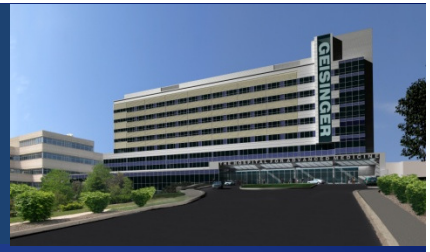


Geisinger Hospital for Advanced Medicine

Jen Redington
Mechanical Option
AE Senior Thesis
Spring 2009

Presentation Outline

- Building Overview
- Existing Mechanical Systems
- Mechanical Depth
  - Dedicated Outdoor Air Systems and Chilled Beams
  - Combined Heat and Power
- Electrical Breadth
- Architectural Breadth
- Conclusions

Building Overview

- Geisinger Hospital for Advanced Medicine
- Location: Danville, PA
- Size: 300,600 SF, 9 stories
- Total Project Cost: $108 million
- Construction Dates : June 2007-Spring 2010

Building Overview

- Building Use
  - Cardiology
  - Surgery
  - Patient Rooms
  - Clinics
  - Diagnostics
  - Staff Areas
  - Food Service
  - Shell Spaces

Existing Mechanical Systems

- Chiller Plant
  - New chiller plant being constructed housing:
    - Two existing 900-ton chillers to a new chiller plant
    - One existing free-cooling plate and frame heat exchanger
    - One new 900-ton chiller
    - One new 8,000 ton-hour, thermal energy storage tank

Existing Mechanical Systems

- Boiler Plant
  - Boiler plant addition being constructed housing:
    - Two new steam boilers, one electric and one gas
    - Two new 8,900 MBH shell and tube heat exchangers for heating water

Existing Mechanical Systems

- Air handling units
  - Five air handling units to be installed now
  - Three air handling units for the future

AHU	Air Flow (CFM)	Serving	VAV/CAV
AHU-4-1	18,000	Operating Rooms	VAV
(F)AHU-4-2	18,000	Operating Rooms	VAV
AHU-4-3	2,700	Surgical Pharmacy	CAV
(F) HV-4-4	24,000	Kitchen Make-Up	VAV
AHU-M-S1	80,000	South	VAV
AHU-M-S2	80,000	South	VAV
(F) AHU-M-N1	80,000	North	VAV
AHU-M-N2	80,000	North	VAV

Mechanical Depth

- Dedicated Outdoor Air System and Chilled Beams
  - Replace VAV boxes with a dedicated outdoor air system and chilled beams
  - Goals
    - Reduce Energy Use and Cost
    - Improve Ventilation and Indoor Air Quality
    - Reduce Mechanical Space

Mechanical Depth

- Dedicated Outdoor Air System and Chilled Beams
  - Advantages
    - Separation of sensible and latent loads
    - Improved indoor air quality (IAQ)
    - Reduced reheating of air
    - Increased comfort level due to chilled beams
    - Ensures ventilation requirements are meet

Mechanical Depth

- System Design
  - Outdoor Design Conditions
    - Summer Conditions (0.4%)
      - 90.1°F DB
      - 72.9°F WB
      - Winds: W 9.8 mph
    - Winter Conditions (99.6%)
      - 3°F DB
      - Winds: WNW 7 mph

Mechanical Depth

- System Design
  - Indoor Design Conditions
    - Operating Rooms
      - Room temperature: 60°F to 70°F (adjustable by room)
      - 50%-55% RH at 60°F
      - 35%-40% RH at 70°F
    - Patient Rooms
      - Room temperature: 70°F to 75°F (adjustable by room)
      - 30% RH min (winter)
      - 60% RH max (summer)
    - Exam/Treatment
      - Room temperature: 75°F
      - 30% RH min (winter)
      - 50% RH max (summer)
    - Other spaces:
      - Summer: 75°F, 50% RH maximum
      - Winter: 70°F, 30% RH minimum

Mechanical Depth

- System Design
  - Replaced AHU-S-1, AHU-S-2, and AHU-N-2 with dedicated outdoor air systems
  - Surgical pharmacy air handling unit eliminated, spaces controlled by south air handling units

Mechanical Depth

- System Design
  - Ventilation rates determined by ASHRAE 62.1-2007 and AIA Guidelines for Design and Construction of Hospitals and Health Care Facilities, 2001

AHU	DOAS
AHU-M-S1	8720
AHU-M-S2	8720
AHU-M-N2	9490
Total	26930

Mechanical Depth

- System design
  - Determining supply air temperature
  - Based on temperature needed for latent loads and to control humidity

AHU	W_{sp} (gr/lb)	# of People	Q_L (Btu/hr)	V_{sa} (CFM)	W_{sa} (gr/lb)	T_{sa} (F)
AHU-M-S1	64.4	389	92250	8720	48.84	47.7
AHU-M-S2	64.4	389	92250	8720	48.84	47.7
AHU-M-N2	64.4	484	116000	9510	46.46	46.4

Mechanical Depth

- System Design
  - High Induction Diffusers
    - Improve mixing in room
    - Necessary due to low supply air temperatures
    - Allow rooms to meet air change rates

Mechanical Depth

- System Design
  - Air Handling Units
    - Trane M-Series Size 21
      - Airflow range – 7350 - 12600

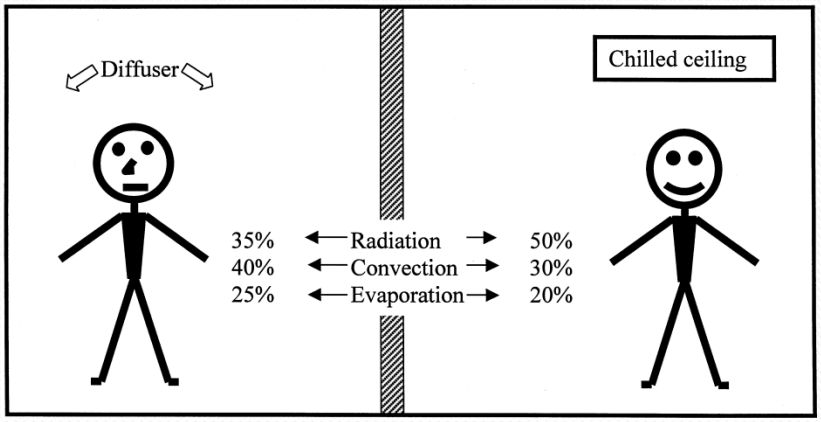
Mechanical Depth

- System Design
  - Enthalpy Wheel
    - Increased energy efficiency
    - T_3 shows temperatures after passing through the enthalpy wheel

AHU	T_1	T_3	W_1	W_3	ε_s	ε_L	T_2	W_2
AHU-M-S1	90.1	70	93.8	64.4	0.85	0.83	73.02	69.40
AHU-M-S2	90.1	70	93.8	64.4	0.85	0.83	73.02	69.40
AHU-M-N2	90.1	70	93.8	64.4	0.85	0.83	73.02	69.40

Mechanical Depth

- System Design
  - Chilled Beams
    - Increase thermal comfort
      - Radiation effects
      - Decreased air motion in the space
    - Decreased fan power



Mechanical Depth

- Results
  - Air Savings

AHU	VAV System	DOAS	Difference	% Decrease
AHU-M-S1	15000	8720	6280	42%
AHU-M-S2	15000	8720	6280	42%
AHU-M-N2	19250	9490	9760	51%
Total	49250	26930	22320	45%

Mechanical Depth

- Results
  - Decreased Mechanical Space
    - Fourth floor mechanical room
      - Removal of AHU-4-3
    - Mechanical Penthouse
      - Original AHU's – 154" x 224"
      - New DOAS AHU's – 52" x 77"
    - Decreased mechanical shaft size
      - Original supply ducts from air handling units – 108" x 138"
      - New supply ducts from air handling units – 42" x 44"

Mechanical Depth

- Results
  - Improved Indoor Air Quality
    - Decreased recirculation of contaminants
    - Increased mixing due to high induction diffusers

Mechanical Depth

- Results
  - Energy Use Savings

	Annual Electrical Use (kWh)	Annual Gas Use (kbtu)
Currrent Design	9,470,283.00	3,292,933.00
DOAS/CRCP	7,794,004.00	803,323.00
Difference	1,676,279.00	2,489,610.00
% Difference	18%	76%

Mechanical Depth

- Results
  - Energy Cost Savings

	Annual Electrical Cost	Annual Gas Cost	Total Cost
Currrent Design	$ 515,183.40	$ 35,867.14	$ 551,050.54
DOAS/CRCP	$ 423,993.82	$ 8,749.92	$ 432,743.74
Difference	$ 91,189.58	$ 27,117.22	$ 118,306.80
% Difference	18%	76%	21%

Mechanical Depth

- Combined Heat and Power (CHP)
  - Install combined heat and power plant on site
  - Goals
    - Lower Energy Use
    - Lower Emissions
    - Lower Energy Cost

Mechanical Depth

- Combined Heat and Power
  - Feasibility
    - Sparks Gap > $12/MMBTU
  - Geisinger Hospital for Advanced Medicine
    - Sparks Gap = $5/MMBTU
      - Much lower than recommended for energy cost savings

Mechanical Depth

- C

Mechanical Depth

- Combined Heat and Power
  - Feasibility
    - Existing on site equipment
  - Geisinger
    - Many of the chillers and boilers are existing
    - Necessary hot water significantly decreased by DOAS
    - For optimal use chiller plant would have to be converted to absorption chiller plant

Electrical Breadth

- Dedicated Outdoor Air
  - Decreases amount of power needed
    - AHU motor size change
    - Decreases breaker sizes

Electrical Breadth

- Dedicated Outdoor Air System
  - AHU motor size changes

AHU	Supply Fan Motor HP	NEW Supply Fan Motor HP
AHU-4-1	50	50
AHU-4-3	6.2	-
AHU-M-N2	150	15
AHU-M-S1	150	15
AHU-M-S2	150	15

Electrical Breadth

- Dedicated Outdoor Air System
  - AHU breaker size changes

Service	Breakers Removed	Breakers Added
AHU-4-3	100	-
	100	-
	100	-
AHU-M-N2	250	50
	250	50
	250	50
AHU-M-S1	250	50
	250	50
	250	50
AHU-M-S2	250	50
	250	50
	250	50

Electrical Breadth

- Combined Heat and Power
  - Power lines to hospital would have to be redesigned
  - Due to the distance from the boiler house this would add a significant amount of cost
  - Back-up power would also have to be available

Architectural Breadth

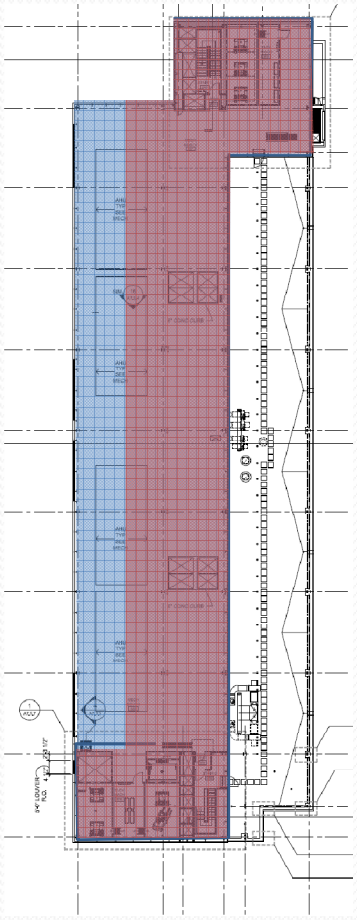
- Dedicated Outdoor Air System
  - Slight increase of space on fourth floor
  - Decreased size of mechanical penthouses

Architectural Breadth

- Dedicated Outdoor Air System

Architectural Breadth

- Dedicated Outdoor Air System



Architectural Breadth

- Combined Heat and Power
  - Boiler house addition would need to be increased to provide space for gas turbines

Conclusions

- Dedicated Outdoor Air System
  - Should be implemented
  - Energy Savings
  - Increased Air Quality
  - Increased Thermal Comfort
- Combined Heat and Power
  - Should not be implemented
  - Cost savings would not be significant
  - Difficult to integrate into existing systems

Questions?


GEISINGER


GEISINGER
Geisinger
Geisinger


Geisinger


Geisinger
Geisinger