Steam to Hot Water Distribution

- Service Life
- Size Availability
- Temperature & Pressure
- Corrosion

- Load collection
  - Trending vs Building Calc
  - Diversity
  - Establish sizing criteria

Pipe Material

- Material cost
- Installation cost
- Restoration

Hydraulic Model

Cost

Constructability

- Expansion
- Trenching
- Civil & Landscape
Distribution Design – Load Confirmation

Data

- Compile data from trend data sources
- Building use – btu/sf calculations
- Existing equipment sizing
- Putting together pieces of a puzzle for the full picture
Distribution Design – Hydraulic Modeling

Considerations

- Future load growth & locations
- Laterals based on existing building dT – not long term goals
- Failure scenarios: Redundancy needs vs. wants
Campus Conversion

- Shallow Bury
- Self-Restrained
- Direct Bury
- Valves
- Eliminated Vaults
Campus Steam to Hot Water Heat Exchanger
Distribution Design – Pipe Material

Materials unable to meet minimum operational requirements of 180°F and 100 PSIG
- ABS
- HDPE
- PE
- PVC
- PEX

Materials able to meet minimum operational requirements of 180°F and 100 PSIG
- Standard Steel
- European thin-wall steel
- Stainless Steel
- Copper
- HDPE High Temperature
- PEX High Temperature

Materials with limited pipe size
- PEX
- PB
- Copper
Distribution Design – Pipe Material

- Standard Steel
- European Thin Wall
- HDPE Raised Temperature
- PEX
- Other
## Distribution Design – Pipe Material

<table>
<thead>
<tr>
<th>Common Industry Designation</th>
<th>Common Name</th>
<th>Pressure Pipe Application</th>
<th>Pipe Size Range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Upper Service Temperature</strong>&lt;br&gt;180°F&lt;br&gt;58 PSIG @ 200°F</td>
<td>(inches)</td>
</tr>
<tr>
<td>PEX</td>
<td>Cross-linked Polyethylene</td>
<td><strong>Typical Temperature and Pressure Rating</strong>&lt;br&gt;66 PSIG @ 180°F&lt;br&gt;</td>
<td>3/4&quot; - 5&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>126 PSIG @ 140°F&lt;br&gt;112 PSIG @ 160°F&lt;br&gt;100 PSIG @ 180°F</td>
<td></td>
</tr>
<tr>
<td>HT HDPE</td>
<td>Polyethylene of Raised Temperature</td>
<td></td>
<td>2&quot; - 24&quot;</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steel</td>
<td>Steel</td>
<td><strong>††</strong></td>
<td>1/2&quot; - 30&quot;</td>
</tr>
</tbody>
</table>

**Legend:**
- Good
- Fair
- Poor
- † Material not suited for LTHW.
- †† Pressure and temperature exceed LTHW requirements – excess of 200°F and 100 psi.
## Distribution Design – Pipe Sizing

### Internal Pipe Diameters

<table>
<thead>
<tr>
<th></th>
<th>EN 253 Thin-wall 12” ID (in)</th>
<th>HT HDPE 12” ID (in)</th>
<th>Steel 12” ID (in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SDR 11</td>
<td>-</td>
<td>10.29</td>
<td>-</td>
</tr>
<tr>
<td>STD</td>
<td>11.87</td>
<td>-</td>
<td>11.94</td>
</tr>
</tbody>
</table>

*HT HDPE has a smaller ID and can require upsizing*
Distribution Design – Expansion

EXPANSION COMPENSATION

Elbow

Z-Bend

Loop
Pipe Leak Detection

• Sources of Leak
  • Carrier Pipe
  • Insulation Jacket @ joint kit

• Consequences
  • Corrosion
  • Damage to insulation

• Difficult System to Maintain
Other Distribution Concerns

- Corrosion and leak detection
- Potholing
- Depth of trench
- Traffic & pedestrian control
- Utility Separation Requirements
- Trench Exposure Duration
- Site Restoration
- Directional Boring & Benefits
Alternate Steam Source

• Replace kitchen steam equipment with electric; e.g. soup kettle and dishwashers

• Provide alternate steam source for lab equipment
Building Heat Exchanger or Decoupled Building Feed

- Building HX Selection
  - Brazed vs Plate Frame HX
  - Differential Pressure at Skid: 10 - 12 psid
  - Heat Exchanger approach: ~ 5F
  - Reliability and Maintenance Consideration
  - Separation between Campus/Building HHW
  - Water Quality – Hard vs Soft

- Decoupled Building Feed
  - No Building Hx – Common HHW water
  - Eliminate building pumping for building closer to Campus Distribution Pumps
  - Possible water contamination
  - Not recommended for European thin all pipes.
Questions?

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Understand Your Campus

• Chiller HR hot water is lower than past industry standard: 180F to 155F
• Identify problem areas before steam shutdown
  • Test Buildings by lowering HW temperature Before conversion
  • Mitigate “Cold Call” problem areas
  • Control HW bypass – Bypass raises HW return temperature
  • Alternate source for steam equipment
Results: Distribution and Building Conversion

- One method to UCOP Goal of Carbon Neutral by 2025.
- Cooling TES can store low grade thermal energy
- Maximizing heating and cooling overlap reduces carbon
- Distribution piping material and sizing determines service life
- Campus HX’s are critical for campus conversion
- Buildings design directly impacts efficiency of HR Chiller
  - Low Return Water Temperature
  - Building HX dP drives Campus Hot Water Pumps
Distribution Design – Standard Steel Expansion Loop
Maximum Operating Pressures of Plastic Piping

- PP-R (SDR 7.4)
- PP-R (SDR 11)
- PP-RCT (SDR 7.4)
- PP-RCT (SDR 11)
- CPVC (Sch 80)
- CPVC (Sch 40)
- HT HDPE (SDR 11)
- PVDF (PN 16)

Acceptable Material Zone

Zone of Operation
Distribution Design – Pipe Material

Thermal Expansion of Pipe

- PP-R
- PVDF
- CPVC
- PP-RCT (Fiberglass Reinforced)
- Copper
- Carbon Steel

Expansion (in / 100 ft) vs. ΔT (°F)
Distribution Design – 12” PIPE @ 180°F

STANDARD STEEL

THIN WALL STEEL

HIGH TEMP HDPE