Cairo University
Faculty of Engineering
Mech. Power Department

دبلوم تطبيقات التحكم الأوتوماتيكى
فى نظم القوى الميكانيكية

MEP 599 Diploma Design Project- Summer Term 2015

Pipelines application on a chiller piping network

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Abstract:

Project objective : **Applying pipeline principles and application on a water chiller pipe network to obtain proper diameter for the pipes along with the suitable pump for that network.**

Project description :

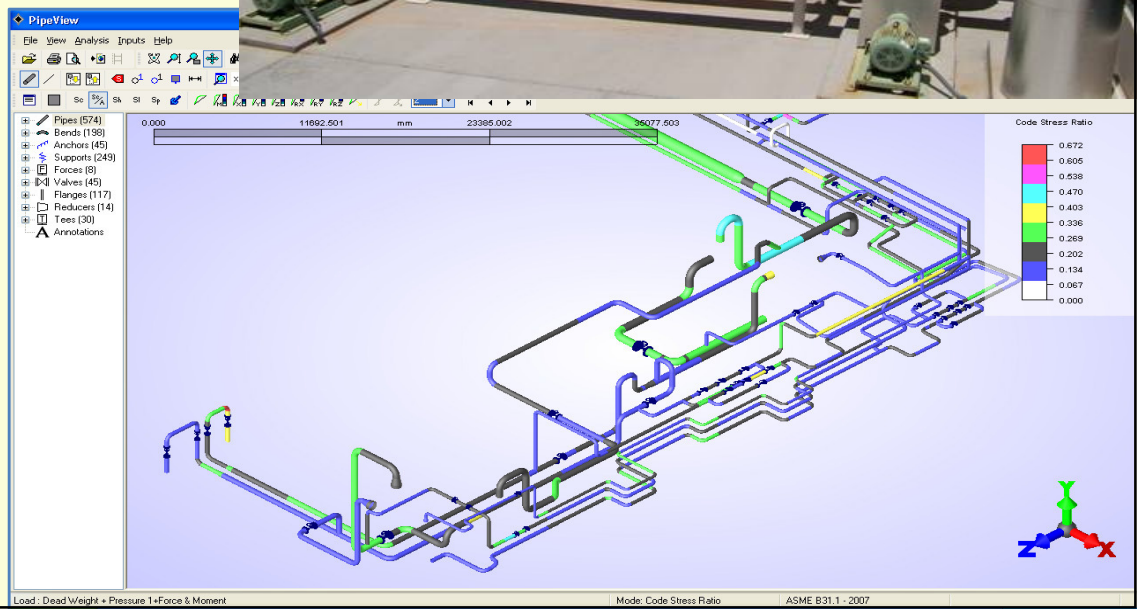
The building where the design takes place is located in Cairo facing north , It is a residential Building of 20 floors , The project takes place on the last 7 floors (14,15,16,17) Identical , (18,19,20) have different drawing

Project steps :

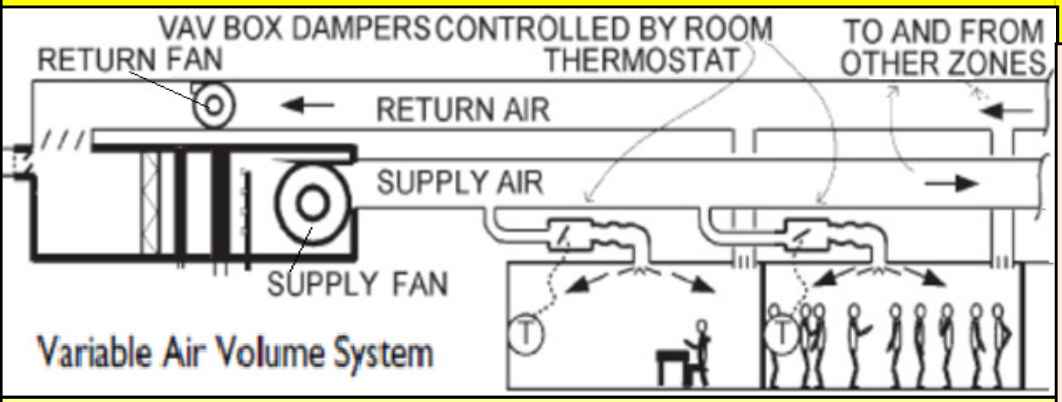
- **Load estimation of the heat load**
- **Water chiller selection for the calculated load**
- **Pipe diam. selection for needed flow in pipe network**
- **pipe network design in each floor**
- **Pressure loss calculations in the piping network**
- **Pipe selection for the piping network**

Programs used :

- ✓ **Hap carrier : load estimation**
- ✓ **Mcqway : pipe inner diameters**
- ✓ **Auto cad : Building floors and pipe estimation**
- ✓ **Pipe flow wizard : losses in pipes**
- ✓ **Pipe flow expert: Required minimum pump power.**



System selection: Water system with variable air volume (VAV)

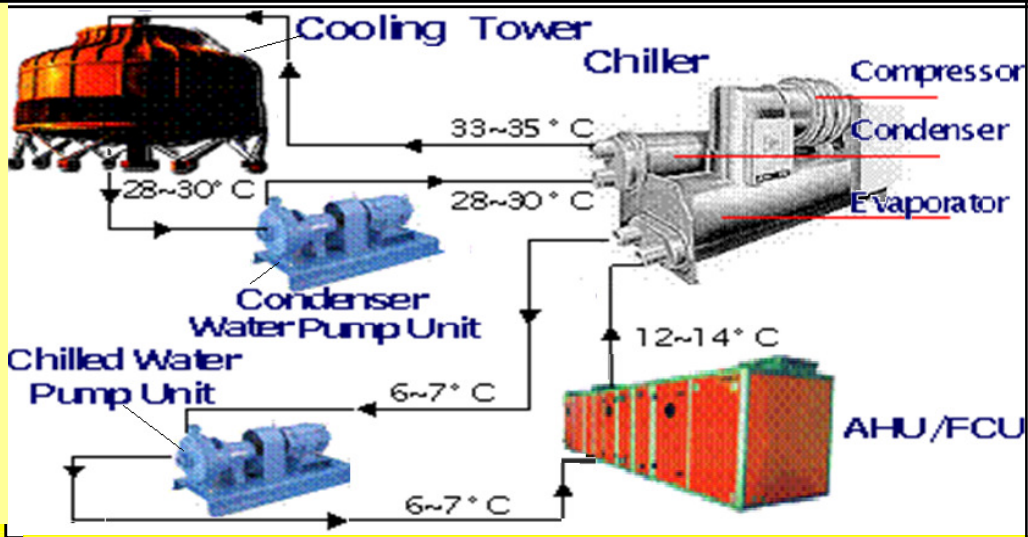


Selected Chiller: 16LJ (Carrier) SINGLE-EFFECT LOW-TEMPERATURE HOT WATER ABSORPTION CHILLER 75 to 525 Nominal Tons

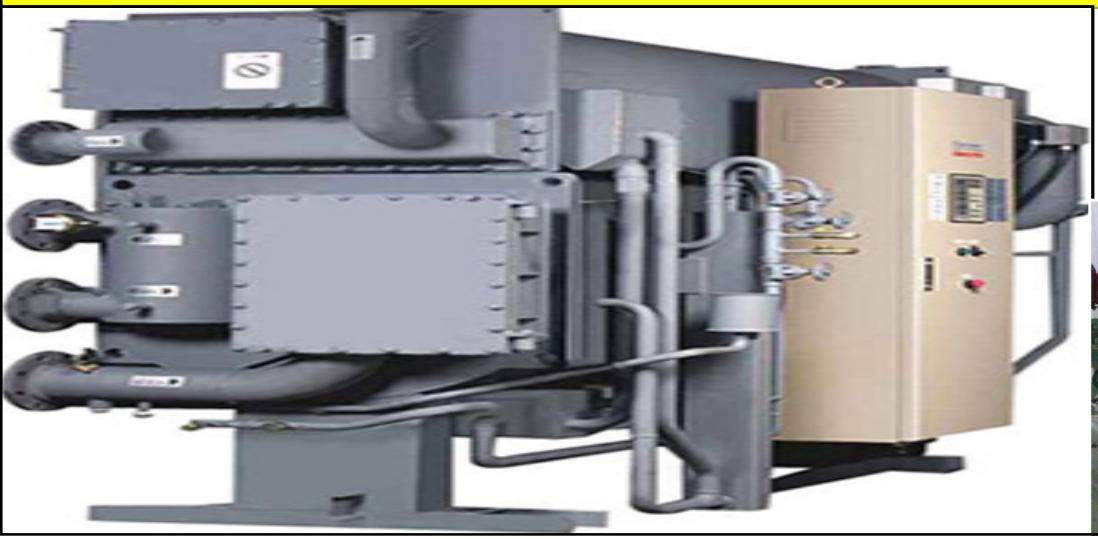
Single-effect absorption chillers are commonly installed in large capacity comfort cooling applications that are also served by centrifugal or screw chillers such as office buildings, hospitals and universities as well as manufacturing facilities and light industrial process cooling. They are also often used in hybrid plant applications, which involve both electric and absorption chillers, and are an ideal choice where waste heat is available or where electric rates and/or demand charges are high.

VAV Advantages:-

- **Low initial costs because the system only requires single runs of duct and a simple control at the end of the duct.**
- **Low operating costs because volume of air,& therefore refrigeration & fan power, closely follow the actual load of the building.**
- **Lower energy consumption in cooling system as air is not cooled to very low temperatures & then reheated as in constant volume systems**
- **Lower energy consumption also results due to lower fan power input due to lower flow rate, when the load is low. These systems lead to significantly lower power consumption, especially in perimeter zones where variations in solar load and outside temperature allows for reduced air flow rates.**



Selection: Type of water chillers: 1- Water cooled 2-Air cooled



Pipe design: Material picked : Steel – black and galvanized

-We Took 7 floors from our building and made pipe system on it

-By using Pipe lines Programs, We calculated the head losses of the Pump so we got power of the Pump.

Calculation of inner diameter

DesignTools PipeSizer Version 6.2

Exit Print About

Sch 40 Steel | 50°F Water | 1¼" | 12. USgpm

Outside Diameter	1.66	in	Fluid density	62.411 lb/ft³
Wall Thickness	0.14	in	Fluid viscosity	3.1667 lb/ft·h
Inside Diameter	1.38	in	Specific Heat	1.002 Btu/lb°F
Inside Area	1.496	in²	Energy factor	501.6 Btu/h°F·gpm
Cross Section Area	0.6682	in²		
Section Modulus	0.23465	in³	Fluid velocity	2.57 ft/s
Moment of Inertia	0.19476	in^4	Reynolds Number	21,002
Radius Gyration	0.5397	in	Friction factor	0.02828
Weight of Pipe	2.273	lb/ft	Head Loss	2.532 ft/100 ft
Weight Pipe + Fluid	2.923	lb/ft	Elbow loss	0.113 ft

McQuay Air Conditioning www.mcquay.com

Calculation of Pump head: By Pipe Flow Wizard program

Pipe Flow Wizard www.pipeflow.co.uk

Registration Layout Help

Trial version: Register program at www.pipeflow.co.uk

Find pressure | Find flow | Find diameter | Find length

Pipe details — Metric / Imperial

Internal roughness: 0.0460 mm — Pipe material: steel

Internal diameter: 25.0000 mm — diam?

Length: 38.100 m — 10

Elevation change: 0.000 m — Rise

Flow: 90.850 litre/min

Water 10°C (50°F)

Centistokes	1.307000
Relative density	1.000000

Results (Find pressure)

Flow type: Turbulent

Reynold's number: 59002

Friction factor: 0.026

Fluid velocity: 3.085 m/s

Pressure drop: 24.008 m hd

Calculate pressure drop

Calculation of Pump Head: By using pipe flow expert

Pumps are selected so that there is no sustained rise in pressure when the water flow is throttled. Systems having considerable throttling have the pump selected on the flat portion of the "head-versus-flow" curve Normally, new installed pipe has less than design friction and, therefore, the pump delivers greater gpm than design and requires more horse power. For this reason a centrifugal pump is always selected for the calculated pump head without the addition of safety factors. If the pump is selected for the calculated head plus safety factors, the pump must handle a larger water quantity. When this occurs and provision is not made to throttle or bypass the excess water flow the possibility of pump motor overload exists Again, if the pump is selected for maximum water quantity and diversity is not applied, the water flow must be throttled. This increases the pump head.

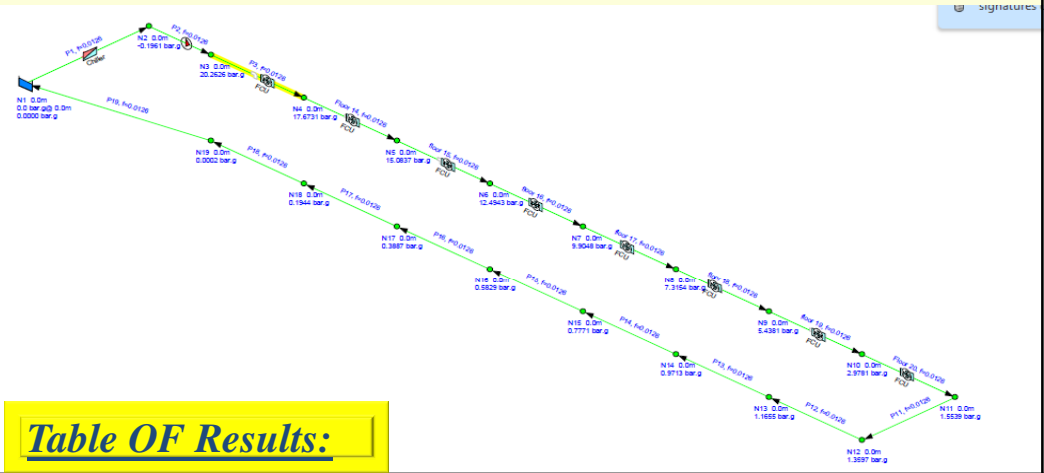
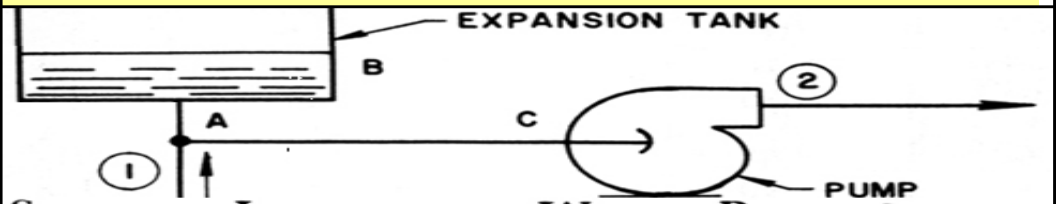


Table OF Results:

Floor	Capacity Of Chiller (Ton Of Refrigerant)(T.R)	Water Flow Rate(GPM US)	Pipe Inside Diameter(in)	Pump Head (m.hd) From Pipe Flow Wizard
13	14.6	27.86	2.067	37.158
14	14.6	27.86	2.067	37.158
15	14.6	27.86	2.067	37.158
16	14.6	27.86	2.067	37.158
17	11.4	24.87	2.067	27.673
18	4.6	11.13	1.38	4.187
19	9.8	23.52	2.067	24.008
20	7.2	17.39	2.067	8.151

Pump Power Calculations:

-Total Capacity = 95 T.R
-Total Pump Head =212.634 m.hd
-Total Water Flow Rate = 189 Gpm USA
-Power Of Pump = q ρ g h/1000
Q = 200 GPM = 0.012618039 m^3/sec
ρ=1000 kg/m^3 g=9.8 m/sec^2
Pump head= 212.634m.hd Power Of Pump=25.72 Kw



STRAINER LOCATION IN WATER PIPING SYSTEM

ACCESSORIE Expansion Tanks:-

An expansion tank is used to maintain system pressure by allowing the water to expand when the water temperature increases, and by providing a method of adding water to the system. It is normally required in a closed system but not in an open system: the reservoir in an open system acts as the expansion tank The open and closed expansion tanks are the two types used in water piping systems. Open expansion tanks are open to the atmosphere and are located on the suction side of the pump above the highest unit in the system. At this location the tank provides atmospheric pressure at or above the pump due to the expansion tank must be greater than the friction drop of the water in the pipe from the expansion line connection to pump suction. the static head *AB* must be greater than the friction loss in line *AC*. Adding any accessories such as a strainer in line *AC* increases the friction drop in *AC* and results in raising the height of the expansion tank. To keep the height of the tank at a reasonable level, The closed expansion tank is used for small or residential hot water heating systems and for high temperature water systems. Closed expansion tanks are not open to the Air vents must be installed in the system to vent the air. Closed expansion tanks are located on the pump suction side of the system to permit the pump suction to operate at or near constant pressure. Locating the expansion tank at the pump discharge is usually not satisfactory. All pressure changes caused by pump operation are subtracted from the original static pressure. If the pressure drop below the original static is great enough, the system pressure may drop to the boiling point causing unstable water circulation and possible pump cavitation. If the system pressure drops below atmospheric, air sucked in at the air vents can collect in pockets and stop water circulation. The capacity of a closed expansion tank is larger than an open expansion tank operating under the same conditions. ASME has standardized the calculation of the capacity of closed expansion tanks. The capacity depends on whether the system is operating above or below160 F water temperature. atmosphere and operate above atmospheric pressure

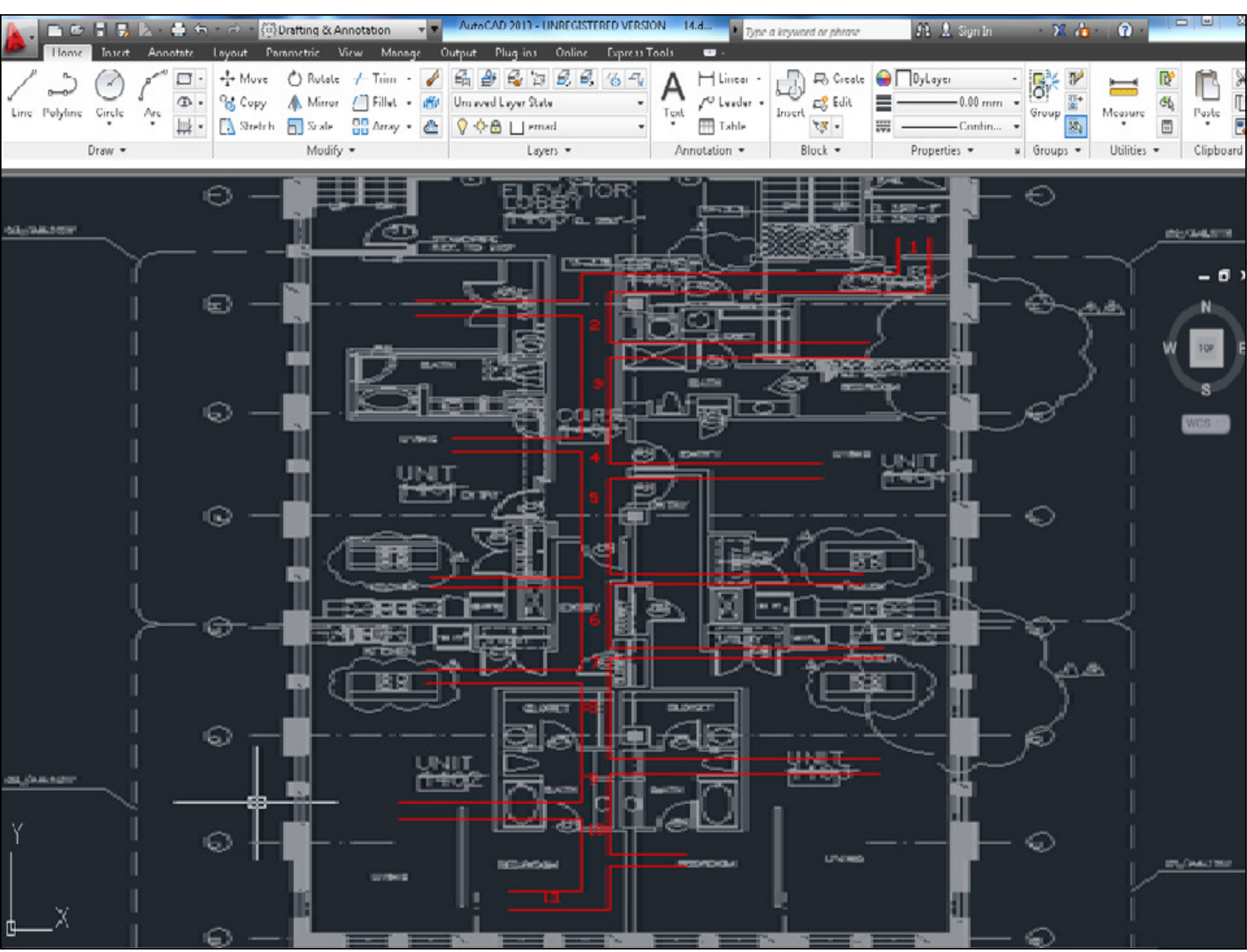
Pipes Size Results For The building By Using (MCQUAY

Pipe Id	Pipe Name and Notes	Material	Inner Diameter mm	Roughness mm	Length m	Total K	Mass Flow kg/sec	Flow m³/sec	Velocity m/sec	Entry Pressure bar.g	Exit Pressure bar.g
1	P1	4" Steel Sch. 40	200.000	0.046	5.000	0.0000	12.5928	0.0126	0.402	0.0000	-0.1961
2	P2	4" Steel Sch. 40	200.000	0.046	5.000	0.0000	12.5928	0.0126	0.402	-0.1961	20.2626
3	P3	4" Steel Sch. 40	52.500	0.046	40.000	2.3400	12.5928	0.0126	*5.829 (Flow Velocity is high)	20.2626	17.6731
4	Floor 14	4" Steel Sch. 40	52.500	0.046	40.000	3.2200	12.5928	0.0126	*5.829 (Flow Velocity is high)	17.6731	15.0837
5	floor 15	4" Steel Sch. 40	52.500	0.046	40.000	7.0400	12.5928	0.0126	*5.829 (Flow Velocity is high)	15.0837	12.4943
6	floor 16	4" Steel Sch. 40	52.500	0.046	40.000	2.7000	12.5928	0.0126	*5.829 (Flow Velocity is high)	12.4943	9.9048
7	floor 17	4" Steel Sch. 40	52.500	0.046	40.000	3.8000	12.5928	0.0126	*5.829 (Flow Velocity is high)	9.9048	7.3154
8	floor 18	4" Steel Sch. 40	52.500	0.046	29.000	7.9200	12.5928	0.0126	*5.829 (Flow Velocity is high)	7.3154	5.4381
9	floor 19	4" Steel Sch. 40	52.500	0.046	38.000	14.8800	12.5928	0.0126	*5.829 (Flow Velocity is high)	5.4381	2.9781
10	Floor 20	4" Steel Sch. 40	52.500	0.046	22.000	22.3200	12.5928	0.0126	*5.829 (Flow Velocity is high)	2.9781	1.5539
11	P11	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	1.5539	1.3597
12	P12	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	1.3597	1.1655
13	P13	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	1.1655	0.9713
14	P14	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	0.9713	0.7771
15	P15	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	0.7771	0.5829
16	P16	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	0.5829	0.3887
17	P17	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	0.3887	0.1944
18	P18	4" Steel Sch. 40	52.500	0.046	3.000	0.0000	12.5928	0.0126	*5.829 (Flow Velocity is high)	0.1944	0.0002
19	P19	4" Steel Sch. 40	200.000	0.046	3.000	0.0000	12.5928	0.0126	0.402	0.0002	0.0000

Our Project Selected Pump:-

Power Of the Pump=25.72kW=35.5Hp
Our Selected Pump is :-
Kirloskar Horiz. Monoblock Pump 100x100 SRF-3095 (3PH) (30HP)
We will need a 3 series pumps to match the required head with 2 more as back up pumps

Brand	**KIRLOSKAR BROTHERS LIMITED**
Power Rating(HP)	**30**
Power Rating(KW)	**22**
Flow Rate (Litre Per Minute)	**960**
Line1	**Motor Power: 22KW (30HP)**
Line2	**Head Range: 68-94 M**
Line3	**Flow Range: 1155-360 LPM**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