1/min]	240
eta[%]	0,0
Lw6[dBA]	39,9

Nominal data

Art.	D00-20000
U[V]	230
f[Hz]	50
P[kW]	0.29
I[A]	1.25
n[1/min]	1260
C[µF]	6
tR[°C]	40
Pst min[Pa]	50
Delta I[%]	10
Ia/In	1.8
Weight [kg]	13
Connection	01.024

ves:



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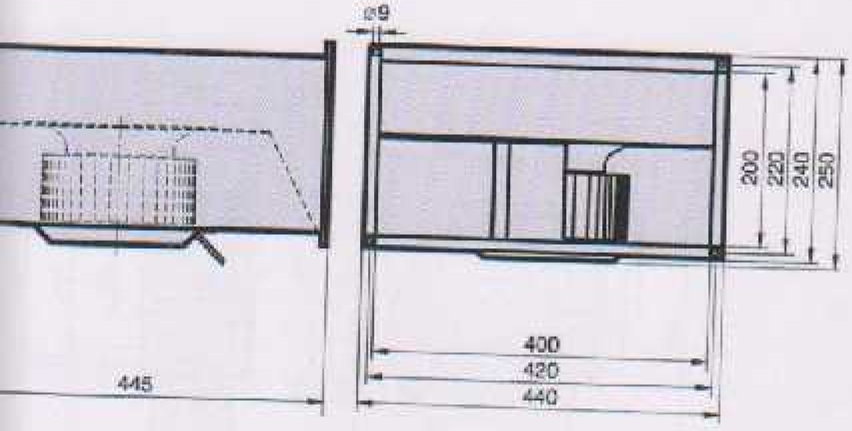

es [dBA]

	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	Total
wA6	24	26	32	35	34	33	23	39,9
wA5	21	19	28	29	27	25	16	33,9
wA2	18	16	14	16	11	6	-1	22,9

wA6: Free outlet sound power level
wA5: Free inlet sound power level
wA2: Casing radiated sound power level

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ERAD 250-6

ErP
Produkt ist ab 2015 außerhalb der EU verfügbar

07.05.2015

Operating data

Vol[cfm]	1000
dp[inWG]	0,01

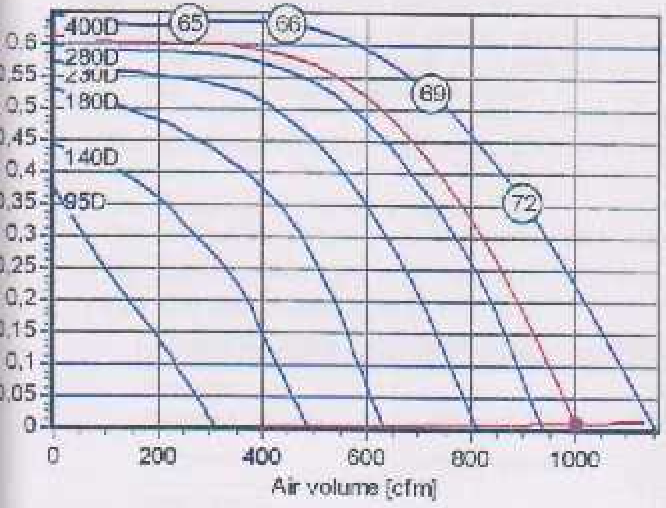
Requested operating point

Vol[cfm]	1000
dp[inWG]	0,01
dp(dyn)[inWG]	0,21
U[V]	317
P[kW]	0,27
I[A]	0,62
n[1/min]	733
eta[%]	0,0
Lw6[dBA]	69,5

Nominal data

Art.	B10-25043
U[V]	400 D
f[Hz]	50
P[kW]	0.33
I[A]	0.70
n[1/min]	820
C[µF]	-
tR[°C]	50
Pst min[Pa]	-
Delta I[%]	-
Ia/In	2,1
Weight [kg]	15
Connection	01.006

...es:



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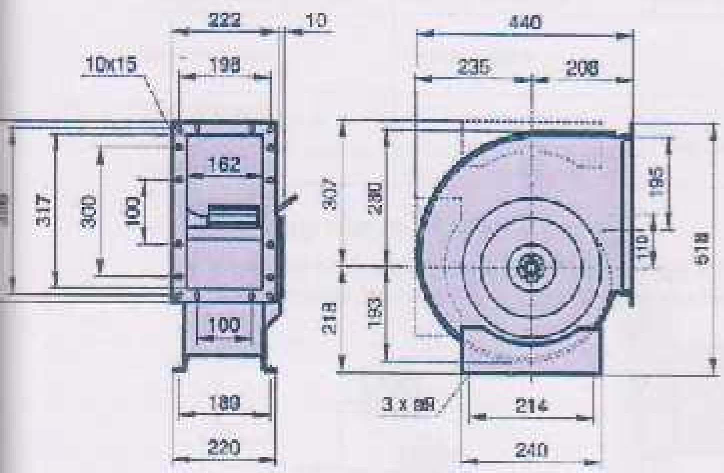


...es [dBA]

	125Hz	250Hz	500Hz	1kHz	2kHz	4kHz	8kHz	Total
LwA6	47	60	64	64	64	62	55	69,5
LwA5	47	49	59	62	62	59	51	66,5

LwA6: Free outlet sound power level
LwA5: Free inlet sound power level

REFRIGERANT PIPING WORKS

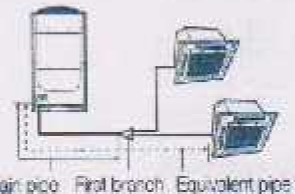
> ⚠ When installing, make sure there is no leakage. When recovering the refrigerant, ground the compressor first before removing the connection pipe.
> If the refrigerant pipe is not properly connected and the compressor works with the service valve open, the pipe inhales the air and it makes the pressure inside of the refrigerant cycle abnormally high. It may cause explosion and injury.

- The piping length between the outdoor unit and the indoor unit may not exceed the allowable piping length.
- The pressure of the R410A is high.
  Use only certified refrigerant pipe and follow the installation method.
- Use clean refrigerant pipe which there is no harmful ion, oxide, dust, iron content or moisture inside pipe.
- Use tools and accessories fit on R410A.

Tool	Work	If compatible with conventional tool	
Pipe cutter	Refrigerant pipe work	Pipe cutting	Compatible
Flaring tool		Pipe flaring	
Refrigerant oil		Apply refrigerant oil on flared part	Ester series oil, alkali benzene oil or synthetic oil
Torque wrench		Connect flare joint with pipe	Compatible
Pipe bender		Pipe bending	
Nitrogen gas	Air tightening test	Inhibition of oxidization	
Brazing tool		Pipe brazing	
Gauge manifold	Air tightening test ~ additional refrigerant charging	Vacuuming, charging and checking operation	Exclusive
Refrigerant charging hose			
Vacuum pump	Vacuuming unit		Use one which has a check valve and 5 torr degree of vacuum.
Electronic scale			Compatible
Gas leak detector		Gas leak test	Exclusive
Flare joint	Use indoor unit's only		

Selecting the refrigerant pipe

- **When the equivalent pipe length from outdoor unit to the farthest indoor unit is over 90m, the main pipe (both liquid and gas pipe) has to be increased with 1 size like below table.**



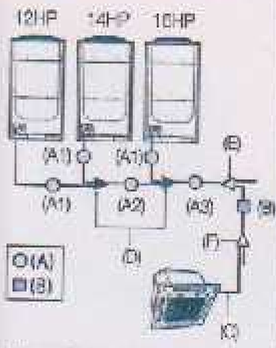
※ Main pipe : from outdoor unit to the first branch joint.

The pipe length between outdoor and the farthest indoor unit	
Below 90m	**90m and over**
ø9.52	ø12.70
ø12.70	ø15.88
ø15.88	ø19.05
ø19.05	ø22.23
ø22.23	ø25.40
ø25.40	ø28.58
ø28.58	ø31.75
ø31.75	ø38.10
ø38.10	ø44.45
ø44.45	ø50.80

installing the unit

REFRIGERANT PIPING WORKS

Pipe selection for DVM PLUS IV



* Example) 42HP of compact combinations

HP	Mark	Pipe size (O. D.mm)	
		Liquid	Gas
12	(A1)	Ø12.70	Ø25.40
14	(A1)	Ø12.70	Ø25.40
16	(A1)	Ø12.70	Ø28.58
26	(A2)	Ø19.05	Ø31.75
42	(A3)	Ø19.05	Ø38.10

Outdoor unit connection pipe size : (A1), (A2), (A3)

A1 : Select the pipes according to the outdoor unit capacity with following table.
A2 : Select the pipes according to sum of outdoor unit capacities behind the outdoor joint with following table.
A3 : Select the main pipe of outdoor units with the following table.

Outdoor unit	Pipe size (O.D. mm), (A)		Oil balancing pipe size
	Liquid	Gas	
8HP	Ø9.52	Ø19.05	Ø6.35
10HP		Ø22.23	
12HP	Ø12.70	Ø25.40	
14HP			
16HP		Ø28.58	
18HP	Ø15.88		
20HP			
22HP			
24HP			
28~30HP	Ø19.05	Ø31.75	
32~34HP			
36~48HP		Ø38.10	
50~60HP	Ø22.23	Ø44.45	

*A1 : Pipes to the outdoor unit (Liquid, Gas)
*A2 : Pipes between outdoor joint kits (Liquid, Gas)
*A3 : Main pipes (Liquid, Gas)

Pipe size between branch joints : (B)

Select the pipe size according to the capacity sum of indoor units which are connected below this pipe.

Total indoor unit's capacity	Pipe size (O. D. mm)	
	Liquid	Gas
15.0kW and below	Ø9.52	Ø15.88
Over 15.0~23.2kW and below		Ø19.05
Over 23.2~29.0kW and below		Ø22.23
Over 29.0~40.6kW and below	Ø12.70	Ø25.40
Over 40.6~46.4kW and below		Ø28.58
Over 46.4~69.6kW and below	Ø15.88	
Over 69.6~98.6kW and below	Ø19.05	Ø31.75
Over 98.6~139.2kW and below		Ø38.10
Over 139.2kW	Ø22.23	Ø44.45

Pipe size between branch joints and indoor unit (C)

Select the pipe size according to the indoor unit's capacity.

Indoor unit's capacity	Pipe size (O. D. mm)	
	Liquid	Gas
2.0~5.6kW	Ø6.35	Ø12.70
7.2~14.5kW	Ø9.52	Ø15.88

Branch joint : (D), (E), (F)

■ Branch joint of outdoor unit's multi connection (D)

Outdoor multi connection branch joint (D)	Model	Capacity of outdoor
	MXJ-T3819*	Below 48 HP
	MXJ-T4422*	Above 50 HP

■ First branch joint (E)
Select branch joint according to the outdoor unit's capacity.

	Outdoor unit	Model
Y-joint (E)	8~14HP	MXJ-YA2512*
	16HP	MXJ-YA2812*
	18~24HP	MXJ-YA2815*
	26~34HP	MXJ-YA3119*
	36~48HP	MXJ-YA3819*
	50~60HP	MXJ-YA4422*

■ Branch joint (F)
Select the pipe size according to the capacity sum of indoor units which are connected below this pipe.

1) Y-joint

	Model	Total indoor unit's capacity
Y-joint (F)	MXJ-YA1509*	15.0kW and below
	MXJ-YA2512*	Over 15.0~40.6kW and below
	MXJ-YA2812*	Over 40.6~46.4kW and below
	MXJ-YA2815*	Over 46.4~69.6kW and below
	MXJ-YA3119*	Over 69.6~98.6kW and below
	MXJ-YA3819*	Over 98.6~139.2kW and below
	MXJ-YA4422*	Over 139.2kW

2) Header joint

	Model	Total indoor unit's capacity	The connectable quantity of indoor units
Header joint (F)	MXJ-HA2512*	0~46.4kW and below	4
	MXJ-HA3115*	Over 46.4kW ~69.6kW and below	8
	MXJ-HA3815*	Over 69.6kW	8

Water Booster / Storage Tanks

74
STD C22.2 No.110-94

Heat-Flo
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Uxbridge, MA 0156
Tel: 508-278-240
Fax: 508-278-246
www.heat-flo.com

VRF

Technical Data Book

DVM S for America (Capacity, HP & HR, 60Hz)

SAMSUNG

DVM Capacity

Capacity table

2FXVA*****

g

TC : Total Capacity, PI : Power Input

on, % [Index]	Outdoor temperature (°F, DB)	Indoor temperature (°F, WB) 57.0 TC MBH	57.0 PI kW	61.0 TC MBH	61.0 PI kW	64.0 TC MBH	64.0 PI kW	67.0 TC MBH	67.0 PI kW	70.0 TC MBH	70.0 PI kW	72.0 TC MBH	72.0 PI kW	75.0 TC MBH	75.0 PI kW
	50.0	68.50	2.25	78.30	2.60	93.70	2.99	98.70	3.16	105.80	3.40	113.60	3.60	123.30	3.88
	54.0	68.00	2.30	78.70	2.68	91.50	3.07	97.90	3.24	104.70	3.47	112.60	3.69	122.30	4.01
	58.0	65.40	2.38	78.00	2.75	91.20	3.15	97.10	3.31	103.90	3.56	111.60	3.78	121.30	4.10
	60.0	64.80	2.43	77.30	2.82	90.20	3.24	96.10	3.40	102.80	3.63	110.60	3.85	120.10	4.20
	64.0	64.10	2.49	76.50	2.90	89.30	3.32	95.10	3.45	101.80	3.71	109.40	3.97	118.90	4.28
	67.0	63.40	2.57	75.60	2.96	88.30	3.43	94.00	3.53	100.60	3.82	108.10	4.09	117.50	4.41
	70.0	62.90	2.65	75.10	3.06	87.70	3.53	93.40	3.70	99.90	3.96	107.40	4.21	116.70	4.53
	73.0	62.20	2.83	74.20	3.28	86.60	3.75	92.30	3.92	98.70	4.16	106.10	4.46	115.30	4.75
	77.0	61.20	2.99	73.00	3.47	85.30	3.90	90.60	4.14	97.20	4.37	104.40	4.69	113.50	5.04
	80.0	60.30	3.23	72.00	3.74	84.10	4.28	89.60	4.40	95.80	4.70	102.90	5.01	111.80	5.40
	84.0	58.80	3.48	70.70	4.00	82.60	4.57	87.80	4.76	94.10	5.01	101.10	5.37	109.80	5.75
	88.0	58.30	3.73	69.50	4.30	81.20	4.81	86.50	5.10	92.50	5.36	99.40	5.74	108.10	6.14
	92.0	57.10	3.98	68.10	4.56	79.50	5.22	84.70	5.41	90.60	5.57	97.40	6.00	105.90	6.45
	95.0	55.90	4.21	66.70	4.89	77.80	5.50	82.90	5.69	88.70	5.90	95.40	6.35	103.70	6.80
	99.0	54.70	4.48	65.30	5.10	76.20	5.80	81.20	6.00	86.80	6.26	93.30	6.68	101.60	7.14
	103.0	53.40	4.85	63.70	5.50	74.30	6.28	79.20	6.43	84.70	6.75	91.10	7.10	99.00	7.58
	50.0	62.40	2.22	74.40	2.56	86.60	2.90	92.40	3.12	98.00	3.32	104.40	3.49	108.00	3.66
	54.0	62.40	2.28	74.40	2.66	86.60	3.04	92.40	3.20	98.00	3.40	104.40	3.58	108.00	3.75
	58.0	62.40	2.34	74.40	2.75	86.60	3.12	92.40	3.28	98.00	3.48	104.40	3.68	108.00	3.83
	60.0	62.40	2.40	74.40	2.80	86.60	3.20	92.40	3.36	98.00	3.55	104.40	3.75	108.00	3.91
	64.0	61.90	2.48	73.90	2.86	85.80	3.28	91.30	3.44	96.80	3.63	103.70	3.85	107.70	3.98
	67.0	60.30	2.56	72.50	2.97	84.60	3.40	90.70	3.55	95.60	3.74	101.90	3.98	106.40	4.12
	70.0	60.50	2.62	72.20	3.05	84.30	3.49	89.70	3.65	95.10	3.84	101.30	4.00	105.60	4.22
	73.0	59.70	2.76	71.20	3.21	83.10	3.62	88.40	3.83	93.70	4.02	99.90	4.28	104.30	4.42
	77.0	58.80	2.87	70.10	3.44	81.80	3.86	87.10	4.11	92.30	4.30	98.40	4.58	102.60	4.72
	80.0	57.80	3.19	69.00	3.69	80.50	4.22	85.70	4.30	90.80	4.56	96.80	4.88	101.10	5.02
	84.0	57.10	3.42	68.10	3.95	79.00	4.52	84.50	4.69	89.50	4.89	95.50	5.20	99.80	5.36
	88.0	56.10	3.68	66.90	4.24	78.10	4.84	83.10	5.02	87.90	5.21	93.90	5.55	98.00	5.71
	92.0	55.50	3.87	65.80	4.45	76.60	5.08	81.60	5.28	86.40	5.48	92.10	5.75	96.10	6.06
	95.0	53.90	4.08	64.30	4.66	75.10	5.33	79.90	5.51	84.70	5.71	90.30	6.04	94.30	6.22
	99.0	52.80	4.32	63.00	4.95	73.60	5.62	78.30	5.80	83.00	6.00	88.40	6.33	92.40	6.59
	103.0	51.70	4.71	61.70	5.38	72.00	6.10	76.60	6.29	81.20	6.49	86.60	6.83	90.40	7.04
	50.0	54.90	2.08	65.50	2.42	77.00	2.79	82.00	2.94	87.00	3.14	97.00	3.44	101.60	3.62
	54.0	54.90	2.13	65.60	2.48	77.00	2.86	82.00	3.01	87.00	3.20	97.00	3.53	101.60	3.70
	58.0	54.90	2.19	65.60	2.56	77.00	2.94	82.00	3.10	87.00	3.28	97.00	3.63	101.60	3.80
	60.0	54.90	2.26	65.60	2.63	77.00	3.03	82.00	3.18	87.00	3.37	97.00	3.73	101.60	3.86
	64.0	54.90	2.32	65.60	2.71	77.00	3.12	82.00	3.27	87.00	3.46	97.00	3.83	101.60	3.96
	67.0	54.90	2.42	65.60	2.81	77.00	3.24	82.00	3.38	87.00	3.58	95.40	3.95	101.60	4.12
	70.0	54.90	2.47	65.60	2.88	77.00	3.31	82.00	3.45	87.00	3.66	95.90	4.01	101.60	4.21
	73.0	54.90	2.61	65.60	3.00	77.00	3.49	82.00	3.55	87.00	3.83	94.50	4.15	100.70	4.37
	77.0	54.90	2.82	65.60	3.26	77.00	3.77	82.00	3.93	87.00	4.13	93.10	4.41	99.20	4.64
	80.0	54.90	3.10	65.60	3.59	77.00	4.13	82.00	4.30	86.50	4.47	91.60	4.73	97.60	4.97
	84.0	54.80	3.32	65.00	3.84	77.00	4.41	82.00	4.59	85.30	4.70	90.30	4.95	96.30	5.21
	88.0	54.10	3.57	64.50	4.12	75.60	4.73	80.70	4.91	83.90	5.01	88.70	5.28	94.70	5.56
	92.0	53.20	3.75	63.50	4.32	74.60	4.95	79.40	5.13	82.30	5.21	87.20	5.48	92.50	5.76
	95.0	52.50	3.98	62.40	4.57	73.30	5.23	77.90	5.41	80.70	5.47	85.50	5.75	91.10	6.04
	99.0	51.30	4.21	61.20	4.87	71.90	5.52	76.50	5.69	79.10	5.74	83.90	6.02	89.20	6.32
	103.0	50.10	4.58	59.80	5.23	72.40	5.98	74.80	6.16	77.40	6.09	82.00	6.49	87.40	6.85
	50.0	48.90	1.93	58.20	2.25	67.80	2.56	72.00	2.65	76.50	2.87	85.20	3.18	90.90	3.50
	54.0	48.90	1.98	58.20	2.31	67.80	2.63	72.00	2.71	76.50	2.94	85.20	3.24	90.90	3.56
	58.0	48.90	2.06	58.20	2.39	67.80	2.73	72.00	2.81	76.50	3.05	85.20	3.36	90.90	3.70
	60.0	48.90	2.12	58.20	2.47	67.80	2.82	72.00	2.98	76.50	3.16	85.20	3.47	90.90	3.81
	64.0	48.90	2.20	58.20	2.55	67.80	2.91	72.00	3.06	76.50	3.23	85.20	3.56	90.90	3.91
	67.0	48.90	2.30	58.20	2.67	67.80	3.05	72.00	3.16	76.50	3.37	85.20	3.74	90.90	4.06
	70.0	48.90	2.37	58.20	2.75	67.80	3.14	72.00	3.28	76.50	3.45	85.20	3.84	90.90	4.19
	73.0	48.90	2.49	58.20	2.89	67.80	3.30	72.00	3.44	76.50	3.62	85.20	4.02	92.50	4.34
	77.0	48.90	2.66	58.20	3.08	67.80	3.51	72.00	3.66	76.50	3.84	85.20	4.27	91.40	4.52
	80.0	48.90	2.86	58.20	3.31	67.80	3.77	72.00	3.90	76.50	4.13	85.20	4.56	90.00	4.75
	84.0	48.90	3.06	58.20	3.53	67.80	4.02	72.00	4.17	76.50	4.38	85.20	4.84	88.70	4.97
	88.0	48.90	3.27	58.20	3.76	67.80	4.28	72.00	4.44	76.50	4.63	85.20	5.13	87.40	5.19
	92.0	48.90	3.50	58.20	4.02	67.80	4.58	72.00	4.73	76.50	4.93	84.20	5.38	86.10	5.44
	95.0	48.90	3.74	58.20	4.29	67.80	4.87	72.00	5.03	76.50	5.22	82.40	5.55	84.40	5.63
	99.0	48.90	4.07	58.20	4.65	67.80	5.28	71.20	5.20	75.60	5.57	80.70	5.55	82.30	5.92
	103.0	48.80	4.54	58.10	5.17	67.30	5.81	70.50	5.06	74.10	6.03	77.90	6.26	79.20	6.30
	50.0	44.60	1.65	53.10	1.95	62.30	2.25	66.50	2.32	69.80	2.50	77.90	2.75	85.90	3.06
	54.0	44.60	1.72	53.10	2.01	62.30	2.30	66.50	2.37	69.80	2.55	77.90	2.82	85.90	3.12
	58.0	44.60	1.77	53.10	2.06	62.30	2.38	66.50	2.43	69.80	2.62	77.90	2.90	85.90	3.19
	60.0	44.60	1.83	53.10	2.13	62.30	2.45	66.50	2.54	69.80	2.70	77.90	2.98	85.90	3.29
	64.0	44.60	1.89	53.10	2.20	62.30	2.52	66.50	2.62	69.80	2.78	77.90	3.08	85.90	3.38
	67.0	44.60	1.98	53.10	2.30	62.30	2.64	66.50	2.74	69.80	2.89	77.20	3.22	85.90	3.52
	70.0	44.60	2.05	53.10	2.38	62.30	2.71	66.50	2.80	69.80	2.98	77.90	3.30	85.90	3.60
	73.0	44.60	2.13	53.10	2.47	62.30	2.84	66.50	2.93	69.80	3.09	77.90	3.44	85.90	3.78
	77.0	44.60	2.25	53.10	2.61	62.30	2.99	66.50	3.09	69.80	3.25	77.90	3.58	85.90	3.94
	80.0	44.60	2.42	53.10	2.79	62.30	3.21	66.50	3.30	69.80	3.47	77.90	3.86	85.90	4.20
	84.0	44.60	2.59	53.10	2.98	62.30	3.42	66.50	3.52	69.80	3.68	77.90	4.10	85.90	4.46
	88.0	44.60	2.73	53.10	3.18	62.30	3.64	66.50	3.74	69.80	3.91	77.90	4.38	85.90	4.72
	92.0	44.60	2.95	53.10	3.39	62.30	3.88	66.50	3.96	69.80	4.15	77.90	4.61	85.90	5.01
	95.0	44.60	3.15	53.10	3.62	62.30	4.15	66.50	4.24	69.80	4.42	77.90	4.88	84.00	5.19
	99.0	44.60	3.41	53.10	3.90	62.30	4.45	66.50	4.47	69.80	4.72	77.90	5.22	81.60	5.41
	103.0	44.60	3.77	53.10	4.30	62.30	4.90	66.50	4.89	69.60	5.16	76.50	5.61	79.60	5.71
	50.0	40.30	1.44	47.80	1.68	55.70	1.91	58.30	1.99	62.40	2.12	69.60	2.34	77.00	2.61
	54.0	40.30	1.47	47.80	1.71	55.70	1.94	58.30	2.02	62.40	2.15	69.60	2.38	77.00	2.64
	58.0	40.30	1.48	47.80	1.75	55.70	1.97	58.30	2.04	62.40	2.19	69.60	2.42	77.00	2.67
	60.0	40.30	1.55	47.80	1.79	55.70	2.05	58.30	2.12	62.40	2.28	69.60	2.50	77.00	2.70
	64.0	40.30	1.59	47.80	1.85	55.70	2.11	58.30	2.18	62.40	2.32	69.60	2.58	77.00	2.85

Capacity table

2FXVA*****

TC : Total Capacity, PI : Power Input

...n, % ...index)	Outdoor temperature (°F, DB)	Indoor temperature (°F, WB) 57.0		61.0		64.0		67.0		70.0		72.0		75.0	
		TC	PI	TC	PI	TC	PI	TC	PI	TC	PI	TC	PI	TC	PI
		MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW
	67.0	40.30	1.67	47.80	1.83	55.70	2.20	58.30	2.27	62.40	2.41	69.60	2.68	77.00	2.64
	70.0	40.30	1.70	47.80	1.87	55.70	2.28	58.30	2.32	62.40	2.48	69.60	2.74	77.00	3.00
	73.0	40.30	1.78	47.80	2.08	55.70	2.36	58.30	2.42	62.40	2.55	69.60	2.88	77.00	3.12
	77.0	40.30	1.87	47.80	2.15	55.70	2.46	58.30	2.50	62.40	2.67	69.60	2.97	77.00	3.25
	80.0	40.30	2.00	47.80	2.30	55.70	2.63	58.30	2.65	62.40	2.84	69.60	3.15	77.00	3.45
	84.0	40.30	2.14	47.80	2.45	55.70	2.81	58.30	2.87	62.40	3.02	69.60	3.36	77.00	3.67
	88.0	40.30	2.28	47.80	2.62	55.70	2.99	58.30	3.05	62.40	3.20	69.60	3.58	77.00	3.88
	92.0	40.30	2.44	47.80	2.80	55.70	3.16	58.30	3.24	62.40	3.40	69.60	3.77	77.00	4.11
	95.0	40.30	2.62	47.80	2.96	55.70	3.40	58.30	3.40	62.40	3.62	69.60	4.01	77.00	4.37
	99.0	40.30	2.80	47.80	3.14	55.70	3.67	58.30	3.66	62.40	3.84	69.60	4.24	77.00	4.63
	103.0	40.30	3.07	47.80	3.43	55.70	3.76	58.30	4.01	62.40	4.17	69.60	4.60	77.00	5.02
	50.0	35.80	1.15	42.40	1.39	49.10	1.57	51.10	1.62	55.00	1.75	61.20	1.82	68.50	2.16
	54.0	35.80	1.23	42.40	1.43	49.10	1.62	51.10	1.67	55.00	1.80	61.20	1.89	68.50	2.20
	58.0	35.80	1.26	42.40	1.46	49.10	1.65	51.10	1.71	55.00	1.84	61.20	2.03	68.50	2.26
	60.0	35.80	1.32	42.40	1.53	49.10	1.70	51.10	1.78	55.00	1.91	61.20	2.11	68.50	2.33
	64.0	35.80	1.37	42.40	1.58	49.10	1.80	51.10	1.85	55.00	1.98	61.20	2.19	68.50	2.43
	67.0	35.80	1.43	42.40	1.65	49.10	1.87	51.10	1.92	55.00	2.05	61.20	2.27	68.50	2.52
	70.0	35.80	1.48	42.40	1.69	49.10	1.91	51.10	1.96	55.00	2.09	61.20	2.32	68.50	2.57
	73.0	35.80	1.53	42.40	1.76	49.10	2.03	51.10	2.04	55.00	2.18	61.20	2.42	68.50	2.67
	77.0	35.80	1.59	42.40	1.85	49.10	2.07	51.10	2.11	55.00	2.26	61.20	2.49	68.50	2.76
	80.0	35.80	1.66	42.40	1.93	49.10	2.18	51.10	2.22	55.00	2.36	61.20	2.67	68.50	2.89
	84.0	35.80	1.74	42.40	2.00	49.10	2.26	51.10	2.30	55.00	2.44	61.20	2.70	68.50	2.99
	88.0	35.80	1.85	42.40	2.11	49.10	2.39	51.10	2.43	55.00	2.57	61.20	2.94	68.50	3.14
	92.0	35.80	1.97	42.40	2.26	49.10	2.55	51.10	2.58	55.00	2.73	61.20	3.01	68.50	3.32
	95.0	35.80	2.12	42.40	2.42	49.10	2.72	51.10	2.70	55.00	2.90	61.20	3.20	68.50	3.50
	99.0	35.80	2.31	42.40	2.63	49.10	2.97	51.10	3.00	55.00	3.15	61.20	3.47	68.50	3.82
	103.0	35.80	2.52	42.40	2.85	43.00	3.21	51.10	3.24	55.00	3.40	61.10	3.73	68.50	4.12
	50.0	31.20	0.93	36.90	1.08	42.60	1.22	43.90	1.25	47.60	1.36	53.10	1.49	59.70	1.69
	54.0	31.20	0.95	36.90	1.10	42.60	1.26	43.90	1.27	47.60	1.38	53.10	1.52	59.70	1.72
	58.0	31.20	0.97	36.90	1.12	42.60	1.27	43.90	1.29	47.60	1.40	53.10	1.55	59.70	1.74
	60.0	31.20	1.00	36.90	1.15	42.60	1.30	43.90	1.33	47.60	1.44	53.10	1.56	59.70	1.78
	64.0	31.20	1.02	36.90	1.18	42.60	1.33	43.90	1.35	47.60	1.49	53.10	1.59	59.70	1.81
	67.0	31.20	1.05	36.90	1.21	42.60	1.37	43.90	1.36	47.60	1.50	53.10	1.63	59.70	1.85
	70.0	31.20	1.07	36.90	1.24	42.60	1.43	43.90	1.42	47.60	1.53	53.10	1.70	59.70	1.88
	73.0	31.20	1.13	36.90	1.30	42.60	1.47	43.90	1.49	47.60	1.60	53.10	1.78	59.70	1.97
	77.0	31.20	1.17	36.90	1.36	42.60	1.53	43.90	1.54	47.60	1.66	53.10	1.84	59.70	2.04
	80.0	31.20	1.23	36.90	1.42	42.60	1.60	43.90	1.62	47.60	1.73	53.10	1.92	59.70	2.13
	84.0	31.20	1.29	36.90	1.48	42.60	1.57	43.90	1.69	47.60	1.80	53.10	2.00	59.70	2.22
	88.0	31.20	1.37	36.90	1.57	42.60	1.72	43.90	1.78	47.60	1.90	53.10	2.11	59.70	2.33
	92.0	31.20	1.45	36.90	1.69	42.50	1.87	43.90	1.88	47.60	2.00	53.10	2.21	59.70	2.46
	95.0	31.20	1.56	36.90	1.78	42.60	2.00	43.90	2.01	47.60	2.13	53.10	2.33	59.70	2.61
	99.0	31.20	1.66	36.90	1.92	42.60	2.15	43.90	2.15	47.60	2.26	53.10	2.52	59.70	2.79
	103.0	31.20	1.84	36.90	2.08	42.60	2.34	43.90	2.34	47.60	2.47	53.10	2.72	59.70	3.02
	50.0	26.40	0.71	31.10	0.82	35.90	0.82	36.60	0.83	40.30	1.03	45.10	1.14	50.90	1.29
	54.0	26.40	0.72	31.10	0.83	35.80	0.85	36.60	0.84	40.30	1.04	45.10	1.15	50.90	1.30
	58.0	26.40	0.73	31.10	0.84	35.90	0.86	36.60	0.86	40.30	1.05	45.10	1.16	50.90	1.31
	60.0	26.40	0.73	31.10	0.85	35.90	0.96	36.60	0.96	40.30	1.06	45.10	1.18	50.90	1.32
	64.0	26.40	0.74	31.10	0.86	35.90	0.97	36.60	0.97	40.30	1.07	45.10	1.19	50.90	1.33
	67.0	26.40	0.76	31.10	0.87	35.90	0.98	36.60	0.98	40.30	1.08	45.10	1.20	50.90	1.35
	70.0	26.40	0.77	31.10	0.88	35.90	1.02	36.60	1.01	40.30	1.10	45.10	1.23	50.90	1.37
	73.0	26.40	0.82	31.10	0.94	35.90	1.06	36.60	1.05	40.30	1.16	45.10	1.29	50.90	1.44
	77.0	26.40	0.86	31.10	0.98	35.90	1.11	36.60	1.11	40.30	1.23	45.10	1.34	50.90	1.50
	80.0	26.40	0.89	31.10	1.02	35.90	1.16	36.60	1.16	40.30	1.28	45.10	1.40	50.90	1.56
	84.0	26.40	0.94	31.10	1.08	35.90	1.21	36.60	1.21	40.30	1.31	45.10	1.46	50.90	1.63
	88.0	26.40	1.00	31.10	1.14	35.90	1.30	36.60	1.28	40.30	1.38	45.10	1.54	50.90	1.72
	92.0	26.40	1.05	31.10	1.20	35.90	1.35	36.60	1.34	40.30	1.44	45.10	1.61	50.90	1.79
	95.0	26.40	1.12	31.10	1.29	35.90	1.45	36.60	1.44	40.30	1.54	45.10	1.71	50.90	1.91
	99.0	26.40	1.21	31.10	1.37	35.60	1.54	36.60	1.53	40.30	1.64	45.10	1.86	50.90	2.02
	103.0	26.40	1.33	31.10	1.50	35.60	1.60	36.60	1.65	40.30	1.79	45.10	1.97	50.60	2.10

Capacity table

2FXVA*****

TC : Total Capacity, PI : Power Input

tion, % y index)	Outdoor temperature (°F)		Indoor temperature (°F, DB) 60.0		65.0		70.0		72.0		75.0	
	DB	WB	TC MBH	PI kW	TC MBH	PI kW	TC MBH	PI kW	TC MBH	PI kW	TC MBH	PI kW
	60.0	56.0	111.15	4.91	103.80	4.79	98.20	4.73	93.50	4.78	88.60	4.91
	57.0	53.0	110.80	5.03	103.70	4.90	98.20	4.85	93.50	4.91	89.00	5.04
	54.0	50.0	110.90	5.17	103.70	5.03	98.20	4.99	93.50	5.05	89.80	5.18
	51.0	47.0	111.00	5.43	103.90	5.28	98.20	5.23	93.50	5.30	89.80	5.44
	47.0	43.0	111.10	5.79	103.80	5.60	98.20	5.55	93.50	5.61	89.80	5.75
	44.0	40.0	109.30	5.91	103.30	5.79	97.90	5.77	93.50	5.88	89.80	6.01
	39.0	35.0	109.10	6.02	102.50	5.89	97.70	5.96	93.50	6.12	88.80	6.25
	35.0	32.0	105.00	6.15	100.30	6.15	95.50	6.24	92.20	6.36	86.90	6.51
	30.0	28.0	103.90	6.29	98.70	6.37	93.30	6.53	89.80	6.62	87.90	6.79
	26.0	24.0	99.80	6.85	93.80	6.94	89.20	7.06	87.30	7.52	84.50	7.71
	23.0	21.0	97.60	7.36	91.70	7.31	86.60	7.38	84.60	8.08	82.00	8.34
	19.0	18.0	94.10	7.56	89.60	7.55	84.40	7.56	82.80	8.24	80.70	8.56
	17.0	15.0	90.60	7.46	88.10	7.50	82.00	7.48	80.30	8.09	78.10	8.36
	13.0	12.0	87.20	7.34	83.70	7.42	79.70	7.38	77.60	7.95	75.40	8.14
	10.0	9.0	84.20	7.23	81.10	7.38	77.20	7.36	75.30	7.83	73.00	8.11
	6.0	5.0	77.80	7.15	78.30	7.17	73.50	7.18	71.10	7.61	68.70	7.78
	2.0	1.0	75.40	7.00	73.40	7.06	70.90	7.09	68.30	7.53	66.50	7.76
	-1.8	-2.2	72.20	6.77	70.50	6.86	68.70	6.57	65.20	7.28	64.00	7.57
	-3.8	-4.0	69.10	6.52	67.70	6.66	65.60	6.85	63.90	7.17	61.50	7.34
	-7.1	-7.6	67.10	6.52	62.80	6.35	57.80	6.13	55.50	6.44	53.20	6.54
	-12.6	-13.0	59.20	6.08	58.70	5.95	51.60	5.76	48.90	6.03	48.90	6.06
	60.0	56.0	105.30	4.82	98.00	4.67	92.30	4.61	88.00	4.67	84.20	4.76
	57.0	53.0	105.30	4.97	98.00	4.81	92.30	4.75	88.00	4.81	84.20	4.92
	54.0	50.0	105.00	5.13	97.90	4.97	92.30	4.91	88.00	4.97	84.20	5.09
	51.0	47.0	105.10	5.38	97.90	5.22	92.30	5.15	88.00	5.22	84.20	5.34
	47.0	43.0	105.10	5.69	97.90	5.51	92.30	5.44	88.00	5.51	84.20	5.64
	44.0	40.0	105.00	5.89	97.90	5.71	92.30	5.64	87.90	5.71	84.10	5.85
	39.0	35.0	103.40	6.05	97.20	5.94	92.30	5.90	87.70	5.96	84.10	6.11
	35.0	32.0	101.90	6.21	96.00	6.11	92.20	6.12	87.70	6.19	83.60	6.25
	30.0	28.0	100.40	6.39	95.60	6.32	92.10	6.36	87.70	6.43	83.60	6.67
	26.0	24.0	95.70	6.78	92.10	6.88	88.50	7.06	85.60	7.16	81.80	7.33
	23.0	21.0	92.80	7.25	89.70	7.34	87.30	7.51	82.40	7.82	80.10	8.16
	19.0	18.0	90.00	7.54	87.10	7.60	84.80	7.74	81.70	8.18	79.30	8.40
	17.0	15.0	87.60	7.62	84.80	7.66	82.40	7.80	79.20	8.20	78.10	8.39
	13.0	12.0	85.20	7.70	82.60	7.73	80.10	7.85	77.30	8.22	74.30	8.37
	10.0	9.0	82.70	7.60	79.60	7.64	77.10	7.79	73.60	7.99	70.80	8.15
	6.0	5.0	76.30	7.36	73.60	7.42	71.60	7.59	68.60	7.80	65.90	7.93
	2.0	1.0	72.40	7.11	69.90	7.19	68.60	7.41	66.20	7.61	62.90	7.74
	-1.8	-2.2	68.60	6.94	67.60	7.05	66.20	7.29	63.30	7.39	60.80	7.60
	-3.6	-4.0	66.80	6.86	65.10	6.86	63.60	7.14	61.20	7.27	58.70	7.46
	-7.1	-7.6	64.70	6.65	61.10	6.61	58.80	6.63	54.50	6.68	52.20	6.62
	-12.6	-13.0	57.20	6.19	54.20	6.20	50.60	6.15	48.40	6.24	46.10	6.36
	60.0	56.0	101.10	4.74	94.00	4.58	88.50	4.52	84.10	4.55	80.30	4.66
	57.0	53.0	101.10	4.88	94.00	4.73	88.50	4.66	84.10	4.71	80.30	4.81
	54.0	50.0	101.10	5.06	94.00	4.90	88.50	4.84	84.10	4.89	80.30	4.99
	51.0	47.0	101.10	5.30	94.00	5.15	88.50	5.08	84.10	5.13	80.30	5.24
	47.0	43.0	101.20	5.62	94.00	5.44	88.50	5.35	84.10	5.41	80.30	5.52
	44.0	40.0	101.20	5.80	94.00	5.61	88.50	5.53	84.70	5.62	80.50	5.72
	39.0	35.0	100.40	6.05	93.90	5.88	88.50	5.80	84.70	5.91	80.50	6.03
	35.0	32.0	99.40	6.11	93.80	6.02	88.50	6.01	84.40	6.09	80.40	6.20
	30.0	28.0	98.30	6.17	93.20	6.18	88.50	6.23	84.00	6.29	80.20	6.47
	26.0	24.0	96.90	6.38	90.90	6.61	86.90	6.76	84.20	6.85	80.30	6.93
	23.0	21.0	91.70	6.83	88.80	6.93	85.80	7.22	82.00	7.80	78.70	7.79
	19.0	18.0	89.00	7.28	85.00	7.40	84.00	7.64	80.00	8.00	76.70	8.26
	17.0	15.0	86.20	7.59	83.40	7.58	81.30	7.82	77.30	8.05	74.00	8.27
	13.0	12.0	83.30	7.71	80.60	7.73	78.70	8.00	74.70	8.00	71.30	8.20
	10.0	9.0	79.60	7.52	77.10	7.70	75.50	7.94	71.40	7.89	68.20	8.06
	6.0	5.0	75.50	7.30	71.30	7.45	69.50	7.75	66.10	7.77	63.80	7.92
	2.0	1.0	70.40	7.14	67.80	7.36	66.20	7.50	62.60	7.48	60.40	7.50
	-1.8	-2.2	67.80	7.02	65.30	7.21	63.50	7.45	60.80	7.41	58.60	7.48
	-3.6	-4.0	65.20	6.90	62.70	7.06	60.80	7.32	58.10	7.33	55.80	7.30
	-7.1	-7.6	62.60	6.81	59.50	6.88	55.80	6.89	53.60	6.84	51.40	6.67
	-12.6	-13.0	56.30	6.37	53.80	6.47	49.50	6.30	47.80	6.40	45.40	6.41
	60.0	56.0	93.60	4.54	86.50	4.37	81.00	4.28	77.00	4.32	73.10	4.39
	57.0	53.0	93.60	4.70	86.50	4.52	81.00	4.43	77.00	4.47	73.10	4.55
	54.0	50.0	93.50	4.92	86.50	4.73	81.00	4.64	77.00	4.66	73.10	4.76
	51.0	47.0	93.50	5.19	86.50	4.96	81.00	4.85	77.00	4.91	73.10	4.99
	47.0	43.0	93.60	5.42	86.50	5.22	81.00	5.11	77.00	5.16	73.10	5.24
	44.0	40.0	93.60	5.58	86.50	5.39	81.00	5.24	77.00	5.29	73.10	5.38
	39.0	35.0	93.50	5.81	86.50	5.59	81.00	5.46	77.00	5.52	73.10	5.62
	35.0	32.0	93.20	5.98	86.40	5.77	81.00	5.66	77.00	5.71	73.10	5.80
	30.0	28.0	92.90	6.15	86.20	5.95	81.00	5.86	77.00	5.91	73.10	6.08
	26.0	24.0	90.50	6.38	85.70	6.24	81.00	6.41	77.00	6.47	73.10	6.57
	23.0	21.0	88.20	6.71	83.40	6.74	81.00	6.86	77.00	6.95	73.60	7.09
	19.0	18.0	86.00	6.54	82.10	6.95	79.70	7.26	77.30	7.46	73.10	7.49
	17.0	15.0	83.20	6.99	79.70	7.12	77.60	7.51	75.00	7.35	71.40	7.72
	13.0	12.0	80.60	7.15	77.40	7.32	75.40	7.79	73.40	7.54	68.70	7.99
	10.0	9.0	78.50	7.35	73.90	7.54	72.00	8.00	69.70	8.01	66.90	8.16
	6.0	5.0	73.60	7.62	69.20	7.81	66.50	8.18	65.00	8.12	62.80	8.26
	2.0	1.0	67.40	7.75	65.40	7.93	63.90	8.10	62.60	8.12	59.90	8.15
	-1.8	-2.2	65.00	7.87	63.20	7.81	60.90	8.21	60.20	7.90	57.50	8.02
	-3.6	-4.0	62.60	7.87	61.10	7.77	60.30	7.91	56.00	7.84	55.10	7.88
	-7.1	-7.6	57.80	7.30	55.20	7.25	54.30	7.12	51.10	7.24	49.90	7.36
	-12.6	-13.0	51.60	6.78	50.20	6.86	48.50	6.47	46.40	6.62	44.20	6.85
	60.0	56.0	84.20	4.16	77.80	3.99	72.90	3.91	69.30	3.95	65.80	4.01

Capacity table

2FXVA*****

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TC : Total Capacity, PI : Power Input

...ation, % (...ity index)	Outdoor temperature (°F)		Indoor temperature (°F, DB) 61.0		65.0		70.0		72.0		75.0	
			TC	PI	TC	PI	TC	PI	TC	PI	TC	PI
	DB	WB	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW
	57.0	53.0	84.20	4.29	77.90	4.13	72.90	4.05	69.30	4.08	65.80	4.15
	54.0	50.0	84.20	4.41	77.90	4.24	72.90	4.16	69.30	4.20	65.80	4.27
	51.0	47.0	84.20	4.63	77.90	4.45	72.90	4.36	69.30	4.40	65.80	4.47
	47.0	43.0	84.20	4.83	77.90	4.65	72.90	4.56	69.30	4.60	65.80	4.68
	44.0	40.0	84.20	5.03	77.90	4.84	72.90	4.74	69.30	4.76	65.80	4.86
	39.0	36.0	84.20	5.26	77.90	5.06	72.90	4.96	69.30	5.01	65.80	5.09
	35.0	32.0	84.20	5.42	77.90	5.22	72.90	5.11	69.30	5.16	65.80	5.24
	30.0	28.0	84.20	5.58	77.90	5.38	72.90	5.27	69.30	5.32	65.80	5.40
	26.0	24.0	84.20	5.83	77.90	5.71	72.90	5.56	69.30	5.72	65.80	5.81
	23.0	21.0	81.90	5.90	77.10	5.95	72.90	5.95	69.30	6.01	65.80	6.11
	19.0	18.0	78.90	6.04	74.80	6.07	72.00	6.27	69.30	6.33	65.80	6.43
	17.0	15.0	77.20	6.11	74.30	6.21	71.90	6.50	68.50	6.50	65.10	6.61
	13.0	12.0	75.50	6.18	72.70	6.37	70.80	6.75	67.80	6.69	64.40	6.80
	10.0	9.0	73.00	6.32	70.20	6.56	68.30	6.96	65.00	6.82	62.30	6.86
	6.0	5.0	68.30	6.57	65.70	6.81	63.80	7.13	61.80	7.23	58.80	7.27
	2.0	1.0	64.90	6.73	62.80	6.90	61.00	7.22	58.80	7.26	56.10	7.43
	-1.8	-2.2	62.50	6.80	60.60	7.01	58.70	7.27	56.60	7.34	53.90	7.49
	-3.8	-4.0	60.10	6.86	58.60	7.14	56.40	7.33	54.20	7.40	51.70	7.57
	-7.1	-7.6	56.20	6.53	53.70	6.76	51.80	6.95	49.80	7.01	47.70	7.21
	-12.6	-13.0	48.90	6.16	47.70	6.39	46.20	6.50	44.10	6.61	42.00	6.70
	60.0	56.0	74.90	3.76	69.20	3.62	64.80	3.55	61.60	3.59	58.50	3.64
	57.0	53.0	74.90	3.88	69.20	3.73	64.80	3.66	61.60	3.70	58.50	3.75
	54.0	50.0	74.90	3.99	69.20	3.84	64.80	3.76	61.60	3.80	58.50	3.86
	51.0	47.0	74.90	4.19	69.20	4.03	64.80	3.95	61.60	3.99	58.50	4.05
	47.0	43.0	74.90	4.40	69.20	4.23	64.80	4.15	61.60	4.19	58.50	4.26
	44.0	40.0	74.90	4.55	69.20	4.47	64.80	4.39	61.60	4.43	58.50	4.50
	39.0	36.0	74.90	4.83	69.20	4.63	64.80	4.54	61.60	4.58	58.50	4.66
	35.0	32.0	74.90	4.99	69.20	4.81	64.80	4.71	61.60	4.76	58.50	4.83
	30.0	28.0	74.50	5.19	69.20	4.99	64.80	4.89	61.60	4.94	58.50	5.02
	26.0	24.0	74.50	5.39	69.20	5.25	64.80	5.23	61.60	5.23	58.50	5.30
	23.0	21.0	72.10	5.45	69.20	5.41	64.80	5.47	61.60	5.53	58.50	5.61
	19.0	18.0	69.40	5.41	66.60	5.51	64.80	5.67	61.60	5.72	58.50	5.81
	17.0	15.0	67.80	5.50	65.00	5.61	63.40	5.77	60.80	5.88	58.10	5.95
	13.0	12.0	65.60	5.61	63.00	5.73	62.00	5.80	60.10	6.00	57.00	6.10
	10.0	9.0	64.40	5.64	62.60	5.80	60.70	6.02	59.40	6.14	57.50	6.24
	6.0	5.0	61.20	5.55	59.30	6.07	57.80	6.24	55.80	6.26	54.10	6.45
	2.0	1.0	59.40	5.54	57.00	6.07	55.60	6.26	53.90	6.29	52.20	6.44
	-1.8	-2.2	57.50	5.63	55.90	6.07	54.30	6.28	52.10	6.32	50.40	6.44
	-3.8	-4.0	55.10	5.62	54.20	6.08	52.70	6.29	50.50	6.20	48.80	6.43
	-7.1	-7.6	52.10	5.79	51.10	5.91	49.70	6.13	47.70	6.09	45.70	6.24
	-12.6	-13.0	46.20	5.48	45.60	5.61	44.50	5.84	42.60	5.76	40.50	5.88
	60.0	56.0	65.60	3.30	60.60	3.17	56.70	3.11	53.90	3.14	51.20	3.19
	57.0	53.0	65.60	3.39	60.60	3.26	56.70	3.20	53.90	3.23	51.20	3.28
	54.0	50.0	65.60	3.48	60.60	3.35	56.70	3.28	53.90	3.32	51.20	3.37
	51.0	47.0	65.60	3.63	60.60	3.49	56.70	3.42	53.90	3.45	51.20	3.51
	47.0	43.0	65.60	3.80	60.60	3.65	56.70	3.58	53.90	3.62	51.20	3.67
	44.0	40.0	65.60	4.00	60.60	3.85	56.70	3.78	53.90	3.81	51.20	3.87
	39.0	36.0	65.60	4.15	60.60	4.00	56.70	3.92	53.90	3.96	51.20	4.02
	35.0	32.0	65.60	4.30	60.60	4.14	56.70	4.06	53.90	4.09	51.20	4.16
	30.0	28.0	65.60	4.45	60.60	4.29	56.70	4.20	53.90	4.24	51.20	4.31
	26.0	24.0	65.60	4.70	60.60	4.58	56.70	4.45	53.90	4.53	51.20	4.60
	23.0	21.0	64.10	4.96	59.00	4.87	56.70	4.77	53.90	4.81	51.20	4.89
	19.0	18.0	62.60	5.04	59.00	5.00	56.70	5.03	53.90	5.07	51.20	5.15
	17.0	15.0	61.90	5.09	58.00	5.10	56.70	5.16	53.90	5.21	51.20	5.29
	13.0	12.0	61.10	5.13	58.10	5.20	56.70	5.30	53.90	5.35	51.20	5.43
	10.0	9.0	59.20	5.27	56.00	5.35	55.50	5.46	53.40	5.74	50.70	5.69
	6.0	5.0	57.00	5.37	55.10	5.53	53.70	5.73	51.80	5.79	48.90	5.80
	2.0	1.0	55.10	5.52	53.30	5.69	52.00	5.90	49.90	5.95	47.40	6.05
	-1.8	-2.2	54.00	5.53	52.20	5.69	50.80	5.91	48.80	5.98	46.40	6.06
	-3.8	-4.0	52.90	5.53	51.10	5.70	48.80	5.81	47.80	5.87	45.40	6.06
	-7.1	-7.6	49.40	5.23	47.50	5.45	46.10	5.66	44.30	5.71	42.40	5.85
	-12.6	-13.0	43.00	4.94	47.30	5.18	41.20	5.39	39.00	5.41	37.50	5.51
	60.0	56.0	58.20	2.83	51.90	2.72	48.60	2.67	45.20	2.70	43.90	2.74
	57.0	53.0	58.20	2.90	51.90	2.79	48.60	2.74	45.20	2.78	43.90	2.81
	54.0	50.0	58.20	2.98	51.90	2.86	48.60	2.81	45.20	2.83	43.90	2.88
	51.0	47.0	58.20	3.07	51.90	2.95	48.60	2.90	45.20	2.93	43.90	2.97
	47.0	43.0	58.20	3.20	51.90	3.08	48.60	3.02	45.20	3.05	43.90	3.10
	44.0	40.0	58.20	3.37	51.90	3.24	48.60	3.17	45.20	3.20	43.90	3.26
	39.0	36.0	58.20	3.50	51.90	3.37	48.60	3.30	45.20	3.33	43.90	3.38
	35.0	32.0	58.20	3.61	51.90	3.48	48.60	3.41	45.20	3.44	43.90	3.50
	30.0	28.0	58.20	3.74	51.90	3.60	48.60	3.53	45.20	3.56	43.90	3.62
	26.0	24.0	58.20	3.98	51.90	3.83	48.60	3.76	45.20	3.79	43.90	3.85
	23.0	21.0	58.00	4.25	51.80	4.09	48.60	4.02	45.20	4.05	43.90	4.12
	19.0	18.0	56.90	4.42	51.80	4.32	48.60	4.26	45.20	4.32	43.90	4.39
	17.0	15.0	55.30	4.49	51.50	4.41	48.60	4.41	45.20	4.45	43.90	4.52
	13.0	12.0	54.70	4.56	51.50	4.52	48.60	4.55	45.20	4.59	43.90	4.67
	10.0	9.0	53.70	4.78	51.10	4.81	48.60	4.90	45.20	4.95	43.90	5.03
	6.0	5.0	52.20	5.09	50.60	5.20	48.60	5.37	45.20	5.42	43.90	5.51
	2.0	1.0	51.00	5.27	49.80	5.42	48.60	5.65	45.10	5.68	43.80	5.77
	-1.8	-2.2	50.20	5.31	48.00	5.46	47.80	5.67	45.80	5.72	43.80	5.81
	-3.8	-4.0	49.50	5.34	48.30	5.50	47.10	5.71	45.20	5.78	43.80	5.86
	-7.1	-7.6	43.00	4.30	42.20	4.95	41.00	5.15	38.30	5.18	37.70	5.21
	-12.6	-13.0	38.30	4.20	38.30	4.30	37.50	5.00	38.50	5.02	34.10	5.02
	60.0	56.0	46.70	2.37	45.20	2.28	40.40	2.24	38.30	2.28	36.00	2.35
	57.0	53.0	46.70	2.40	45.20	2.32	40.60	2.27	38.30	2.32	36.60	2.38

Capacity table

2FXVA*****

TC : Total Capacity, PI : Power Input

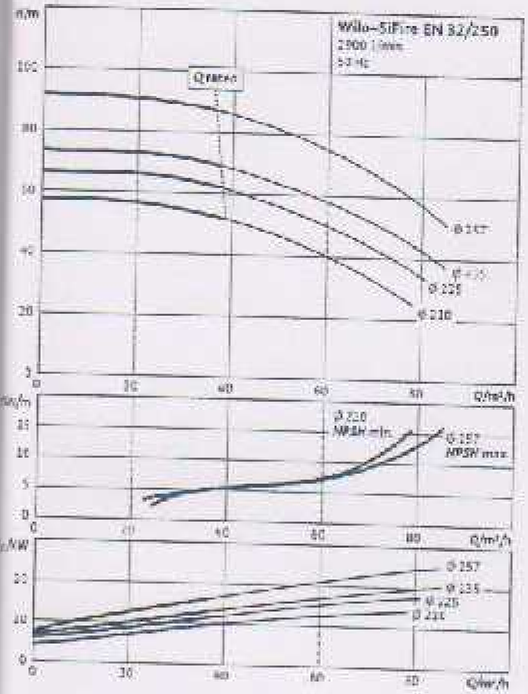
...ition, % ...y index)	Outdoor temperature (°F)		Indoor temperature (°F, DB)									
			65.0		68.0		70.0		72.0		75.0	
			TC	PI	TC	PI	TC	PI	TC	PI	TC	PI
	DB	WB	MBH	kW	MBH	kW	MBH	kW	MBH	kW	MBH	kW
	54.0	50.0	45.70	2.26	43.20	2.37	40.50	2.32	38.50	2.37	36.60	2.44
	51.0	47.0	45.70	2.29	43.20	2.40	40.50	2.35	38.50	2.40	36.60	2.47
	47.0	43.0	45.70	2.37	43.20	2.48	40.50	2.43	38.50	2.48	36.60	2.55
	44.0	40.0	45.70	2.08	43.20	2.58	40.50	2.54	38.50	2.59	36.60	2.66
	39.0	36.0	45.70	2.60	43.20	2.70	40.50	2.65	38.50	2.70	36.60	2.78
	35.0	32.0	45.70	2.68	43.20	2.78	40.50	2.73	38.50	2.78	36.60	2.86
	30.0	28.0	45.70	2.97	43.20	2.86	40.50	2.81	38.50	2.86	36.60	2.94
	26.0	24.0	45.70	3.15	43.20	3.05	40.50	2.98	38.50	3.04	36.60	3.13
	23.0	21.0	45.70	3.41	43.20	3.26	40.50	3.22	38.50	3.29	36.60	3.38
5	19.0	18.0	45.70	3.71	43.20	3.47	40.50	3.51	38.50	3.58	36.60	3.68
	17.0	15.0	45.70	3.62	43.20	3.68	40.50	3.61	38.50	3.68	36.60	3.79
	13.0	12.0	45.70	3.94	43.20	3.83	40.50	3.73	38.50	3.80	36.60	3.91
	10.0	9.0	45.70	4.20	43.20	4.05	40.50	3.97	38.50	4.05	36.60	4.17
	6.0	5.0	45.70	4.50	43.20	4.34	40.50	4.26	38.50	4.35	36.60	4.47
	2.0	1.0	45.70	4.85	43.20	4.67	40.50	4.59	38.50	4.68	36.60	4.81
	-1.3	-2.2	45.70	5.25	43.20	4.85	40.50	4.77	38.50	4.85	36.60	5.01
	-3.0	-4.0	45.70	5.26	43.20	5.05	40.50	4.97	38.50	5.07	36.60	5.21
	-7.1	-7.8	40.30	4.89	38.20	4.82	35.70	4.62	33.50	4.61	32.10	4.73
	-12.5	-13.0	36.70	4.54	35.60	4.57	34.30	4.59	32.50	4.70	31.00	4.85


wilo

wilo

Data sheet: Wilo-SiFire EN 32/250-210-15/17.7/1.1 EDJ

Pump curves



System

Max. fluid temperature	T	50 °C
Max. ambient temperature	T	40 °C
Maximum operating pressure	p_{max}	10 bar
Number of electrical drives		1
Number of diesel drives		1
Number of jockey pumps		1
Protection class system		IP 54
Nominal diameters of the pipe connections on suction side	*RPS*	DN 50
Nominal diameters of pipe connections on the pressure side	*RPD*	DN 65

Materials

Base frame	Steel galvanized
Joint tubings	Painted steel
Wear rings	Bronze (CuSn5Pb20)
Pump shaft	1.4057 (AISI431)
Pump housing	EN-GJL-250
Impeller	1.4408 (AISI316)

Electric pump

Mains connection		3~400 V, 50 Hz
Mains frequency	f	50 Hz
No. of poles		2
Insulation class		F
Screwed cable connection		2xM40 PG 1x M20 PG
Nominal motor power	P_2	15.00 kW
Motor efficiency level		IE2
Power factor 400V	$\cos \varphi_{N}$	0.86
Nominal current 3~400 V, 50 Hz	I_N	27.60 A

Diesel pump

Nominal motor power	P	17.50 kW
Cylinder capacity	V	1.248 l
cylinder number		2
Cooling method		Air
Air volume flow cooling	H	1578 m³/h

Data sheet: Wilo-SiFire EN 32/250-210-15/17.7/1.1 EDJ

Fuel tank volume		55 l

Jockey pump

Nominal current 3~400 V, 50 Hz	I_N	2.50 A
Nominal motor power	P_2	1.10 kW
Vessel volume	V	20 l
Impeller (jockey)		1.4301
Pump housing (jockey)		EN-GJL-250
Motor shaft (jockey)		1.4301
O-ring (jockey)		EPDM

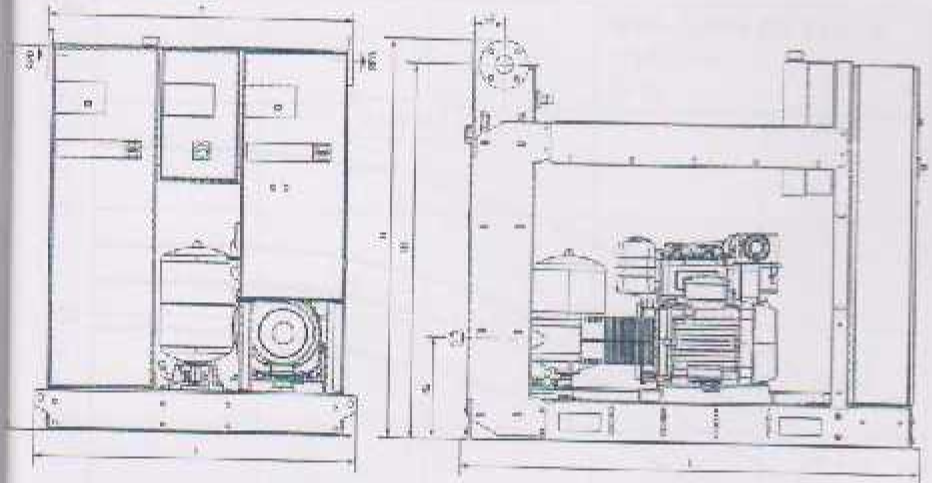
Information for order placements

Make		Wilo
Type		SiFire EN 32/250-210-15/17.7/1.1 EDJ
Art no.		4183399
Weight approx.	m	884 kg
Gross weight	m	914 kg

• = available, - = not available

Dimensions and dimension drawings: Wilo-SiFire EN 32/250-210-15/17.7/1.1 EDJ

imension drawing

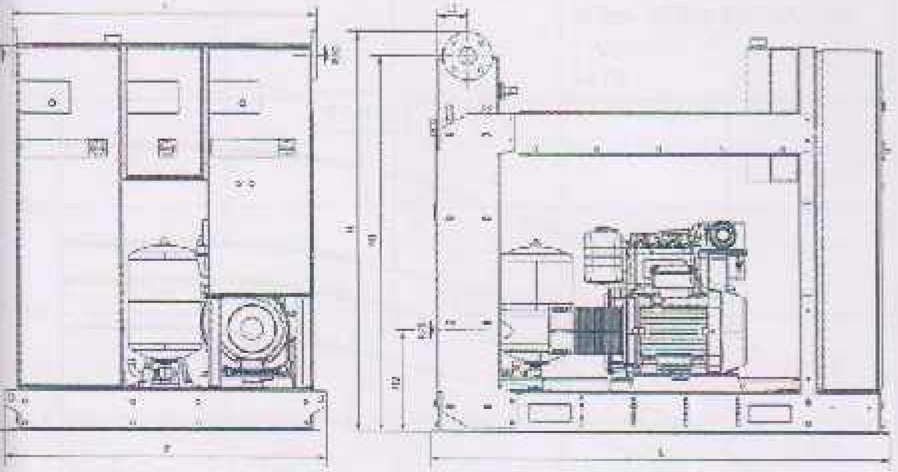


Nominal diameters of pipe connections on the pressure side	RPD	DN 65
Nominal diameters of the pipe connections on suction side	RPS	DN 50
Dimensions	H	1528 mm
Dimensions	H1	1435 mm
Dimensions	H2	388 mm
Dimensions	HB	1460 mm
Dimensions	L	1747 mm
Dimensions	L1	116 mm
Dimensions	P	1230 mm
Dimensions	T	1151 mm

mple systems are shown.
ccessories to be ordered separately.
stallation surface: flat and horizontal
stallation location: dry, well ventilated and frost-proof

mensions and dimension drawings: Wilo-SiFire EN 32/250-210-15/17.7/1.1 EDJ

ension drawing

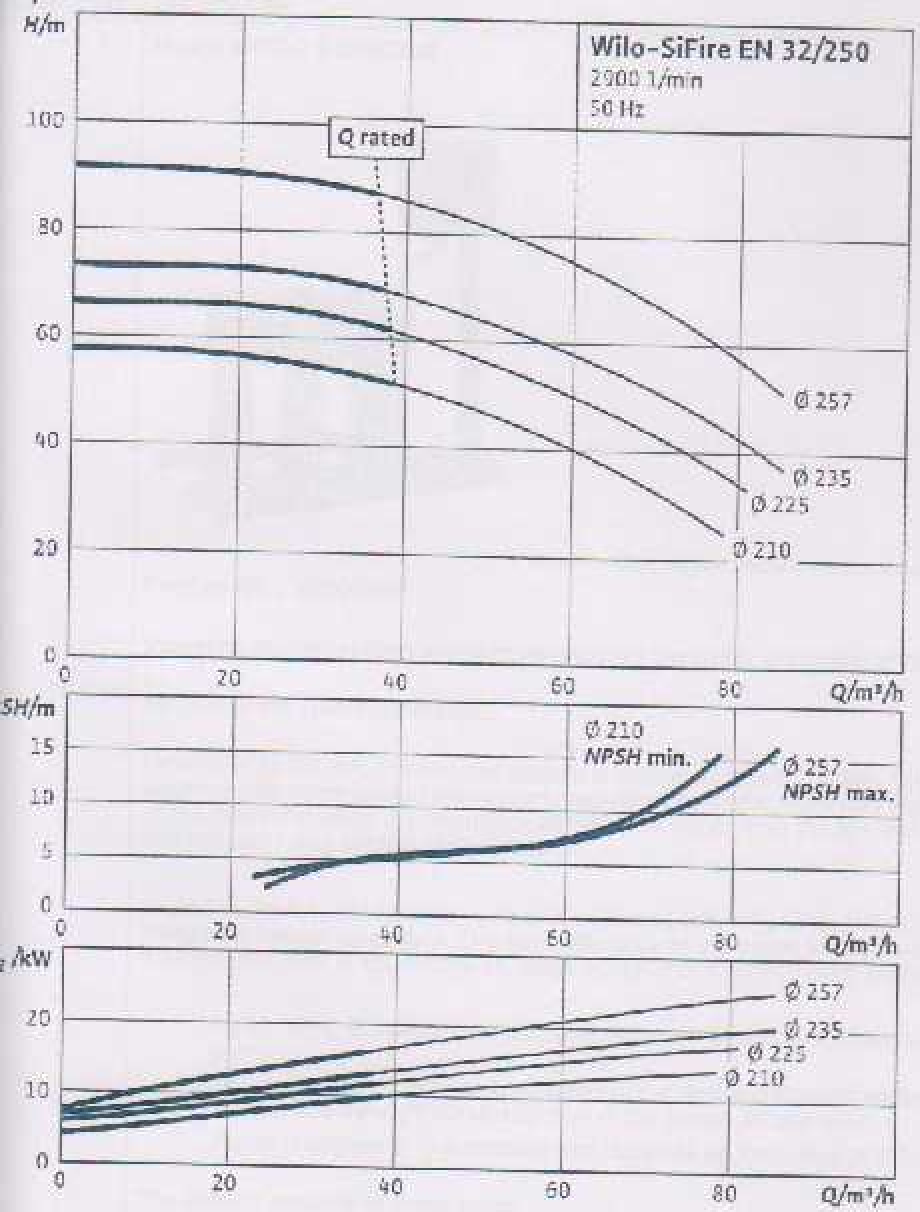


Nominal diameters of pipe connections on the pressure side	RP D	DN 65
Nominal diameters of the pipe connections on suction side	RP S	DN 50
Dimensions	H	1528 mm
Dimensions	H 1	1435 mm
Dimensions	H 2	388 mm
Dimensions	H B	1460 mm
Dimensions	L	1747 mm
Dimensions	L1	116 mm
Dimensions	P	1230 mm
Dimensions	T	1161 mm

le systems are shown.
ssories to be ordered seperately.
llation surface: flat and horizontal
llation location: dry, well ventilated and frost-proof

Pump curves: Wilo-SiFire EN 32/250-210-15/17.7/1.1 EDJ

ump curves



Company name:
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Phone:

Date:

Position	Qty.	Description
	1	Hydro MPC-E 2 CRE32-2

Note! Product picture may differ from actual product

Product No.: 96009098

Pressure booster system supplied as compact assembly according to DIN standard 1988/T5.

All pumps are speed-controlled.

From 0.37 to 2.2 kW, the booster system is equipped with CR, CRE, CRI, CRIE pumps with electronically commutated permanent magnet motors with extremely high efficiency. The total efficiency of the motor including the frequency converter is better than the IE4 level in IEC60034-31, even though this standard only applies to the motor.

From 3 to 22 kW, the booster system is equipped with CR, CRE, CRI, CRIE pumps with motors with integrated frequency control. The total efficiency of the motor including the frequency convertor is better than the IE3 level in IEC60034-31, even though this standard only applies to the motor.

* Hydro MPC-E maintains a constant pressure through continuous adjustment of the speed of the pumps.
* The system performance is adapted to the demand through cutting in/out the required number of pumps and through parallel control of the pumps in operation.
* Pump changeover is automatic and depends on load, time and fault.

The system consists of these parts:
: 2 vertical, multistage, centrifugal pumps, type CRE32-2
Pump parts in contact with the pumped liquid are made of stainless steel EN DIN 1.4301
Pump bases and heads are of either cast iron/stainless steel (CRI) or cast iron EN-GJS-500-7 (CR), depending on pump type; other vital parts are made of stainless steel EN DIN 1.4301
The pumps are equipped with a service-friendly cartridge shaft seal, HQQE (SiC/SiC/EPDM)

* Two stainless steel manifolds to EN DIN 1.4571
* Stainless steel base frame to EN DIN 1.4301 up to CR 90; above CR 90 the pumps are placed on a galvanized I-Beam frame
* One non-return valve (POM) and two isolating valves for each pump
* Non-return valves are certified according to DVGW, isolating valves according to DIN and DVGW
* Adapter with isolating valve for connection of diaphragm tank
* Pressure gauge and pressure transmitter (analog output 4-20 mA)
* Control MPC in a steel cabinet, IP54, including main switch, all required fuses, motor protection, switching equipment and microprocessor-controlled CU 352.

Dry-running protection and diaphragm tank are available according to the list of accessories.

Pump operation is controlled by Control MPC with the following functions:
* Intelligent multi-pump controller, CU 352

on	Qty.	Description
		* Constant-pressure control through continuously variable adjustment of the speed of each individual pump * PID controller with adjustable PI parameters (Kp + Ti) * Constant pressure at setpoint, independent of inlet pressure * On/off operation at low flow * Automatic cascade control of pumps for optimum efficiency * Selection of min. time between start/stop, automatic pump changeover and pump priority * Automatic pump test function to prevent idle pumps from seizing up * Possibility of standby pump allocation * Possibility of backup sensor (redundant primary sensor) * Manual operation * Possibility of external setpoint influence * Log function * Setpoint ramp * Possibility of digital remote-control functions: * system on/off * max., min. or user-defined duty * up to 6 alternative setpoints. * Digital inputs and outputs can be configured individually * Pump and system monitoring functions: * minimum and maximum limits of current value * inlet pressure * motor protection. * Sensors and cables monitored for malfunction * Alarm log with the previous 24 warnings/alarms * Display and indication functions: * colour screen display * green indicator light for operating indications and red indicator light for fault indications * potential-free changeover contacts for operation and fault. * Grundfos bus communication It is possible to add CIM communication modules for communicating with Scada/BMS. Pumps, piping, cabling complete as well as Control MPC are mounted on the base frame. The booster system has been preset and tested. Flow media: Drinking water Allowed liquid temp.: 5 °C .. 60 °C System pressure max.: 16 bar Flow (Plant): 423 US GPM Flow without one stand-by pump acc. DIN 1988/T5: 211 US GPM Flow (Pump): 168 US GPM Head: 27 m Mains suply: 380 - 415 V, 50 - 60 Hz, PE Nom. current of plant: 30 A Number of main pumps: 2 Nominal power: 7.5 kW Starting main: electronically Number of aux. pump(s): 0 Net weight: 330 kg

Company name:
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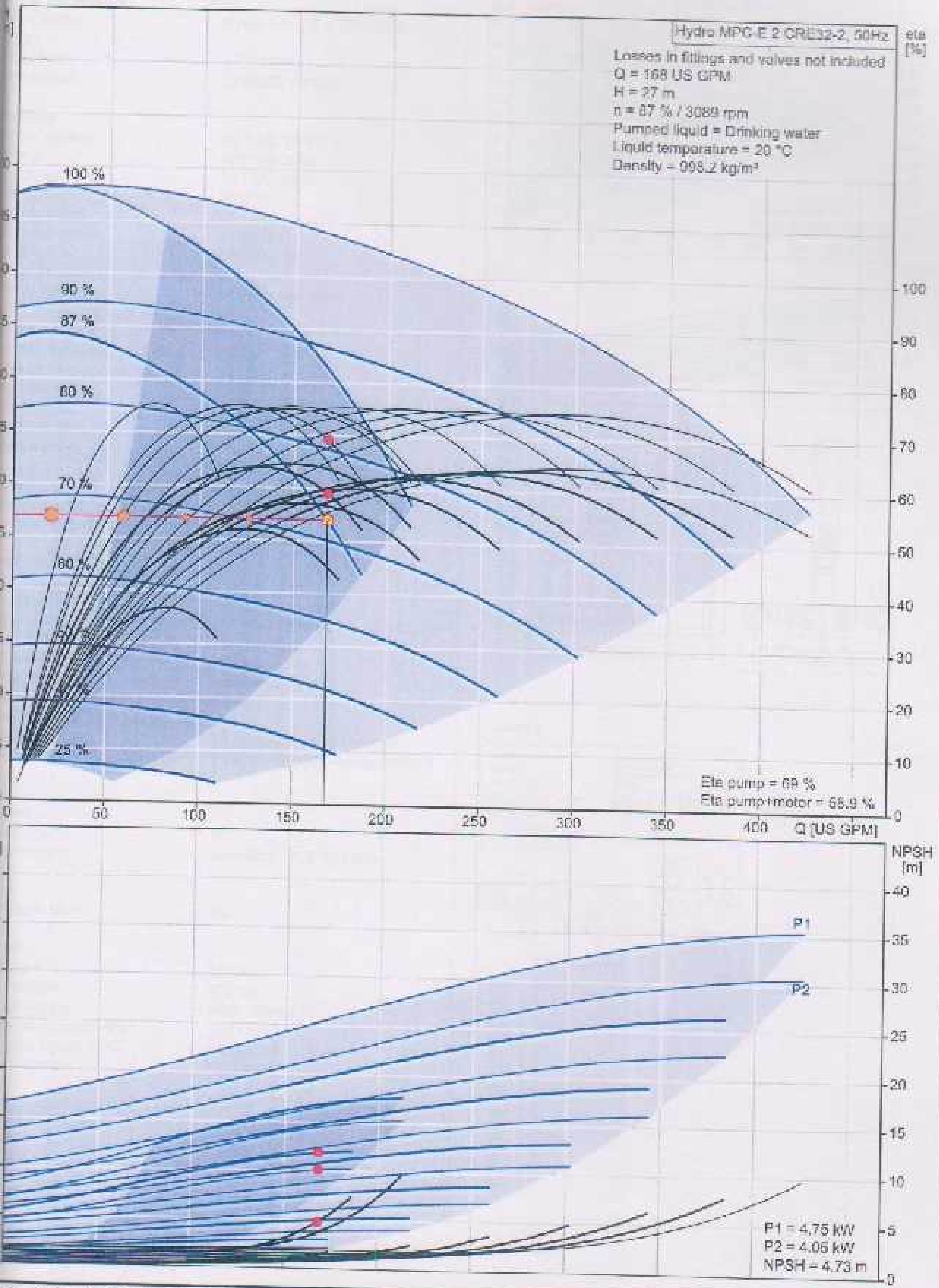
5009098 Hydro MPC-E 2 CRE32-2 50 Hz



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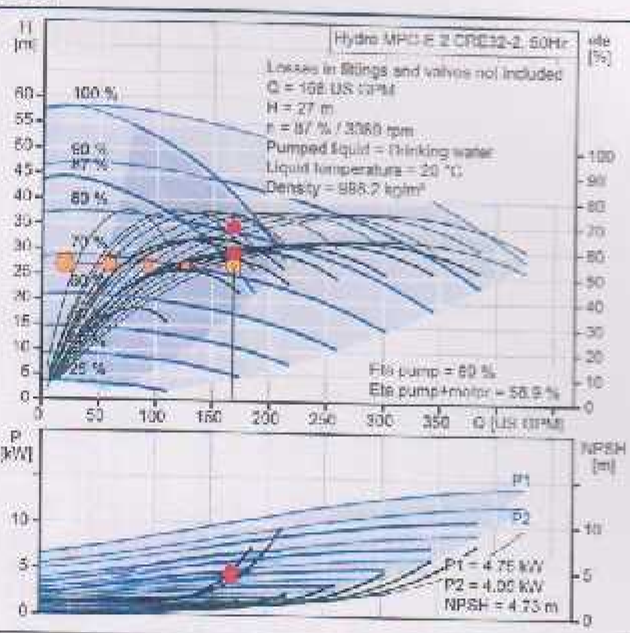
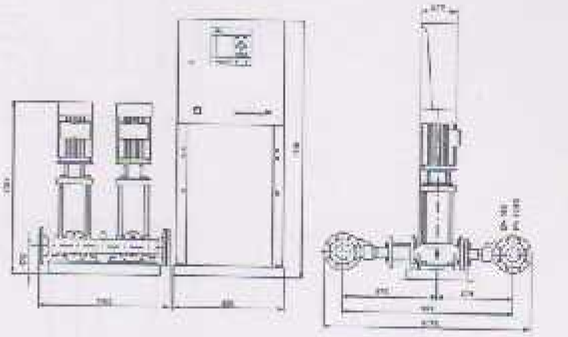
Company name:
Created by:
Phone:

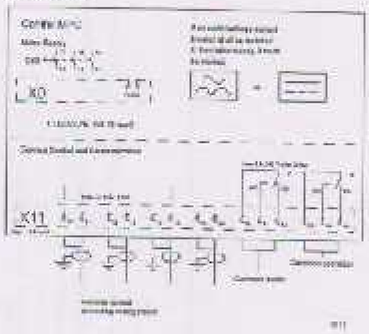
Date:

ription	Value
ral information:	
ct name:	Hydro MPC-E 2 CRE32-2
on	
ct No:	95005098
umber:	5700835167200
ical:	
w system:	16.7 US GPM
ow:	423 US GPM
ow system:	211 US GPM
max:	57.2 m
ers main:	2
ump name:	CRE32-2
ump No:	96122861
er of pumps:	2
t. valve:	at discharge side
ation:	
um operating pressure:	16 bar
um inlet pressure:	10.3 bar
standard:	DIN
d inlet:	DN 100
d outlet:	DN 100
re stage:	PN 10/16
:	
temperature range:	5 .. 60 °C
atic viscosity:	1 mm2/s
cal data:	
(P2) main pump:	7.5 kW
requency:	50 Hz
voltage:	3 x 380 - 415 V, 50 - 60 Hz, PE
voltage main pump:	3 x 380 V
nethod:	electronically
g main:	electronically
current of system:	30 A
ure class (IEC 34-5):	IP54
cable size:	L1,L2,L3,PE: 4x6-10 mm2
nterference supression:	EMC Certificate - Hydro MPC 1 [2007]
ls:	
type:	E
control:	Grundfos MGE 3 phase
agm tank:	No
:	
ght:	330 kg
weight:	450 kg
range:	International
ile Control MPC:	98271946
ile Hydro MPC:	98272018
version:	V5.1347





Field Wiring

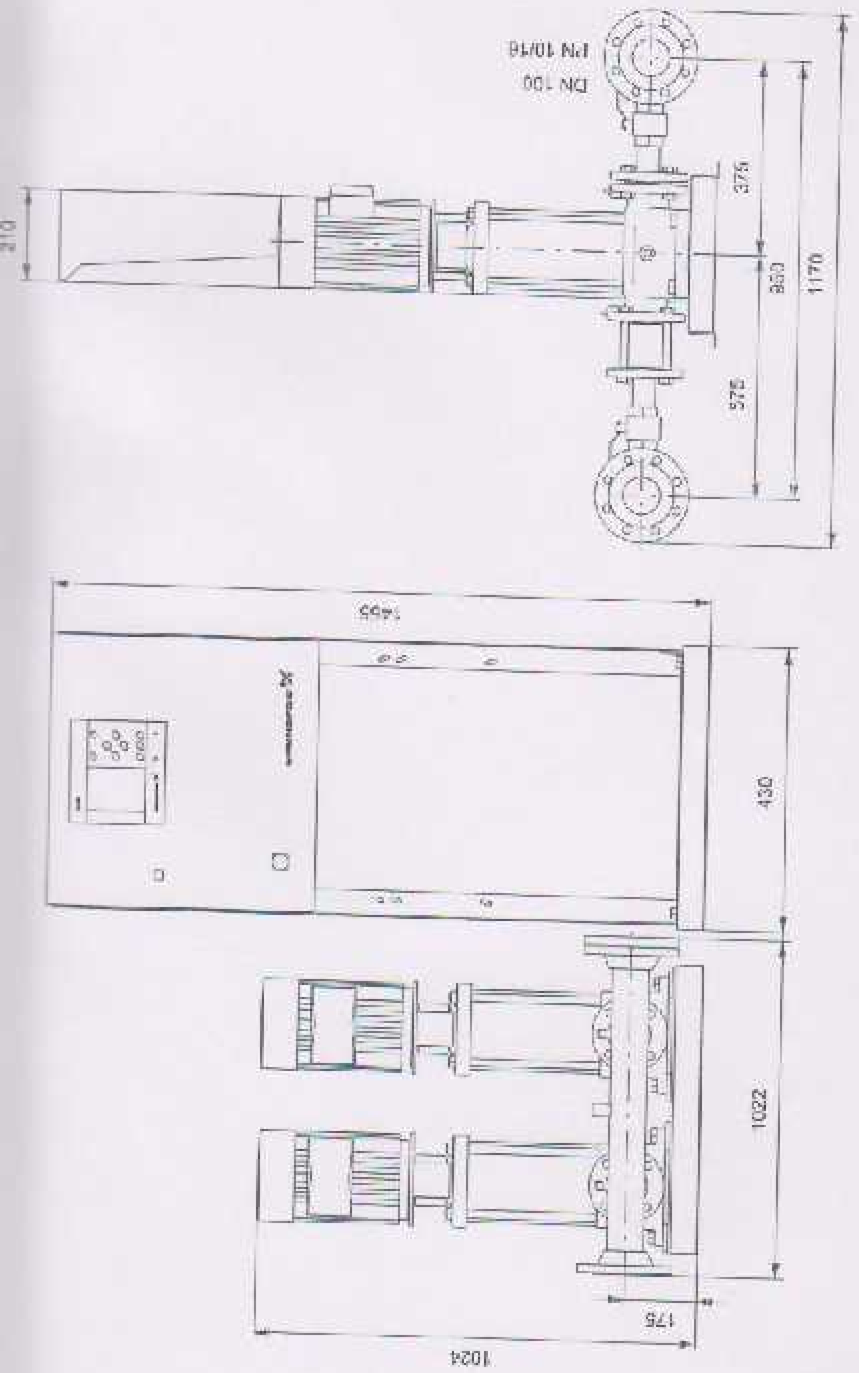


RUNDFOS

Company name:
Created by:
Phone:

Date:

09098 Hydro MPC-E 2 CRE32-2 50 Hz



its are in [mm] unless others are stated.
This simplified dimensional drawing does not show all details.