

Market and Performance Limitations to Consider When Planning for District Cooling Applications

Seth Kraal, PE
Mechanical Engineer, Jacobs

Background

How is master planning impacted by market and performance factors?

Installation Cost

- ✓ **Equipment Availability**
- ✓ **Phasing**

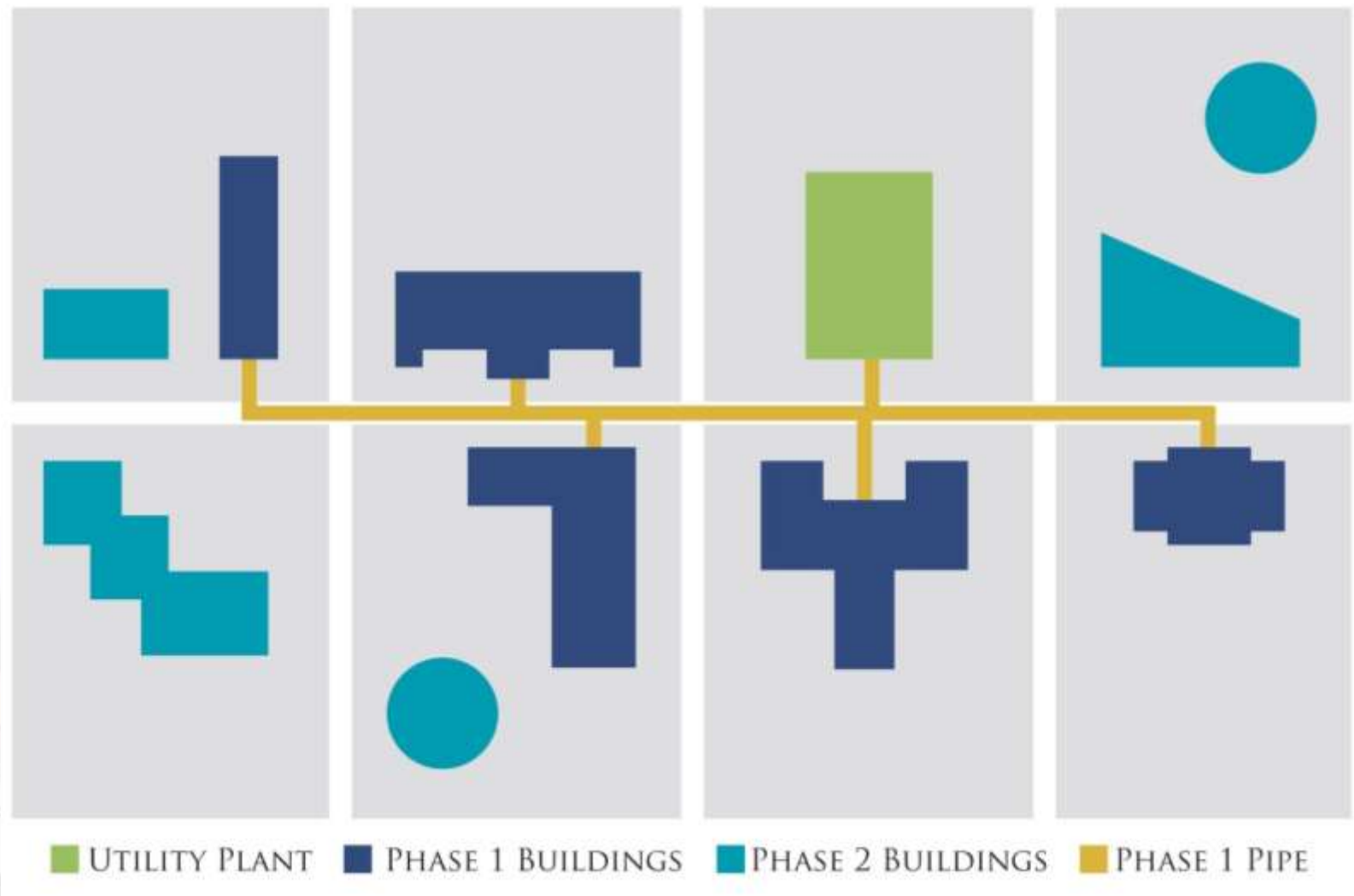
Operational Cost

- ✓ **Equipment Efficiency**
- ✓ **Life Cycle**
- ✓ **Maintenance**

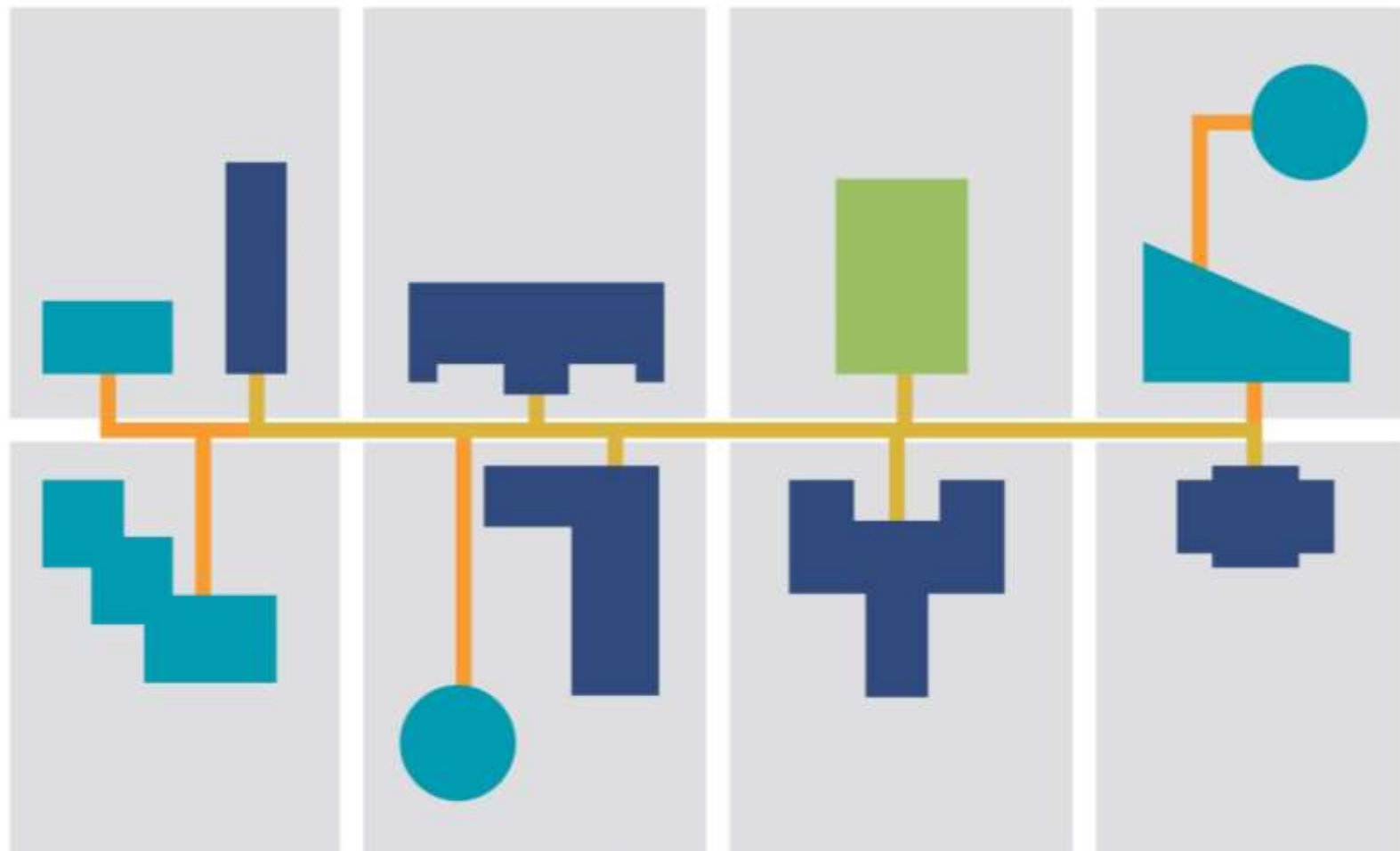
Piping Distribution

- Considerations for long-term planning for new infrastructure installation:
 - How to size pipe appropriately for various phases of implementation
 - Market limitations
 - Up-front cost
 - Operational costs and savings
 - ASHRAE Interpretation 5 (Table 6.5.4.5)

Piping Distribution: Phasing



Piping Distribution: Phasing



■ UTILITY PLANT ■ PHASE 1 BUILDINGS ■ PHASE 2 BUILDINGS ■ PHASE 1 PIPE ■ PHASE 2 PIPE

Piping Distribution: Installation Cost

- Availability:
 - Pipe is available in diameter increments of:
 - 2" greater than 4" up to 36" diameter
 - 6" increments from 36" to 72"
 - 12" increments from 72" diameter higher
 - Seamless vs. Welded
 - Seamless Pipe: Available in sizes up to 55" (International) or 36" (North America)
 - Welded Pipe: Available in sizes up to 196" (North America)
 - Valves
 - Same size increments as pipe
 - Up to 60" available from most manufacturers and in most pressure ratings
 - Above 60" more limited manufacturers and ratings but can custom order

Piping Distribution: Installation Cost

Lead Times	
Domestic Welded	17-20 weeks
Domestic Seamless	18-22 weeks
International Seamless	24-32 weeks
Valves <60" (50 Piece Order)	24-34 weeks
Valves >60" (50 Piece Order)	52-77 weeks

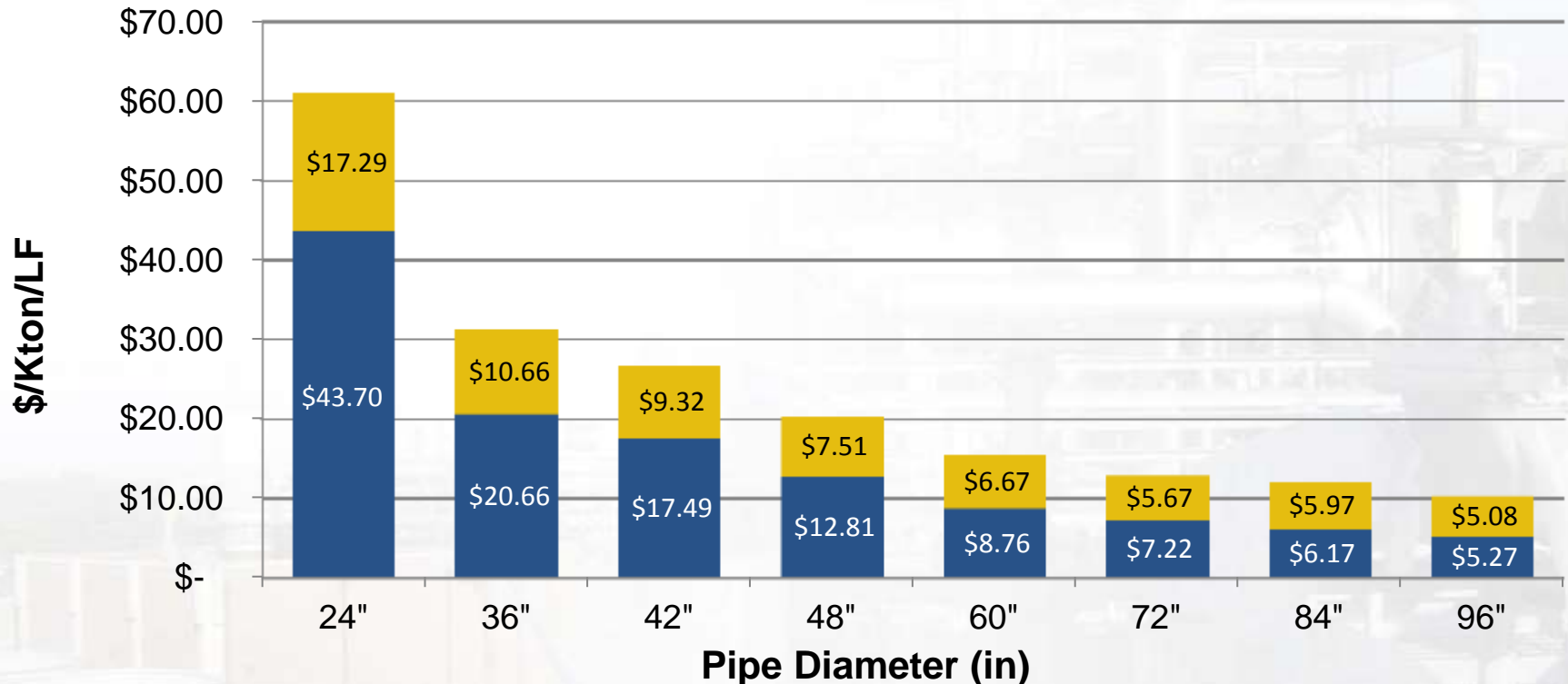
Piping Distribution: Operational Cost

Pipe Losses vs. Maximum Velocity

Diameter (in)	Velocity (ft/s)	Flow (gpm)	Friction Loss (ftH ₂ O/100ft)	Capacity (tons at 12deg Δt)
18	8.5	6,222	1.0	3,111
24	10.2	13,499	1.0	6,749
30	11.7	24,493	1.0	12,246
36	13.1	39,747	1.0	19,874
42	14.3	59,760	1.0	29,880
60	17.8	152,826	1.0	76,413
72	19.8	246,464	1.0	123,232
84	21.7	368,846	1.0	184,423
96	23.6	529,516	1.0	264,758

Piping Distribution: Installation Cost

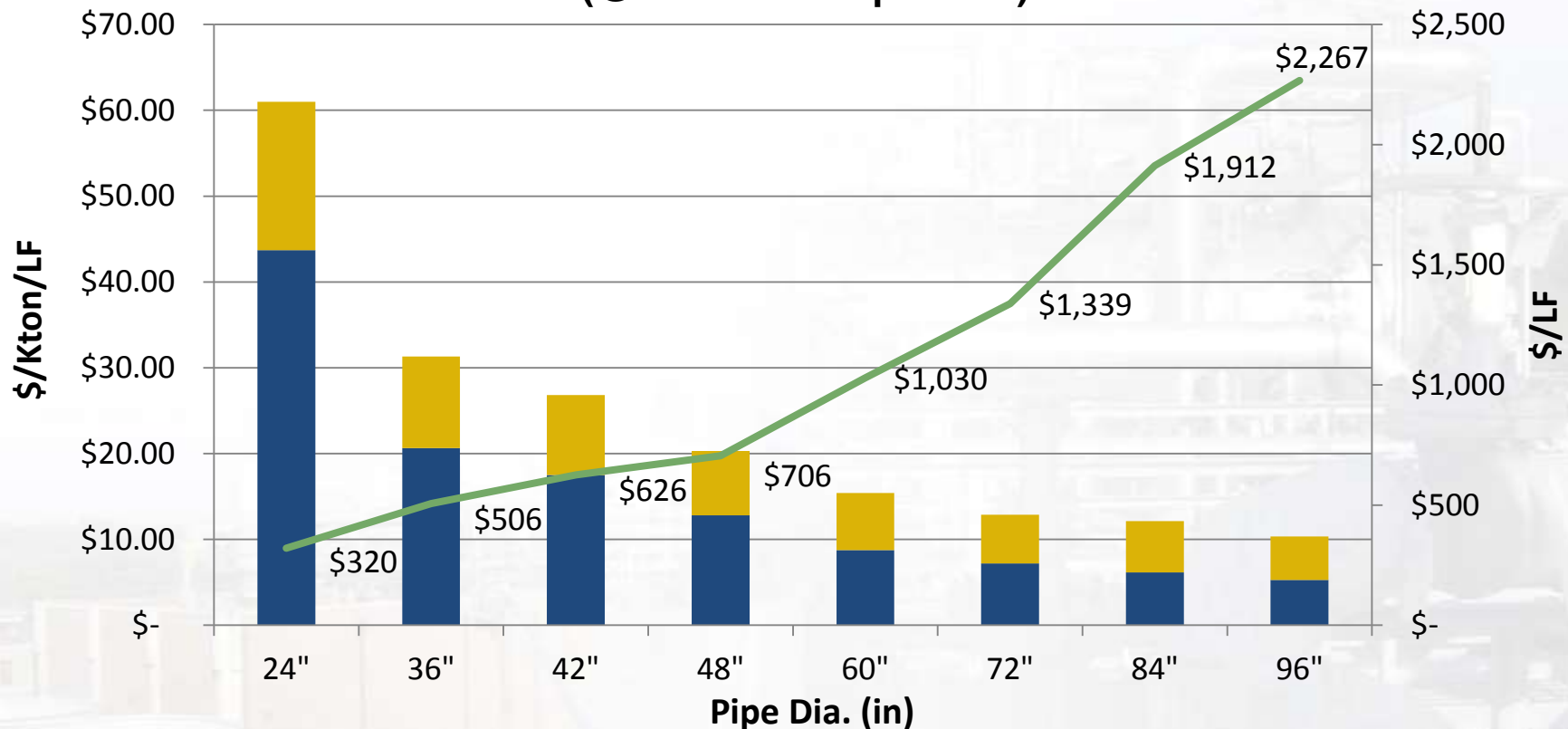
**Cost To Install DB Chilled Water System
(@ 1' head loss per 100')**



■ Labor (trenching, welding & insulating) ■ Materials (pipe, valves and insulation)

Piping Distribution: Installation Cost

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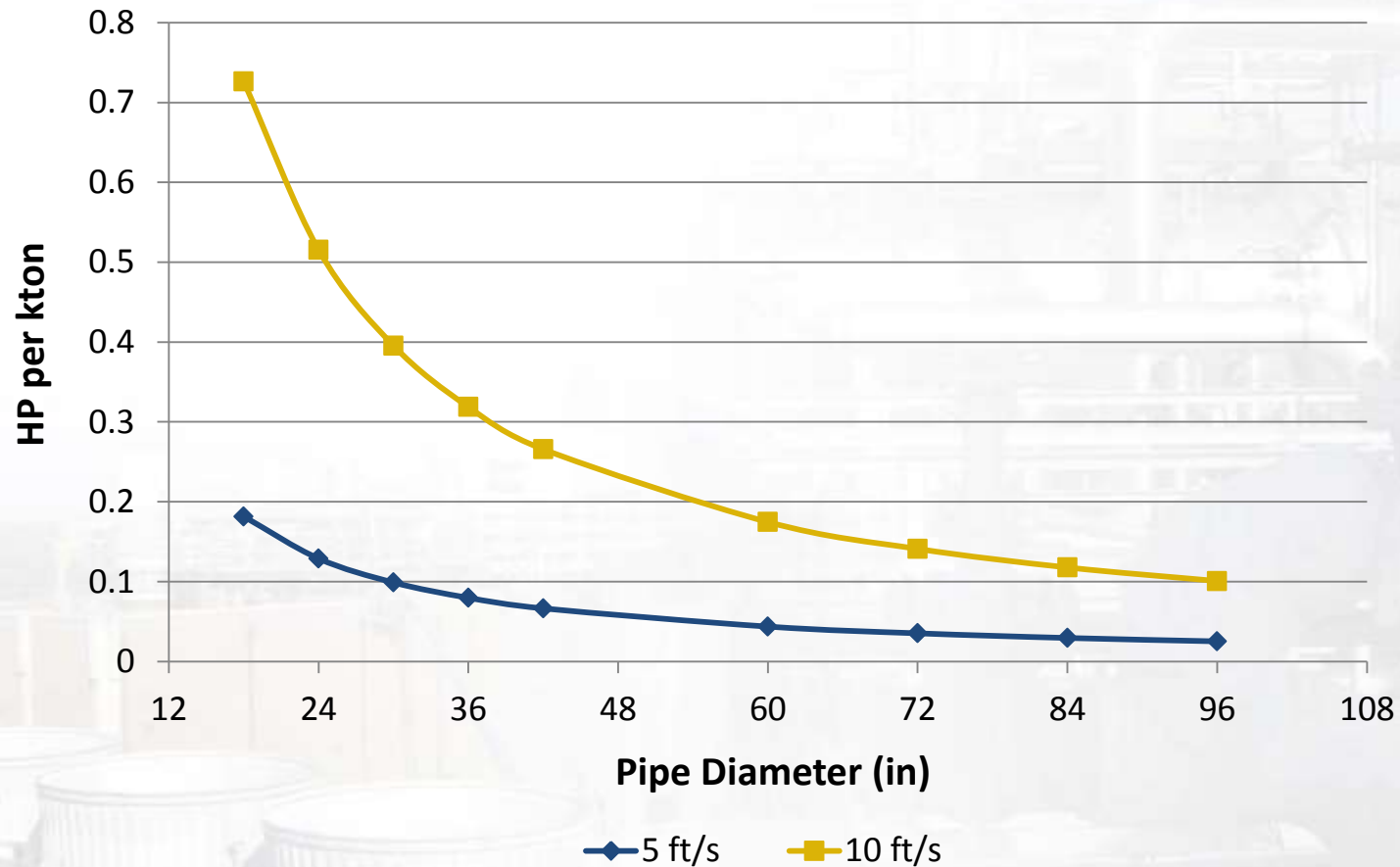


■ Labor (trenching, welding & insulating)

■ Materials (pipe, valves and insulation)

— Average Cost per Linear Foot

Piping Distribution: Operational Cost

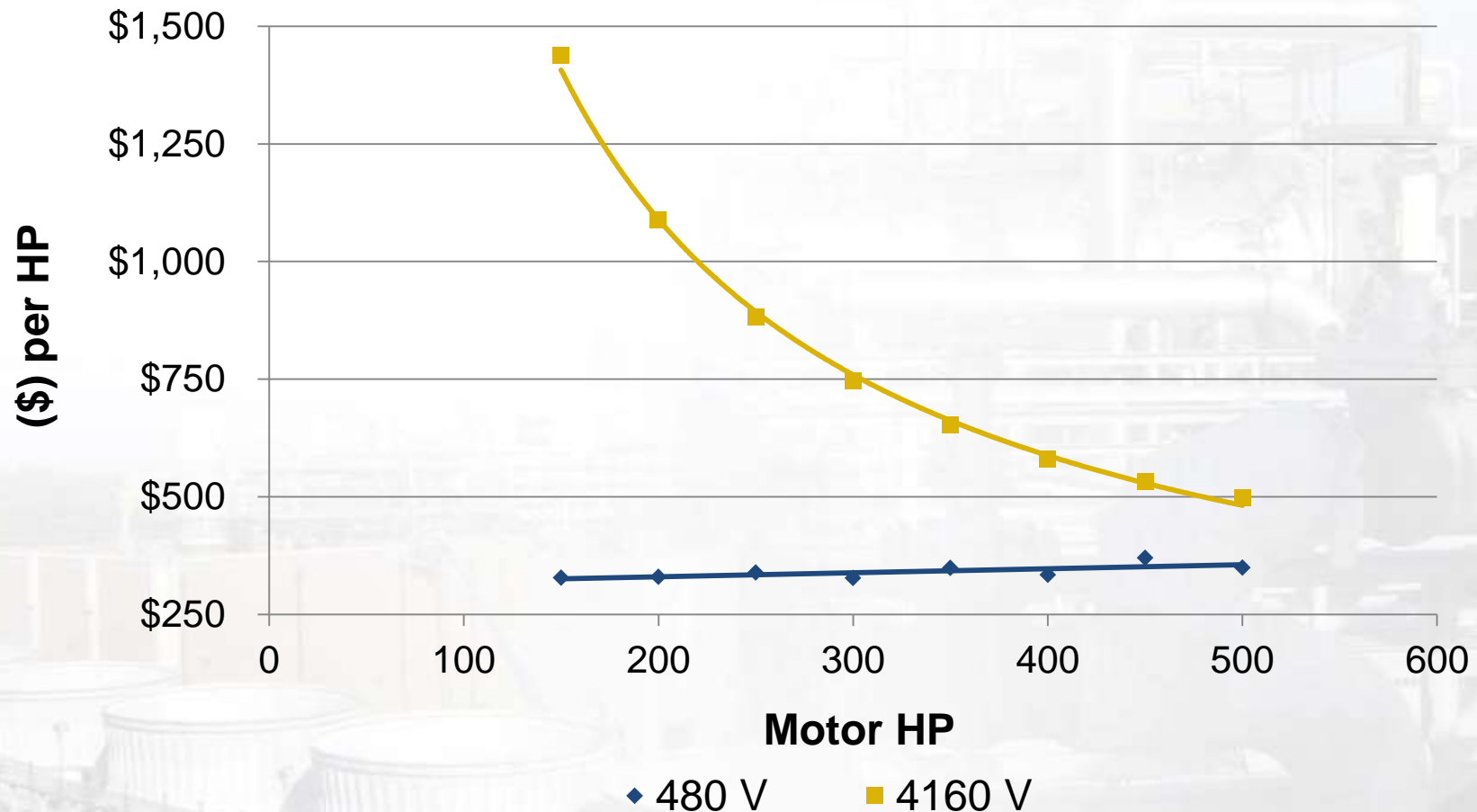


Motors

- Considerations for long-term planning for new infrastructure installation:
 - Size of 480V vs. 4160V components
 - Market limitations and availability
 - Up-front costs
 - Raceway length
 - Consolidation of pumping
 - Constant speed vs. variable speed process
 - Training

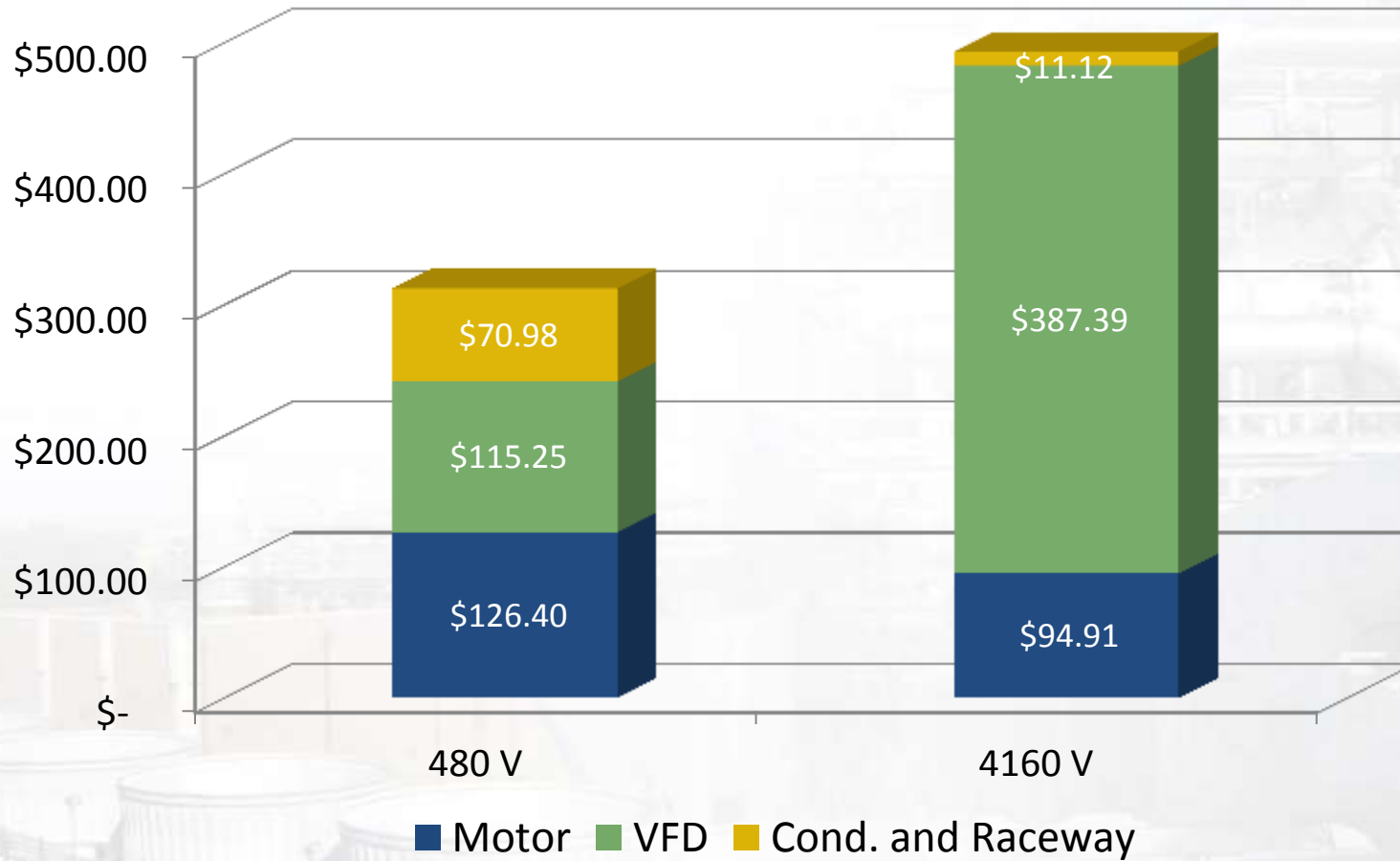
Motors: Installation Cost

Cost Per HP: 480V vs. 4160V



Motors: Delineated Installation Cost

500 HP Motor & Service



Cooling Towers

- Considerations for long-term planning for new infrastructure installation:
 - Footprint
 - Height of tower
 - Desired tower efficiency
 - Number of cells
 - Number of air inlets to the tower (tower placement)
 - Controls (turndown)
 - Up-front cost

Cooling Towers

Market Limitations

Cooling Tower	Capacity (tons)	Lead Time	Efficiency (gpm/HP)
Field Fabricated	Typically >20,000	8-12 months	25-50 or more
Factory Supplied	Up to ~7,500 per cell	6-8 months	22.5-44

Chillers

- Considerations for long-term planning for new infrastructure installation:
 - Maximum turndown (testing vs factory recommendations)
 - Market limitations
 - Capacity
 - Type
 - 480V vs. 4160V
 - Lead times
 - Up-front cost

Chillers

Market Limitations

Chiller	Capacity (tons)	Typical Lead Time	Efficiency Range (Full Load kw/ton)
Centrifugal Water Cooled	180 – 6,000	19-21 weeks	0.60 – 0.45
Other Water Cooled	75 – 650	18-25 weeks	0.75 – 0.45
Air Cooled	10 – 500	varies greatly	1.2 – 0.85

Summary

Installation Cost

- ✓ **Equipment Availability**
- ✓ **Phasing**

Operational Cost

- ✓ **Equipment Efficiency**
- ✓ **Life Cycle**
- ✓ **Maintenance**