mae 439/539 Spring 2012
CHICAGO OFFICE BUILDING PROJECT

A single floor rectangular office building is located in a Chicago, IL suburb. The building is 114 ft wide by 265 ft long with a ceiling height of 10 feet. The long axis of the building is oriented at a North-South direction with the main double door entrance to the lobby located on the North face of the building as is shown in the attached floor plan. All dimensions are to the wall centers. All floor and roof areas can be calculated with these dimensions without accounting for wall thickness. The building floor is a 4 in concrete slab-on-grade. At least 6 zones are required. There is a 2 ft plenum below the roof structure above a .75 in acoustical time ceiling. Overall building height is 12 feet.

DOORS

The North facing entrance façade has double 3 ft wide by 7 ft. high glass doors. The South façade has three 1.75 in. thick 3 ft. wide by 7 ft. high, polyurethane insulated steel doors two configured as double doors and one as a single door entrance.

WINDOWS

All windows are double clear .25 in glass with .25 in argon between the panes in aluminum frames with thermal breaks. All the office, laboratory and conference windows are identical 10 ft wide by 7 ft high units.

A window, 5 ft. wide by 7 ft. high, is located on either side of the North facing entrance façade door.

A window, 2 ft. wide by 7 ft. high, is located adjacent to the single South facing façade entrance door.

Lighting is 1. watts/ ft^2. General office equipment power is .5 watt/ ft^2. Maximum occupancy is 1 person per 250 ft^2 plus up to 25 conference room visitors for part of the day. The server and computer equipment room zone has a design equipment load of 5 watts/ft^2 which is constant for all 8760 hours of the year. Infiltration is .25 air changes per hour. Local building codes require at least 20 cfm of outside air per person of occupancy as the ventilation requirement for the building with a minimum ventilation flow, regardless of occupancy, of 10% of the maximum flow. The Electronics and Mechanical Laboratories do not have any special cooling or ventilation requirements beyond those of the rest of the building.

The building will be operated with one shift 8 AM to 5 PM. Select a schedule of occupancy, lights and equipment that allows for 15% of the occupancy being present 2 hours before and 4 hours after working hours and on weekends and holidays.

The building is surrounded by areas of asphalt parking lots and grass. Assume .2 as the ground reflectivity.

The structure of the building is specified in the following table. Also listed in the table are the properties of the materials used in the structure from the building specifications and from the manufacturers and suppliers of the specified materials.

	Specific Heat	Conductivity, k	Density
	BTU/lb F	BTU-in/ft^2 F	lb/ft^2
EXTERIOR WALLS			
4 in face brick	.19	6	100.
1 in air gap			
8 in concrete block	.2	.96	18.
1 in air gap			
.009 in vapor barrier	.2	2.40	116
4. in insulation	.17	.3	2.
.75 in gypsum board	.3	1.08	50.
INTERIOR WALLS			
.75 gypsum board	.3	1.08	50.
4. in insulation	.17	.3	2.2.
.75 in gypsum board	.3	1.08	50.
ROOF			
.5 in stone chips	.4	9.96	55.
.4 in membrane	.4	.3	6.
5 in insulation	.2	.3	6.
2 in concrete	.22	12.	144.
.08 in steel pan	.1	312.	481.
air space			
.75 in acoustical tile	.2	.48	30.
FLOOR			
4 in concrete slab on grade	.17	12.	160.
4 in x 3 ft deep peripheral mineral board insulation.	.2	.26	16

PROJECT DESIGN SCHEDULE

The project work is divided into 9 phase reports with due dates. Each phase report will be reviewed and corrected but not graded. These corrected phase reports can be used as the basis of the final report.

Phase 1 Select the number and arrangement of zones for your analysis of this building. Chapter 2. February 15

Phase 2 Determine, using a spread sheet, the winter and summer design, hourly design day, steady state, heat loads from conduction, ventilation, people, lights and equipment for the whole building without considering zones. Chapter 5. Due February 29.

Phase 3 Calculate the total zone hourly cooling load including solar radiation for July 21 for your zone of the building which contains the majority of the office windows in the West facing wall for comparison with the HAP results for this zone. Due March 21

Phase 4 Using the Carrier Hourly Analysis Program (HAP) determine the hourly space heating and cooling loads and extraction rates for all of the building zones. Compare the HAP results for the zone used in Phase 3 to your calculated results for Phase 3. Chapter 8. Due March 28

Phase 5 Define the psychrometric processes for summer design conditions, winter design conditions, and 4 summer extreme conditions including 75 F dry bulb and 85% relative humidity and 105 F dry bulb 20% relative humidity. Chapter 3. Due April 9.

Phase 6 Specify the type and capacity of equipment required by the heating and cooling loads of Phase 4. Carrier.com and Trane.com web sites have catalogues giving equipment specifications and performance however equipment from any manufacturer can be specified. Simulate the yearly performance of the system specified using the HAP Program with particular attention to the hours for which the specified return temperature is unmet. Chapter 15. Due April 13.

Phase 7 Select the coil location and size the fan and ducts required. Sketch a layout of the duct system. Chapter 12 and Chapter 3. Due April 18.

Phase 8 Estimate the yearly heating and cooling cost using the BIN method. Calculate these costs using the Carrier Hourly Analysis Program. Chapter 8 Due April 23

Phase 9 Incorporate the calculations and results for all 8 Phases in a final report. Identify and list options for structural changes and operating strategies that could be adopted to reduce the yearly heating and cooling costs. Due April 25.

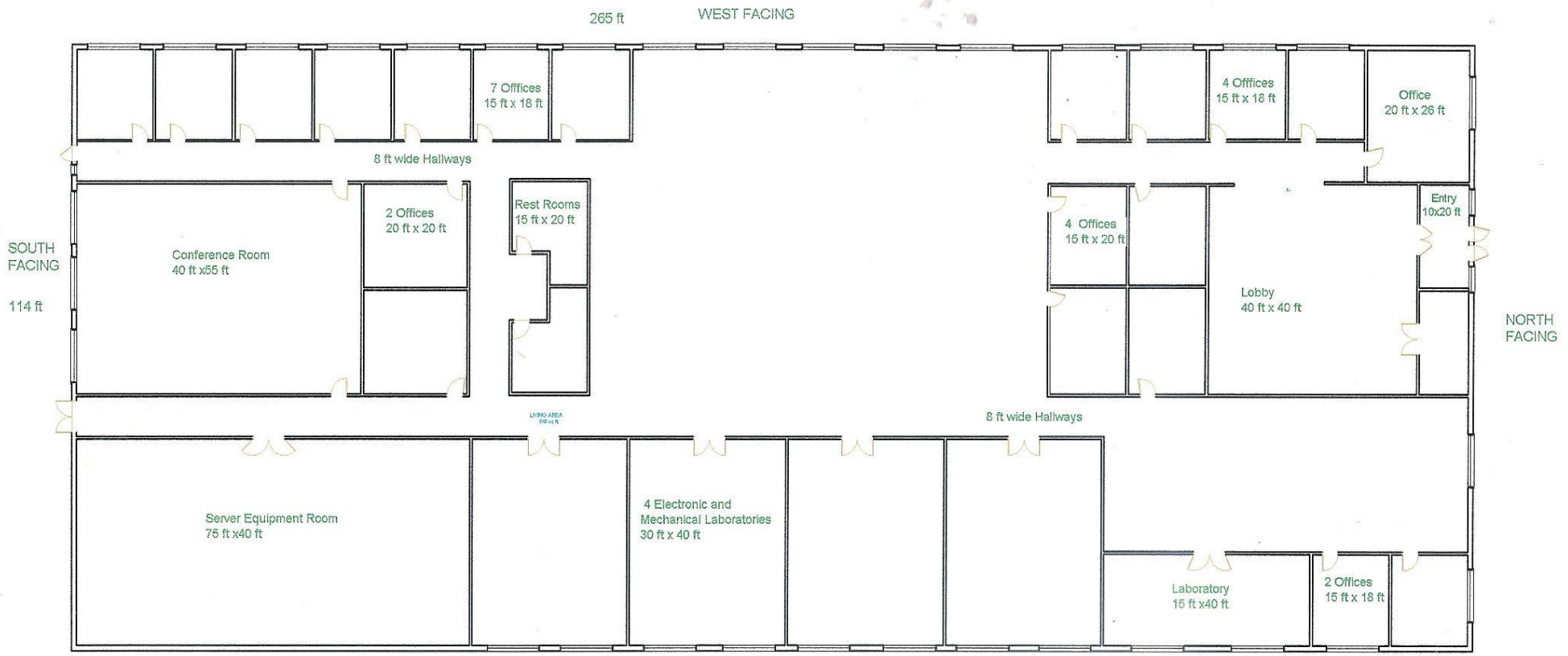
FINAL REPORT

The final report for this project (Phase 9) should be a typed, organized, professional level report suitable for submission to a client. The report should begin with a one page summary of the analysis and the results achieved. The results for this project are the heating and cooling loads(Phase 4), a specification of the required heating and cooling equipment (Phase 6) , specification of the ducting system required (Phase 7) and an estimate of the yearly heating and cooling operating cost (Phase 8).

The body of the report should include separate organized headings for the Problem Statement, Approach and Assumptions including a discussion of the zone configuration chosen (Phase 1), Methods and Limitations, Results and Conclusions.

Copies of any spread sheets or other calculations should be included in an Appendix with the following Carrier HAP reports for each system,

Air System Sizing Summary
Air System Design Load Summary
Ventilation Sizing Summary
Unmet Hours Report
Annual Cost Summary


265 ft
WEST FACING
7 Offfices
15 ft x 18 ft
4 Offfices
15 ft x 18 ft
Office
20 ft x 26 ft
8 ft wide Hallways
SOUTH
FACING
114 ft
Conference Room
40 ft x55 ft
2 Offices
20 ft x 20 ft
Rest Rooms
15 ft x 20 ft
4 Offices
15 ft x 20 ft
Entry
10x20 ft
Lobby
40 ft x 40 ft
NORTH
FACING
8 ft wide Hallways
Server Equipment Room
75 ft x40 ft
4 Electronic and
Mechanical Laboratories
30 ft x 40 ft
Laboratory
15 ft x40 ft
2 Offices
15 ft x 18 ft
2012 CHICAGO BUILDING PROJECT
EAST FACING
All dimensions are to wall centers.

To obtain cooling, heating and fan product specifications use the following Carrier web site or the web site or catalogues of any other equipment supplier you may prefer.

http://www.carrier.com
Commercial Systems
Building Process Heating and Cooling Systems
Products
Packaged Outdoor
Rooftop Units
48 Z or 48 A
Gas fired Heating and Electric Cooling
Document Downloads
Product Data, Export and Domestic

Carrier HAP Building Project Energy Analysis

View
Options
Other Options
Enable Energy Analysis

Weather
Simulation Tab
Select Chicago

Systems
Supply Fan
Enter static pressure of selected fan (1 to 2 in. water)

Humidification
Select self contained steam-natural gas

Electric Rates, use these or your own rates.
Set up a Building Rate from the default
Rate - .03 to .13 $/ kW hr, my rate in buffalo is $.124/ kwhr

Fuel Rates, use these rates or your own rates.
Set up building fuel rate
A therm is 100,000 BTU/hr
A cubic foot of natural gas has a heating value of about 950 BTU.
Rate -$.80 to $ 1.25/ therm, my rate in Buffalo is $1.21/therm