Converting to District Cooling: Efficiency vs. Risk

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Discussion Overview

- Project Objectives and Background
- Design Team Challenges
- Process to Develop Decision Criteria
- Options for Conversion
- Decision Example
- Lessons and Next Steps
- Q/A

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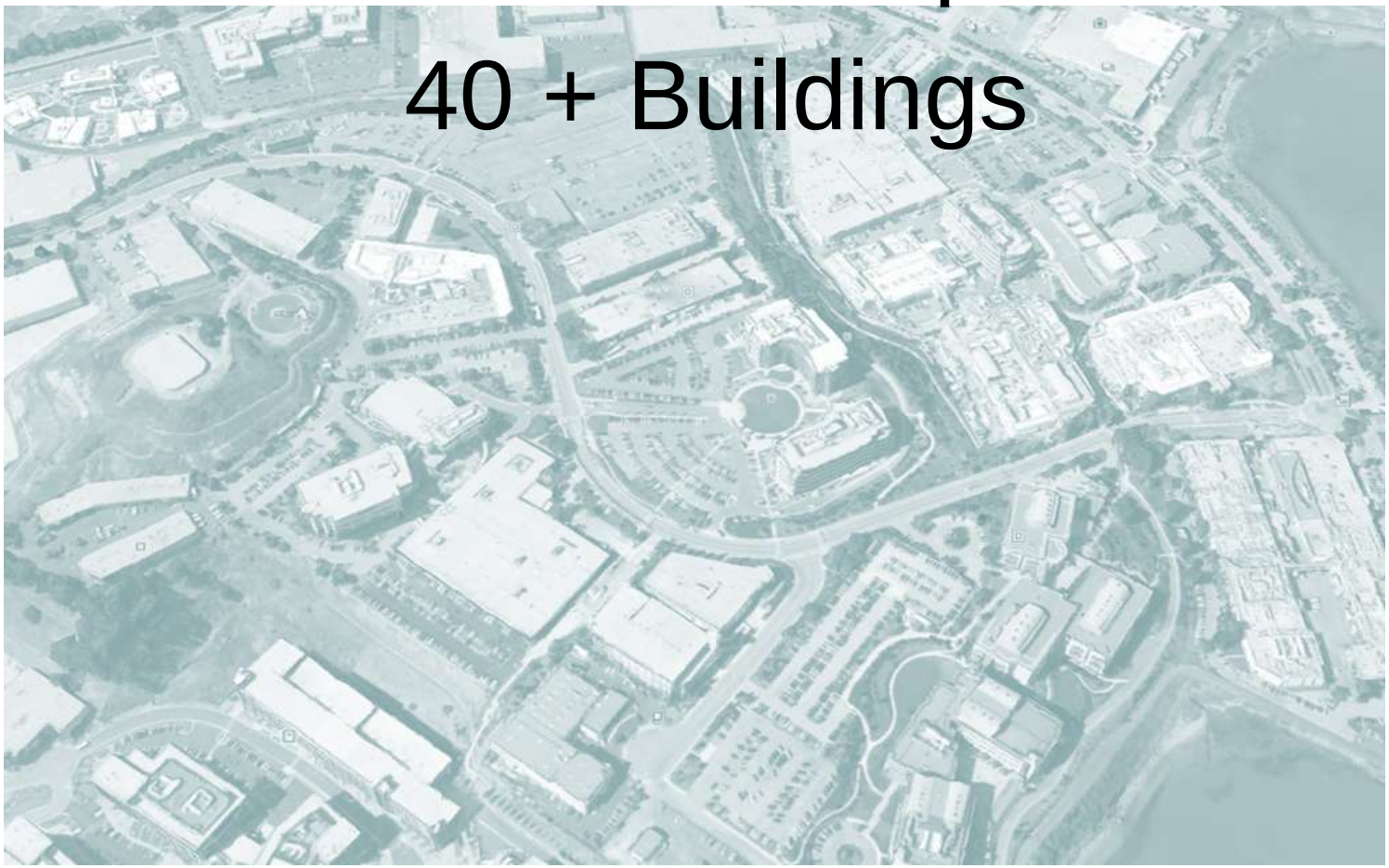
Project Objectives

- Connect 40+ independently cooled buildings to a district Refrigerated Water (RW) cooling system
- Factors for Success:
  - Risk Mitigation
    - Reliability
    - Resiliency
  - Energy Efficiency
  - GHG Reduction
  - Cost Effectiveness
  - Stakeholder Agreement

Project Background – South San Fran

3.8 Million Sq Ft



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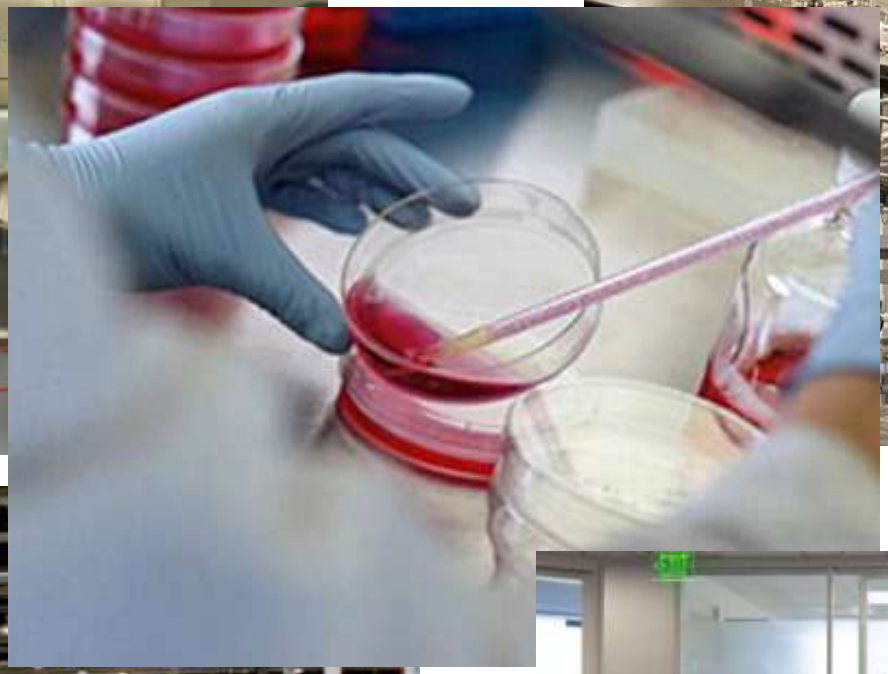
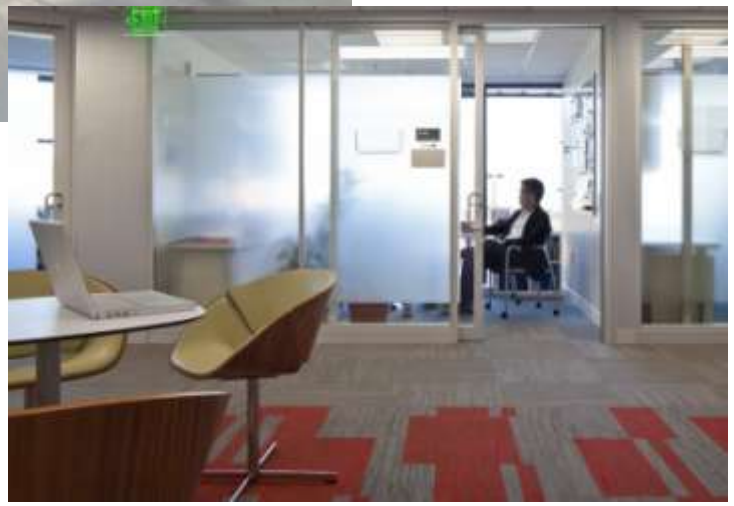
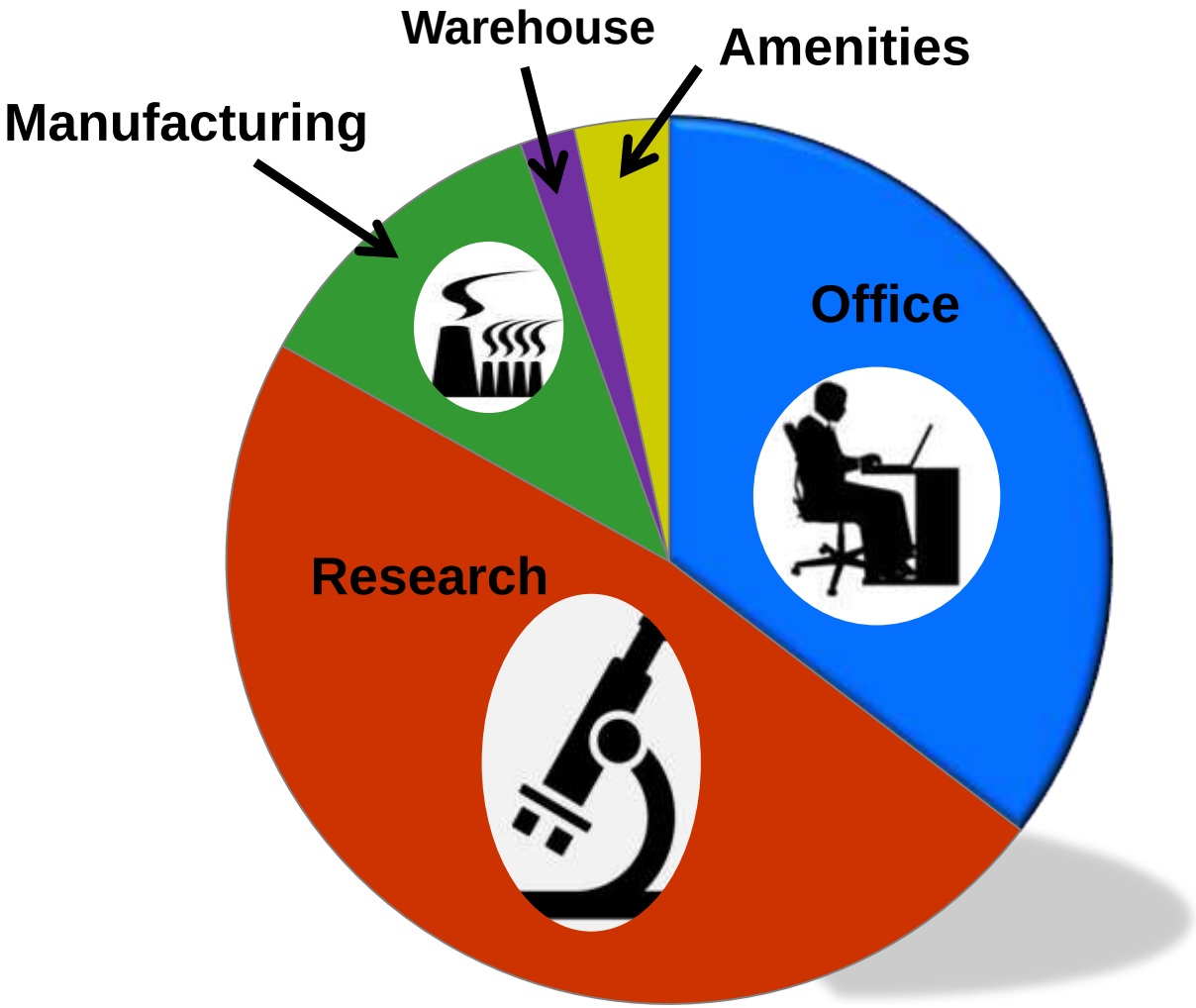
Building Types





Sq Ft by Building Type



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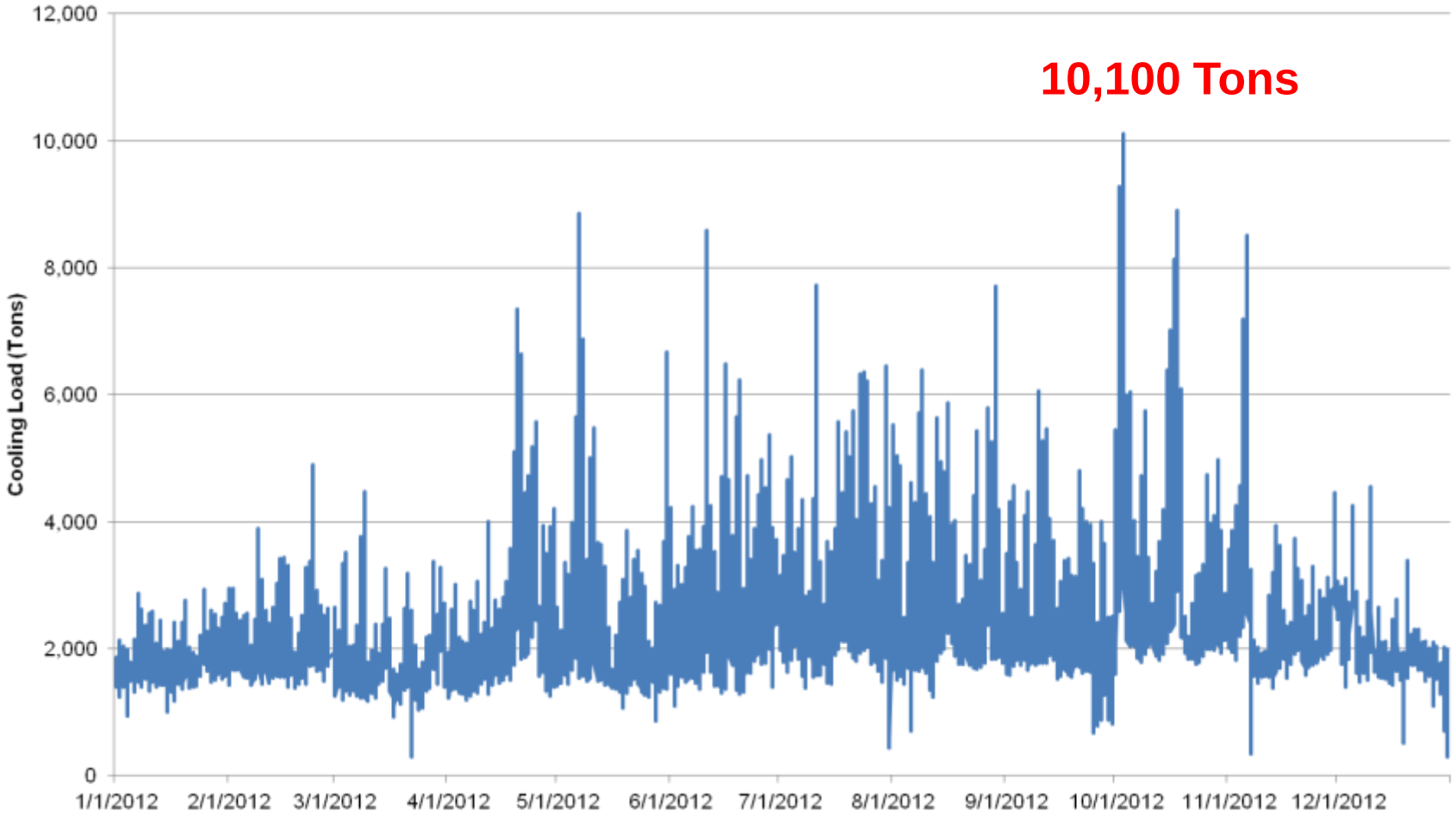
Campus RW Coincident Peak



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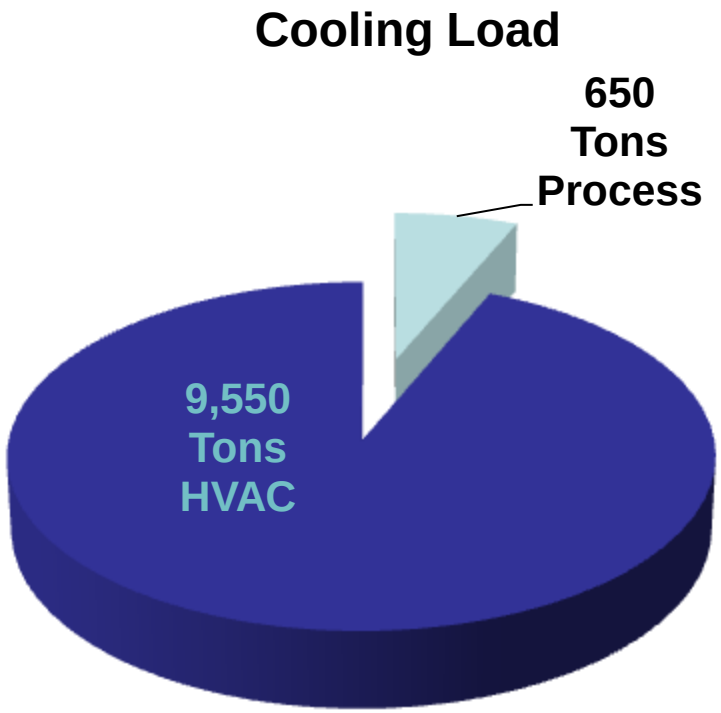
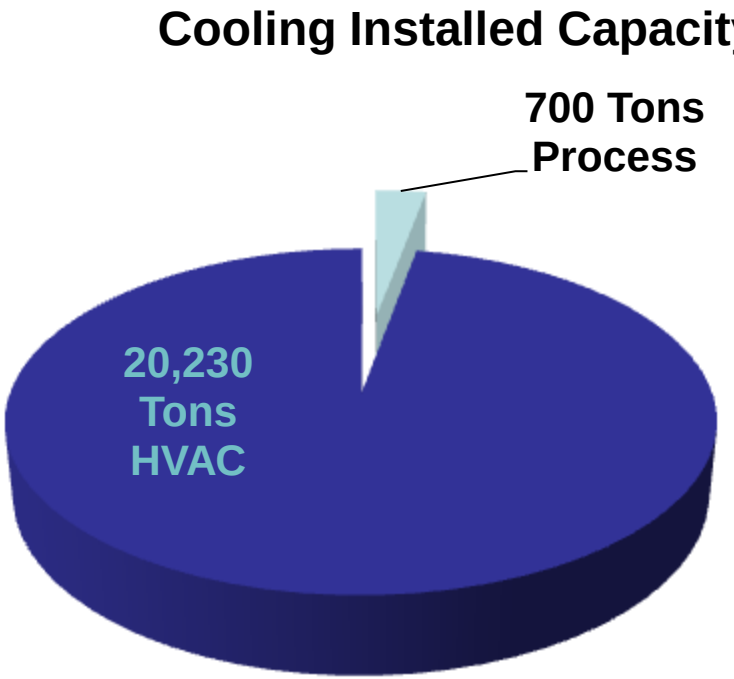
Cooling Load vs Current Capacity





HVAC Chillers Includes process condenser loads

- Cooling capacity is over 200% of peak coincident load for HVAC – Opportunity to reduce unused capacity

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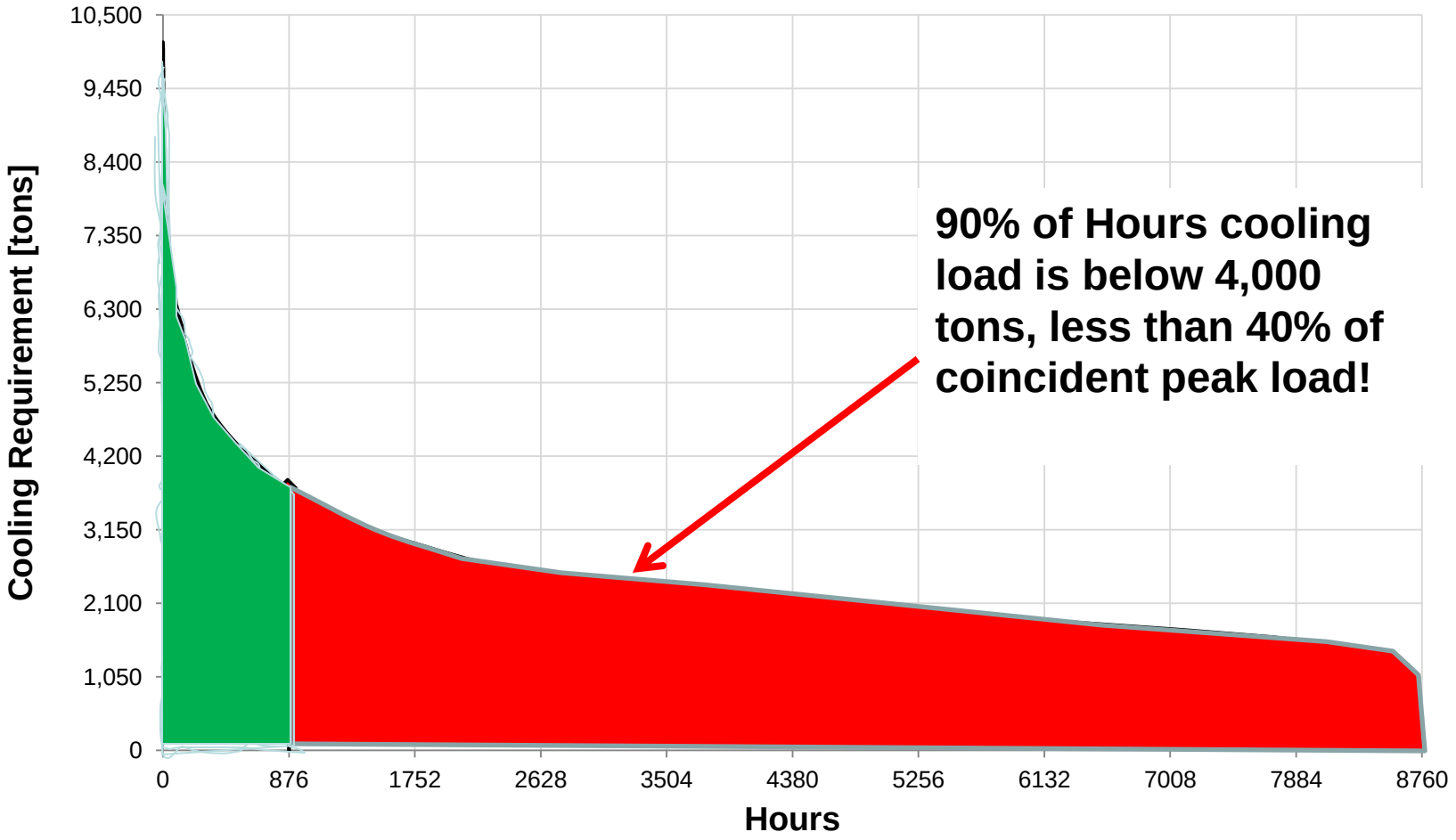
Unique Microclimate



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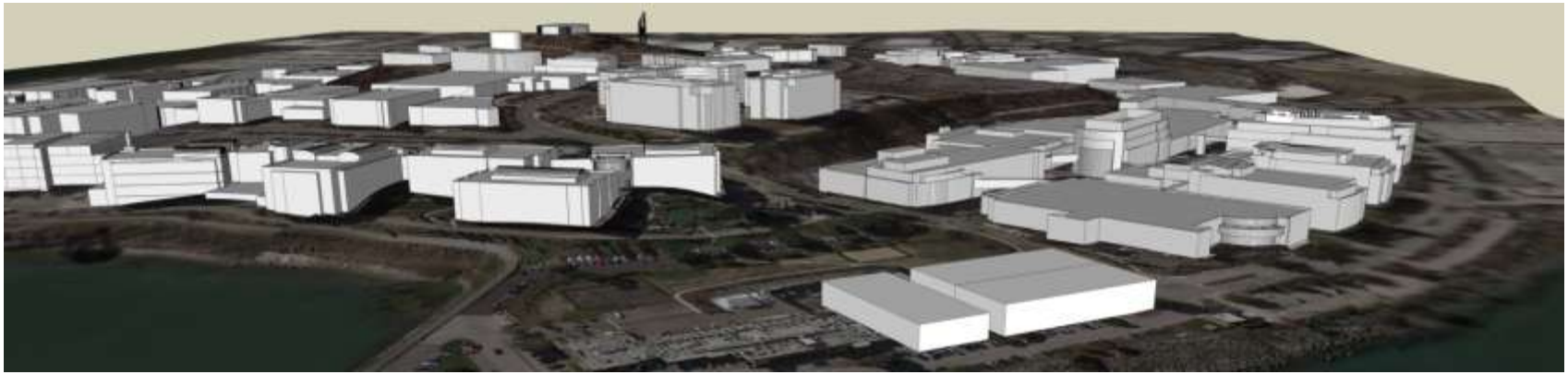
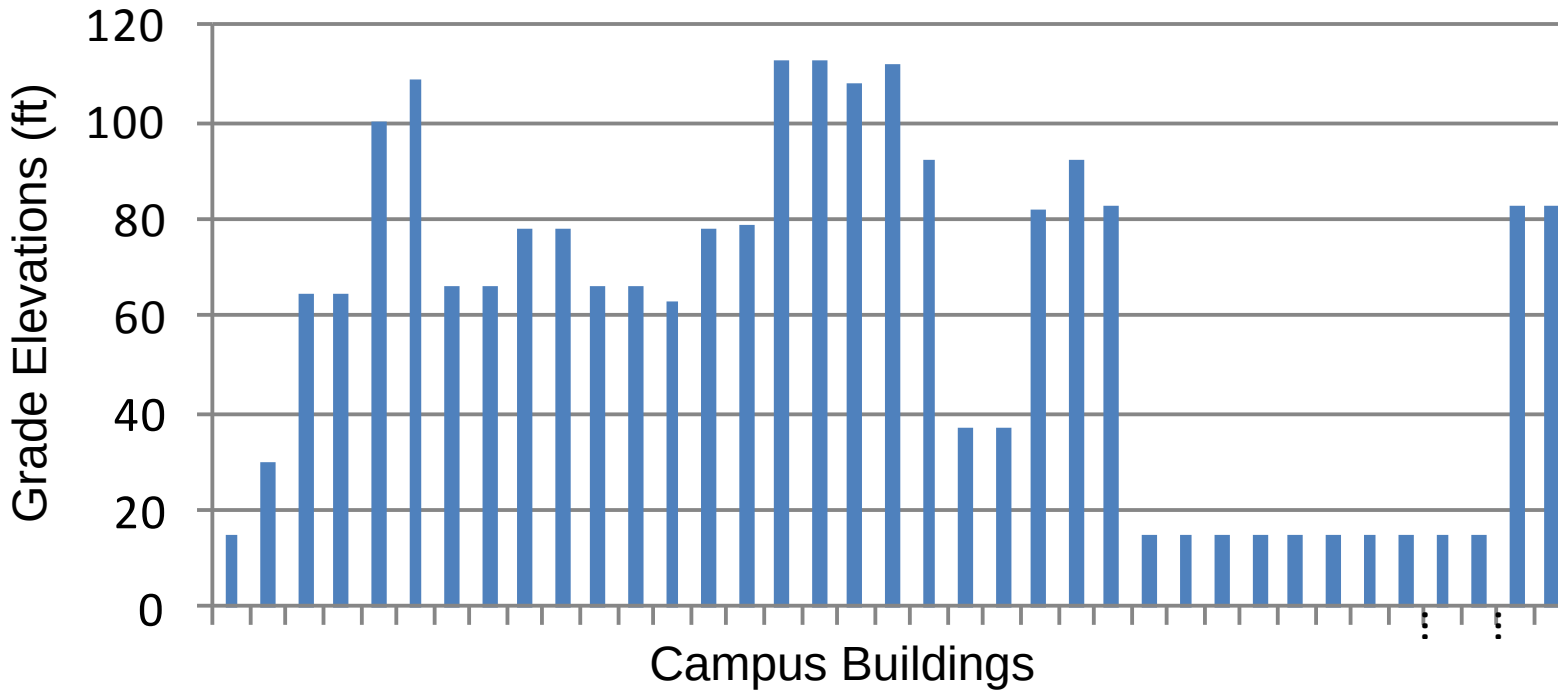
Campus Topo

Grade from 15’ to 110’ Above Sea Level





Design Team Challenges

- Connect buildings to central cooling system:

  "No One Size fits All" Solution

- How to Balance Project Goals with Stakeholder Needs

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Integrated Design Team

- Stakeholders
  - Facilities Engineering
  - Design Engineering
  - Building Users
  - O&M Contractors

- Collaboration – Weekly workstream meetings
- Sharing Information – Online database
- Schedule Compliance

Risk Mitigation - Process Systems

Cooling is CRITICAL to Process Systems that support medications that:

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First Steps to Develop Design Criteria

- Collected data on each building cooling system
  - Cooling Equipment
  - Process Systems
  - Operation and Criticality
  - Physical limitations
  - Owner Requirements
- Developed and gained agreement on:
  - Cooling load profile for each building
  - Building cooling equipment modification design
    - Local Chillers, DX, heat pumps
  - RW Distribution System and Hydraulic Model
  - Central Plant Design

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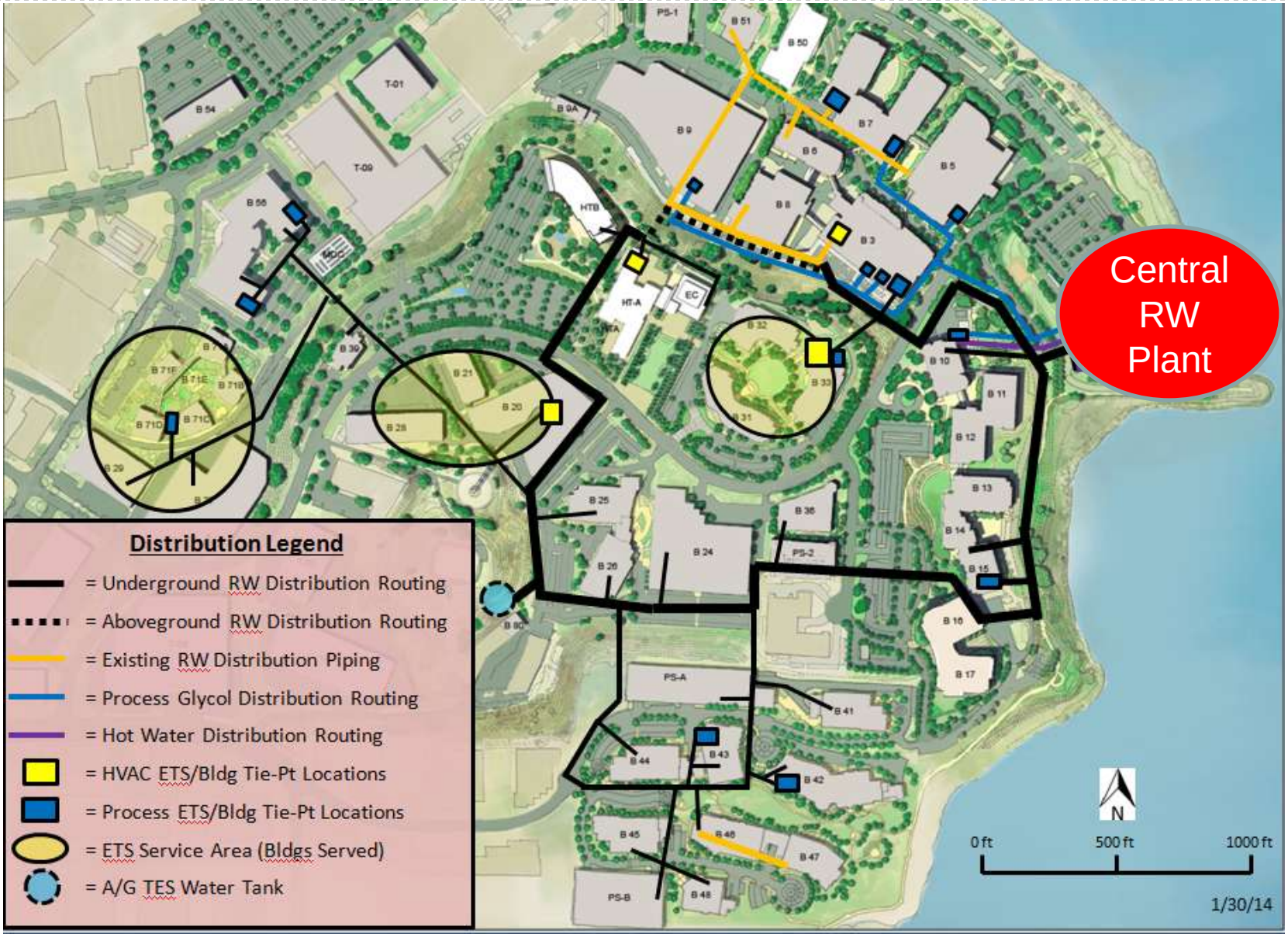
Refrigerated Water Distribution Map



What are the Options?

- Armed with existing building information, cooling loads, the distribution system routing & central plant location we have to answer the question:

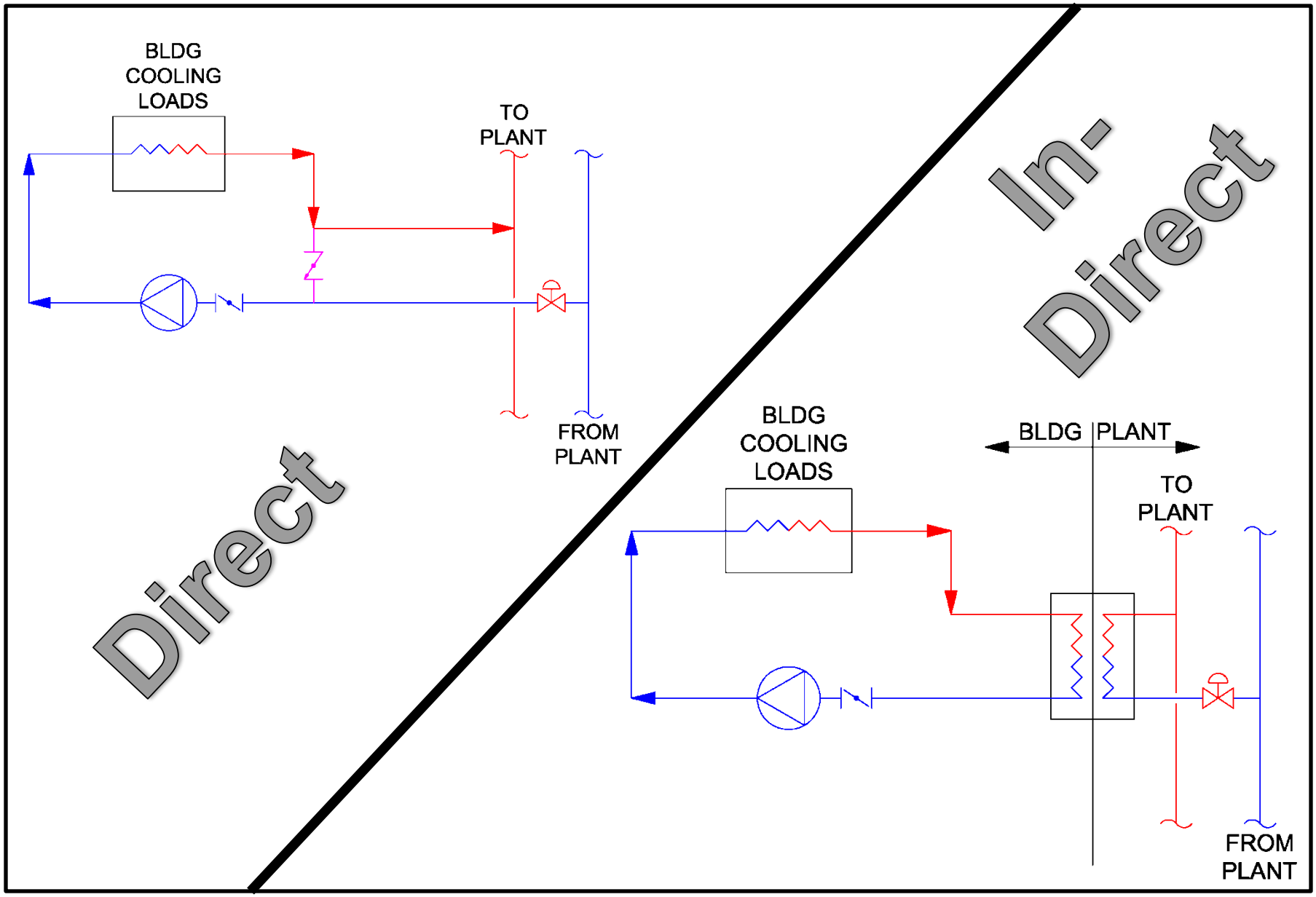
How to connect building cooling systems to the RW distribution system?

Direct Connection

or

Indirect Connection

Options for Building Conversion



Direct Connection: Pros / Cons

- Pros
  - Less Building Side Equipment
    - Lower Capital Cost
    - Lower O&M Cost
  - Somewhat reduced pump operation and cost
  - Readily available solution – Easy to installation
- Cons
  - Potential Business Interruption
  - Major Flood / Contamination Risk
  - No boundary separation

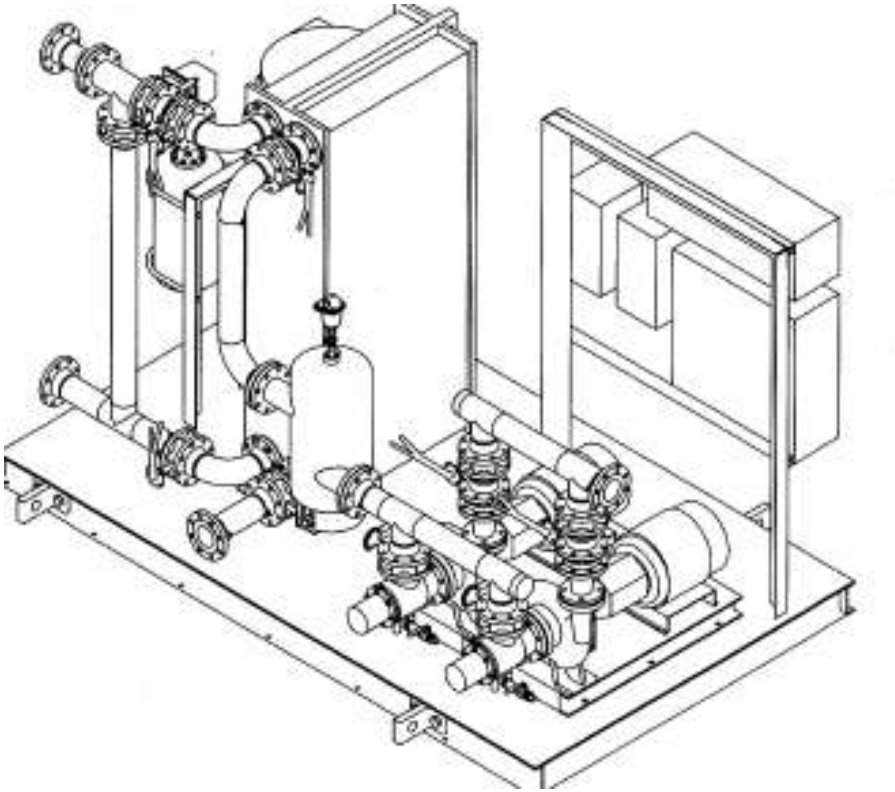
Energy Transfer Station: Pros / Cons

- Pros
  - Boundary separation for critical Process systems
  - Reduces risk of major flood / contamination
  - Independent metering
- Cons
  - Higher capital cost
  - Somewhat Higher Operating Cost
  - Thermal energy cost increase: 2°F approach
  - More building side equipment to maintain
  - Complexity of Installation – physical space

Indirect Connection: Energy Transfer Station (ETS)

Additional components needed for ETS in each building:

- Heat Exchanger (s)
- Make Up System
- Water Treatment System
- Stand-alone PLC
- Design for 20 psig dP across HX



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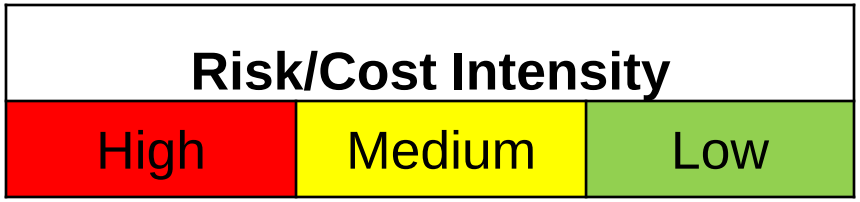
Direct vs Indirect Decision Criteria

- Temperature and Pressure Impacts
  - Sensitivity to district system pressure fluctuations – Risk Level
  - Sensitivity to district system temperature fluctuations – Risk Level
  - Impact on district return pressure or temperature – Risk Level
  - Impact of building elevation on system static pressure – Risk Level
- Building Specific Impacts
  - Construction/Shutdown Interruptions – Risk Level
  - Pipe Integrity – Risk Level
  - Exceeding existing Pipe Pressure Class **– Yes or No**
  - Exceeding equipment max pressure limits **– Yes or No**
  - Physical separation between bldg and district **– Yes or No**
  - Building Operation – Client Vs Third Party? – Same Team
- Costs
  - Building Valve Modification Cost – Cost Level
  - First Cost – $$$ Amount difference
  - O&M Cost – Cost Level
  - Energy Cost – Cost Level

Decision Criteria Legend



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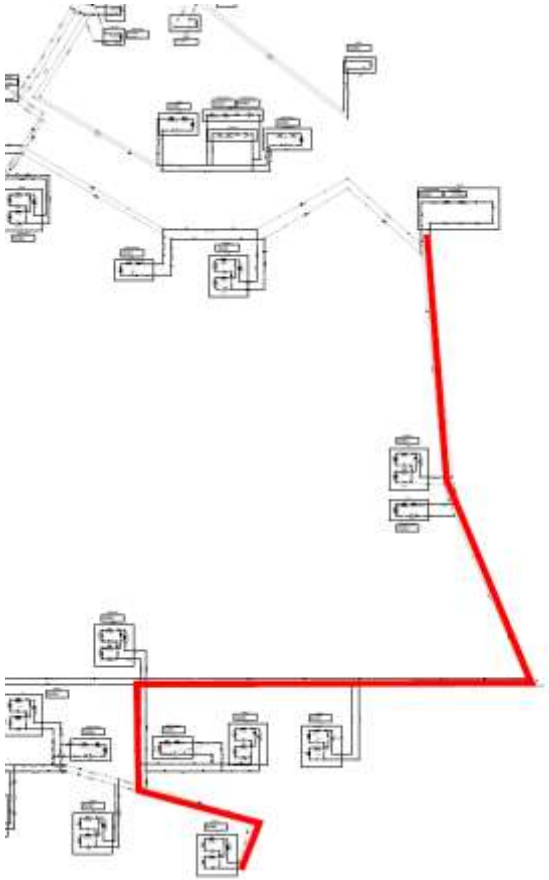
Decision Example: Research Building

Distance: 2,195 feet



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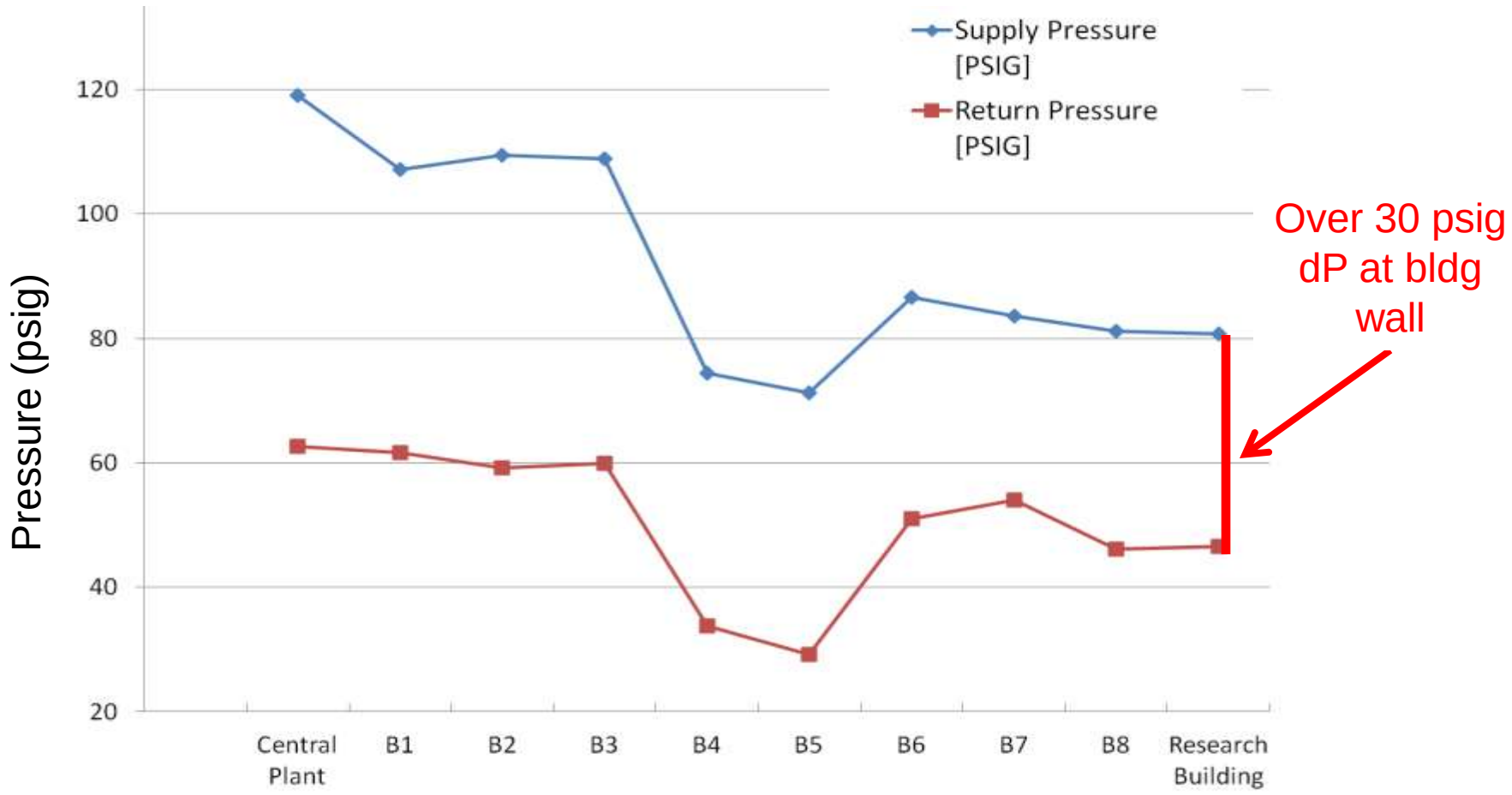
Research Building: Pressure Distribution Diagram



Research Building decision is pressure INDIFFERENT

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Decision Criteria – Research Building

Temperature and Pressure	**Indirect**	**Direct**
Sensitivity to district system pressure fluctuations	Low	Medium
Sensitivity to district system temperature fluctuations	Low	Medium
Impact on district return pressure or temperature	Low	Low
Impact of building elevation on system static pressure	Low	Low
Building Specific	**Indirect**	**Direct**
Construction/Shutdown Interruptions	Low	Low
Pipe Integrity	Low	Low
Exceed existing Pipe Pressure Class?	NO	NO
Exceed equipment max pressure limits?	NO	NO
Physical separation bldg and district?	YES	NO
Cost	**Indirect**	**Direct**
Building Valve Modification Cost	Low	Low
O&M Cost	Medium	Low
Energy Cost	Medium	Medium
First Cost	$90,000	Low

Recommendation: DIRECT CONNECTION

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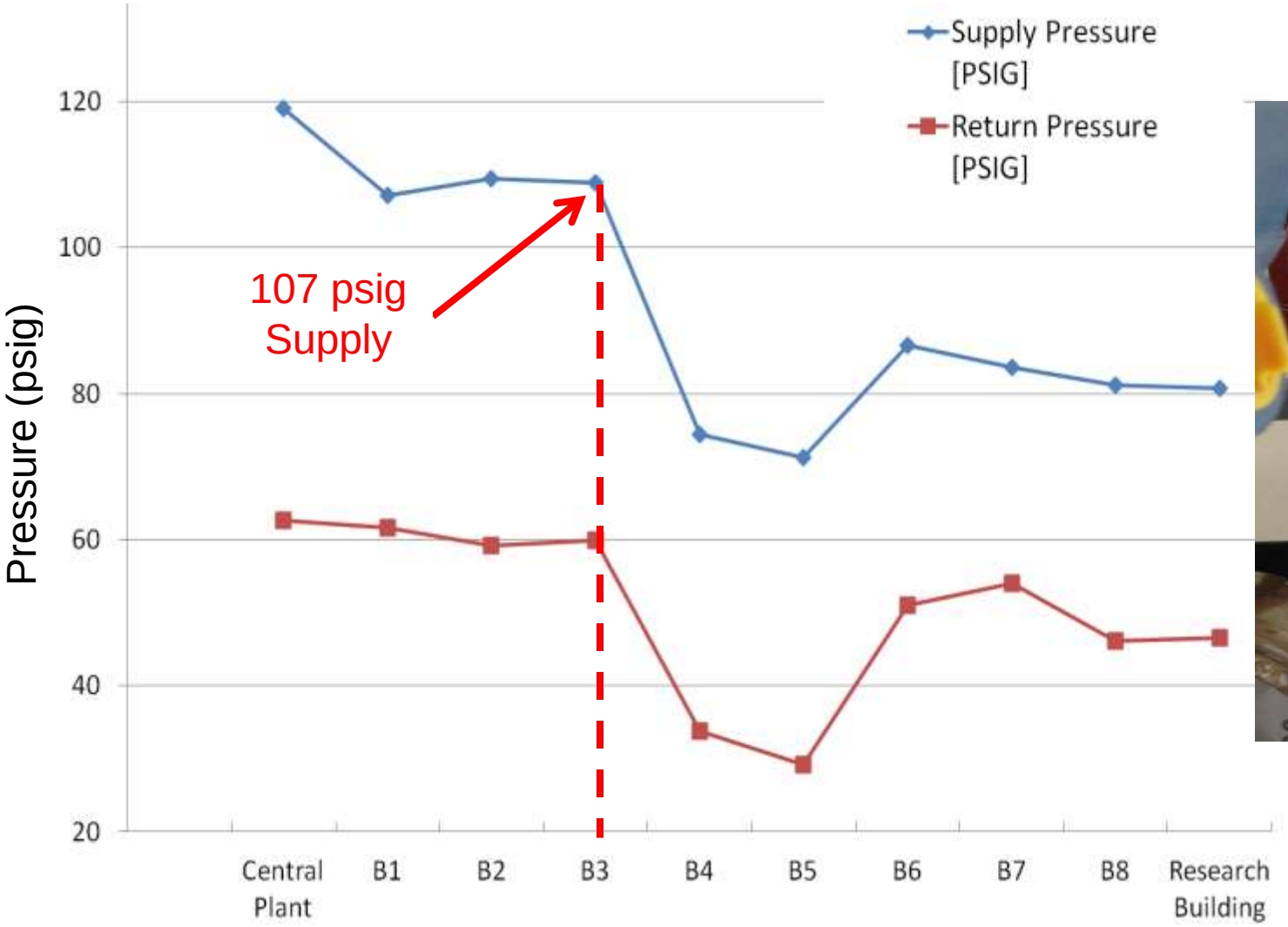
Manufacturing Bldg: Pressure Distribution Diagram



Manufacturing Building decision is pressure *SENSITIVE*

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Decision Criteria – Manufacturing Building

Temperature and Pressure	**Indirect**	**Direct**
Sensitivity to district system pressure fluctuations	Low	High
Sensitivity to district system temperature fluctuations	Low	Medium
Impact on district return pressure or temperature	Low	Low
Impact of building elevation on system static pressure	Low	Low
Building Specific	**Indirect**	**Direct**
Construction/Shutdown Interruptions	Low	Medium
Pipe Integrity	Low	Low
Exceed existing Pipe Pressure Class?	NO	NO
Exceed equipment max pressure limits?	NO	YES
Physical separation bldg and district?	YES	NO
Cost	**Indirect**	**Direct**
Building Valve Modification Cost	Medium	High
O&M Cost	Medium	Medium
Energy Cost	$1,500	Medium
First Cost	$42,000	Medium

Recommendation: IN DIRECT CONNECTION

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Lessons Learned and Next Steps

- Early Engagement with ALL stakeholders in decision making process
- Early Decisions on Risk and Criticality Standards
  - Main driver for ETS is Risk Mitigation
- Early Development and Agreement on Decision Criteria
- Understand Building Operation and Control
- Accurately estimate TCO for comparison
  - Capital cost
  - Energy cost
  - O&M Cost

Q/A

Thank you!

Any Questions?

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