Balfour Beatty

HGA

DISTRICT ENERGY SYSTEM BUILDOUT TO SUPPORT A 100 YR OLD CAMPUS EXPANSION

Case Study: Confidential Government Client

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System Summary

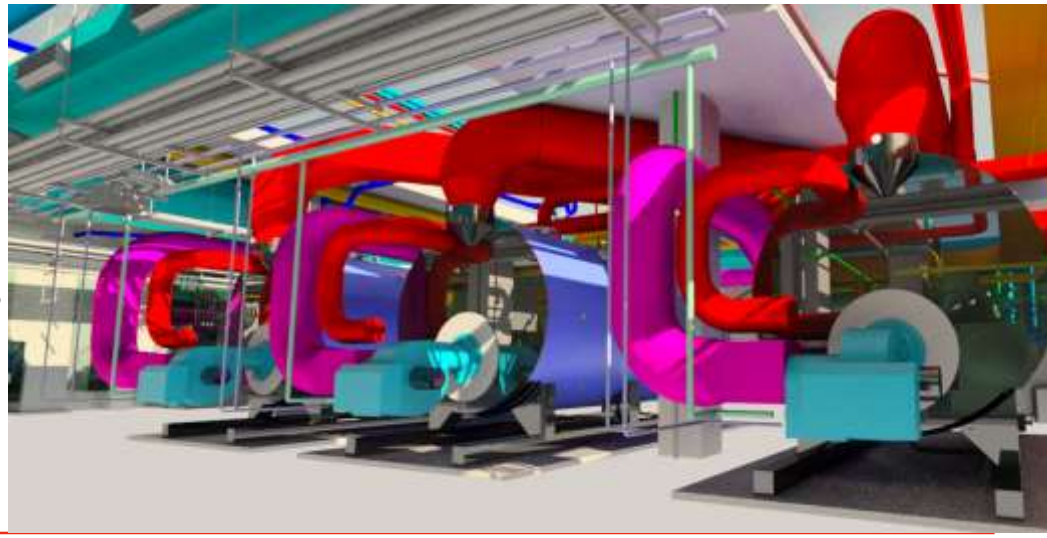
- Plant: 3 floors underground
- Building Square Footage: 37,600 sq ft (3,500 sq M)
- Area Served: over 3 million sq ft.
- Buildings Served include office and support facilities for second phase of campus development

System Summary

DISTRICT ENERGY EXPANSION

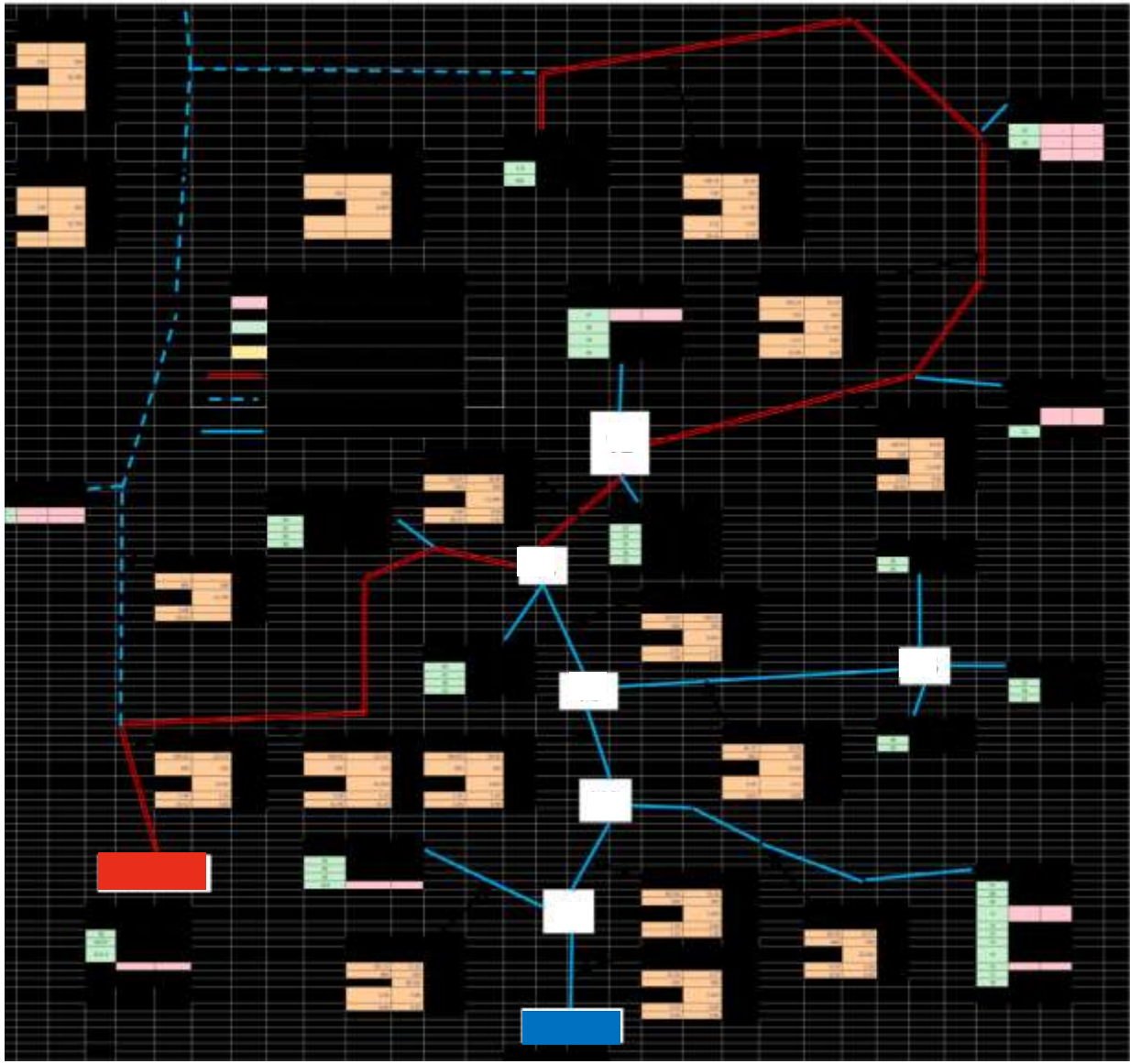
- Installed Cooling Capacity: 9,100 Tons
- Peak Heating Load: 200°F HW 4,500 MBH
- Emergency Generation Capacity: 21,000 MW

- 7 Chillers
- 8 Cooling Towers
- 3 HW Boilers
- 7 Tier 4 ULSD Generators
- 80,000 gal fuel storage



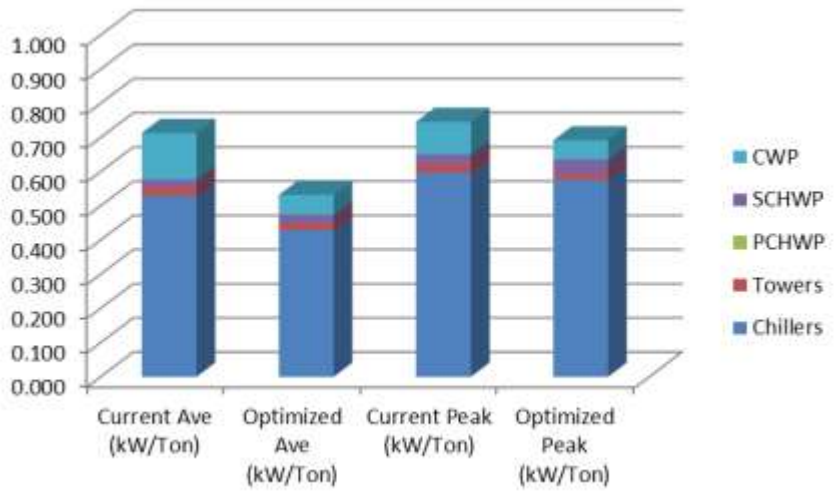
Campus Distribution

- Temporary Central Plant
- New Central Plant



Chiller Plant Optimization Results

- 3,800 Ton Peak Load
- 7.3 Million Ton Hours per Year
- Savings: 22% Energy Reduction
- 220 kW (7.5%)
- 1,185,000 kWh Phase 1
- 485,000 gallons of Water saved
- Average Plant Performance: 0.50 kW/ton



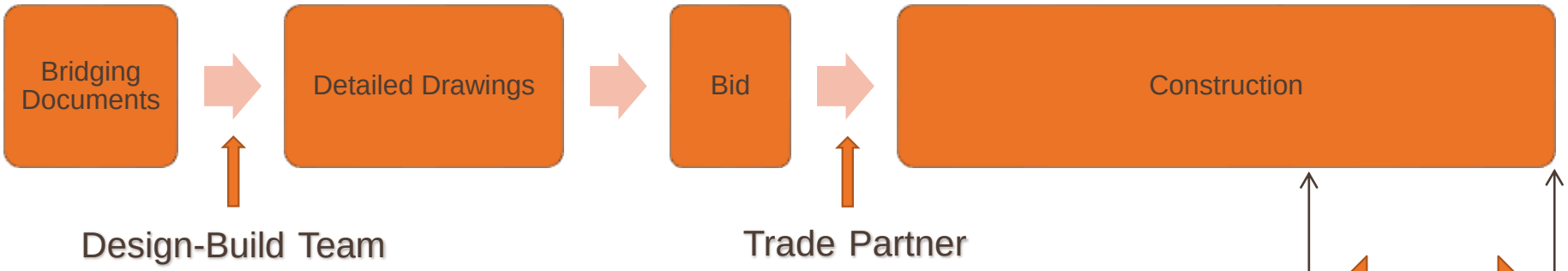
Project Delivery Method

- Cloud Platform for drawings
- Task Breakdown
  - Engineering
  - Drafting
- Alternate design progression
  - Typical 35/65/95
  - Packages to support construction

Trade	Sheet Type	Scale	Drawn By	Prelim Review	Final Review / Design Responsibility
M	General Notes	NTS	Designer	Design/Builder	Designer
M	Mech Piping Layout	1:100	Design/Builder	Designer	Designer
M	Mech Piping Enlarged	1:50	Design/Builder	Designer	Designer
M	HVAC Duct Layout	1:100	Design/Builder	Designer	Designer
M	HVAC Duct Enlarged	1:50	Design/Builder	Designer	Designer
M	Building Sections	1:100	Design/Builder	Designer	Designer
M	Water Side Schematic	NTS	Designer	Design/Builder	Designer
M	Airflow Schematic	NTS	Designer	Design/Builder	Designer
M	Mechanical Details	NTS	Designer	Design/Builder	Designer
M	Equipment Schedules	NTS	Designer	Design/Builder	Designer
M	Controls	NTS	Designer	Design/Builder	Designer
ME	M/E Coordination	NTS	Designer	Design/Builder	Designer
P	Plumbing Layout	1:100	Design/Builder	Designer	Designer

Project Delivery Method

Design Build with MEP Design Assist



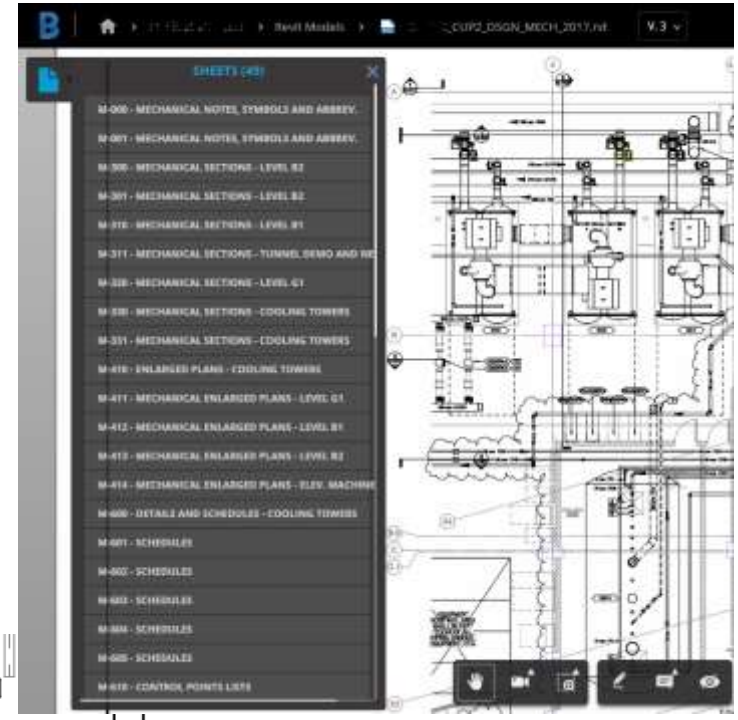
Unified Design-Build Workflow

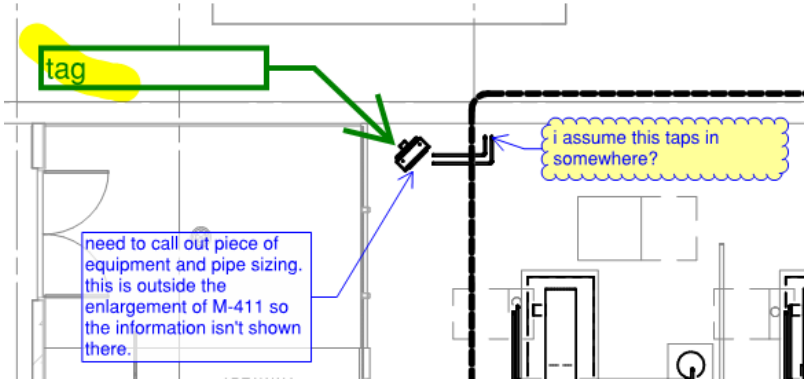
Design Integration

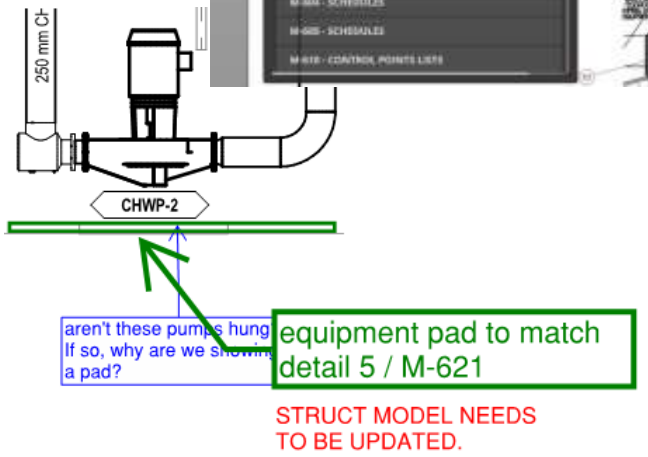
- Design Team Project Manager
- GSA Touchpoint
- Facilitate relationship between
  - Architect/ Engineer Team
  - Contractor Design Assist
- Keeper of the Contract
  - Bridging documents
  - P-100
  - Basis of cost – what we bought
- Schedule

Communication

- Weekly project meetings
- Trello
- BIM 360 Team
- Bluebeam Studio







Design Challenges

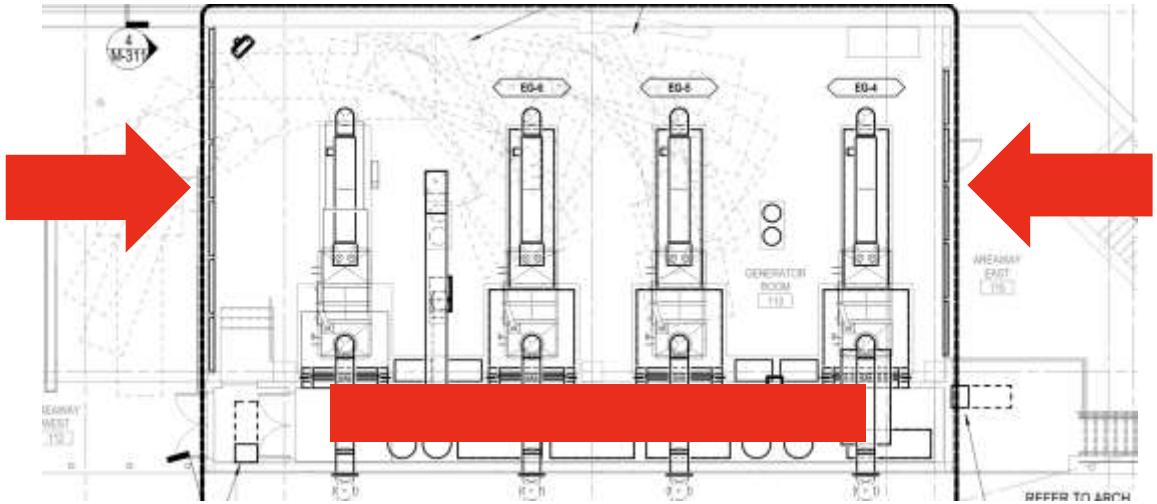
- Cooling and Combustion Air
- Integration with design of other buildings
- Distribution System Pressurization and control
- Cooling Tower Performance

Cooling and Combustion Air

- Generator Louver Area
  - High intake velocities (>1100 fpm)
  - Excessive pressure drop through louvers (> capacity of Gen Fans)
- Adding Louver to resolve would result in short circuiting
- Space Constrained
  - Then Generator capacity Increased by 1500 kW

Cooling and Combustion Air

- Increased capacity
  - Increased fuel storage (from 40,000 gal to 80,000 gal)
  - Forced Moving electrical equipment
  - Cramped Generators even more



Interaction of Multiple Building Projects

- Multiple buildings
- Multiple contracts
- Varying design conditions
- Master plan…

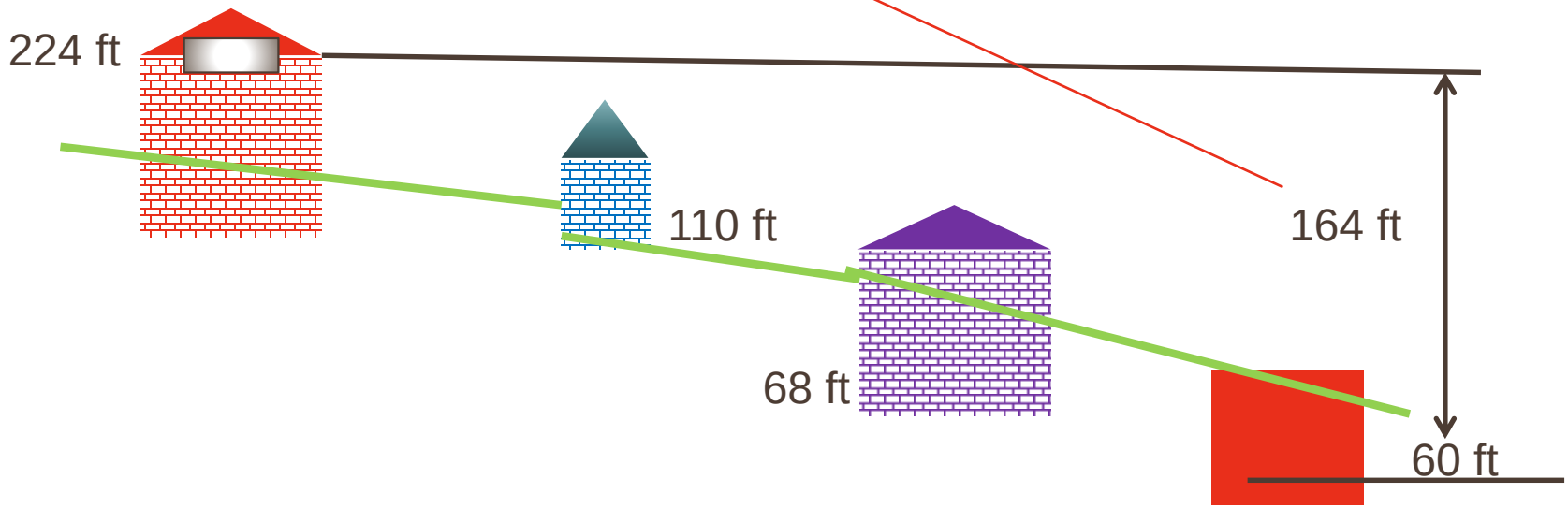
Heat Exchangers or Not?

71 psig Static

+ 4 psig

75 psig
- 3 psig Fill height
72 psig fill pressure

BD Pump Design point:
HHWPs: 870 gpm @ 95 ft, (41 psig)
CHWPs: 1,950 gpm @ 120 ft, (52 psig)



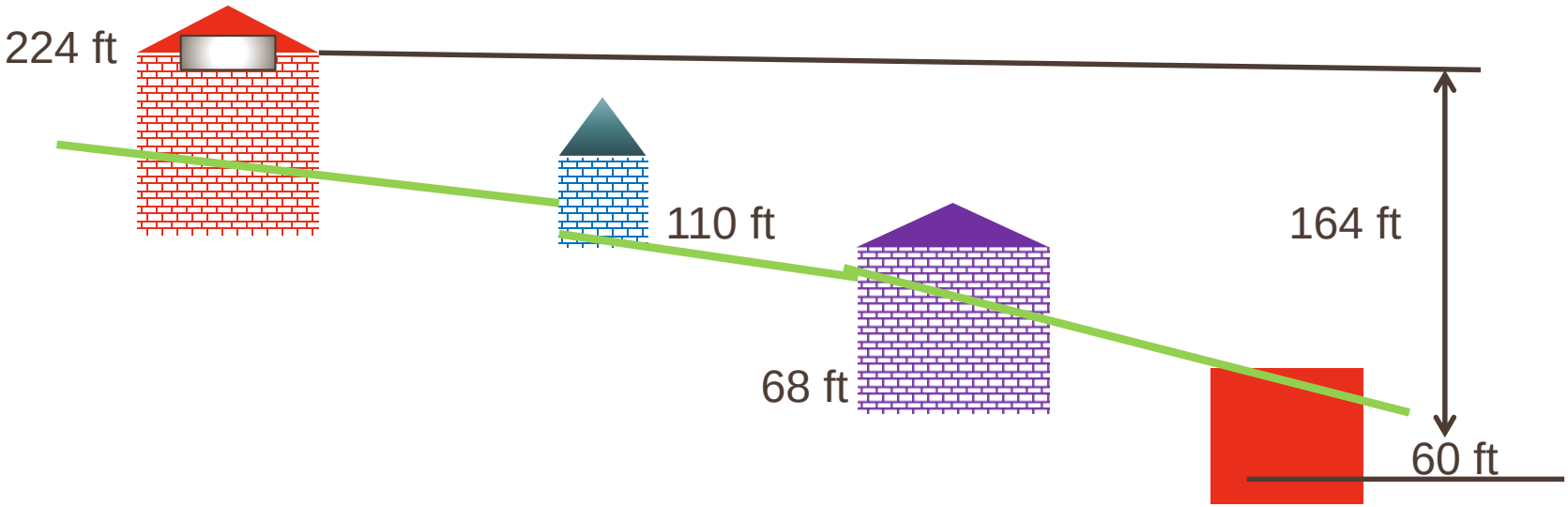
Heat Exchangers or Not?

71 psig Static

+ 4 psig

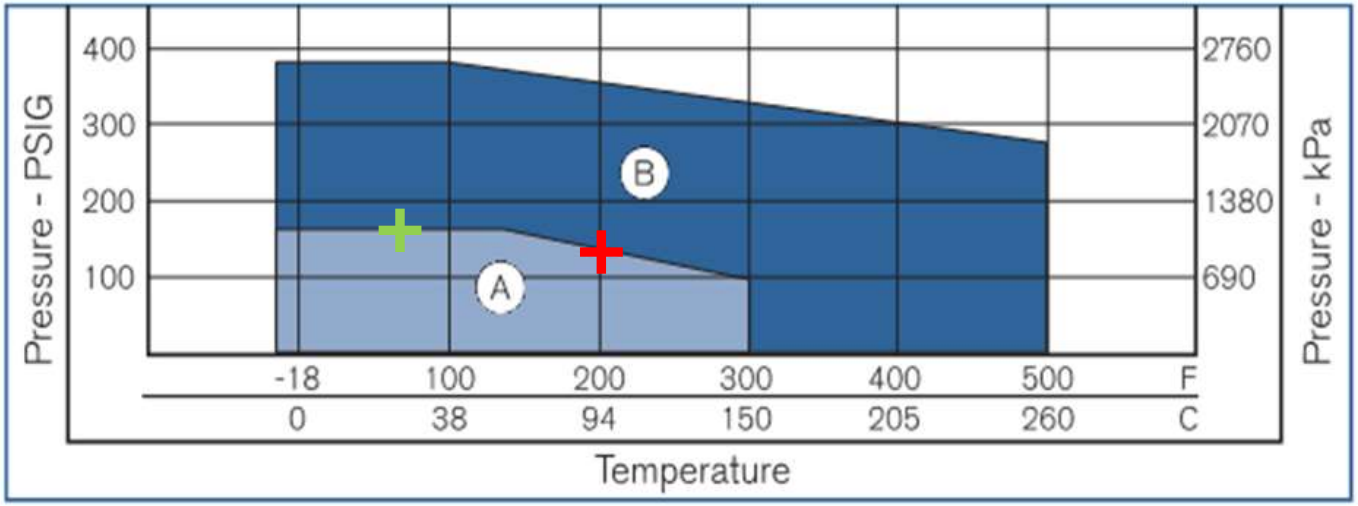
75 psig
- 3 psig Fill height
72 psig fill pressure

Final Pump Design point:
HHWPs: 870 gpm @ 125 ft, (54 psig)
CHWPs: 1,950 gpm @ 185 ft, (80 psig)



Heat Exchangers or Not?

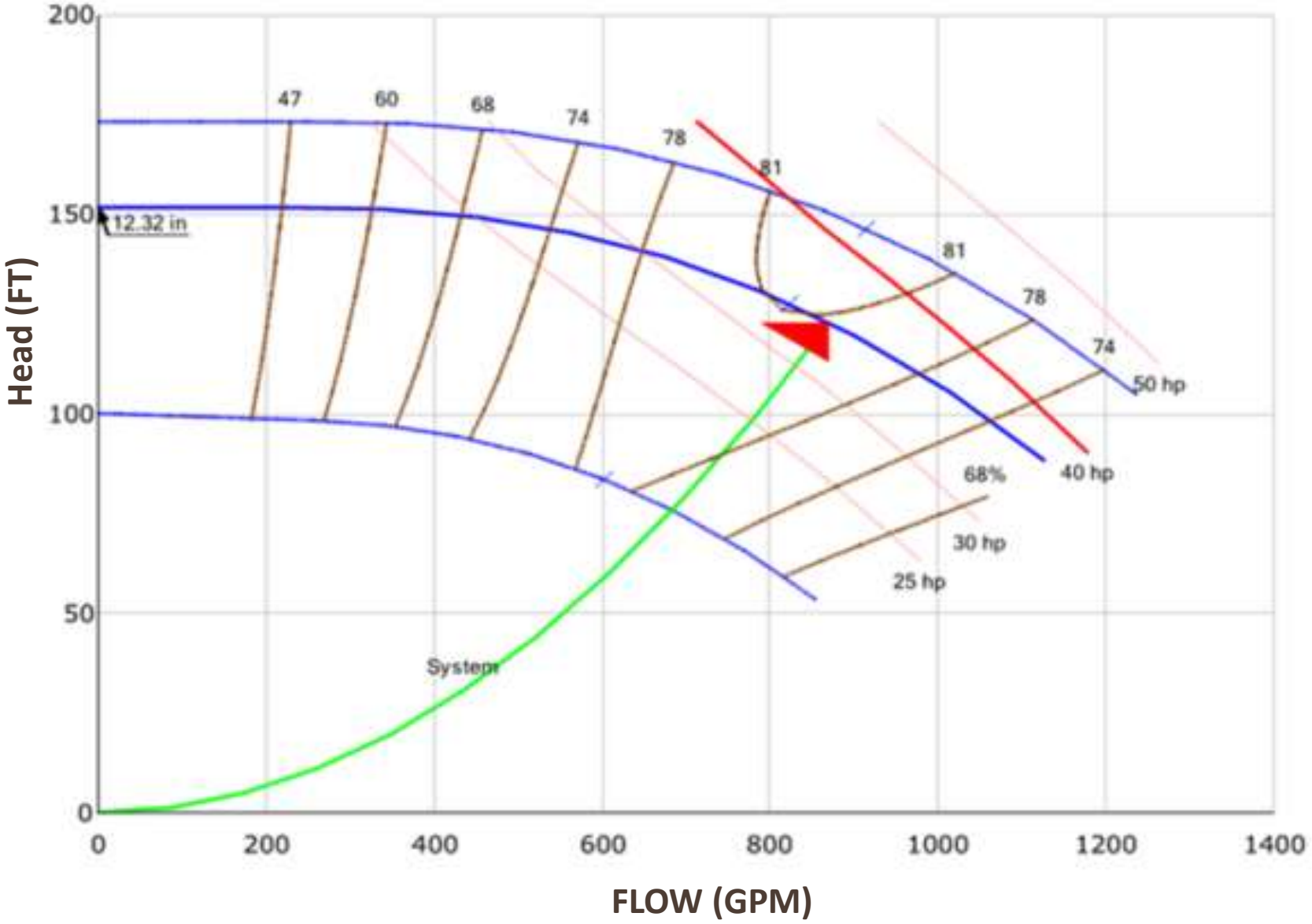
▶Pressure/Temperature Chart*



(A) 125 lb Cast Iron/ Cast Bronze

(B) 250 lb Ductile Iron

*Refer to File No: 43.50 for mechanical seal pressure/ temperature limitations.


Head (FT)
200
150
100
50
0
47
60
68
74
78
81
12.32 in
81
78
74
50 hp
68%
40 hp
30 hp
25 hp
System
0
200
400
600
800
1000
1200
1400
FLOW (GPM)

Heat Exchangers or Not?

71 psig Static

+ 4 psig

75 psig

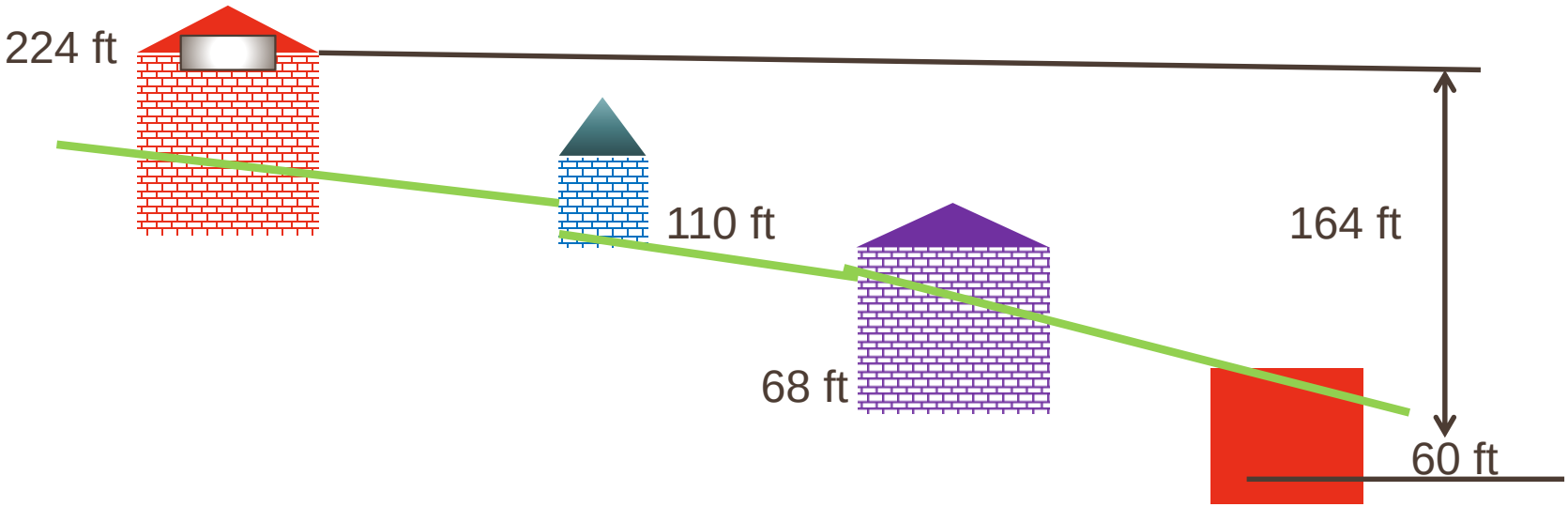
- 3 psig Fill height

72 psig fill pressure

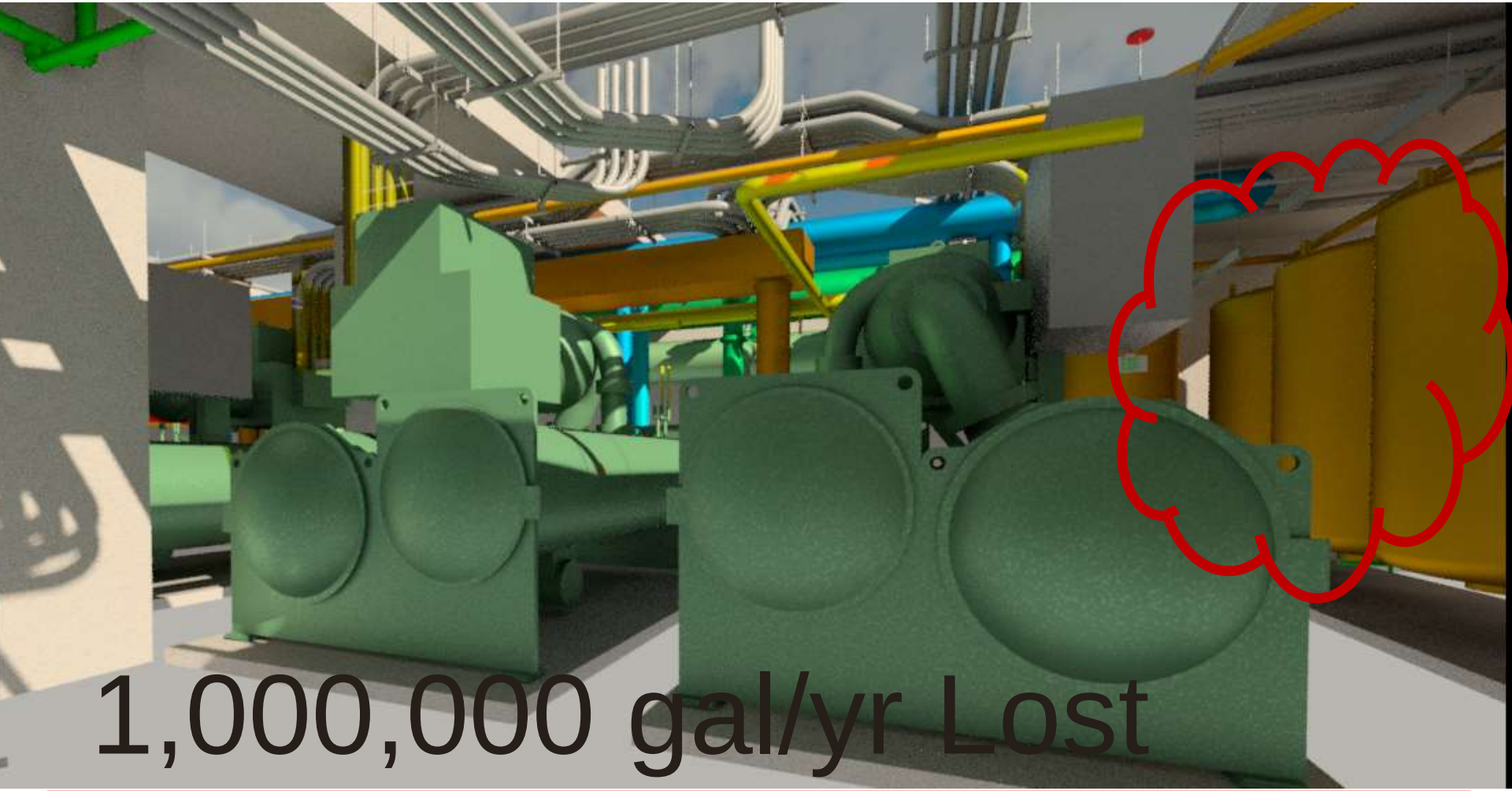
Final Pump @ shutoff head:

HHWPs: 870 gpm @ 152 ft, (66 psig)

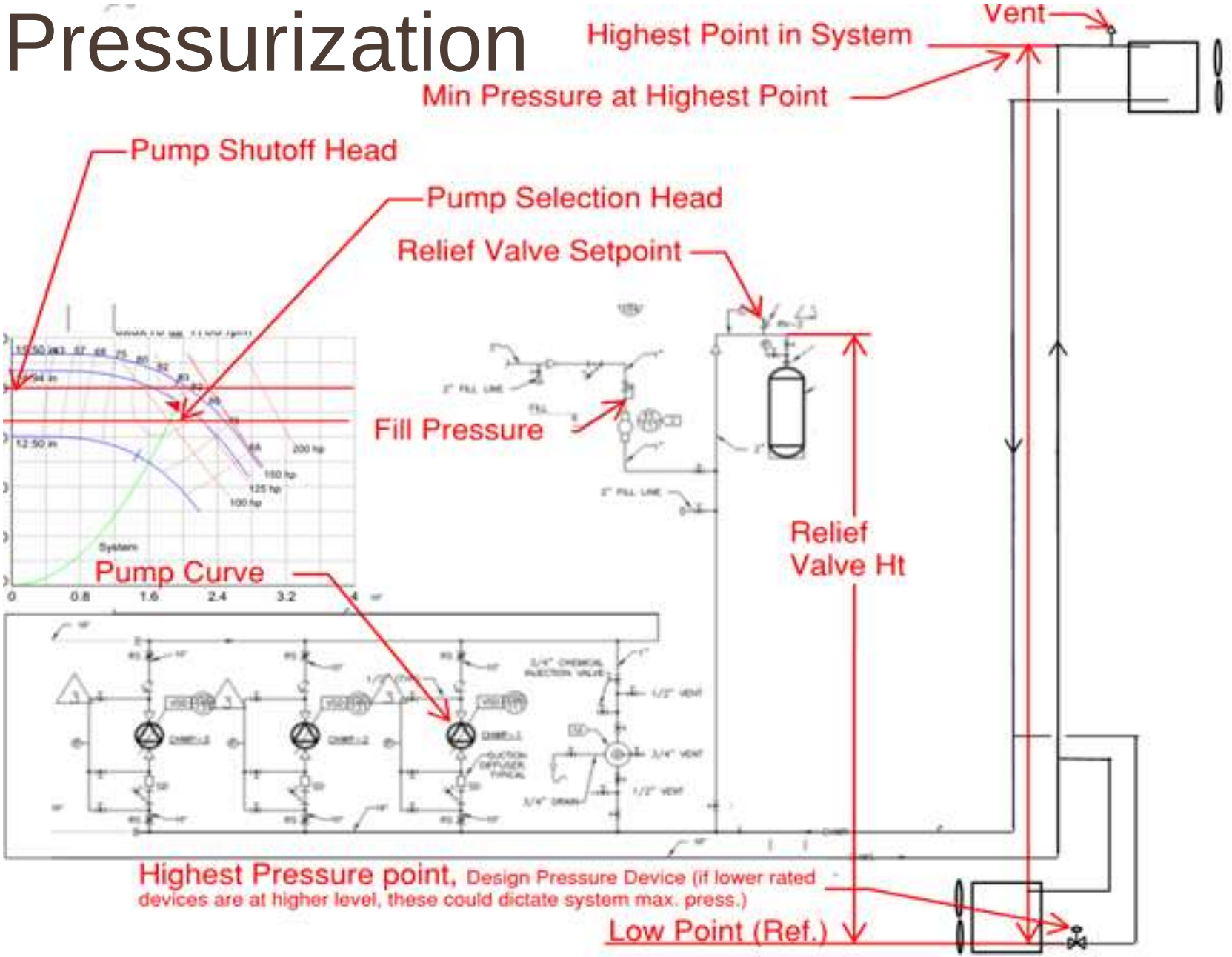
CHWPs: 1,950 gpm @ 218 ft, (94 psig)



Pressurization



Pressurization



Pressurization

Option	Does it Work?	Comment
Direct Connect Bldg 1 and Bldg 2	No	Fill pressure greater than Relief Valve setpoint.
Direct Connect Bldg 1 Isolate Bldg 2, BLR at 125#	No	Fill pressure greater than Relief Valve setpoint.
Bldg 2 and Bldg 1 Isolated with HXR, BLR and Pumps @ 125# as per BD	No	(15) 2000 gallon tanks would be required.
Bldg 1 Isolated with HXR, Bldg 2 Direct Connect BLR & Pumps @ 125# per BD	No	15 Tanks would be required due to low pump pressure ratings.
Bldg 2 and Bldg 1 Isolated with HXR, BLR Pressure @ 150#, Pumps @ Class 250	Yes	7 Tanks would be required. Need to Upgrade Boiler and Pump Pressure Ratings from BDs
Direct Connect Bldg 1 and Bldg 2, Variable Pressure System:	Yes	4 Tanks would be required. Equipment Pressure Ratings per BD
Bldg 1 Isolated, Blrs and Pumps @ Class 250	No	Upgrade Boiler and Pump Pressure Ratings from BDs

Cooling Towers

- Meeting BD Design Intent
- Available equipment
- Physical Constraints
- Psychometrics

		SCHEDULED CUP 2 TWR	ALTERNATIVES TO MEET PERFORMANCE CRITERIA			RECOMMENDED SELECTION -STAY IN 8414 BOX AND 75 HP FAN- ADD SCOPE ASSOCIATED WITH
SELECTION		SCHEDULED CUP 2 TWR	EVEREST 5 CELLS AT 75 HP QUIET FAN	8412 BOX AS SHOWN ON CUP 1 DRAWINGS	8414 BOX with VRS QUIET FAN	ADD 8414 BOX with VRS QUIET FAN
CONDENSER WATER PER CELL	FLOW (GPM)	3,641	5,460	2,832	3,900	3,350
	EWT (DEG F)	95.0	94.3	95.0	93.3	**93.3**
	LWT (DEG F)	84.2	85	84.2	84.2	83.2
AMBIENT WB (DEG F)		**78.8**	78.5	78.5	78.2	78.5
APPROACH (DEG F)		5.4	6.5	5.7	6.0	4.7
CAPACITY (BTUH)		137,629,800	126,945,000	137,629,800	124,215,000	135,340,000
% CAPACITY (BTUH)		100%	102%	104%	100%	100%
FAN MOTOR	HP	75	75	75	100	75
	Type	ULTRA LOW SOUND	QUIET FAN	STANDARD FAN	QUIET FAN	QUIET FAN
SOUND	dBA 7 cells @ Air inlet 50 FT	73	73	83	77	73
# CELLS		7	5	9	7	8
VRS					X	X
DIMENSIONS	WIDTH (IN)	269	354	269	269	269
	LENGTH (IN)	167	269	167	167	167
	HEIGHT (IN)	326	324	280	326	326
MANUFACTURER		MARLEY	MARLEY	MARLEY	MARLEY	MARLEY
MODEL		NC 8414WAS7	NC 8422WLN5	8412WAS9	NC 8414YAS7	NC 8414YAS7
COMMENTS		SELECTED MODEL AND HP CAN'T MEET PERFORMANCE, MODEL NOT ULS FAN	MEETS ALL CRITERIA BUT REDUNDANCY. RESULTS IN 2 GPM/TON ON LOSS OF TOWER		TOWERS ARE NOISIER THAN CUP 1 & THIS ADDS 175 HP AND ASSOCIATED COSTS	MEETS ALL CRITERIA AND REDUNDANCY- REQUIRES ADDITIONAL TOWER

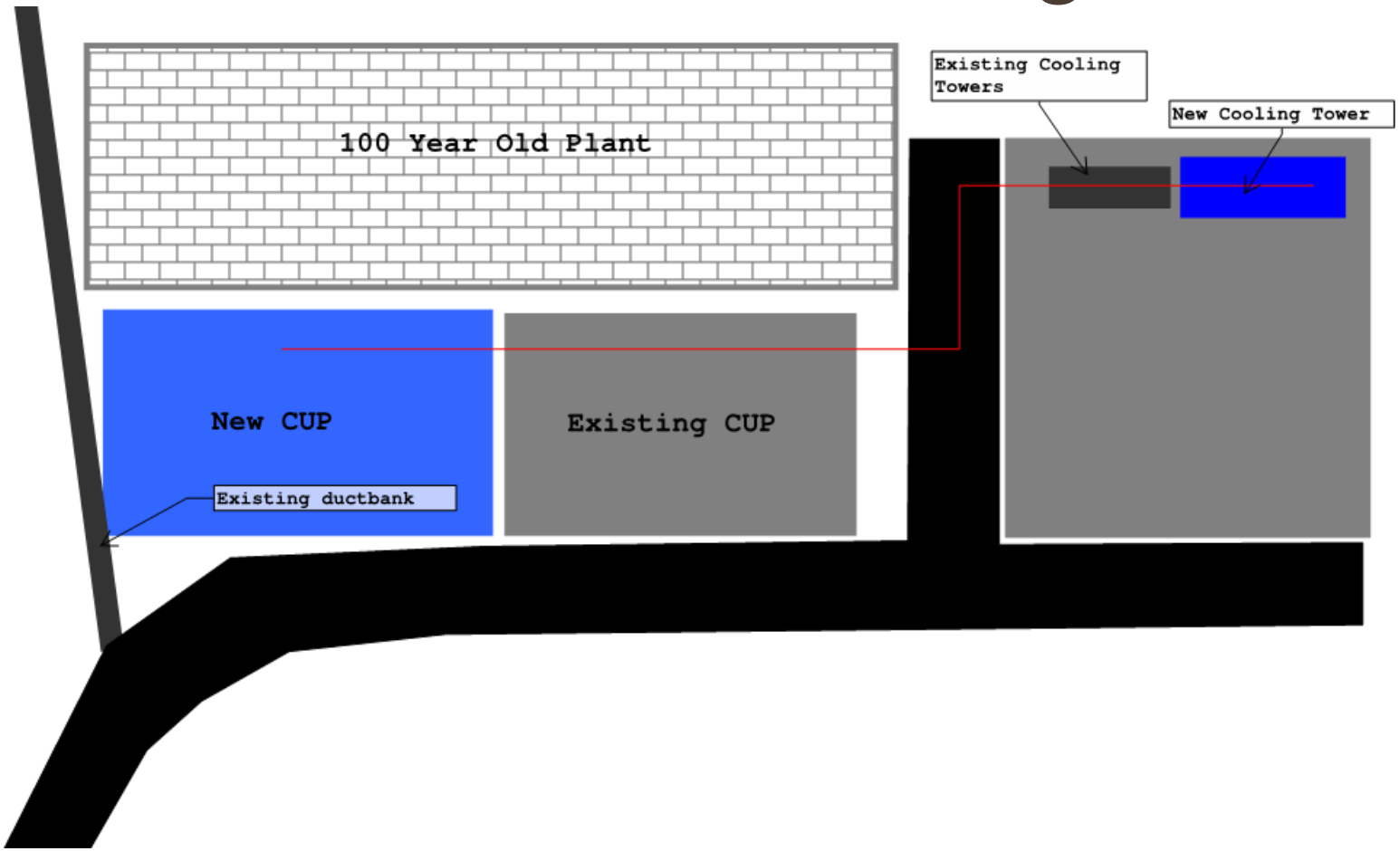
Design Challenge Conclusion

- Design Criteria and Space Constraints Clashed
- Compromises had to be made
- Required Education of Decision Makers
- Difficult Decisions for Owner
- Owner made Value Decisions

Construction Challenges

- Fixed building location, footprint, and elevation
- Tying in to existing buildings and systems on campus
- Site Security and Logistics
- Water on site

Construction Challenges



Conclusion

- Built an Integrated Team to meet the demanding project requirements
- Provide creative solutions to difficult design and construction issues
- Satisfy Owner Requirements
  - A plant that won’t be seen
  - Well Designed
  - Reliable Operations
  - Supporting Campus Growth
  - Efficient
- Questions

Thank You

- Sarah Michaelson, Balfour Beatty
- Joe Witchger, HGA