# A Conundrum – The Difficulties of Pipe Stress Analysis for Cold Pipes

Water NZ Conference 2017

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# Introduction

- Why carry out pipe stress analysis on a cold pipe?
  - Changes in temperature
  - Displacements
  - Limits on nozzle loads
  - To quantify forces and stresses for large diameter piping systems

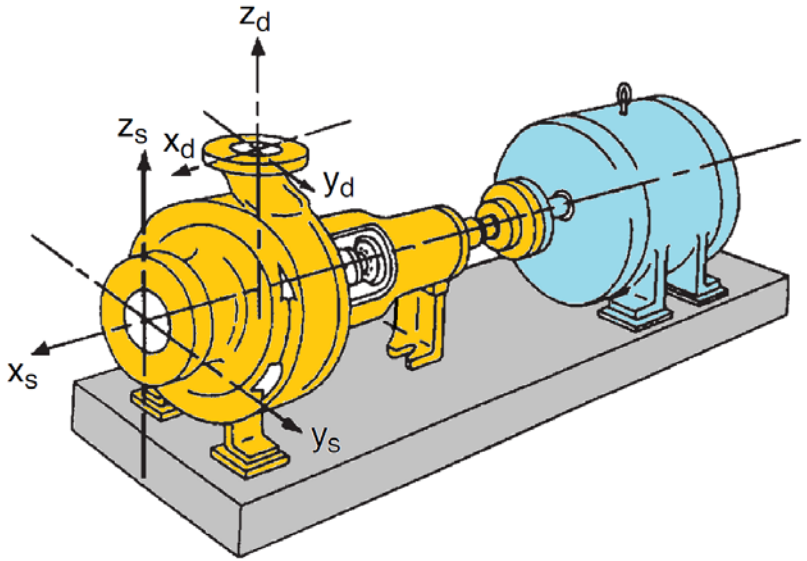
# Pump Nozzle Load Compliance

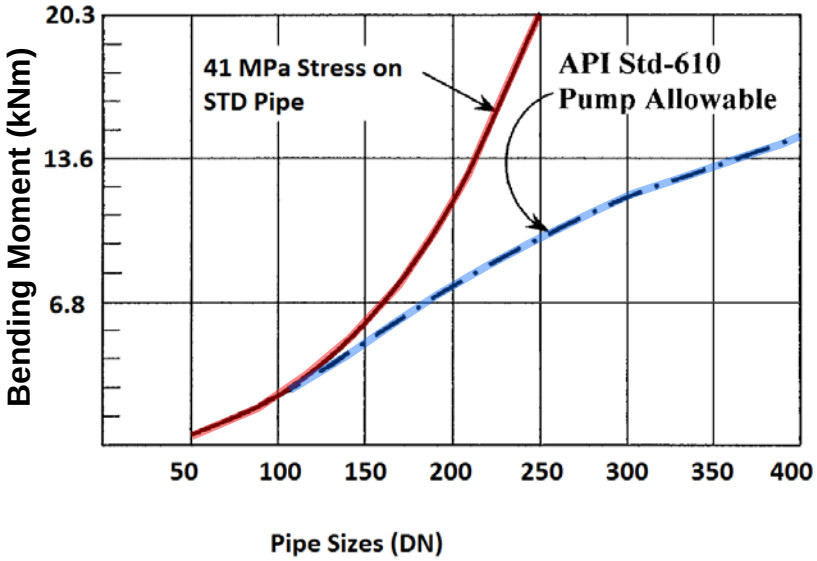
Client:

*“We are happy with the piping design…….*

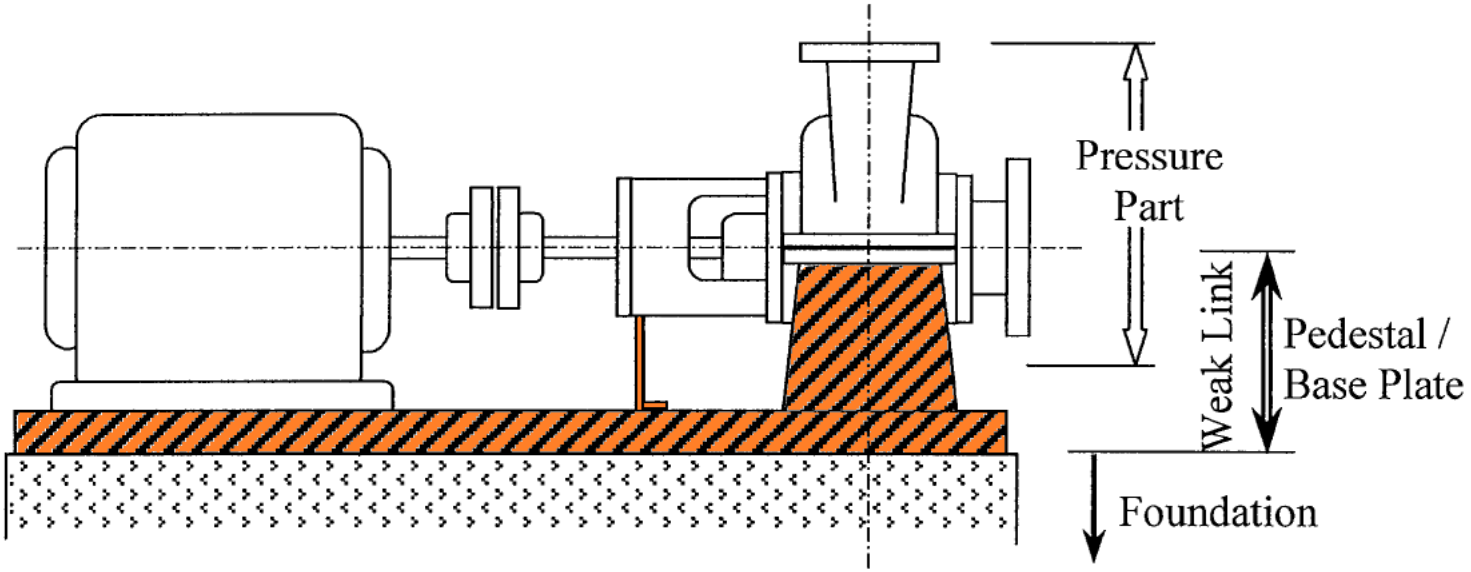
*provided the pump supplier accepts the nozzle loads.”*

# Nozzle Loads on Pumps



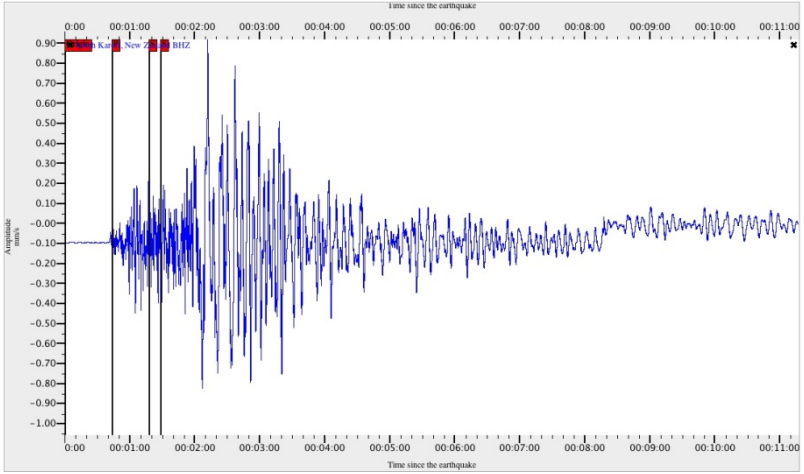



# Pump Structure



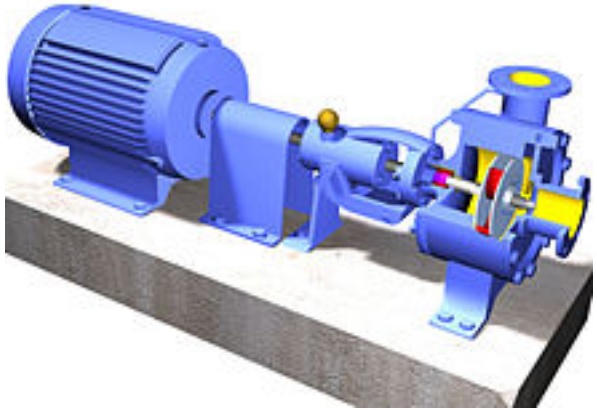
# Nozzle Loading Categories

- Allowable nozzle loadings are based on operating conditions
- What do we do for loads arising from seismic action?

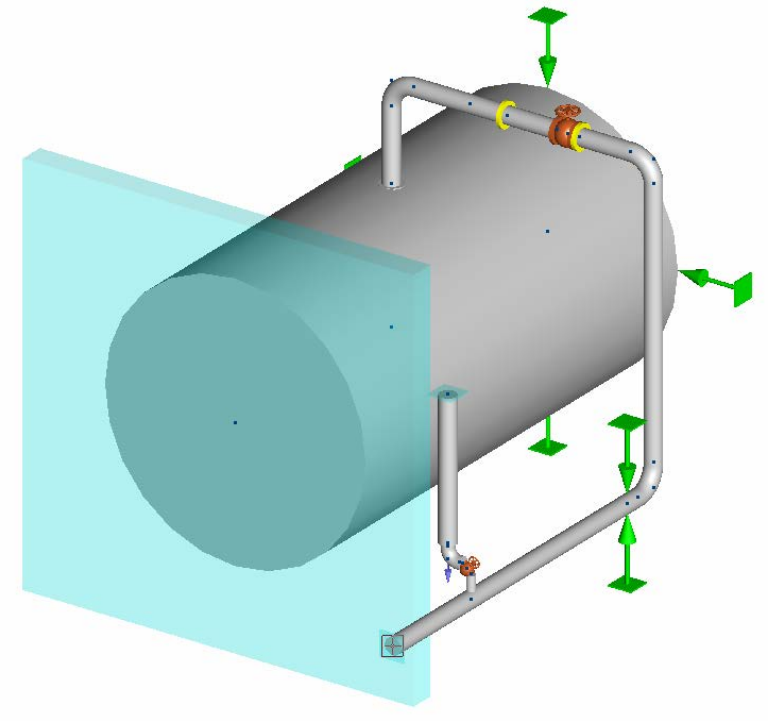


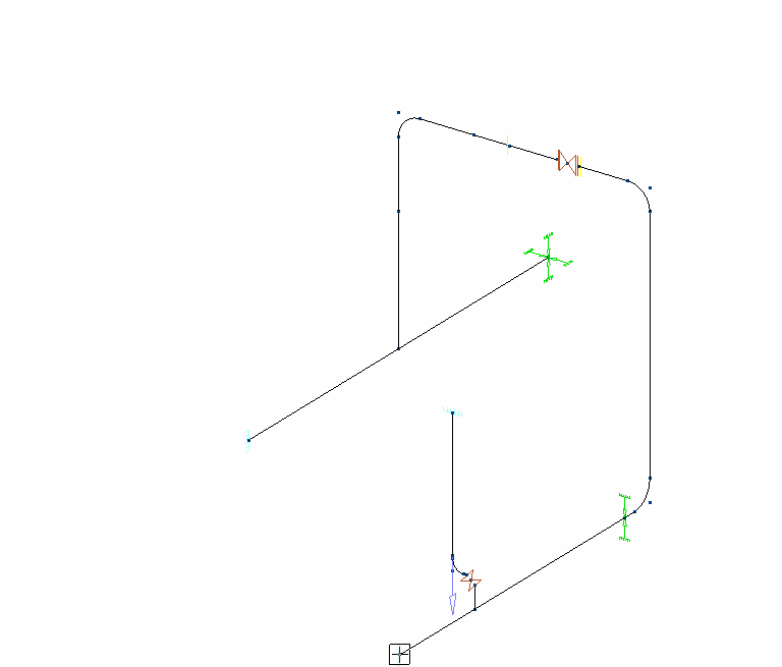
# Pump Procurement

- Agree nozzle loading values before purchasing pump
  - Operating loads
  - Higher loads for occasional actions (seismic/wind)
- Always beneficial to engage in a dialog with pump vendors on nozzle loadings



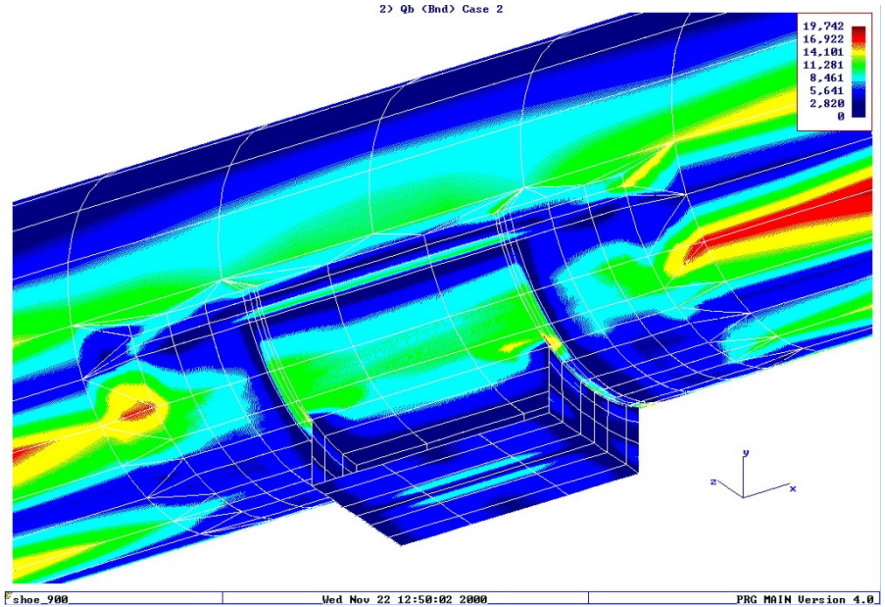
# Behind the scenes in pipe stress analysis



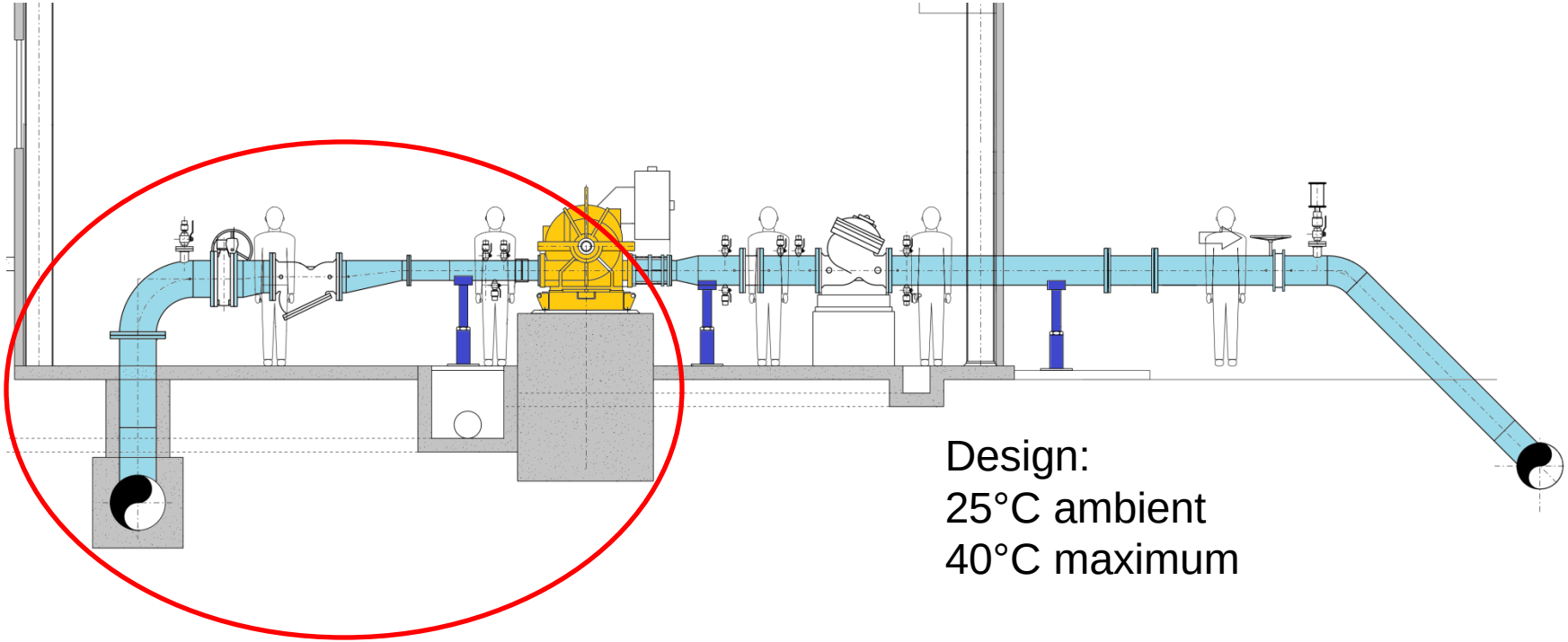


# Local stresses on pipe wall

- Finite element analysis
- High load supports
  - next to valves
  - bottom of risers
- Sensitive pipes
- Thin walled pipes

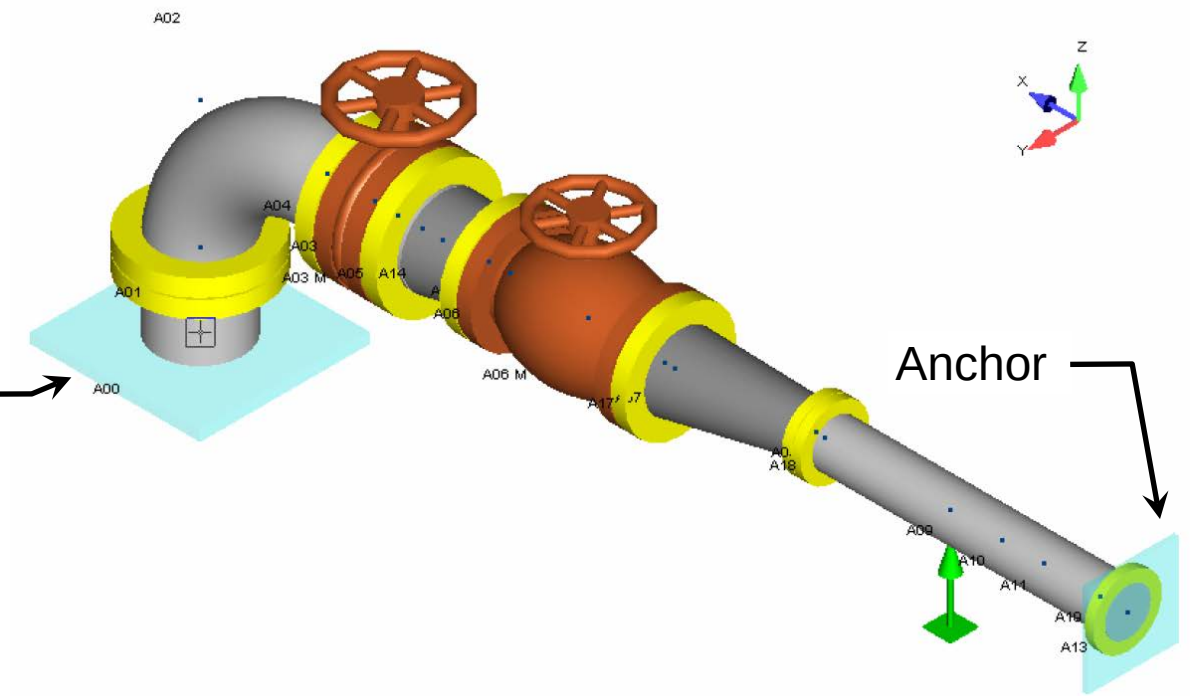


# Pump Station Example



Design:
25°C ambient
40°C maximum

# Pump Station - Suction piping

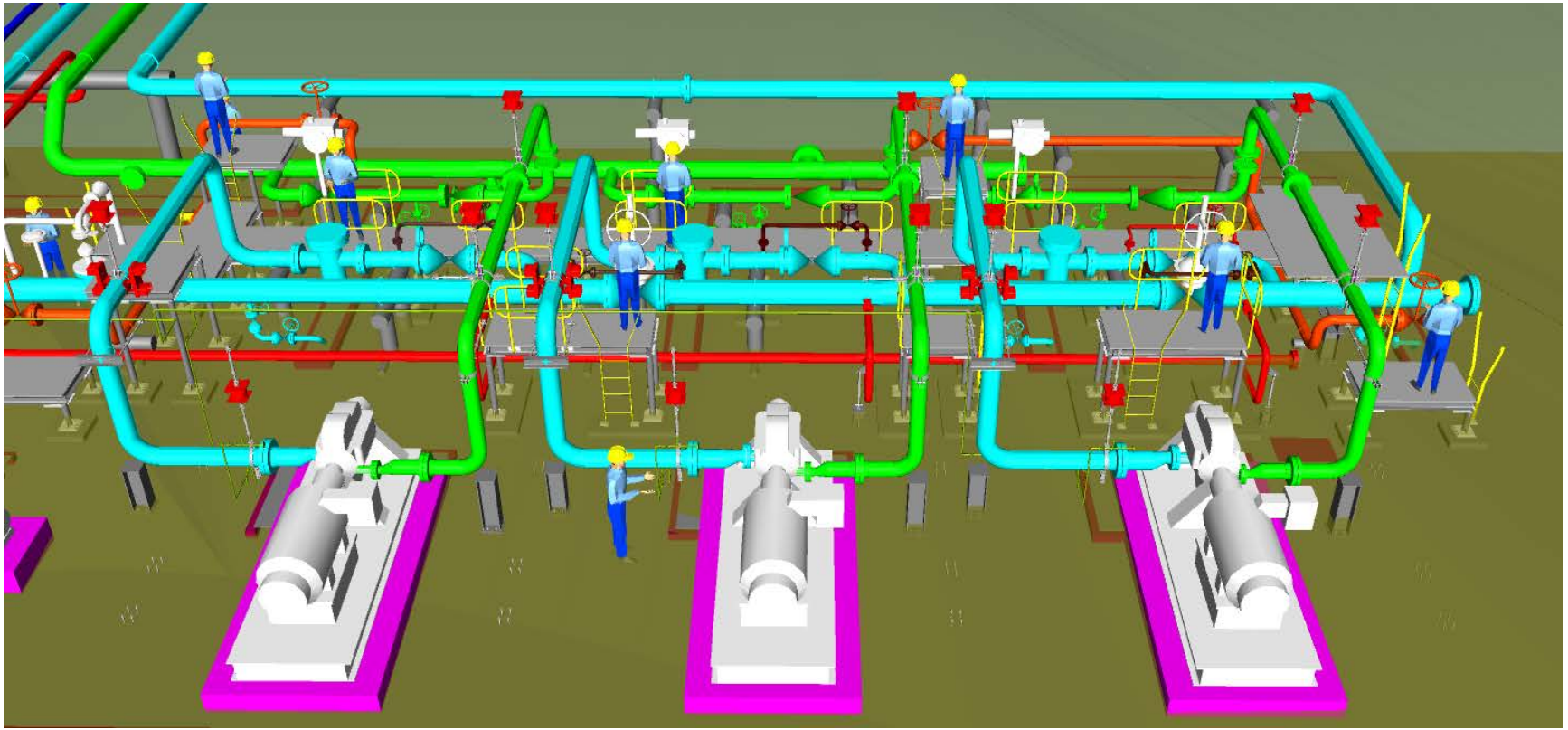



Anchor

Anchor

**54 kN load vs.**
**10 kN allowable**

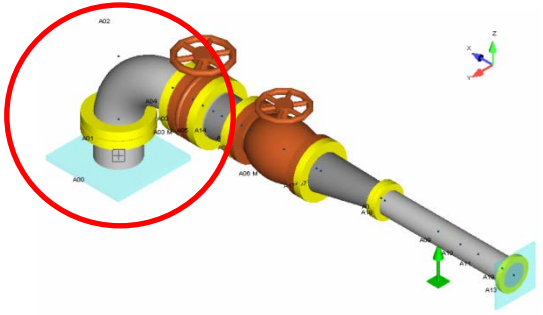
# Modelling – Hot vs. Cold Systems

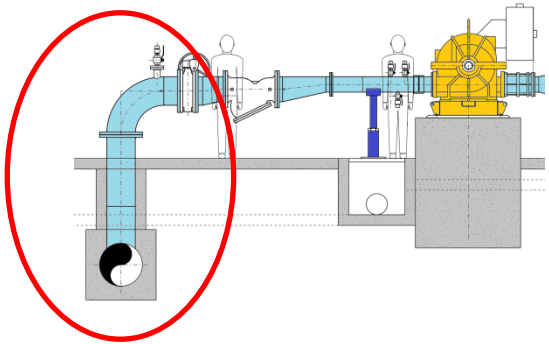


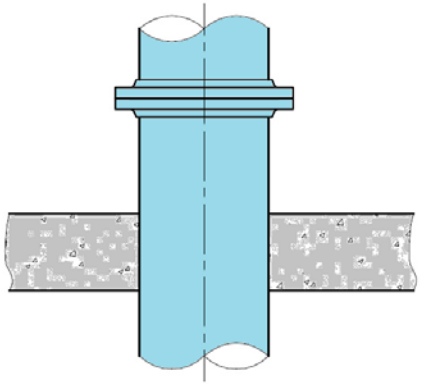
# “The world is a spring”

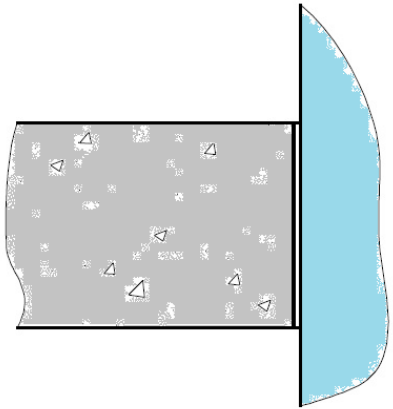
Edward Klein, Pipe Stressing Engineer, Houston

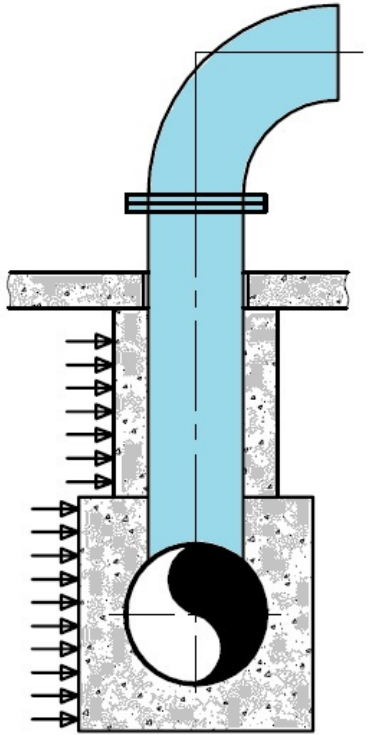
# Pump Station - Suction Piping











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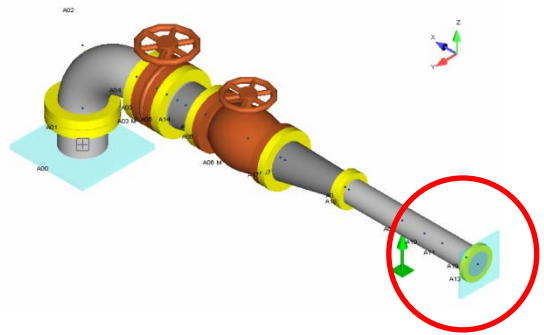
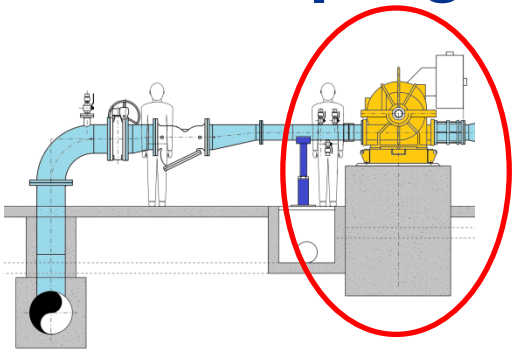
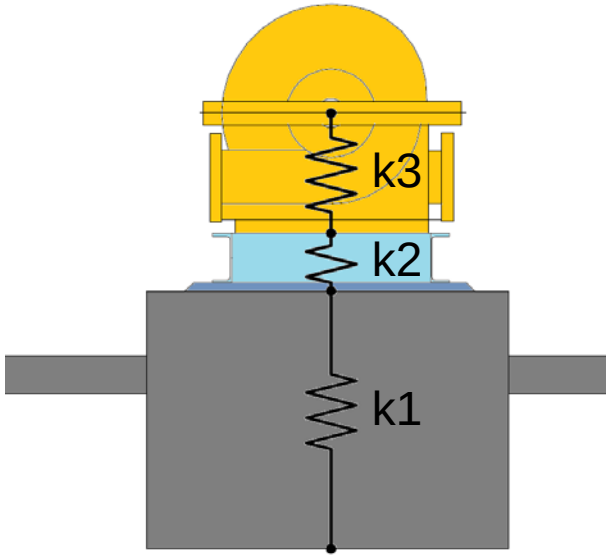
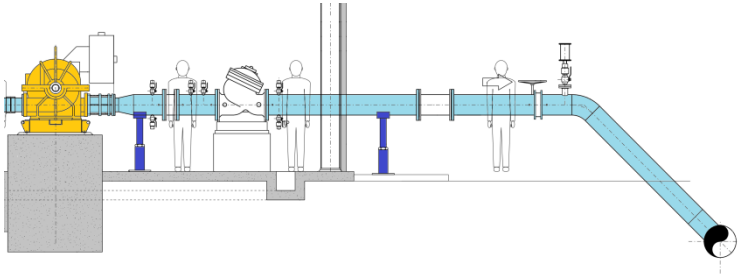
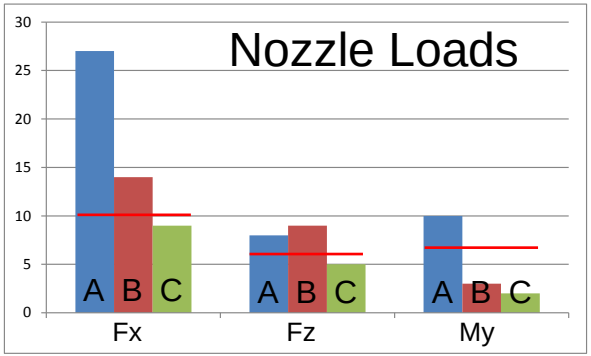




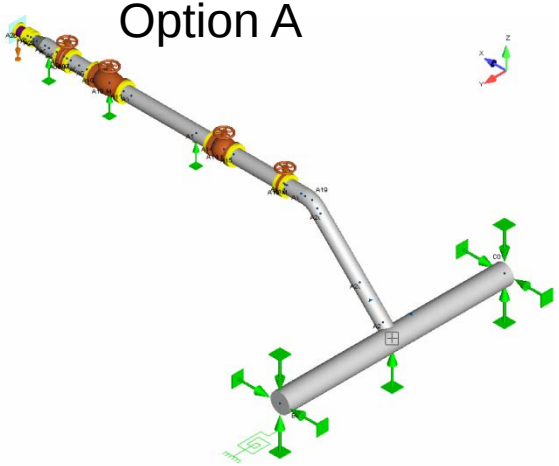


# Pump Station–Discharge Piping

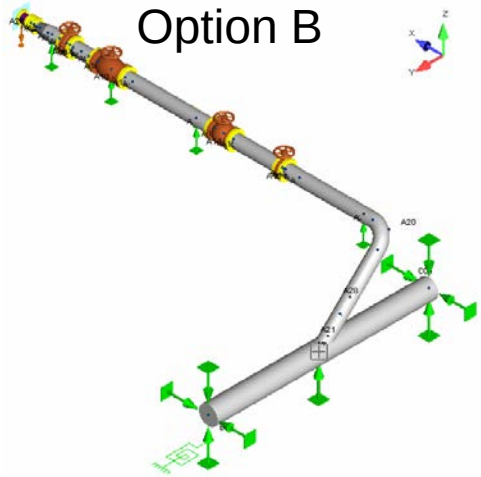




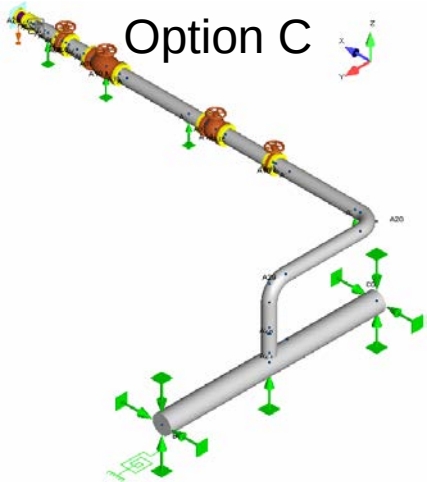

Option A



Option B

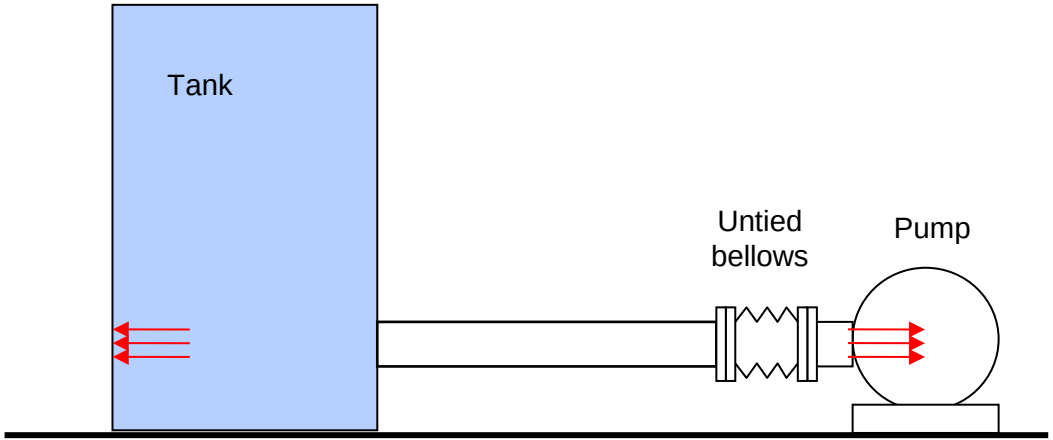


Option C

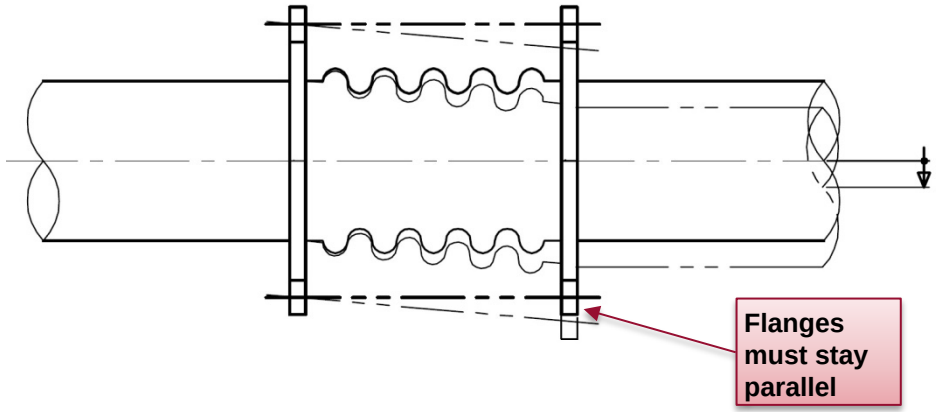


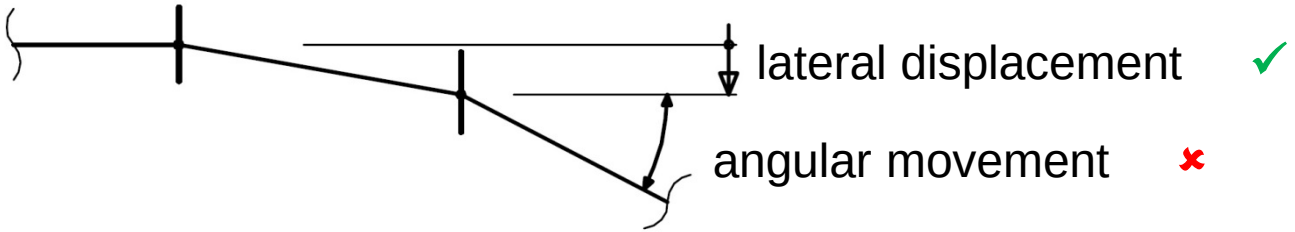
# Bellows or Expansion Joints

# Untied Bellows

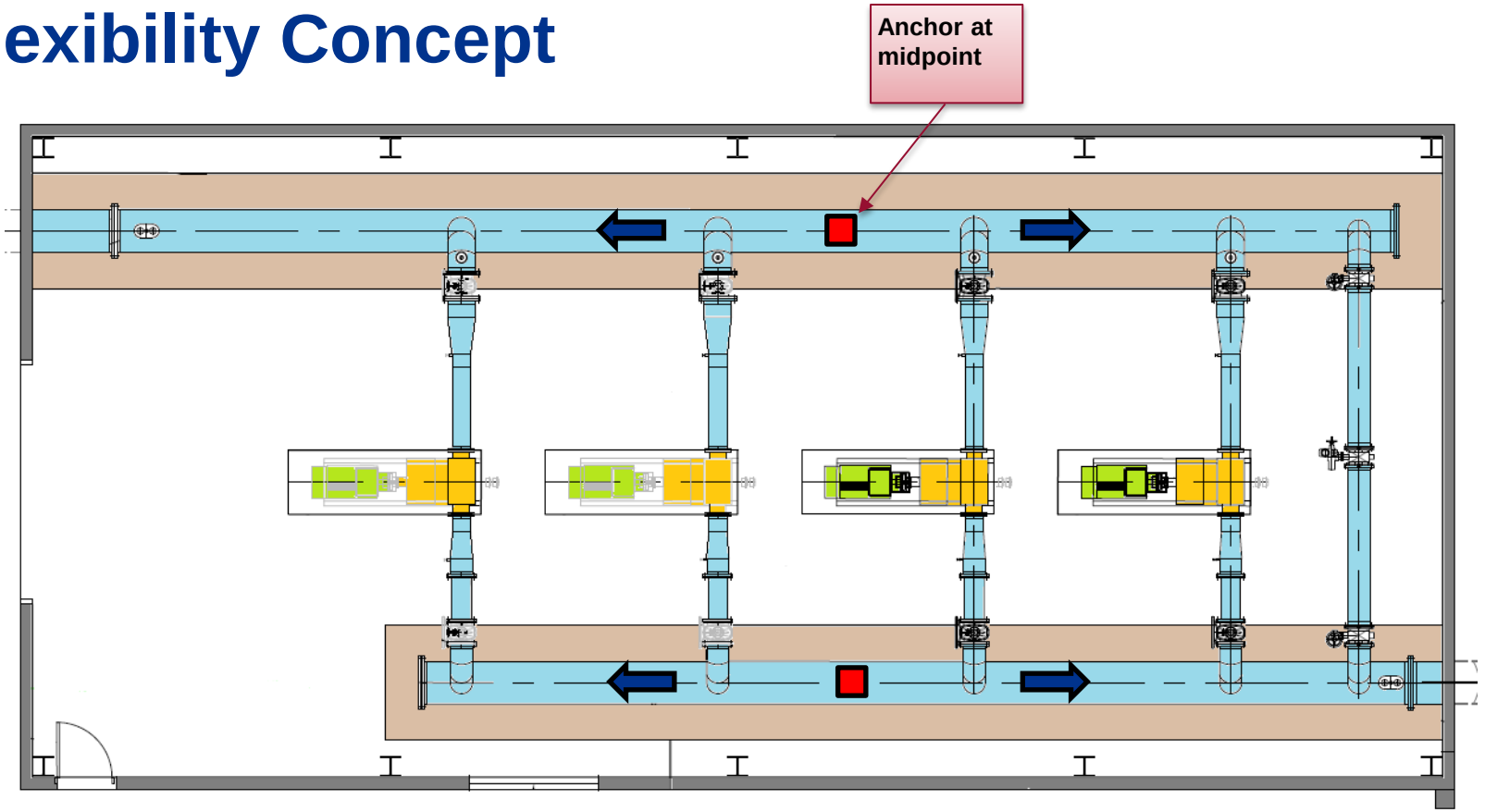


# Tied bellows movement



# Flexibility Concept



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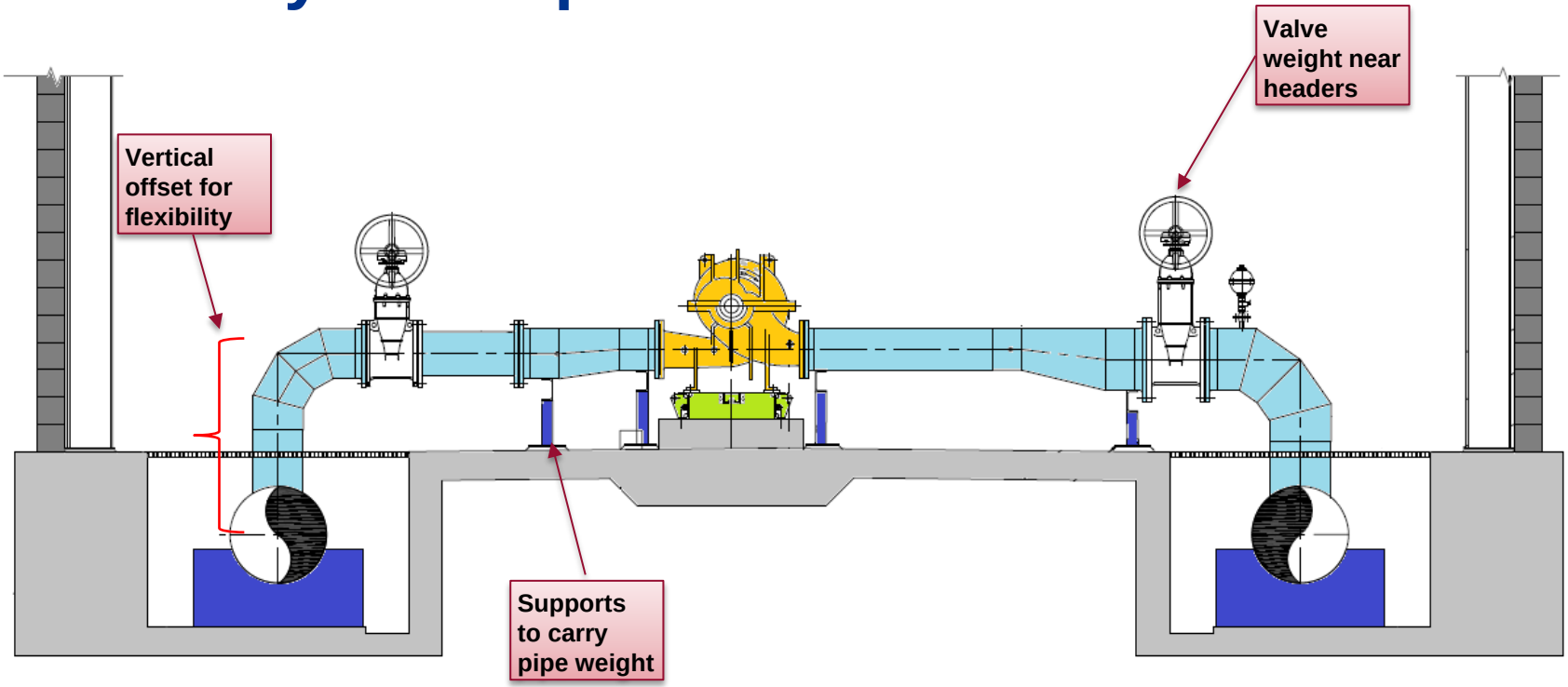

# Conclusions – Cold Water Piping Systems

- More effort required for analysis of system with limited flexibility
- Piping designs should start with a sound “flexibility concept”
- Pipe stress is desirable if compliance has to be demonstrated
- Pipe stress analysis can be beneficial for large systems
- Bellows should be used with care

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