UC Davis Main Campus Hot Water Conversion Project Implementation

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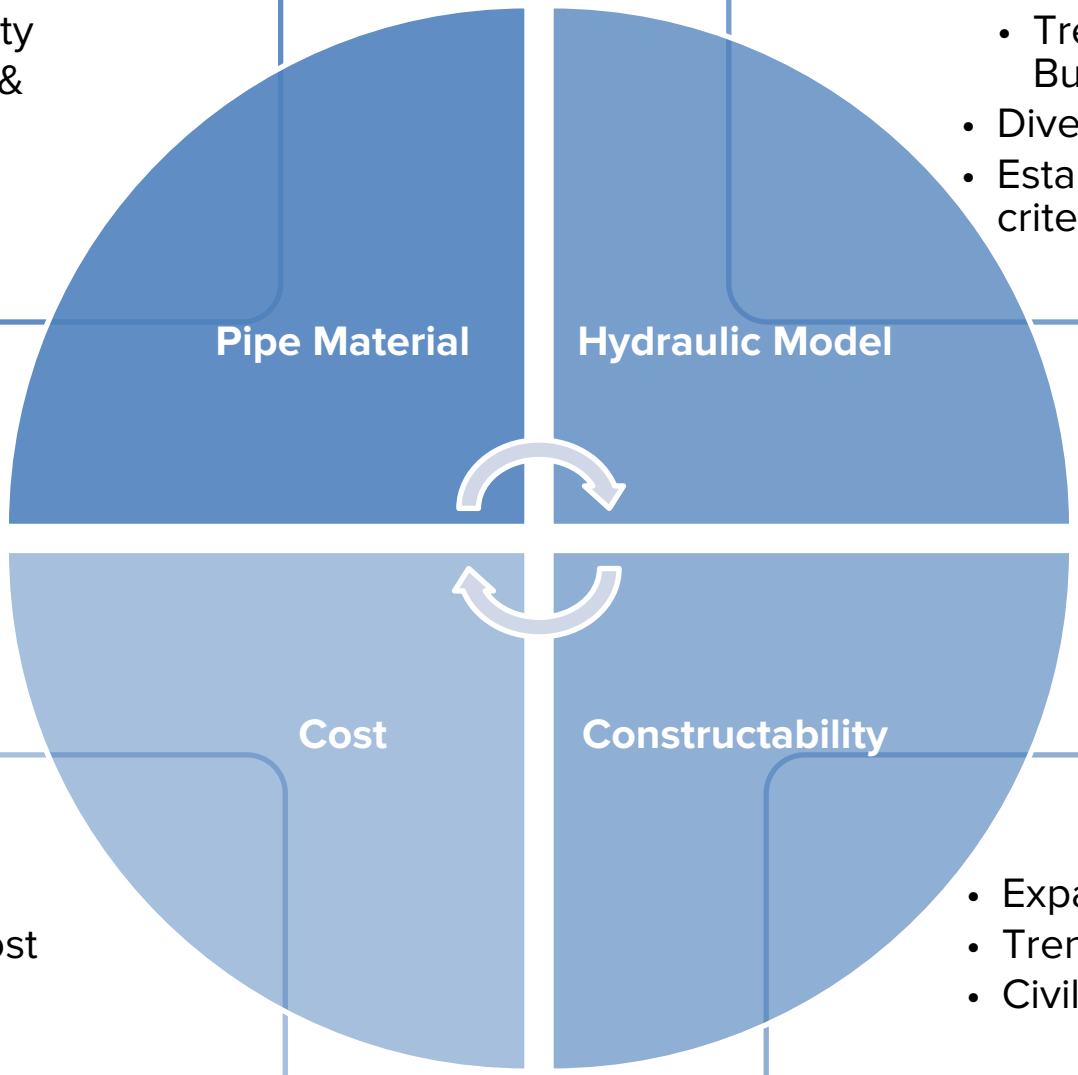
AEI Affiliated Engineers

Steam to Hot Water Distribution

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

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



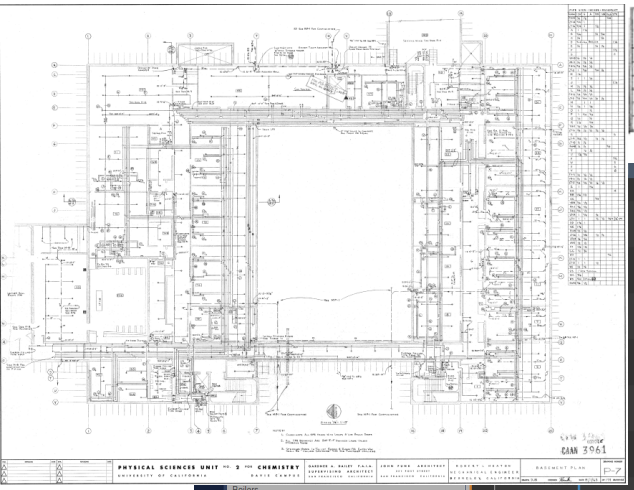
- Material cost
- Installation cost
- Restoration

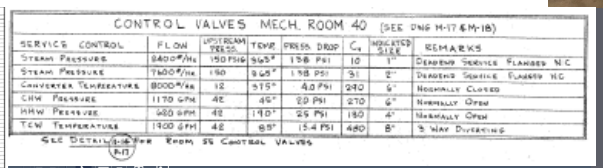
- Expansion
- Trenching
- Civil & Landscape

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

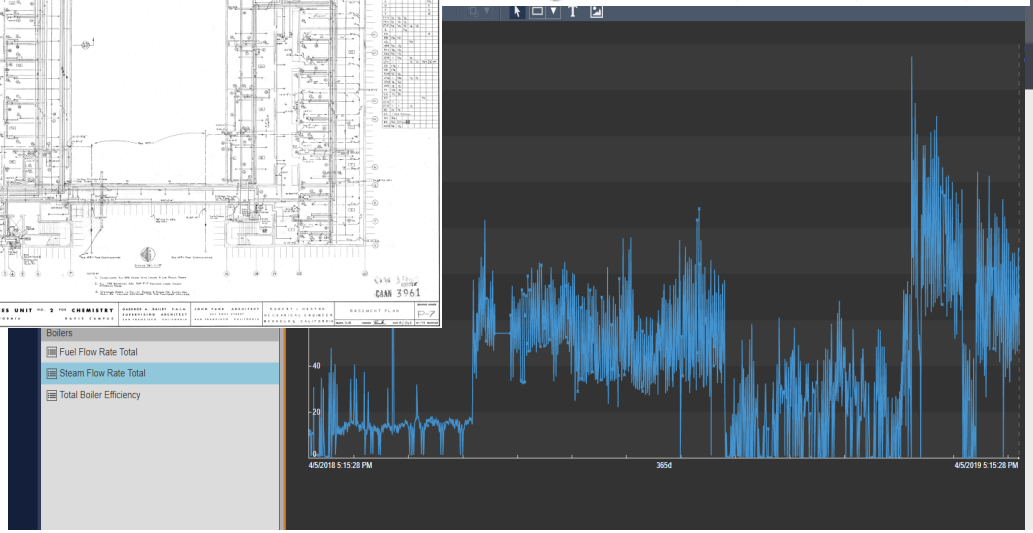


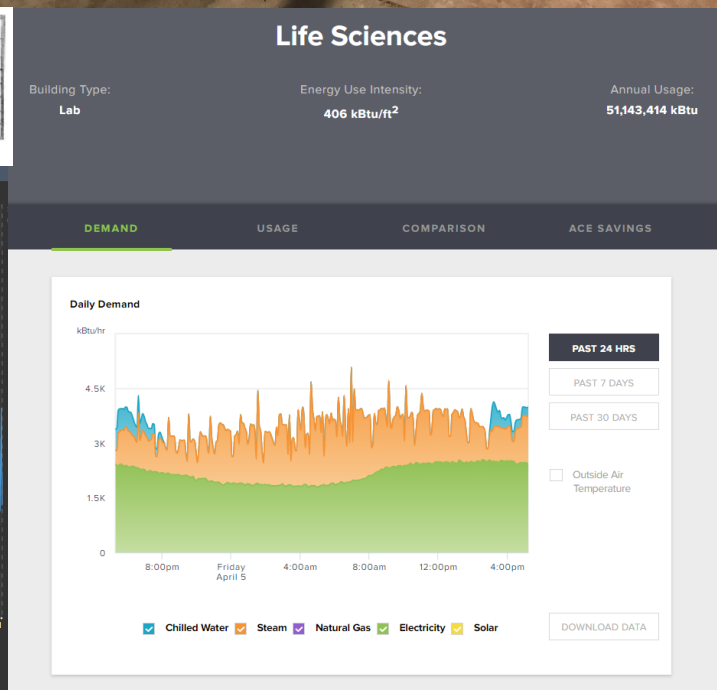


CONTROL VALVES MECH. ROOM 40 (SEE DWG M-17 & M-18)

SERVICE CONTROL	FLOW	UPSTREAM PRESS.	TEMP	PRESS. DROP	C_v	NOMINAL SIZE	REMARKS
STEAM PRESSURE	8400#/HR	150 PSIG	366°	138 PSI	10	1"	DEADEND SERVICE FLANGED N.C.
STEAM PRESSURE	7600#/HR	190	365°	178 PSI	9.1	2"	DEADEND SERVICE FLANGED N.C.
CONVERTER TEMPERATURE	8000#/HR	12	375°	4.0 PSI	270	6"	NORMALLY CLOSED
CHW PRESSURE	1170 GPM	42	45°	20 PSI	270	6"	NORMALLY OPEN
HHW PRESSURE	480 GPM	42	140°	25 PSI	180	4"	NORMALLY OPEN
TCW TEMPERATURE	1900 GPM	42	85°	15.4 PSI	480	8"	3 WAY DIVERTING

SEE DETAIL 1/M-17 FOR ROOM 56 CONTROL VALVES



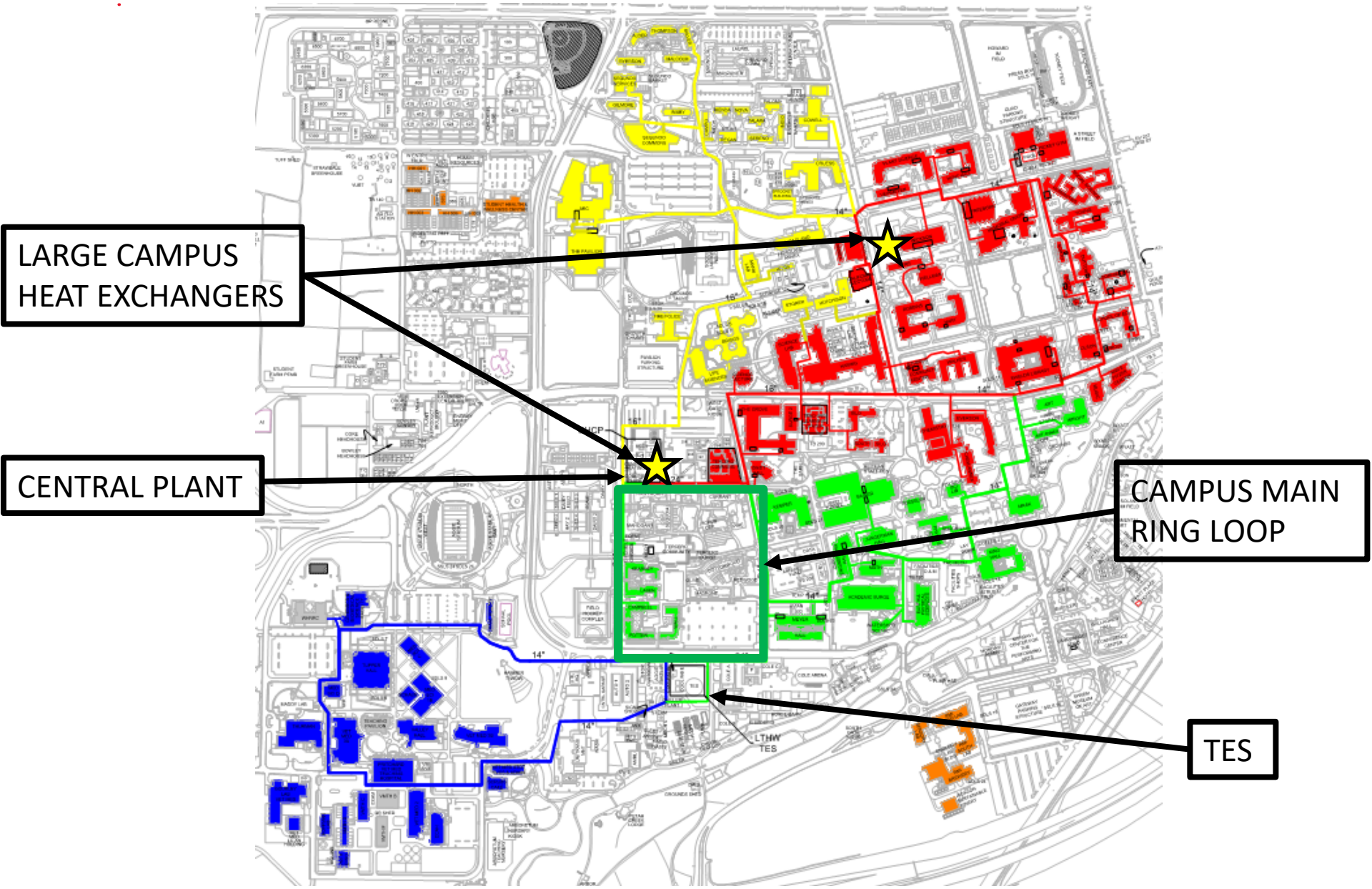


Distribution Design – Hydraulic Modeling

Considerations

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

Distribution Design

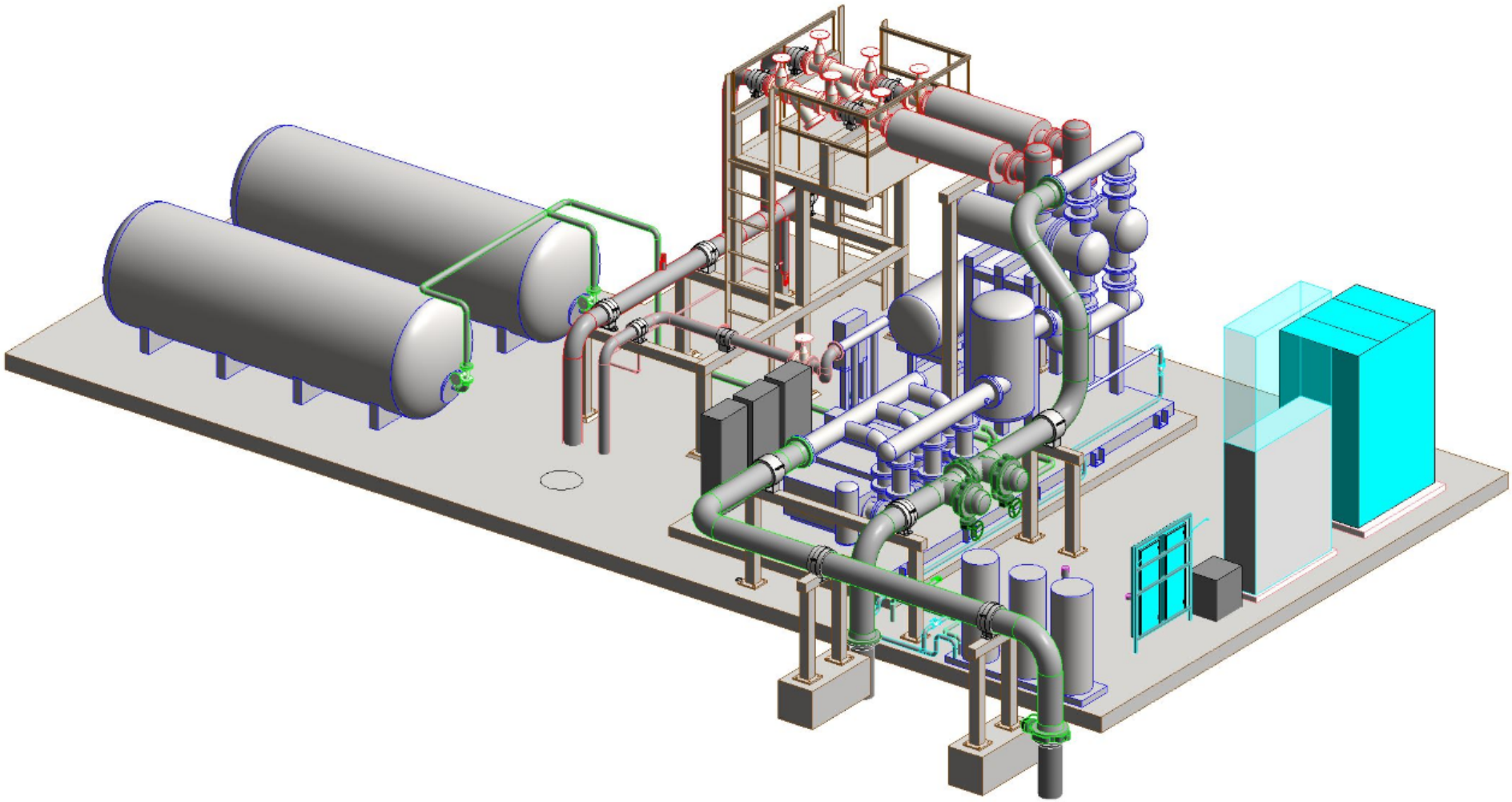


Campus Conversion

- 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 with limited pipe size

- PEX
- PB
- Copper

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

Distribution Design – Pipe Material

- Standard Steel
- European Thin Wall
- HDPE Raised Temperature
- PEX
- Other

Distribution Design – Pipe Material

Common Industry Designation	Common Name	Pressure Pipe Application		Pipe Size Range
		Upper Service Temperature	Typical Temperature and Pressure Rating	(inches)
PEX	Cross-linked Polyethlene	180°F	66 PSIG @ 180 F 58 PSIG @ 200 F	3/4" - 5"
HT HDPE	Polyethylene of Raised Temperature	180°F	126 PSIG @ 140°F 112 PSIG @ 160°F 100 PSIG @ 180°F	2"-24"
Steel	Steel	250°F	††	1/2" - 30"

Legend:

Good Fair Poor

† Material not suited for LTHW.

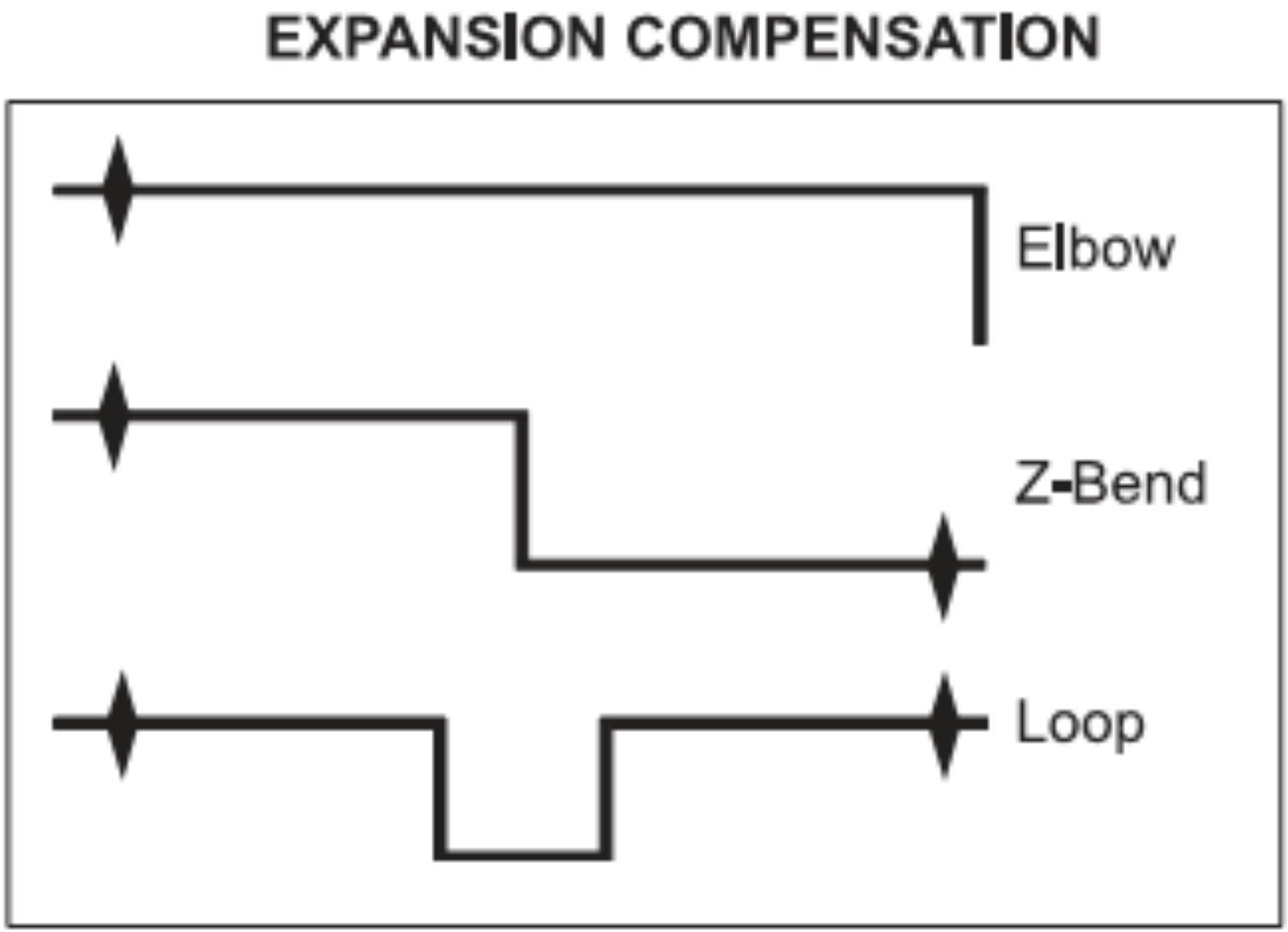
†† Pressure and temperature exceed LTHW requirements – excess of 200°F and 100 psi.

Distribution Design – Pipe Sizing

Internal Pipe Diameters			
	EN 253 Thin-wall 12” ID (in)	HT HDPE 12” ID (in)	Steel 12” ID (in)
SDR 11	-	10.29	-
STD	11.87	-	11.94

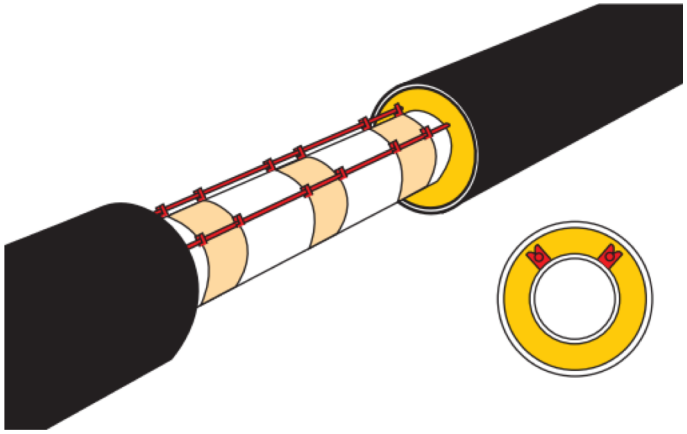
HT HDPE has a smaller ID and can require upsizing

Distribution Design – Expansion

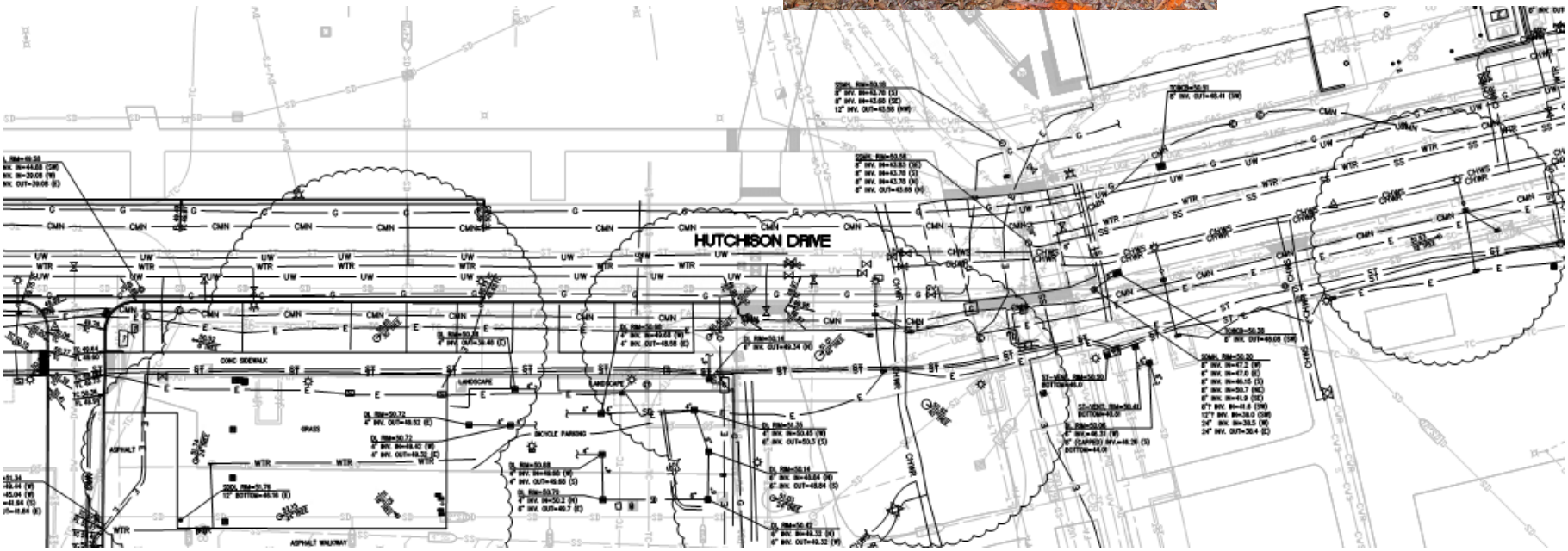


Pipe Leak Detection

- Sources of Leak
  - Carrier Pipe
  - Insulation Jacket @ joint kit
- Consequences
  - Corrosion
  - Damage to insulation
- Difficult System to Maintain



Distribution Design – Site



Other Distribution Concerns

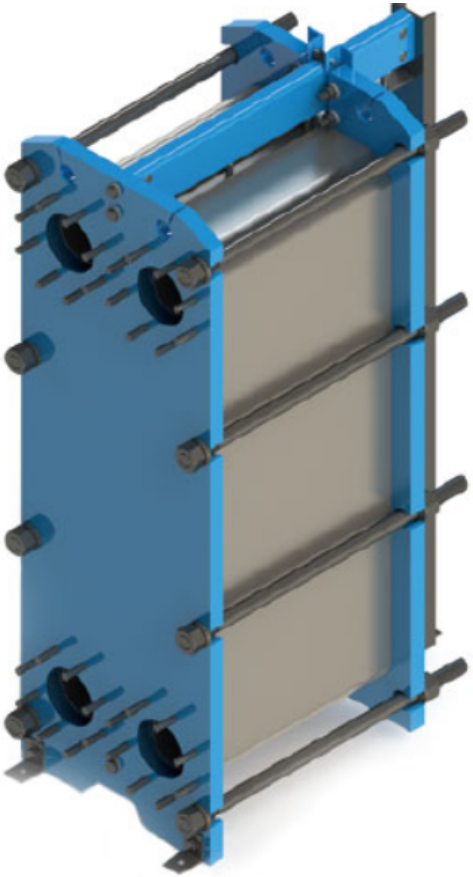
- Corrosion and leak detection
- Potholing
- Depth of trench
- Traffic & pedestrian control
- Utility Separation Requirements
- Trench Exposure Duration
- Site Restoration
- Directional Boring & Benefits

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

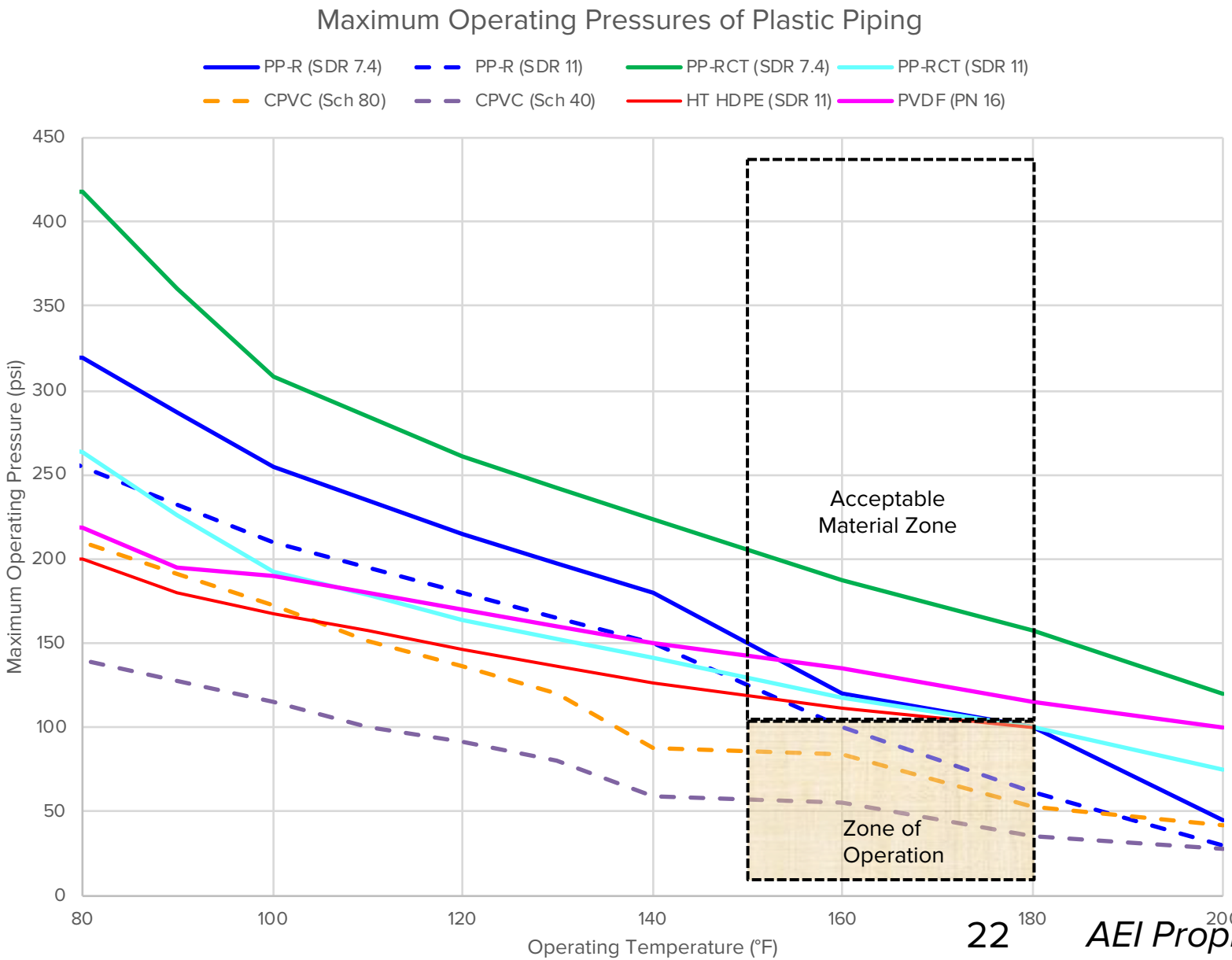
- Chiller HR hot water is lower than past industry standard: 180F to 155F
- Identify problem areas before steam shutdown
  - Test Buildings by lowering HW temperature <u>Before</u> conversion
  - Mitigate “Cold Call” problem areas
  - Control HW bypass – Bypass raises HW return temperature
  - Alternate 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

Distribution Design – Pipe Material



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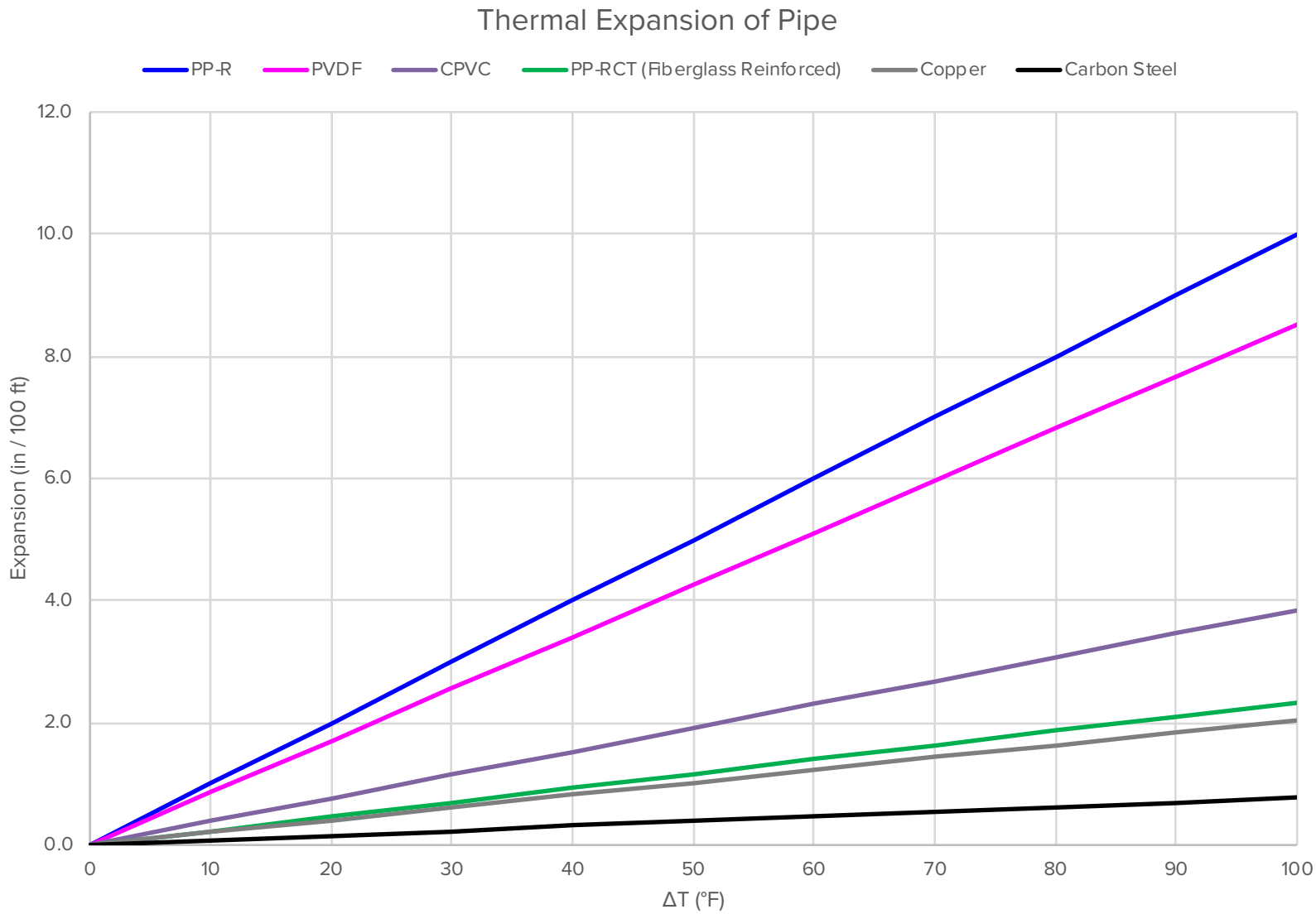
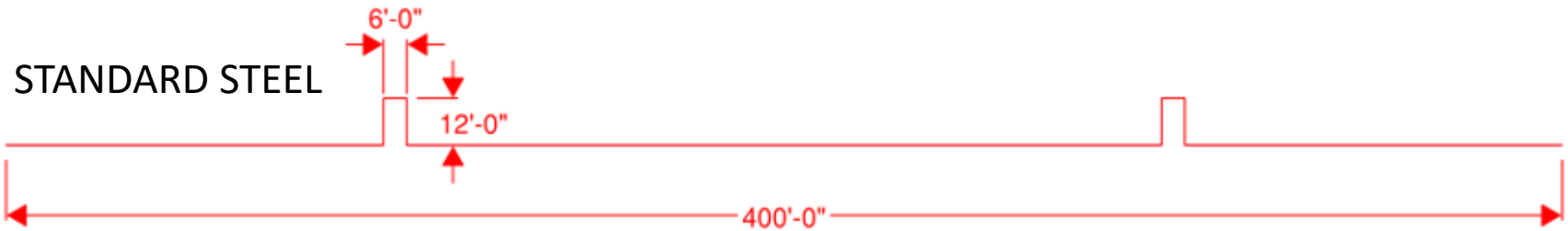
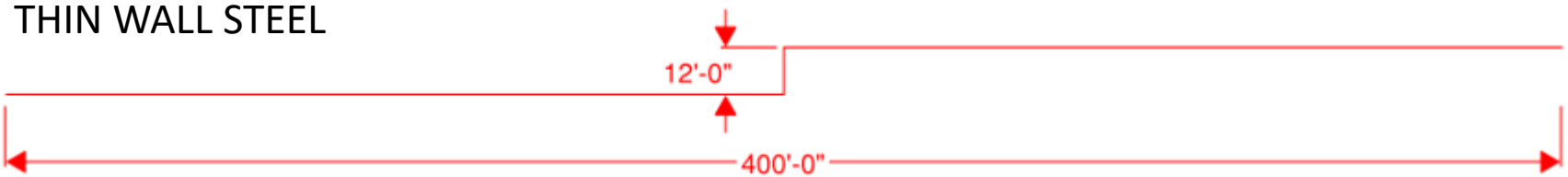


Distribution Design – 12” PIPE @ 180°F

STANDARD STEEL



THIN WALL STEEL



HIGH TEMP HDPE