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District Cooling Air Conditioning System

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ABSTRACT:

The main aim of this project is to facilitate human comfort in any weather condition with small capital and less energy losses. In this thesis by using District cooling Air Conditioning system we can reduce the capital, loss of energy efficiency. District cooling means the centralized production and distribution of cooling energy. Chilled water is delivered via an underground insulated pipeline to office, industrial and residential buildings to cool the indoor air of the buildings within a district. Specially designed units in each building then use this water to lower the temperature of air passing through the building's air conditioning system.The output of one cooling plant is enough to meet the cooling-energy demand of dozens of buildings. District cooling can be run on electricity or natural gas, and can use either regular water or seawater. Along with electricity and water, district cooling constitute a new form of energy service.

District cooling systems can replace any type of air conditioning system, but primarily compete with air-cooled reciprocating chiller systems serving large buildings which consume large amounts of electricity. This air-conditioning system is subject to a difficult operating environment, including extreme heat, saline humidity and windborne sand. Over time, performance, efficiency and reliability suffer, leading to significant maintenance costs and ultimately to equipment replacement. District cooling is a system in which chilled water is distributed in pipes from a central cooling plant to buildings for space cooling and process cooling. A district cooling system contains three major elements: the cooling source, a distribution system, and customer installations. The district cooling system is going to be the future of Air Conditioning for Residential and Commercial buildings as the Townships are being developed with the purpose of living and working. The District cooling system give saves a huge power and initial cost of installing air conditioning units.

Key words :

Cooling plant,district cooling system,HVAC

1.INTRODUCTION:

1.1. Air-Conditioning:

A form of air treatment whereby temperature, humidity, ventilation, and air cleanliness are all controlled within limits determined by the requirements of the air conditioned enclosure.

1.2 Importance of Air Conditioning:

One of the greatest engineering achievements of the 20th century was the development of air Conditioning and refrigeration. It used to be that people had to go to a market every day and buy fresh groceries before they perished. Both technologies make the lives of others and me far more comfortable and enjoyable.

Fig1: Winter season in cold country

1.3 Air-conditioning applications:

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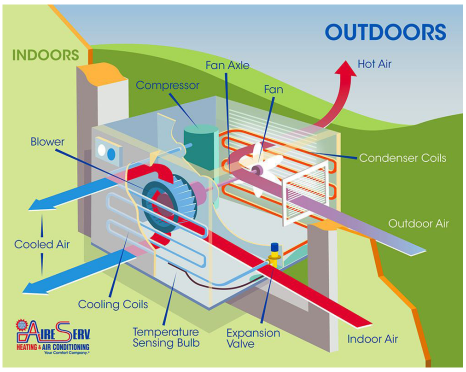

Fig.2 Window air conditioner

Air conditioning also allows buildings to be taller, since wind speed increases significantly with altitude making natural ventilation impractical for very tall buildings Comfort applications are quite different for various building types and may be categorized as Low-Rise Residential buildings, including single family houses, duplexes, and small apartment buildingsHigh-Rise Residential buildings, such as tall dormitories and apartment blocksProcess applications include these:Hospital operating theatres, in which air is filtered to high levels to reduce infection risk and the humidity controlled to limit patient dehydration., relatively high temperatures (about 28 °C, 82 °F).Clean rooms for the production of integrated circuits, pharmaceuticals, and the like, in which very high levels of air cleanliness and control of temperature and humidity are required for the success of the process.

•Chemical and biological laboratories
•Mining
•Industrial environments
•Food cooking and processing areas

In both comfort and process applications, the objective may be to not only control temperature, but also humidity, air quality, and air movement from space to space.

2.TYPES OF AIR CONDITIONING SYSTEMS:

There are various types of air conditioners like window air conditioner, split air Conditioner, packaged air conditioner and central air conditioning system. This series of articles describes all types of air conditioners.

2.1 Types of Air Conditioning Systems:

•Window Air Conditioning System
•Split Air Conditioner System
•Central Air Conditioning Plants
•Packaged Air Conditioners - Types of Packaged AC

2.2 Window Air Conditioning:

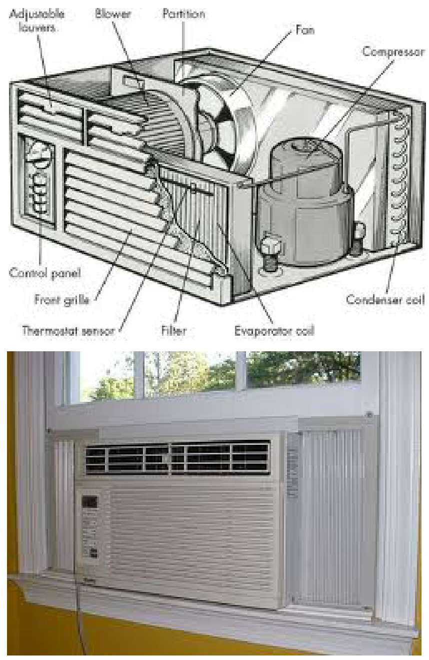

Fig.3 Window air conditioner

Window air conditioners are one of the most commonly used and cheapest type of air conditioners.

2.3 Split Air Conditioning:

Fig4: Window air conditioner

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This is what people most commonly think of when they speak of wanting air conditioning.

2.4 Package Unit:

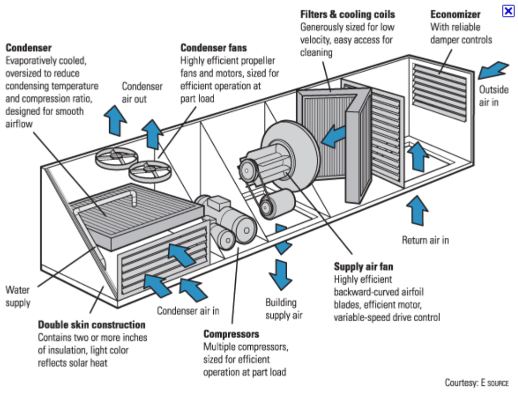

Fig5: Package unit

Usually mounted on the roof or on a slab besides the building. (These are known self-contained units, or Direct Expansion (DX).

2.5 Central air conditioning:

There are two types of central air conditioning system which are as follows:

•Direct Expansion
•Chilled water system

2.5.1 Chilled water system:

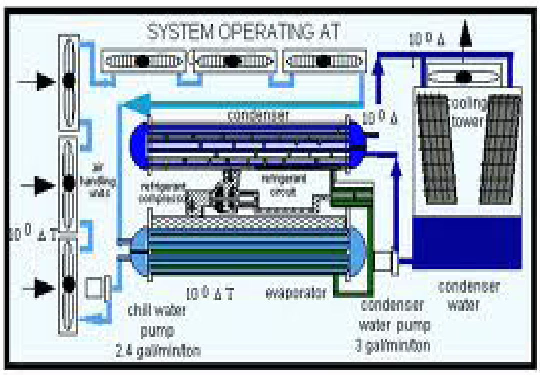

Fig 6: Chilled water system

A chilled-water applied system uses chilled water to transport heat energy between the airside, chillers and the outdoors. These systems are more commonly found in large HVAC installations, given their efficiency advantages.

•Central Air Conditioning Plants
•Direct Expansion or DX Type of Central Air Conditioning Plant
•Chilled Water Type of Central Air Conditioning Plant

2.6 Chilled Water Air Conditioning Plant:

The chilled water types of central air conditioning plants are installed in the place where whole large buildings, shopping mall, airport, hotel, etc, comprising of several floors are to be air conditioned. which in turn chills the room air.

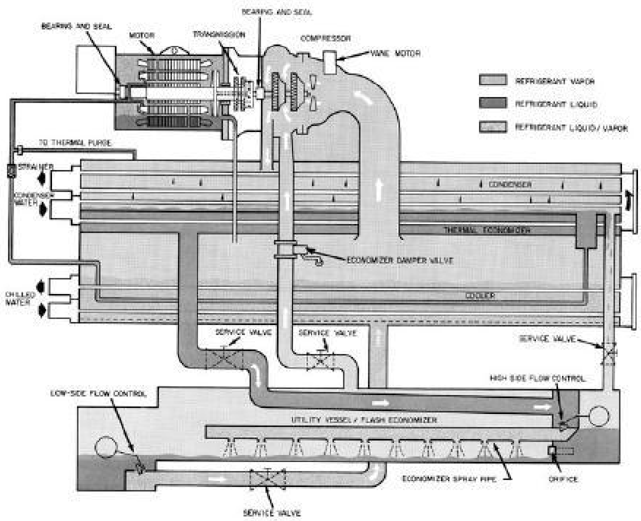

Figure 10-5 Complete operation of a shell-and-tube chiller. (*Courtesy of Carrier.*)

Fig7 Chilled water air conditioning plant

3.DISTRICT COOLING AIR CONDITIONING SYSTEM:

3.1 District Cooling:

District cooling system can replace any type of air conditioning system, but primarily complete with air-cooled reciprocating chiller systems serving large buildings which consume large amount of electricity.

This air conditioning system is subjected to a difficult operating environment, including extreme heat, saline humidity and windborne sand.

Empowers District cooling system is underpinned by a skilled around-the-clock service team and a comprehensive set of emergency back-up systems that ensure complete reliability and ease of use.

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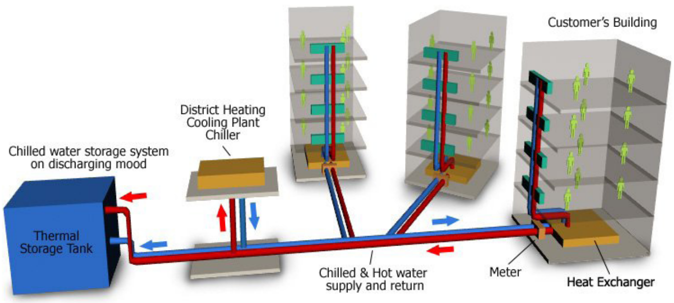

Fig 8: District Cooling Air Conditioning System

3.2 cooling cycle (chilled water system):

The supply air, which is approximately 20° F cooler than the air in the conditioned space, leaves the cooling coil through the supply air fan, down to the ductwork and into the conditioned space. The main equipment used in the chilled water system is a chiller package that includes

•A refrigeration compressor (reciprocating, scroll, screw or centrifugal type),
•Shell and tube heat exchanger (evaporator) for chilled water production
•Shell and tube heat exchanger (condenser) for heat rejection in water cooled configuration (alternatively, air cooled condenser can be used, where water is scarce or its use is prohibited)
•A cooling tower to reject the heat of condenser water
•An expansion valve between condenser and the evaporator

The chilled water system is also called central air conditioning system. This is because the chilled water system can be networked to have multiple cooling coils distributed throughout a large or distributed buildings with the refrigeration equipment (chiller) placed at one base central location.

3.3 Advantages of District Cooling:

District cooling systems provide a variety of benefits, both qualitative and economic are reduced and the costs of chillers are eliminated.
•Better quality of cooling
•Maximum cost effectiveness
•Capital cost elimination
•Space saving
•Decrease in sound pollution
•Environmentally friendly

3.4 Tenant/user comfort:

•Individual space or room temperature control using multiple indoor fan-coil units.

3.5 System Reliability:

•Units used are high-tech and industrial which dramatically decreases the failure frequency compared to commercial equipment.

4.DISTRICT COOLING A.C. SYSTEM CONTROLS

4.1 Controls:

The capacity of the HVAC system is typically designed for the extreme conditions.

4.1.1 TEMPERATURE:

ASHRAE 55-1992 suggests the following temperature ranges for overall thermal comfort.

Season	Clothing	Optimum Temperature	Temperature range
Winter	heavy slacks, long-sleeve shirts and sweaters	22°C 71°F	20-23.5°C 68-75°F
Summer	light slacks, and short sleeve shirt	24.5°C 76°F	23-26°C 73-79°F

4.1.2 Humidity:

Usually air is humidified to between 25 -45% during winter and dehumidified to below 60% during summer.

4.1.3 Ventilation:

ASHRAE Standard 62-1999: “Ventilation for Acceptable Indoor Air Quality” recommends minimum ventilation rates per person in the occupied spaces. The ventilation rates specified by ASHRAE effectively dilutes the carbon dioxide and other contaminants created by respiration and other activities; it supplies adequate oxygen to the occupants; and it removes contaminants from the space.

4.1.4 Pressure:

Air moves from areas of higher pressure to areas of lower pressure through any available openings.

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4.2 Special Control Requirements:

The special requirements pertain to the interlocking with fire protection systems, smoke removal systems,

4.2.1 Controls Required:

The HVAC control system is typically distributed across three areas:

•The HVAC equipment and their controls located in the main mechanical room. Equipment includes chillers, boiler, hot water generator, heat exchangers, pumps etc.

4.2.2 Benefits of A Control System:

Controls are required for one or more of the following reasons:

•Maintain thermal comfort conditions
•Maintain optimum indoor air quality
•Reduce energy use
•Safe plant operation
•To reduce manpower costs
•Identify maintenance problems
•Efficient plant operation to match the load
•Monitoring system performance

4.2.3 Bulb Sensors & Capillary:

Bulb and capillary elements are used where temperatures are to be measured in ducts, pipes, tanks or similar locations remote from the controller.

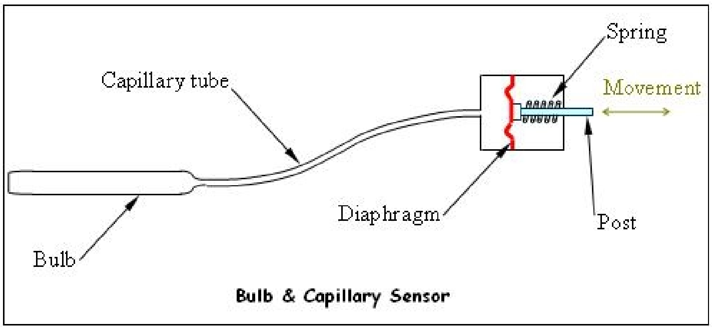


Fig9: Bulb & capillary sensor

4.3 Electronic Sensors:

The electronic temperature sensors are classified in three categories;

•Resistance Temperature Devices (RTD),
•Thermistors and
•Thermocouples

4.4 Resistance Temperature Devices (Rtd):

Resistance Temperature Detectors (RTD) operates on the principle that the electrical resistance of a metal changes predictably and in an essentially linear and repeatable manner with changes in temperature.

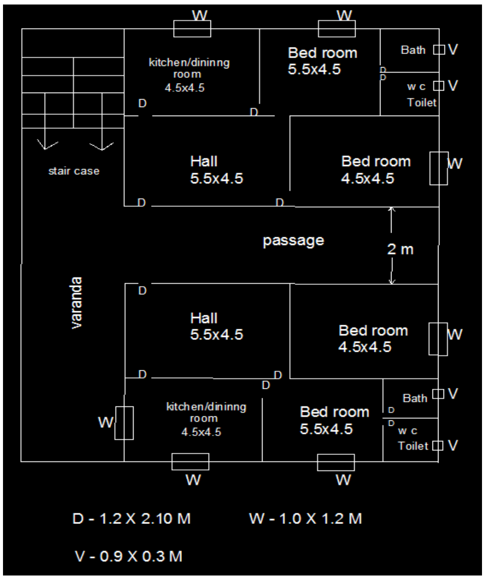
5.DESIGN FOR DISTRICT COOLING SYSTEM:

The district cooling system contributes to a larger scale and has a single cooling unit with several utility units.

5.1 Design criteria:

The space for which the district cooling system is to be designed is a township contains five residential towers and one commercial hall each tower together contributes to 100 TR thus the town ship totally contributes to a cooling load of 600 TR Components of centralised cooling plant the plant comprises of 3 chillers each of 300TR capacity 2 together contribute to block load and the third one is kept as standby as per the norms and these chillers are connected to a cooling tower of capacity 600TR and also there is a provision of standby cooling tower of same capacity.

PLAN OF RESIDENTIAL BUILDING:



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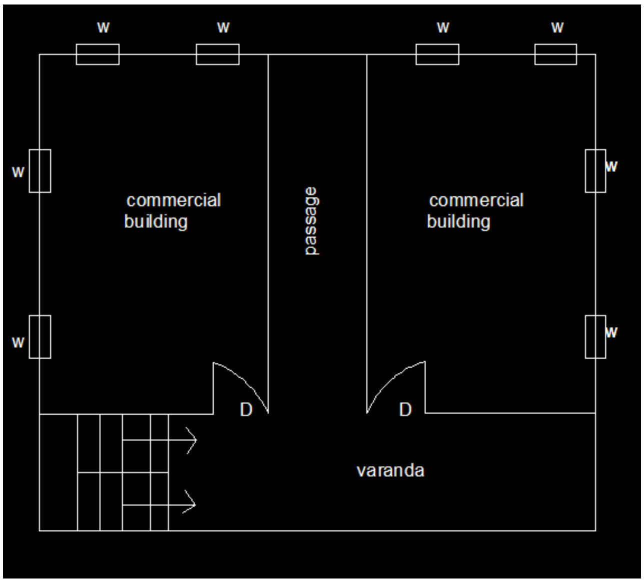
PLAN OF COMMERCIAL HALL:



The tonnage or the required tonnage for each building is calculated as follows:
Space used for: commercial, Hall-1
Size: 44.27'x 58.29' = 2583 sq.ft x Height
= 2583 sq.ft x12
Volume = 30990 cubic feet

	DBT	WBT	RH	HR	DP
OUTSIDE	106	76	88	88	63
ROOM	75	72	50	66	56
DIFFRENCE	31	-	-	22	7

Estimation --20
Q = A x ⌂T
Co-efficient factor: the rate of heat transfer through the building barriers
U- Factor =1 / ∑R
∑ R =Ri + X1 R1 + X2 R2 + …………Xn Rn +R0
Ri = Resistance of inside
ASHRAE = American society of heating Refrigeration & Air conditioning Eng
Solar heat gain through glass
Specification of Glass: it is a heat absorbing glass, Venetian blind with 45 degree slant on outside with light colour on outside and dark colour on inside, vertical glass, with storm windows
The ⌂T value for window is:
North side window = 23
South side Window = 14
East side window =163
West side window =163

Also the coefficient of absorption is 0.10, hence the heat gain through the glass is
On north side – 70x 23 x 0.65=1047 Btu/hr (as the area of glass exposed is equal to 40 sq.ft)
On south side – 182x 14 x 0.65 =1654 Btu/hr (as the area of glass exposed is equal to 22 sq.ft)

Specification of wall: It is a poured concrete blocks, and the internal finish is made of insulating 1" board plain or plastered on furring
W- Side = 52
E- Side = 53
N- Side = 31
S- Side = 52

South side wall:
330x52x0.43 = 7379 Btu/hr

North side wall:
442x31x0.43 = 5892 Btu/hr

West side wall:
12x52x0.43 = 266 Btu/hr
Roof = A x ⌂T x U

Specification of roof: roof is made of concrete mixed with sand & gravel with suspended acou. Tile bearing a coefficient of 0.06.
Heat transfer through roof:
=2583 x 97 x0.20
= 50110
Transmission Heat gain through glass
All glass = 404 x 31 x 0.54 = 6763 BTU/hr
Partition = 410 sq.ft x (31-5) x 0.27 = =2880 BTU/hr

Apparatus due temperature

ESHF	0.84	0.85	0.86	0.87	0.88	0.89	0.90	0.91	0.92
ADP	52	52.25	52.5	52.75	53	53.25	53.5	53.75	54

ADP = 49.2 ° F
Dehumidified Rise = (1-BF) x (Rm Temp - ADP)
= 14.42 ° F
De humidification CFM = Qs / 1.08 x DR
= 11559 Cfm

The calculation for the rest of halls is carried out in a similar manner and the sheets are attached thus totally making the TR calculation as follows:

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29.03 TR+29.03 TR+34.09 TR =92 TR but the standard package unit available is 100TR thus we take up the 100TR equipment.The calculations are performed in the similar manner as above and the tabular formats of it are attached.

5.2 AHU / FCU to CHILLER:

Note: for closed piping network the GPM= 2.4 X TR. For open piping network the GPM=3 X TR AHU/ FCU – Secondary pump – open piping network- suctional Secondary pump - chillers – Discharge- open piping network

5.3 Primary pump

5.3.1 Discharge head loss

Sections	Friction loss (F) "wg/100'	Length of pipe (L) 'ft'	Equivalent length (E) 'ft'	Total length (T)	Total head loss
Straight Length	4	40.29	0	40.29	1.6
A-B-C	10	394	0	394	39.4
B-B1-B2	5	76	0	76	3.8
C-D	6	7.39	0	7.39	0.44
D-E	7	84	0	84	5.88
E-F	10	40	0	40	4
F-G-H					
Standard Equipment	4	0	9	9	0.36
Gate valve	10	0	3.2X6	19.2	1.92
Gate valve	10	0	42 X 6	252	25.2
(6)	4	0	220	220	8.8
Strainer	10	0	5X6	30	3
(6)					
Globe valve					
Elbow (6)					
Total head loss					94.4

Head loss = total length x frictional loss
100

Total head loss for section A-B-C = 40.29x4
100
= 160

100
= 1.6

Therefore head loss for all the sections and standard equipments of the discharge and suctional head losses for both primary and secondary pumps are similarly done.

5.3.2 Discharge head loss

Sections	Friction loss (F) "wg/100'	Length of pipe (L) 'ft'	Equivalent length (E) 'ft'	Total length (T)	Total head loss
traight Length					
Secondary pump - Chiller's	8	81	0	81	6.48
Standard	5.5	0	12	12	0.66
Equipment	5.5	0	280	280	15.4

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Gate valve Globe valve					
Total head loss					22.54

5.4 Primary pump calculation:

Pump Hp = GPM X TDHL X Specific Gravity
360 X efficiency

Therefore,
GPM = 1440gpm
TDHL for primary pump = total discharge head loss + total suction head loss
= 94.4 + 4.84
= 99.24
Specific gravity of secondary refrigerant = 1
Efficiency = 75% = 0.75

Primary pump Hp = 1440 x 99.24 x 1
360 x 0.75
= 142905.6
2970
= 48.11
= 50Hp
Primary pump = 50Hp
5.5 Secondary pump calculation:

Pump Hp = GPM X TDHL X Specific Gravity
360 X efficiency

Therefore,
GPM = 1800gpm
TDHL for primary pump = total discharge head loss + total suction head loss
= 22.54 + 59.98
= 82.52
Specific gravity of secondary refrigerant = 1
Efficiency = 75% = 0.75
Secondary pump Hp = 1800 x 82.52 x 1
360 x 0.75
= 148536
2970
= 50.01
= 50HP
Secondary pump = 50HP

6.LITERATURE SURVEY
HISTORY OF AIR CONDITIONING:

The concept of air conditioning is known to have been applied in Ancient Rome, where aqueduct water was circulated through the walls of certain houses to cool them down. conditioning as well as rising jet streams of water from fountains. down to −14°C (7 °F) while the ambient temperature was 18 °C (64 °F). the ice mass was about a quarter-inch thick when they stopped the experiment upon reaching −14 °C (7 °F).

Three-quarters scale model of Gorrie's ice machine. John Gorrie State Museum, Florida.

beef sales to the United Kingdom. Norfolk for an experimental beef shipment to the United Kingdom.
In 1902, the first modern electrical air conditioning unit was invented by Willis Havilland Carrier in Buffalo, New York. "air conditioner," designed and built in Buffalo by Carrier, began working on 17 July 1902.
Thomas Midgley, Jr. created the first chlorofluorocarbon gas, Freon, in 1928.
Freon is a trade mark of Dupoint forany DuPont forany Chlorofluorocarbon (CFC)Hydrogenated CFC (HCFC), or Hydrofluorocarbon (HFC) refrigerant,the name of each including a number indicating molecular composition (R-11, R-12, R-22, R-134A). As an alternative to conventional refrigerants, natural alternatives, such as CO2 (R-744), have been proposed.

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7.CONCLUSION:

The district cooling system is going to be the future of Air Conditioning for Residential and Commercial buildings as the Townships are being developed with the purpose of living and working. The District cooling system give saves a huge power and initial cost of installing air conditioning units. The District cooling system will give you the Chilled water and the same is metered by using BTU-Meter as per the usage of Chilled water the bill will be coming.The whole load calculations design for District Cooling system are the same as of any other Air conditioning system , the only difference being the design stops at the Fan Coil Unit or Air Handling Unit chiller water In and Out connections.In this project we have demonstrated the concept of District cooling system for different application Residential 5 Blocks and a Function hall the total load calculation we got 600 TR and we have done selected 3 chillers each of 300TR of which we includes 300TR chiller as stand by. The chilled water pipe sizing has also been done.

8.FUTURE SCOPE:

The district cooling system is going to be the future of Air Conditioning for Residential and Commercial buildings as the Townships are being developed with the purpose of living and working. The District cooling system give saves a huge power and initial cost of installing air conditioning units. In the district cooling system the centralised cooling plant is located at a distance and the chilled water from the cooling plant is carried to the user stations where the AHU's present from there the coolant is again returned to the centralised plant via a closed piping network and with the help of pumps, whereas the chilled water from the cooling tower to the chillers The District cooling system will give you the Chilled water and the same is metered by using BTU-Meter as per the usage of Chilled water the bill will be coming.

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