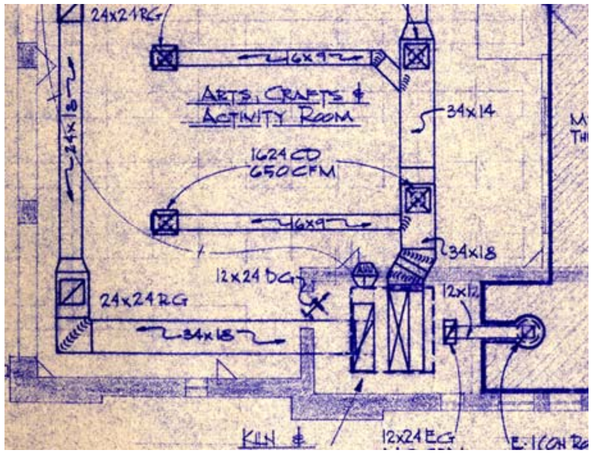
SIZING SYSTEMS
for Schematic Design



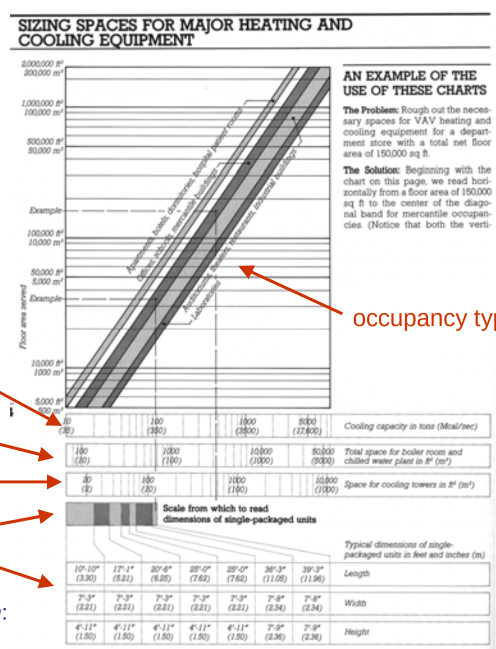
HVAC System ***Design*** Process

Establish design intents/criteria (including codes/standards)
Establish zoning requirements
Make preliminary system selection
Calculate design heating/cooling loads
Select appropriate source equipment
Select appropriate distribution approach
Coordinate HVAC components with other building systems
Run energy analyses to optimize selections
Size equipment (fans, pumps, valves, dampers, pipes, ducts, condensers, air-handlers, tanks, …)
Coordinate individual equipment selections into a cohesive whole
Develop appropriate control strategies and logic
Develop commissioning tests and checklists
Oversee systems installation
Develop Systems Manual for owner

Key HVAC Coordination Issues

- **Equipment *Locations***
  - Source equipment (noise, maintenance access, access for replacement, connection to utilities)
  - Condenser (is **exterior**, noise, appearance, air flow)
  - Air-handlers (air supply and return paths, outdoor air access, noise)
  - Terminal devices (maintenance access, noise)
- **Floor Area for Equipment**
  - Mechanical room(s), satellite fan room(s), condenser
- **Volume for Distribution (and Equipment)**
  - Ductwork (by itself and in coordination with beams, lighting fixtures, sprinkler piping, electrical/data runs)
- **Aesthetics**
  - Exposed elements (especially diffusers)

Large Equipment Areas



The Architect's Studio Companion: Allen & Iano, 3rd Ed.

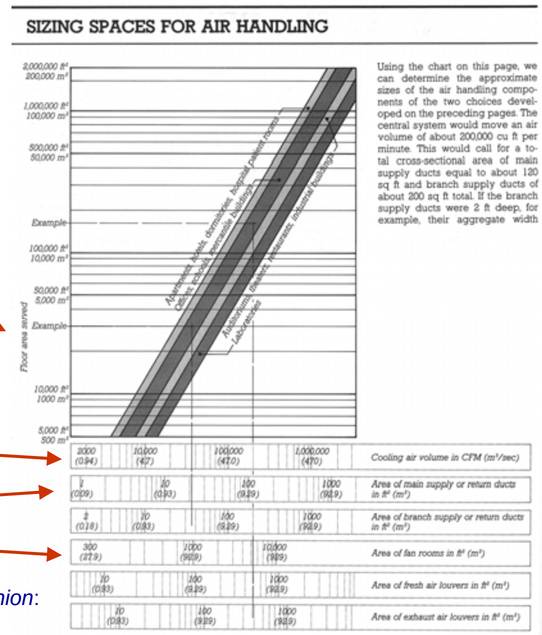
Air Handling Unit Areas

floor area served

air flow (cfm)

main duct size

fan room size



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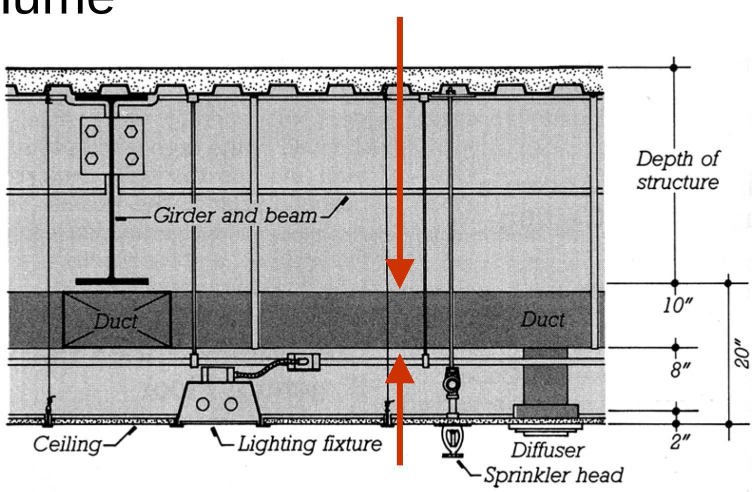
Volume



SECTION THROUGH CEILING/FLOOR ASSEMBLY

Allen & Iano, *The Architect's Studio Companion*, 3rd Ed., Wiley.

Estimating Duct Sizes

- Assume 1 cfm per square foot (for an all-air system)
  - For an air-water system, assume about 0.1 cfm per square foot
- Duct volume (ft^2) = air flow / air speed
- Assume 1000 fpm air speed (can be higher, but increased speed increases energy costs, noise potential, and cost of ductwork)
  - cfm = cubic feet per minute (air flow rate)
  - fpm = feet per minute (air speed in ducts)
- Estimate duct dimensions as needed *for area served by a given duct* (main ducts, branch ducts, …)

Estimating Duct Sizes Example

- An air-handler serves 15,000 sq ft
- (15,000 sq ft) (1 cfm/sq ft) = 15,000 cfm
- Verify that proposed fan room will accommodate a 15,000 cfm AHU
- Main supply duct size =
  (15,000 cfm) / (1000 fpm) = 15 sq ft
- Verify that the duct will fit (and return air can be accommodated)

Estimating Duct Sizes Example

- A branch duct serves 1,000 sq ft
- (1,000 sq ft) (1 cfm/sq ft) = 1,000 cfm
- Branch supply duct size =

  (1,000 cfm) / (1000 fpm) = 1 sq ft

  duct can be 12” by 12” or 24” by 6” …
- Verify that the duct will fit (and return air can be accommodated)

Estimating Duct Sizes Example

- It is not necessary to estimate the size of all ductwork—just look at the *critical points* in the system
  - Where the ductwork is largest (at AHU)
  - Where the passages are smallest (structural crimp points)
  - Where the ductwork will be exposed to view (it becomes an architectural feature)

Estimating PV Area

Orientation	Tilt	Annual Output kWh (kWh/ft²)
Horizontal	0	4312 11.3
South	40	4895 12.9
South	90	3079 8.1
East	40	3838 10.1
East	90	2426 6.4

estimates for Indianapolis, from PVWatts software:
rredc.nrel.gov/solar/codes_algs/PVWATTS/version1/
4 kW array size (apx. 380 sq ft)

PV Area in Context

- Assume a plug load of 1 W/sq ft (for commercial/ institutional building)
- This becomes around 2 kWh/sq ft per year (1 W)(8 hours)(5 days)(50 weeks)
- If using a south-facing, 40 deg tilt PV array, then each sq ft of PV can power about 6 sq ft of plug load (or 170 sq ft of PV can power about 1000 sq ft of floor area plug loads; dc-ac, grid interconnected)

PV Area in Larger Context

Plug load in context

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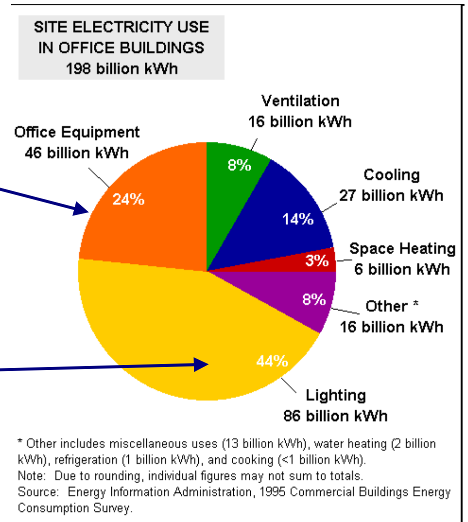


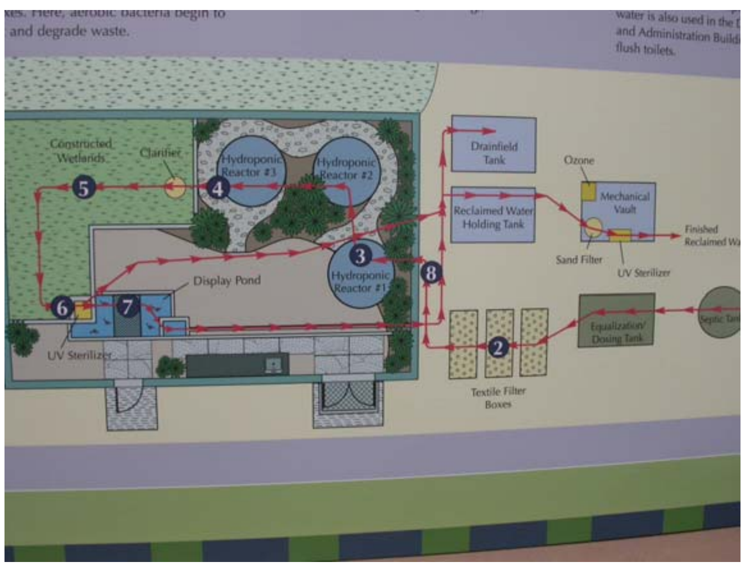
Solar Domestic Hot Water

- System separate from PV
- Water-based collectors (most likely evacuated tube type)
- Perhaps 4-6 collectors (say 4' by 8' each), facing south at about a 40 deg tilt, should be able to supply potable hot water for this building

Roofs

- Green roof – retains water runoff (good) and consumes some of retained water
- Water collection roof – gets water to storage fast, would be better if a hard surface (not a green roof)
- Which is better depends upon objective – help storm drains or collect water for use (campus storm water will likely go to the duck pond)

Living Machine



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