

# Bronx School for Law Government & Justice



Bronx, New York

Yulien Wong  
Mechanical Option  
2006 Senior Thesis

# Presentation Outline

- General Information
- Existing Systems
- Mechanical Redesign
- Structural Considerations
- Construction Considerations
- Electrical Considerations
- Final Thought
- Questions & maybe answers

# General Information

## BACKGROUND

- Location: Bronx, NY
- 6 stories plus 1 mechanical penthouse & 1 floor below grade
- Approx. Size: 114,000 SF
- Occupied: Sept. 2003
- Estimated Cost: 75 million

## PROJECT TEAM

- Owner: New York School Construction Authority
- Architect: The Hillier Group Architecture
- Structural Engineer: Ysrael A Seinuk, P.C.
- MEP/Telecom: Joseph R. Loring & Associates, Inc
- Civil Engineer: Langan Engineering
- Lighting: Lighting Design Collaborative
- Contractor: Silverite Construction



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# Existing Systems

- (2) 250 Ton -York Air Cooled Reciprocating Chillers
- (10) York AirPak packaged air handling units (AHU)
- (2) Duel-fired boilers



Air Handling Units (AHU)	Type	Total [CFM]	Min. Outdoor Air [CFM]	OA %
AHU 1 [Classrooms & misc.]	VAV	48000	26000	54.2
AHU 2 [Classrooms & misc.]	VAV	19000	9000	47.4
AHU 3 [Gymnasium]	CAV	18500	7500	40.5
AHU 4 [Library]	CAV	3400	1020	30.0
AHU 5 [Lobby & Corridor]	CAV	12000	6900	57.5
AHU 6 [Kitchen]	CAV	5200/2600	5200/2600	100/100
AHU 7 [Administration]	VAV	12000	3800	31.7
AHU 8 [Dining]	CAV	6000	3360	56.0
AHU 9 [Plant Operations]	CAV	7200	2200	30.6
AHU-10 [Orchestra]	CAV	3100	1050	33.9
TOTAL		133440	66030	49.1

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# Mechanical Redesign

## Proposed System

- Ice Thermal Energy Storage
  - Full Storage
  - Partial Storage
- Cold Air Distribution
  - Supply Air at 44°F vs. 55°F
  - Entering Chilled Water 39°F vs. 44°F

## Design Goals

- Reduce high demand costs
- Downsize the needed chiller capacity
- Increase chiller efficiency
- Reduce energy consumption
- Minimize first cost



# Mechanical Redesign

## Design Procedure

- Screening Initial Economics
- Calculating Load Profiles
- Selecting Storage Type
- Selecting Operating Strategy
- Sizing Cooling Plant and Storage
- Determining Chiller & Equipment Parameters
- Sizing New Cooling Coils for Cold Air Distribution
- Laying Schematics
- Evaluating Economics
- Finalizing Design



# Mechanical Redesign

## Screening Initial Economics

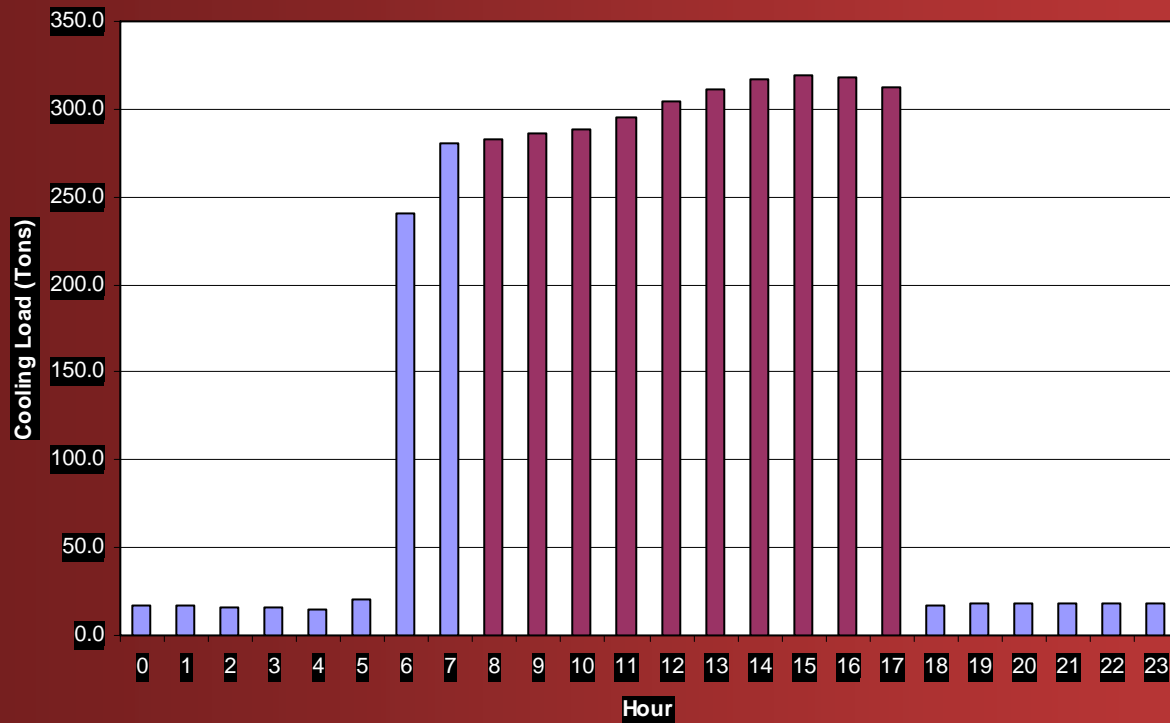
Con Edison Electric Utility Rate for January 2006

On-Peak Demand Charge	\$12.17 per kW
On-Peak	\$0.183 per kWh
Off-Peak	\$0.147 per kWh

*\*New York State Energy Research and Power Authority*

# Mechanical Redesign

## Calculating Load Profiles



# Mechanical Redesign

## Selecting Storage Type

- Chilled Water
- Ice Harvesting
- External Melt Ice-on-Coil
- Internal Melt Ice-on-Coil

## Selecting Operating Strategy

- Full Storage
- Partial Storage

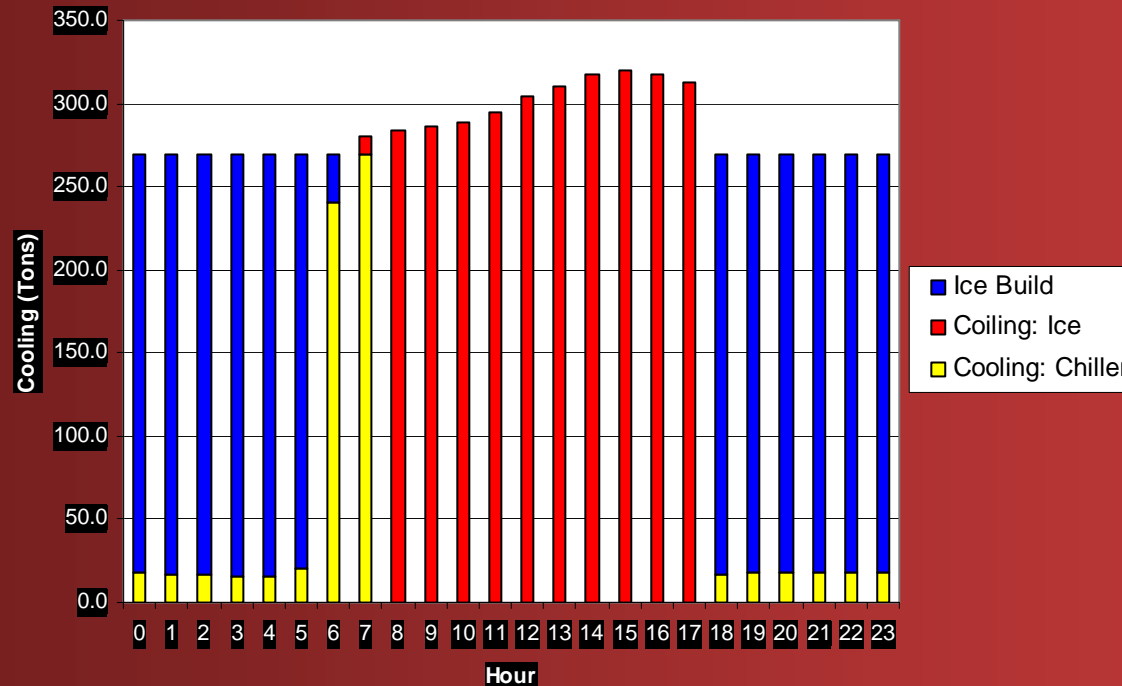
## Sizing Cooling Plant & Storage

- Full Storage
- Partial Storage

# Mechanical Redesign

## Full Storage

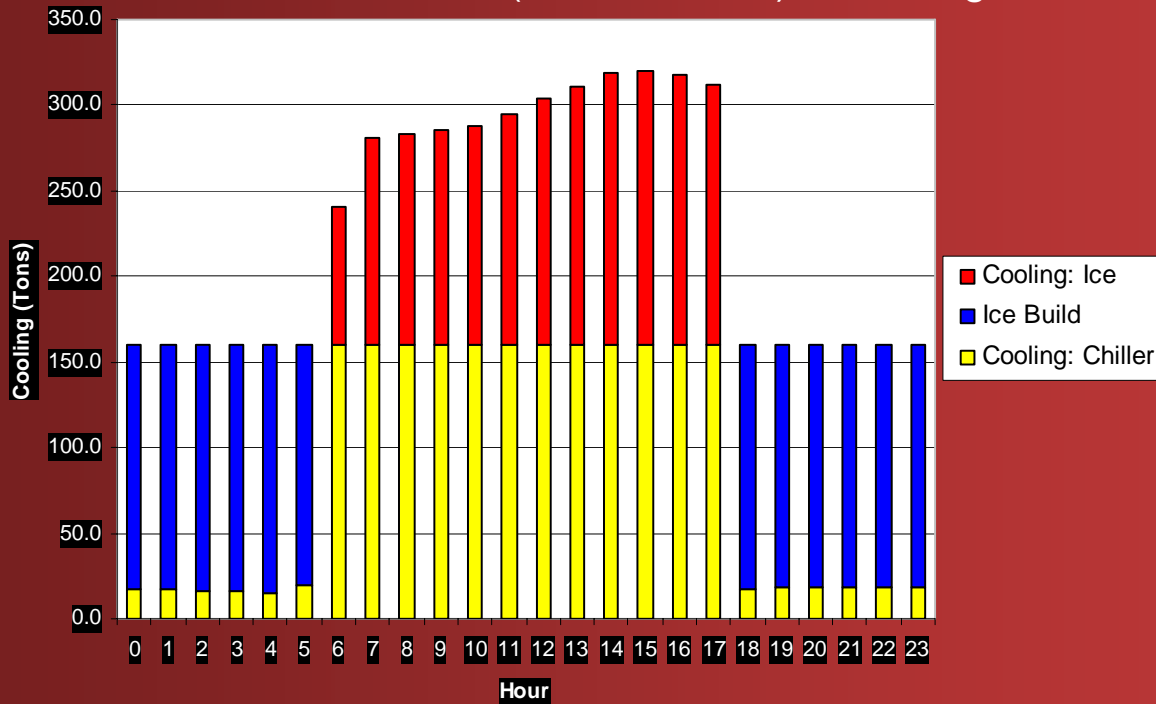
- (2) 410 ton York propylene glycol chillers
- (2) 1400 gpm Marley cooling towers
- (6) 486 ton-hour Calmac IceBank (model 1500C) ice storage tanks
- (1) 162 ton-hour Calmac IceBank (model 1190C) ice storage tanks



# Mechanical Redesign

## Partial Storage

- (2) 240 ton York propylene glycol chillers
- (2) 800 gpm Marley cooling towers
- (3) 486 ton-hour Calmac IceBank (model 1500C) ice storage tanks
- (2) 162 ton-hour Calmac IceBank (model 1190C) ice storage tanks



# Mechanical Redesign

## Determining Chiller & Equipment Parameters

- “n+1” rule of thumb
- Chiller Upstream vs. Downstream
- Chiller Priority vs. Storage Priority

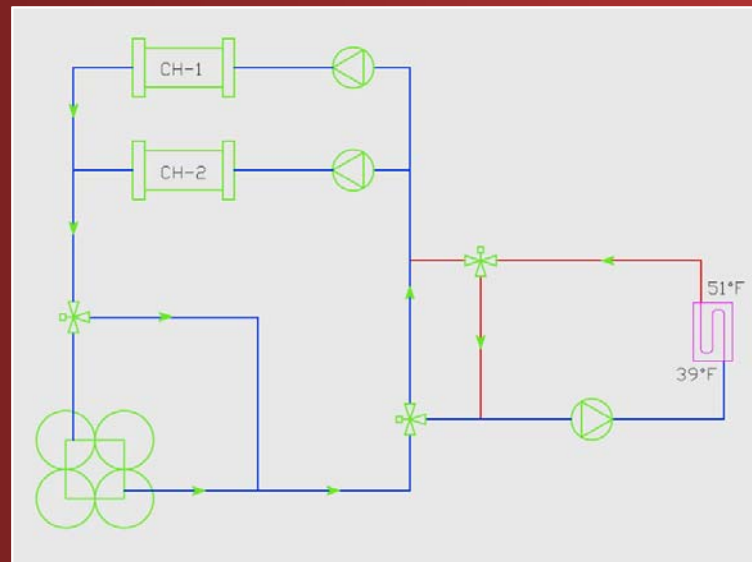


# Mechanical Redesign

## Sizing New Cooling Coils for Cold Air Distribution

	CFM	GPM	Sensible
Original Coil Data	134400	1096	4398.3
Redesigned Coil Data	103300	880.4	4473.1

## Laying Schematics



# Mechanical Redesign

## Evaluating Economics

### First Cost

	Conventional	Partial Storage	Full Storage
Total	\$2,260,237.00	\$2,110,891.00	\$2,352,824.00
Savings	-	\$149,346.00	-\$92,587.00

### Operating Cost

	Conventional System	Partial Storage	Full Storage
Demand Cost (kW)	26,626.01	22,318.81	0.00
Operating Cost (kWh)	49,140.21	40,079.48	52,300.05
Total Annual Cost	75,766.22	62,398.29	52,300.05
Total Savings	-	13,367.94	23,466.17

### Payback Period

	Partial Storage	Full Storage
Payback (yrs)	-1.9	10.5



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# Structural Considerations

## Existing Conditions

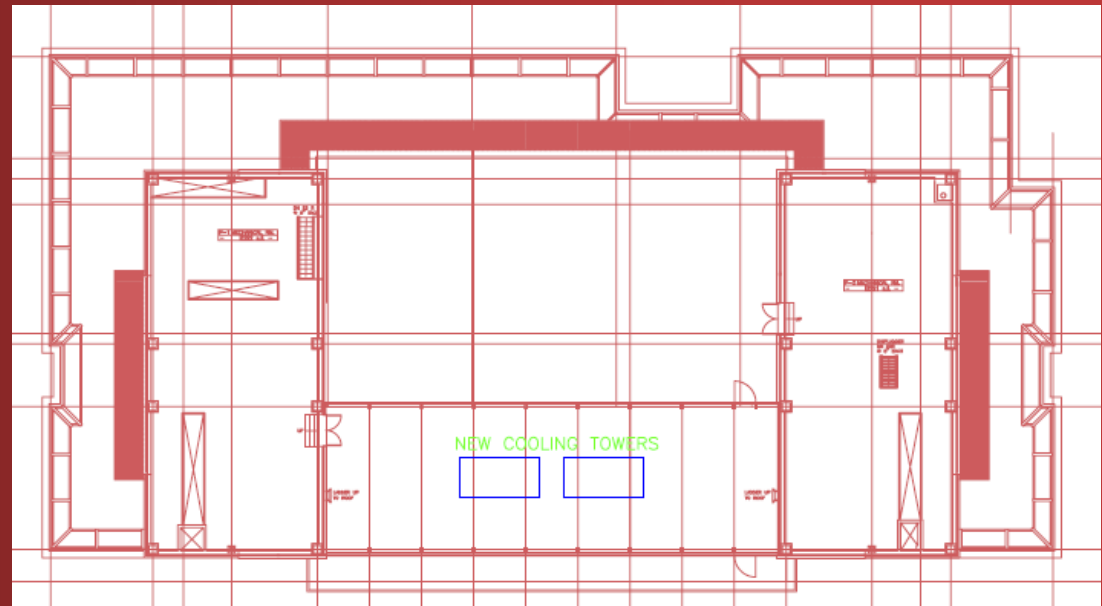
- Steel Frame & Concrete on Metal Deck
- Beams in Question: HSS 16 x 6 x 3/8

Required Design Flex  
Strength = 116.63 ft-k

Required Design Flex  
Capacity = 135.2 ft-k

HSS 16 x 6 x 3/8

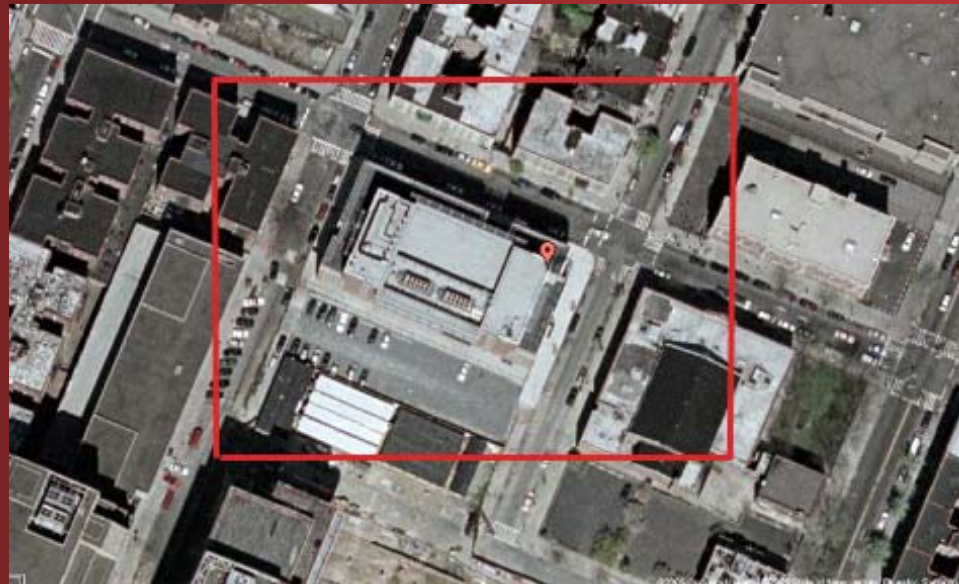
IS OK!!



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# Construction Considerations



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# Electrical Considerations

## Current System

- A 6000A, 208/120 V, 3 phase, 4 wire
- 208/480/277 V Transformer
- (2) 1200A Motor Control Centers

Only 40A Reduction

Keep Original Designed 1200A MCC

	Original	New
AHU-4	15	10
AHU-5	45	35
AHU-6	15	10
AHU-7	20	15
AHU-8	35	25
AHU-9	15	10
AHU-10	10	10
RF-4	6	6
RF-5	10	10
RF-8	6	6
RF-9	10	10
RF-10	6	6
Unchanged Loads	846	846
<b>Total</b>	<b>1039</b>	<b>999</b>

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# Final Thought

## Design Goals Met!!

- Reduce high demand costs
- Downsize the needed chiller capacity
- Increase chiller efficiency
- Reduce energy consumption
- Minimize first cost



# Acknowledgements

## Professors

- Dr. William P. Bahnfleth
- Dr. James D. Freihaut
- Dr. Stanley A. Mumma
- Dr. Jelena Srebric
- Dr. Jae-Weon “JJ” Jeong

## Professional

- Loring Engineers

## Students

- All of my fellow classmates I had the privilege of meeting and working with throughout my years in AE

# Questions



# Mechanical Redesign

## Sizing New Cooling Coils for Cold Air Distribution

### Original Coil Data

	CFM	GPM	Sensible	Total
AHU-1	48000	404	1614.0	2440.0
AHU-2	19000	164	612.4	903.5
AHU-3	18500	138	578.7	848.3
AHU-4	3400	25	101.3	152.1
AHU-5	12000	119	479.3	728.1
AHU-6	5200	47	178.6	287.5
AHU-7	12000	77	333.3	471.6
AHU-8	6000	53	207.3	323.0
AHU-9	7200	47	202.4	284.9
AHU-10	3100	22	91.0	134.1
Totals:	134400	1096	4398.3	6573.1

### New Design Data

	CFM	GPM	Sensible	Total
AHU-1	37500	336.6	1656.3	2442.8
AHU-2	14500	120.2	621.9	875.3
AHU-3	13500	112.3	580.4	817.6
AHU-4	2400	19.3	103.4	140.6
AHU-5	11200	92.8	480.4	675.6
AHU-6	4200	35.8	183.4	260.9
AHU-7	8000	64.3	335.4	468.2
AHU-8	4800	40.7	208.4	296.0
AHU-9	4800	40.7	208.4	296.0
AHU-10	2400	17.7	95.1	128.9
Totals:	103300	880.4	4473.1	6401.9

# Mechanical Redesign

## Evaluating Economics

### First Cost

	Conventional		Partial Storage		Full Storage	
	Material	Labor	Material	Labor	Material	Labor
Chillers	\$314,000.00	\$34,080.00	\$378,103.00	\$47,003.00	\$614,103.00	\$52,936.00
Pumps	\$9,525.00	\$1,695.00	\$22,100.00	\$1,365.00	\$22,100.00	\$1,365.00
Air Handling Units	\$187,050.00	\$13,185.00	\$154,750.00	\$11,985.00	\$154,750.00	\$11,985.00
Cooling Coils	\$23,828.00	\$12,638.00	\$27,315.00	\$14,537.00	\$27,315.00	\$14,537.00
Fans	\$59,985.00	\$16,140.00	\$41,135.00	\$12,225.00	\$41,135.00	\$12,225.00
Air Distribution	\$396,525.00	\$836,663.00	\$375,875.00	\$740,544.00	\$375,875.00	\$740,544.00
Pipe	\$128,765.00	\$157,613.00	\$103,012.00	\$126,090.00	\$103,012.00	\$126,090.00
Pipe Insulations	\$38,585.00	\$29,960.00	\$30,868.00	\$23,984.00	\$30,868.00	\$23,984.00
Subtotal	\$1,158,263.00	\$1,101,974.00	\$1,133,158.00	\$977,733.00	\$1,369,158.00	\$983,666.00
Grand Total	\$2,260,237.00		\$2,110,891.00		\$2,352,824.00	