Fabrication considerations

For Hydrothermal liquefaction (HTL) plants

Who is presenting?

Scott Cooper, P. Eng.

- ✓ Chemical engineering degree from University of Waterloo
- ✓ project engineer for various HTL pilot and demonstration plants starting in 2015

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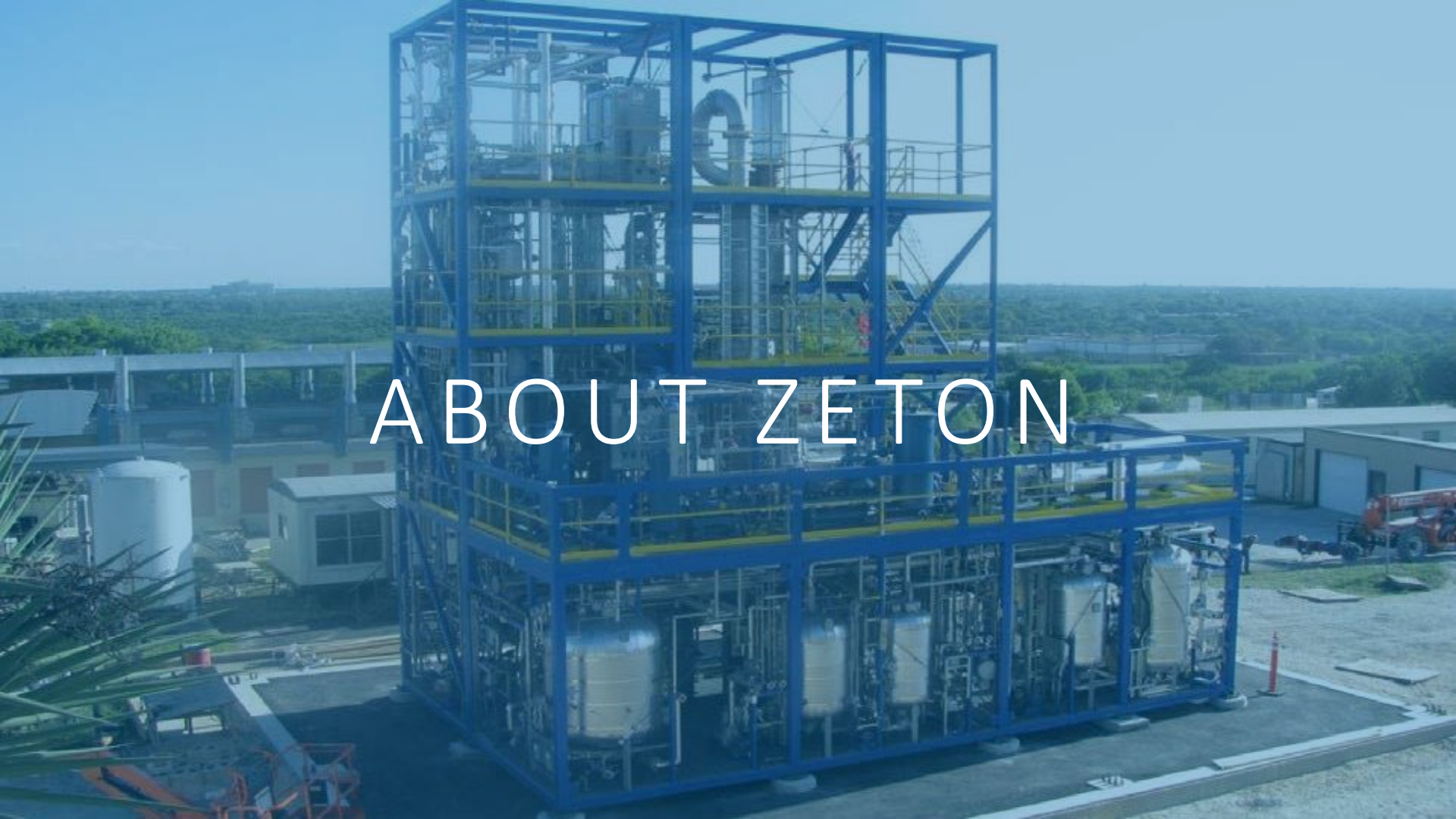


ABOUT ZETON

The world leader in the design and fabrication of pilot plants

- ✓ Canadian company, founded in 1986, Zeton has grown to become the largest designer and builder of pilot plants in the world.
- ✓ Providing Design-Build solutions for pilot plants, including Controls engineering and Factory Testing
- ✓ Serving all major process industries

Zeton in North America

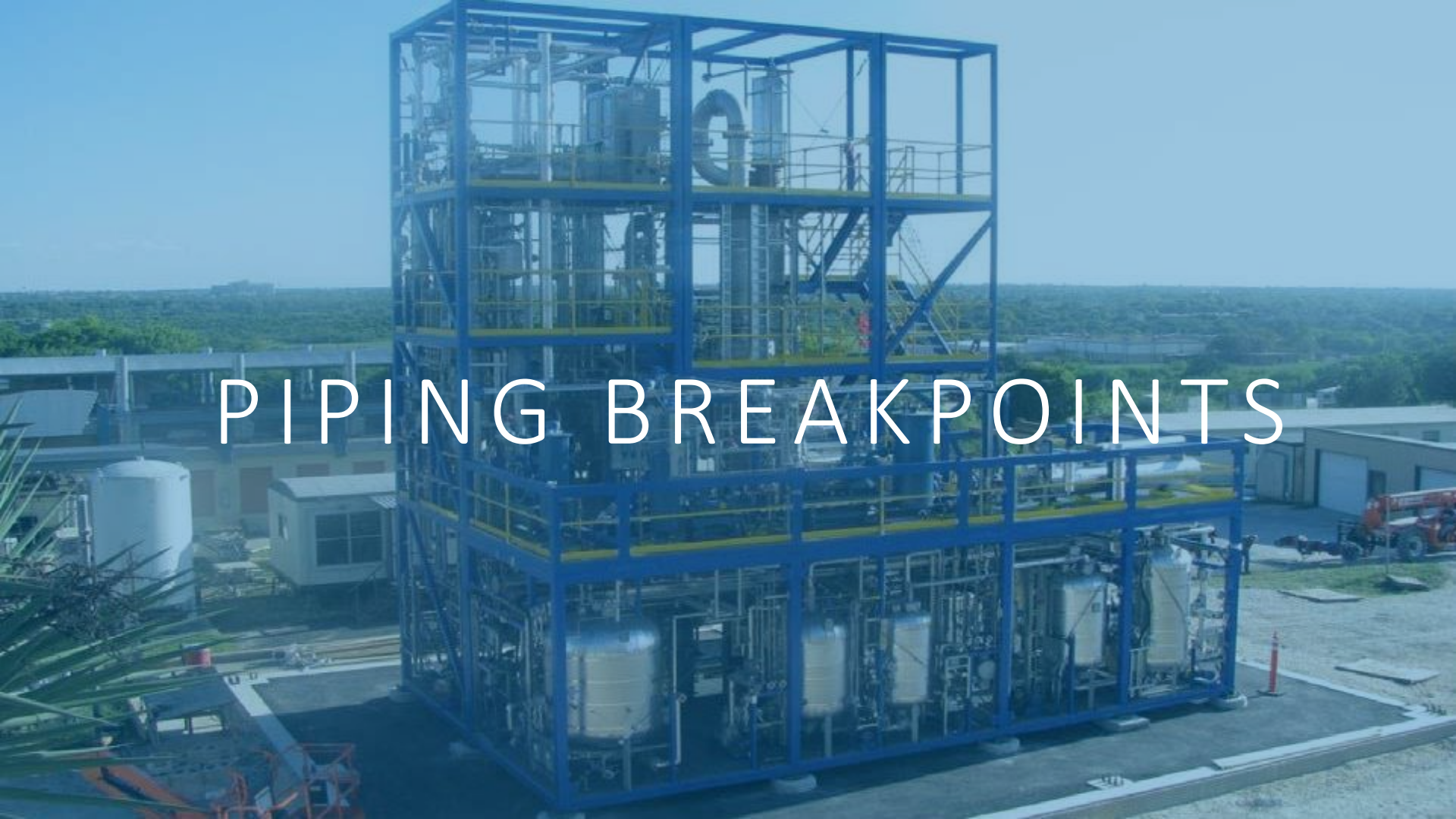
Our facility in Ontario, Canada has seven fabrication bays, totaling over 77,000 ft2. These bays are able to accommodate skids up to 48 ft in height.

In addition to standard fabrication bays, Zeton also offers a clean fabrication bay for food and pharma projects.

HTL Fabrication Considerations

- Takes place at a combination of higher pressures and temperatures
- Produces difficulties in fabrication that need to be both taken into consideration in capital cost evaluations and eventually resolved
- Two examples that are the focus of this presentation:

  A. Piping Breakpoints – where does piping go from readily available to heavily customized?
  B. Pipe Support Design – What factors contribute to the difficulties of piping design for HTL plants, and how to resolve them?



PIPING BREAKPOINTS

Quick HTL Introduction

"Underwater Pyrolysis" – Combination of Decomposition and Condensation Reactions

Temperature range of **250 – 374°C**

Liquid water is involved in the reaction – water must remain in liquid form despite high temperatures

Resultant pressure range of **20 – 250 barg**

Creates medium to high temperature and pressure combination

HTL Pressure/ Temperature Ratings

Consider a reaction temperature of 350°C

164 barg → Boiling Point

\+ 35 bar → Operating Margin Above Boiling Point

\+ 35 bar → Piping Pressure Losses Upstream

234 barg

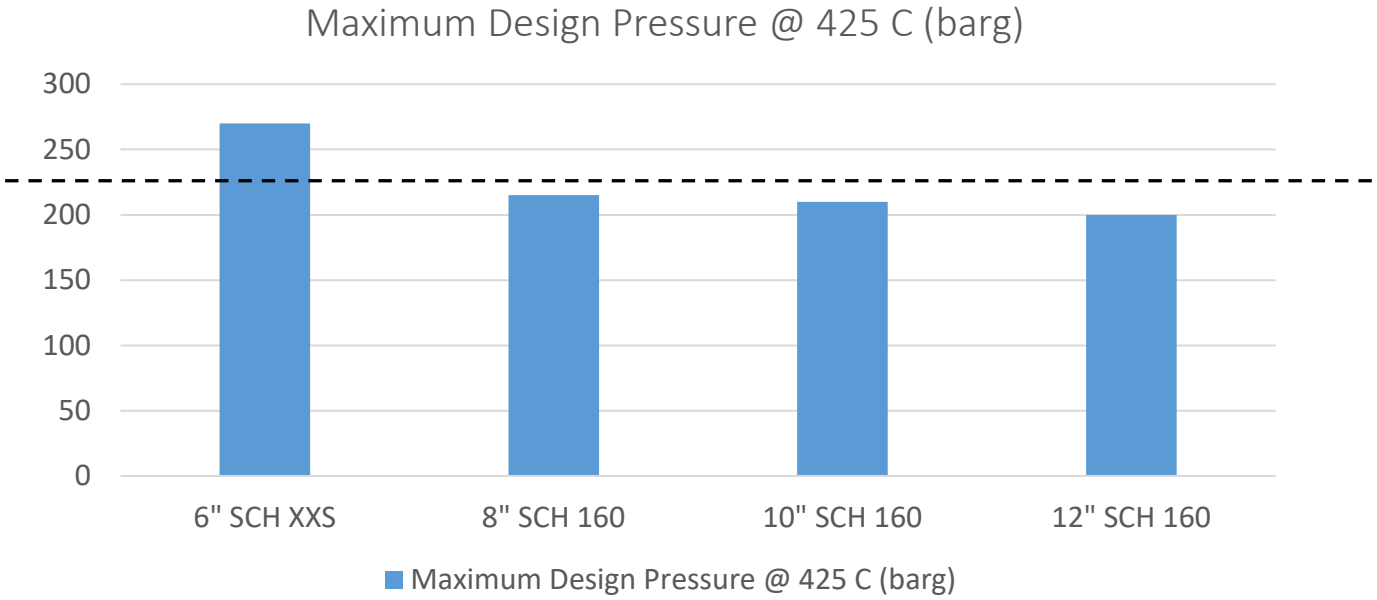
↓

Max Operating Pressure

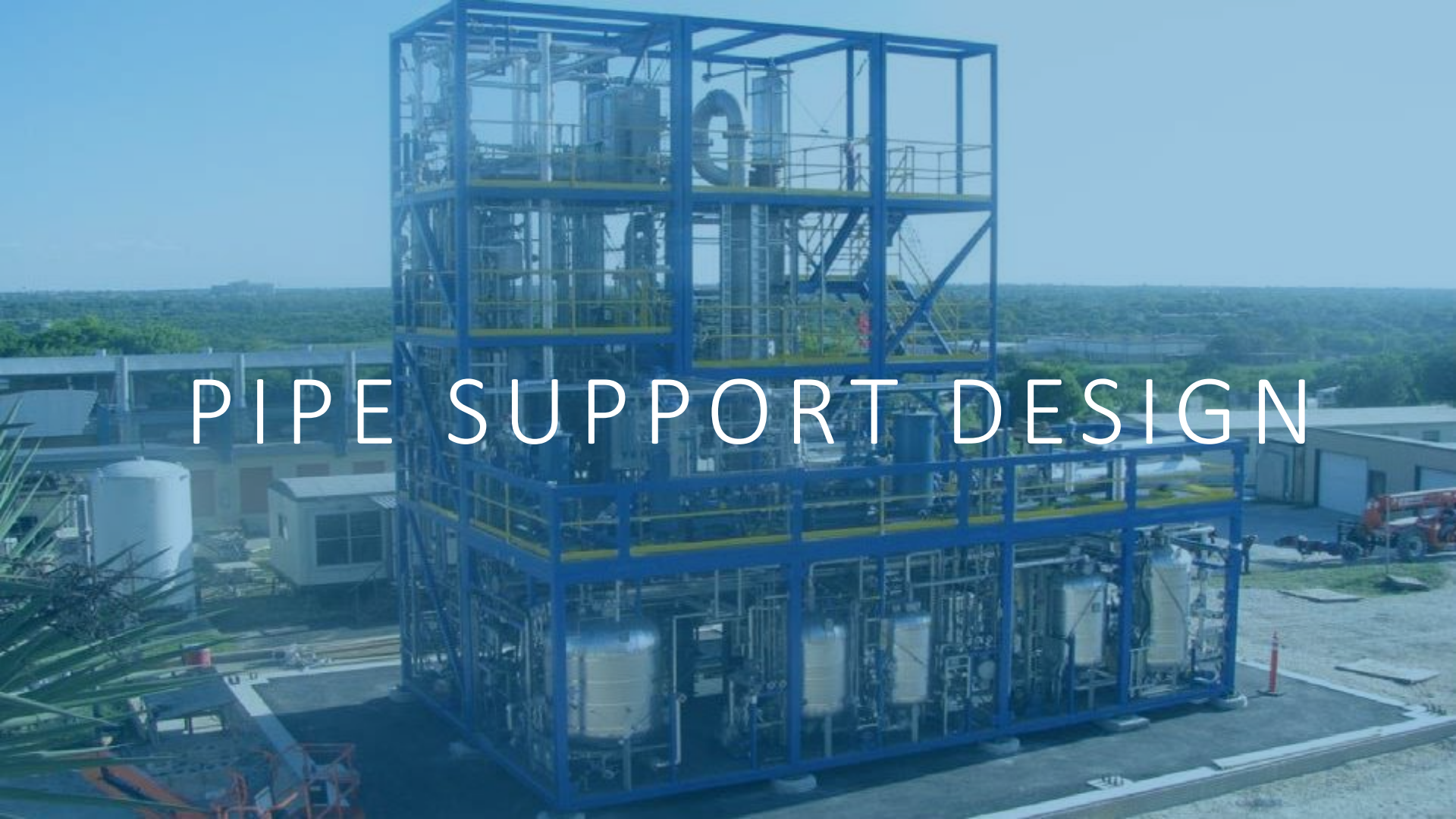
PUTTING APPROPRIATE DESIGN MARGIN, THIS CASE PRODUCES DESIGN CONDITIONS OF

260 BARG @ 425°C

Maximum Pipe Ratings



- SS 316/L Pipe
- Assumes no corrosion allowance
- Price difference between 6” SCHXXS and 7” Heavy Wall Tubing, same ID:
  3.6X Multiplier on Materials



PIPE SUPPORT DESIGN

HTL Challenges for Pipe Stress Analysis

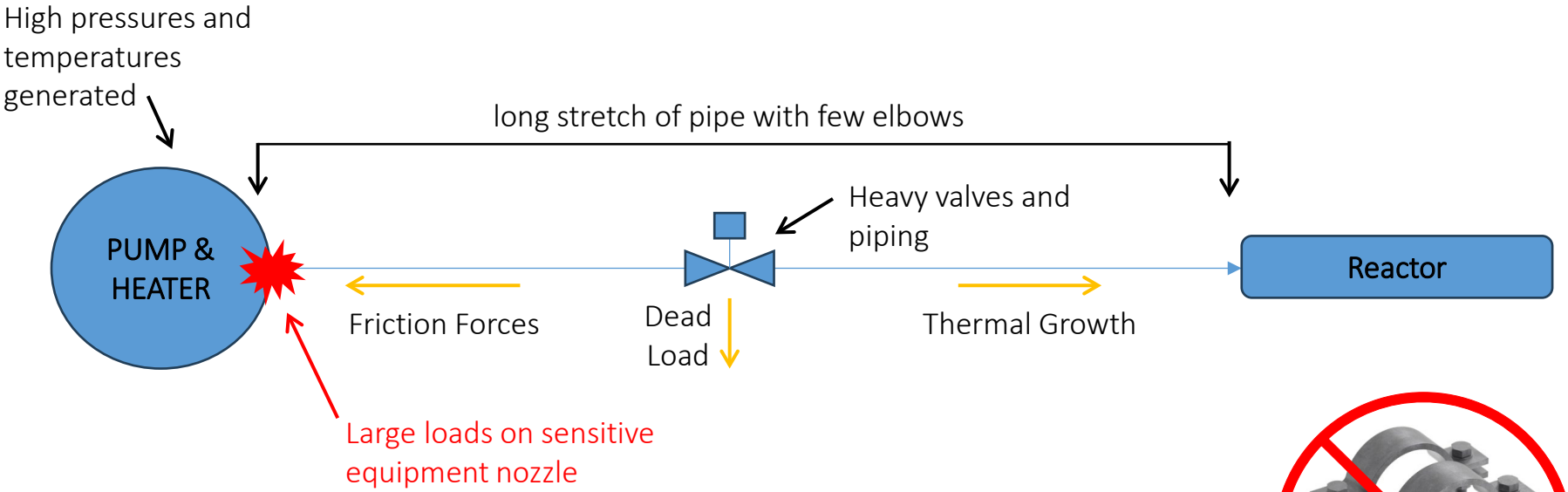
HTL Plants present a number of challenges when designing pipe and equipment supports

In general, we look to reduce stress and increase flexibility

High temperatures	→	Thermal expansion	→	Increases Stress
High pressures	→	Thick-walled pipe	→	Decreases Flexibility
Flowing solids	→	Avoid bends	→	Decreases Flexibility
Modular design	→	Tight spaces	→	Decreases Flexibility
Sensitive equipment	→	Low allowable loads	→	Increases Stress

None of these issues are unique on their own, but the combination of all these issues often make traditional pipe supports insufficient

Troublesome Loads in an HTL Layout



Typical shoes and sliders are not sufficient to support the valves and piping AND allow flexibility to reduce loads.

Custom Solutions Are Complex

Lateral guides

Low friction rollers

Beefy rigid structure

THANK YOU

Questions?