



DESIGN OF HVAC SYSTEM FOR A COMMERCIAL BUILDING (Case Study Hotel)

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Objectives

- To study and understand the working of various types air conditioning systems.
- To estimate the cooling/heating loads and select the appropriate HVAC system components
- To design complete ductworks and chilled water piping systems.

Abstract

This report introduces complete HVAC system design for a general Hotel in Riyadh city. The Hotel consists of 8 levels with a total area of 207453 ft² (19280 m²). Manual cooling load calculations were done for a bedroom on the first floor as an example and. Then HAP (Hourly Analysis Program) was used to complete the calculations with a goal of 10% error or less. The complete building load estimation was performed using HAP program. The maximum load estimated is 548 TR and the resulting, 362 fan-coil units are selected for small spaces and 4 air handling units are selected for large spaces. The cooling capacity for the selected FCUs and AHUs is 764 TR with 1841 GPM and a diversity factor of 85% reduces the capacity to 649 TR with 1565 GPM. Also, the air outlet for each space are selected and located. Two air cooled chillers in duty and one in standby are chosen to overcome the cooling load. Complete air duct sizing from AHUs or FCUs to their linked air outlets is performed based on equal friction method by using duct sizer Mc-Quay software. Also, the total static pressure is calculated for the critical path of each duct work to select the proper fan size. Then, complete chilled water pipes sizing is performed using pipe sizer Mc-Quay software.

Methodology

- Hourly Analysis Program HAP

This Software is used to estimate the cooling/heating load for each space and the required quantity of supplied air

Summary of HAP output

FLOOR	Total Load (TR)	Total Chilled Water Flow Rate (gpm)	Total Air Flow (cfm)	Total Fresh Air (cfm)
Ground Floor	75.97	157.27	30292	4082
Mezzanine Floor	57.9	128.77	20528	3672
First Floor	71.004	157.45	37343	1624
Second To Fifth Floor	68.8	153.15	35907	1564
Sixth Floor	68.75	153.37	35105	1746
HOTEL TOTAL	548.824	1209.46	266896	17380

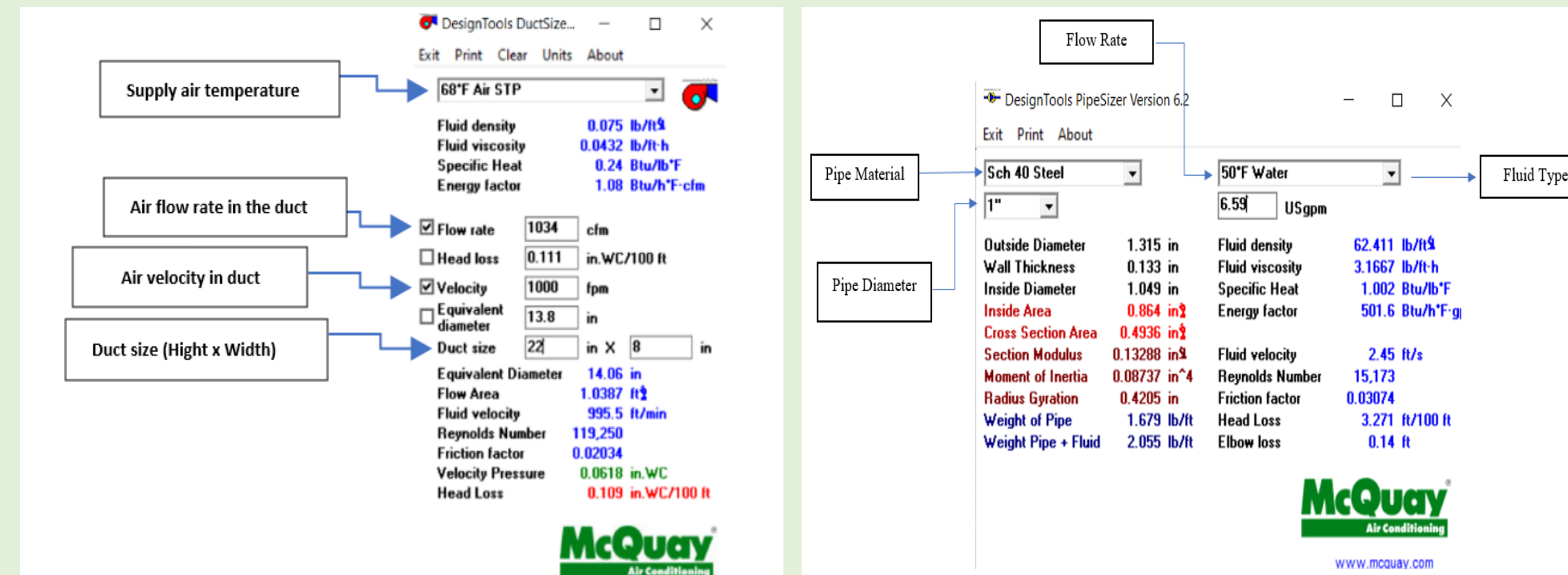
- Equipment Selection

In this step air diffusers, grills, air handling units (AHUs), fan coil units (FCUs), and the chiller, are selected from manufacturer's catalogues based on the criteria of ASHRAE standard. After equipment selection the total load and chilled water requirements will be:

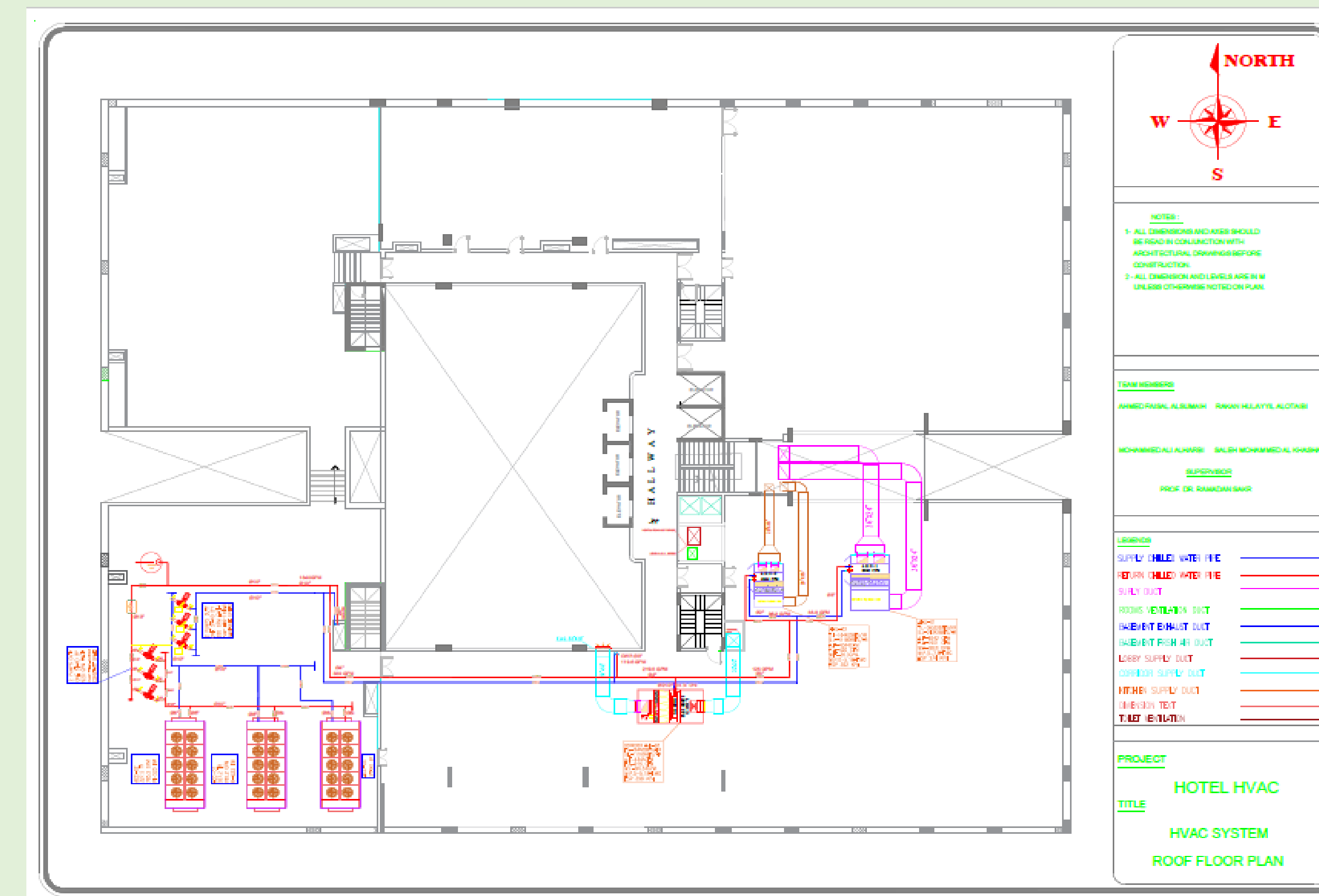
FLOOR	TOTAL LOAD (T.R)	TOTAL FLOW (gpm)
GROUND FLOOR	70.5	165.53
MEZANINE FLOOR	61.4	166.9
FIRST FLOOR	90.75	217.52
SECOND TO FIFTH FLOOR	91.02	215.5
SIXTH FLOOR	87.78	215.5
CORRIDORS	39.5	94.34
LOBBY-CAFETERIA-Atrium	50.11	119.6
TOTAL	764.1	1841.39
AFTER using 85% D.F		
TOTAL LOAD (T.R)	649.5	1565

- Duct and Pipe sizing

Equal friction method is applied for duct sizing and duct sizer software (McQuay) is utilized



- AutoCAD Drawings: Samples: Roof Floor Plan



- Ground Floor Plan



- Total pressure losses of fans (Centrifugal , Axial)

Name of Fan Space	Total Static Pressure	
	Pa	(in.wg)
AHU-01-Restrant	507.25	2.029
AHU-04-Lobby	906.5	3.626
AHU-04-Kitchen	539.25	2.157
AHU-04-Corridors	747.75	2.991
Fan-07 Hotel ventilation	219.03	0.876
Fan-01 Basement exhaust	307.44	1.23
Fan-02 Basement exhaust	381.73	1.527
Fan-03 Basement exhaust	302.29	1.209
Fan-01 Basement ventilation	253.43	1.014
Fan-02 Basement ventilation	273.91	1.096
Fan-04 Toilet Exhaust	142.27	0.569
Fan-05 Toilet Exhaust	156.1	0.624
Fan-06 Toilet Exhaust	148.84	0.595
Fan-07 Toilet Exhaust	148.76	0.595
Fan-08 Toilet Exhaust	148.23	0.593



Conclusions

- The cooling load for commercial building (Hotel) is estimated with good accuracy using Hourly Analysis Program (HAP4.9 Software).
- Total load of 548 TR, total airflow rate of 26689 CFM, and total chilled water of 1209 GPM.
- 362 Fan/coil units are chosen for small room.
- 4 Air handling units are chosen for large spaces.
- Air outlets are selected according to the required air quantity, the noise level recommendation and comfort requirements.
- Complete duct design and chilled water pipe sizing are performed using (duct sizer and pipe sizer Mc-Quay Software).
- Selection of different types of fans and pumps is achieved.

References

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Acknowledgements

All Praise is due to Almighty Allah who gave us the knowledge that enabled us to complete this project. We express our deep sense of gratitude to our supervisor, Dr. Ramadan Youssef Sakr for his guidance, support and continuous supervision throughout the course of this project. We are thankful to the members of our examination committee, Dr. Syed Muhammad Fakhir Hasani and Dr. Murugesan Palaniappan for spending their valuable time going through the manuscript and providing useful suggestions. We are also very grateful to Dr. Mohammad Almeshaal, Chairman, Mechanical Engineering Department and Dr. Adel Alfozan, Dean, College of Engineering for their support.