– PUMP PIPING SYSTEM CASE STUDY –

INSUFFICIENT DAMPENERS

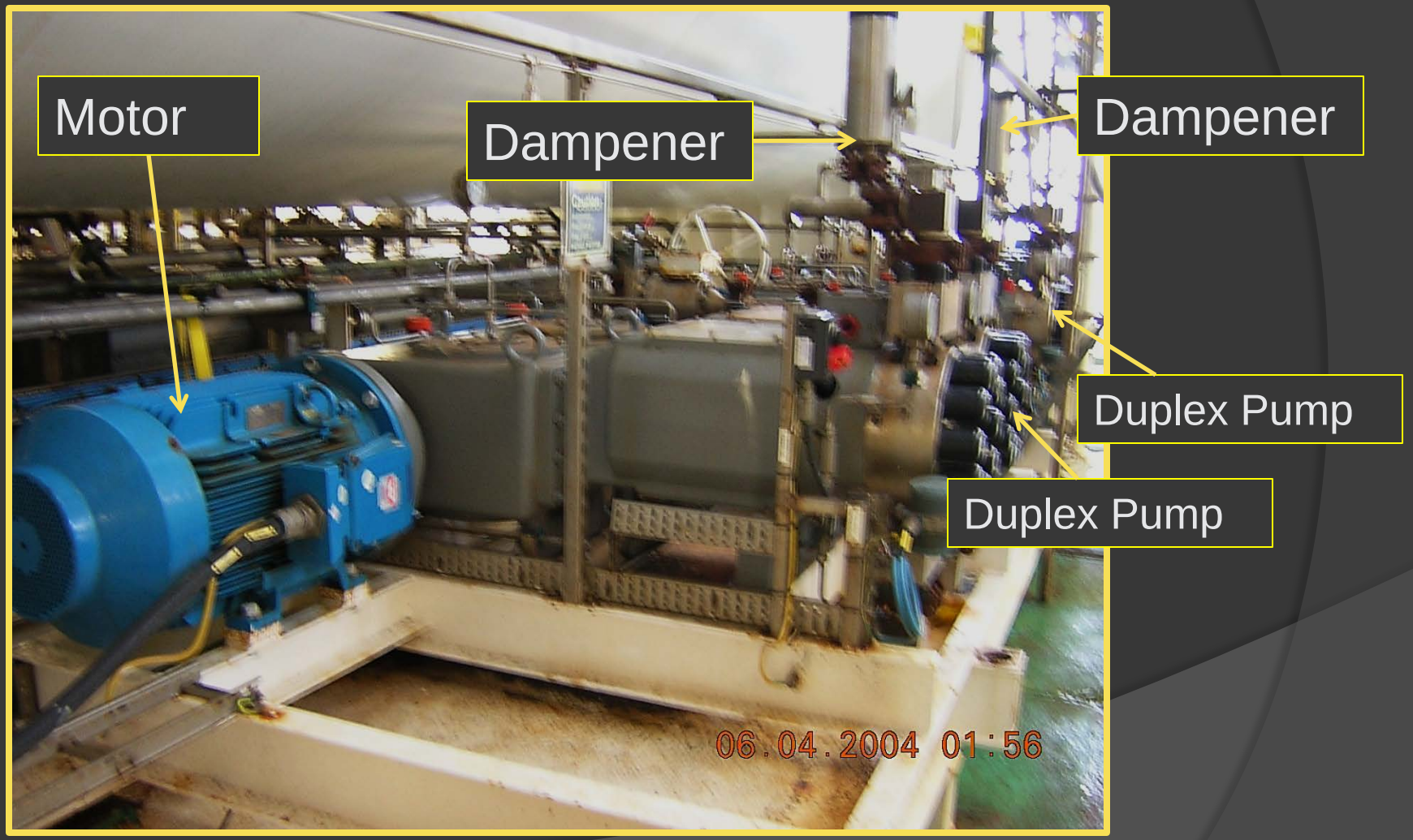
Eugene "Buddy" Broerman
Senior Research Engineer
Southwest Research Institute

Sarah Simons
Scientist
Southwest Research Institute

Agenda

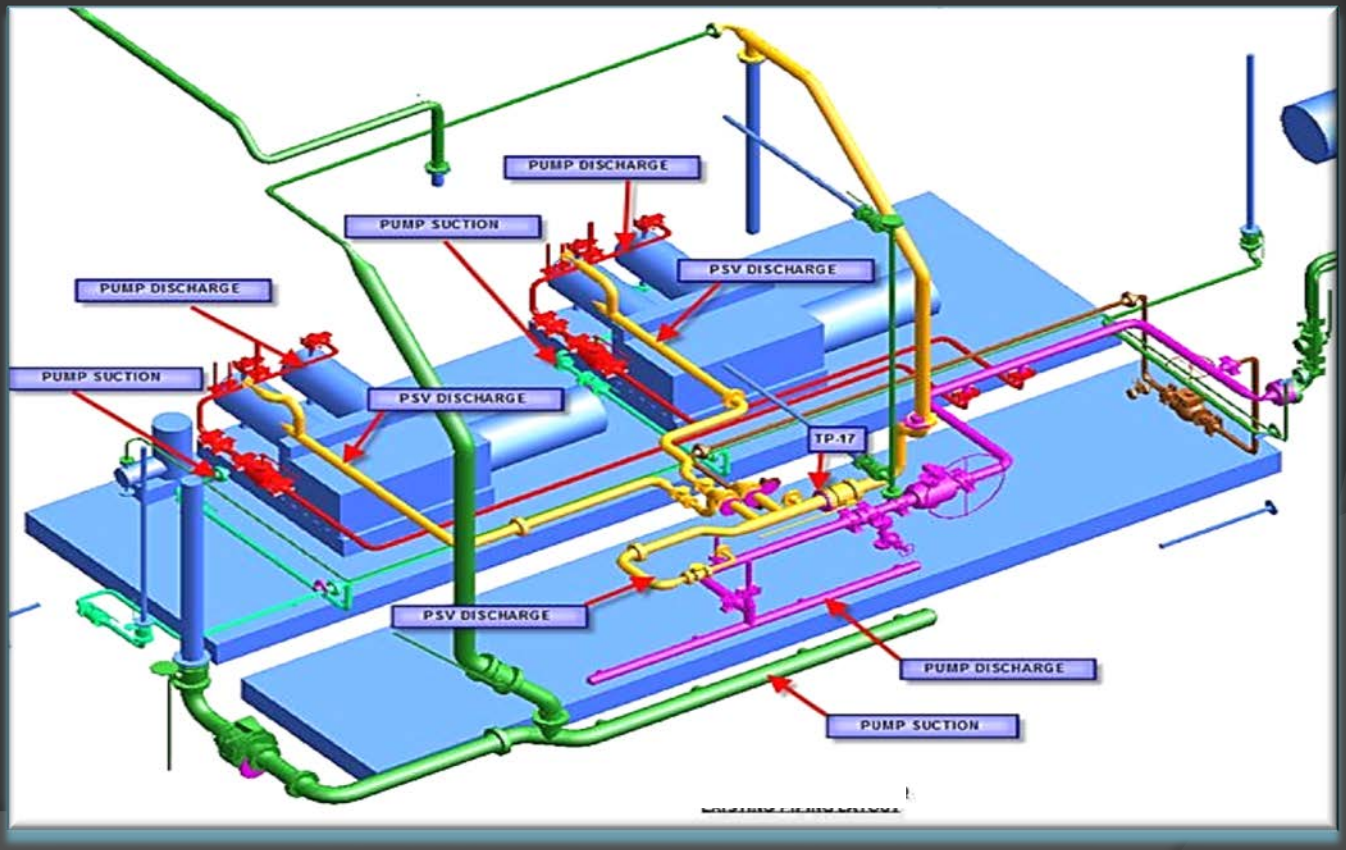
- Introduce System and Problem
- Steps Used to Solve Problem
- Summary and Lesson Learned

Two-Plunger Existing Methanol Units A & B

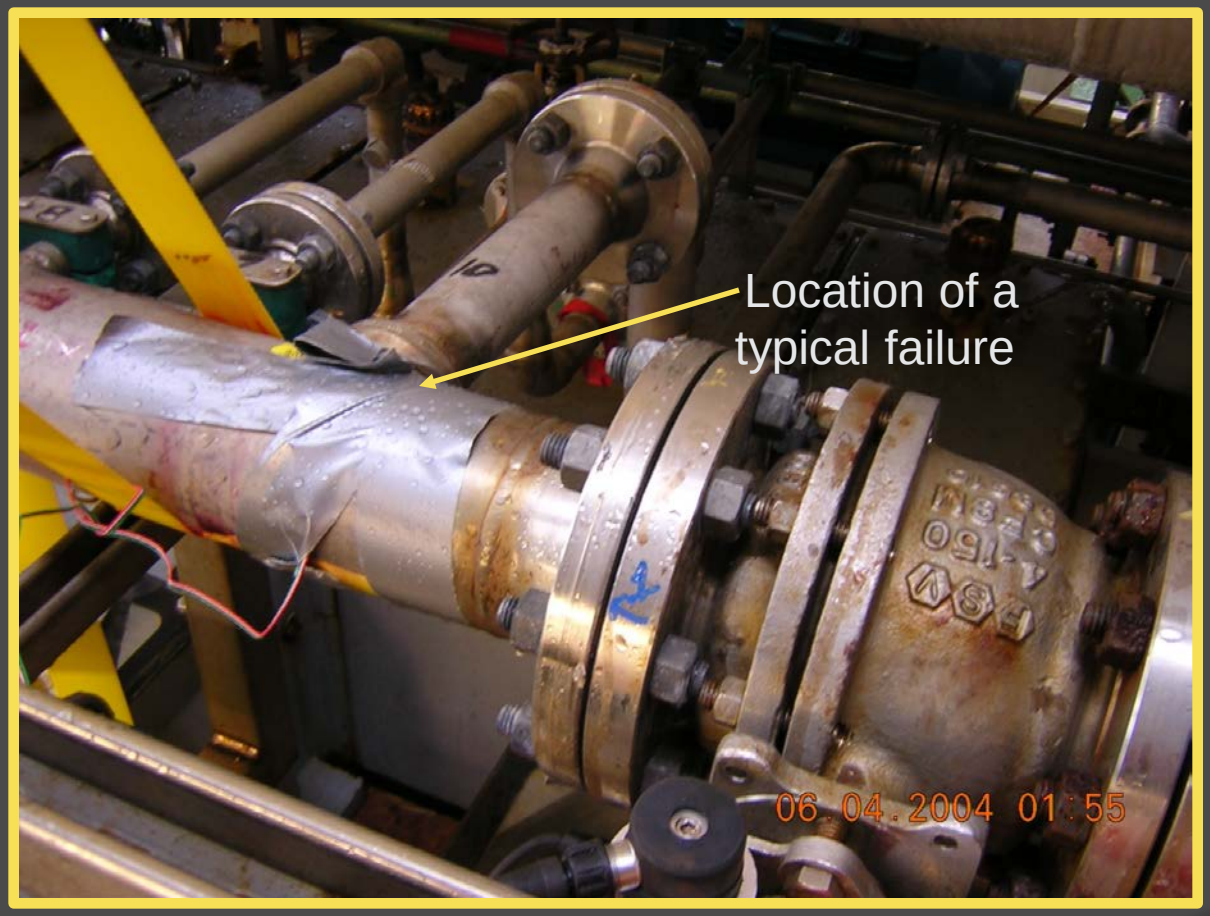


Problem: Piping Failures and High Vibrations

- Duplex methanol pump discharge piping system
- Small piping connections experiencing failures
- High vibrations even with dampeners installed

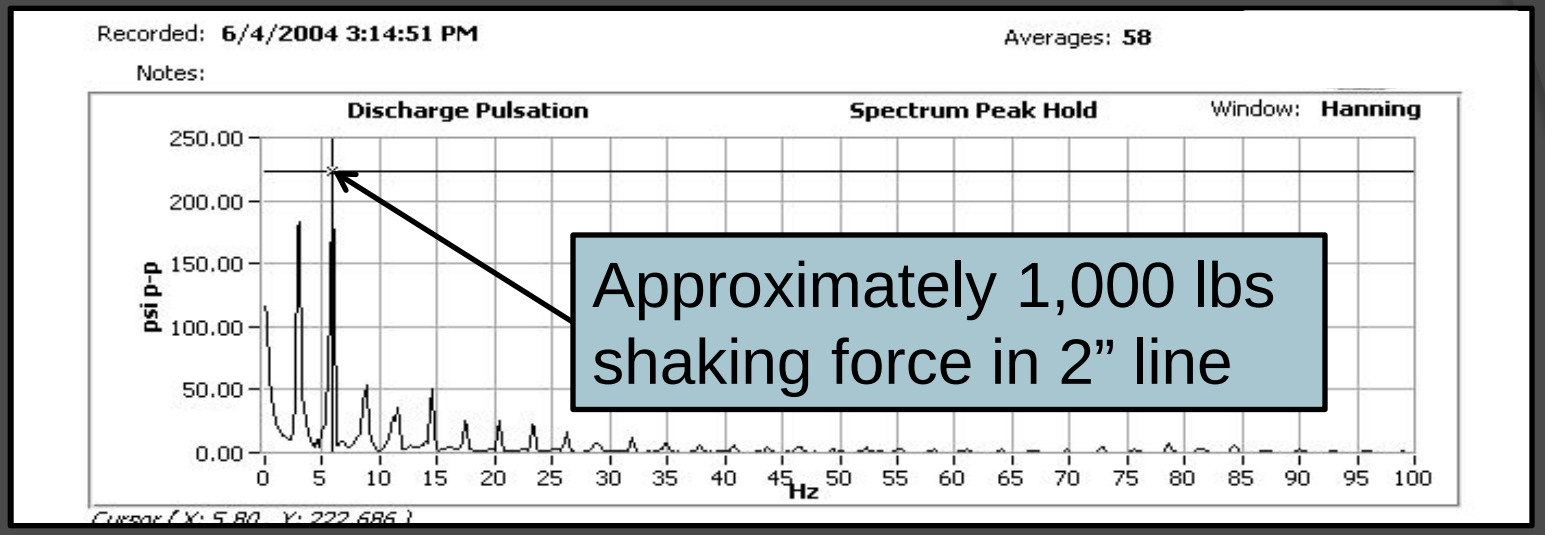


Methanol Piping Recycle Line Failures



- Failure on different methanol pump operating in parallel
- Location and type typical of failures of subject duplex pump

Field Data: Unit B Discharge Pulsation



- Unclear if dampener is correctly pre-charged
- High 1x = possible valve leakage
- Unclear operating conditions

Pump System Description

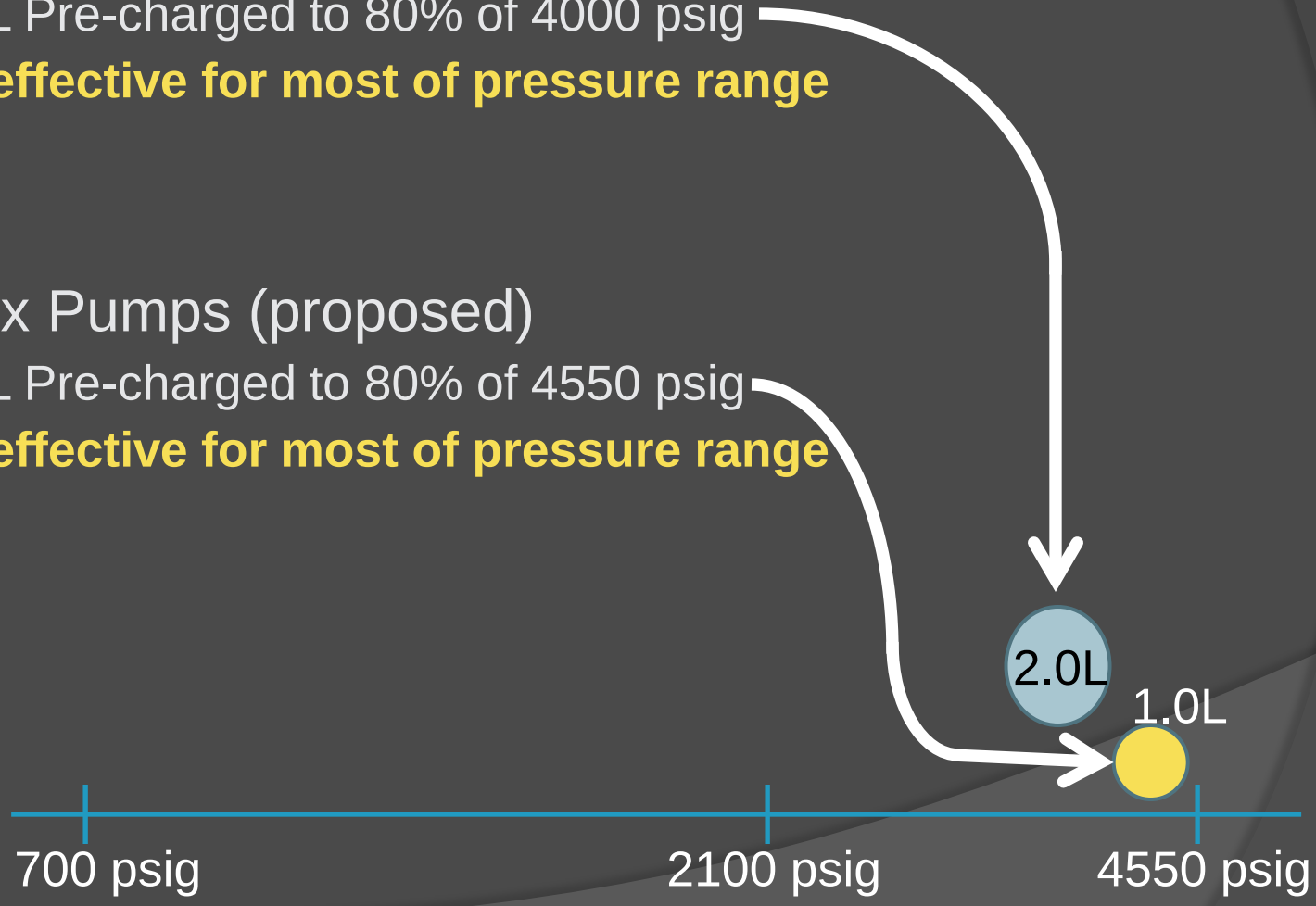
Existing Duplex Pumps	Future Triplex Pumps
1.65” bore (4.19 cm)	1.75” bore (4.45 cm)
4.72” stroke (12.0 cm)	2.95” stroke (7.50 cm)
170 rpm	140 rpm
10.27 gpm (2.33 m^3/hr)	11 gpm (3.0 m^3/hr)

36 psia (2.48 bara) suction pressure

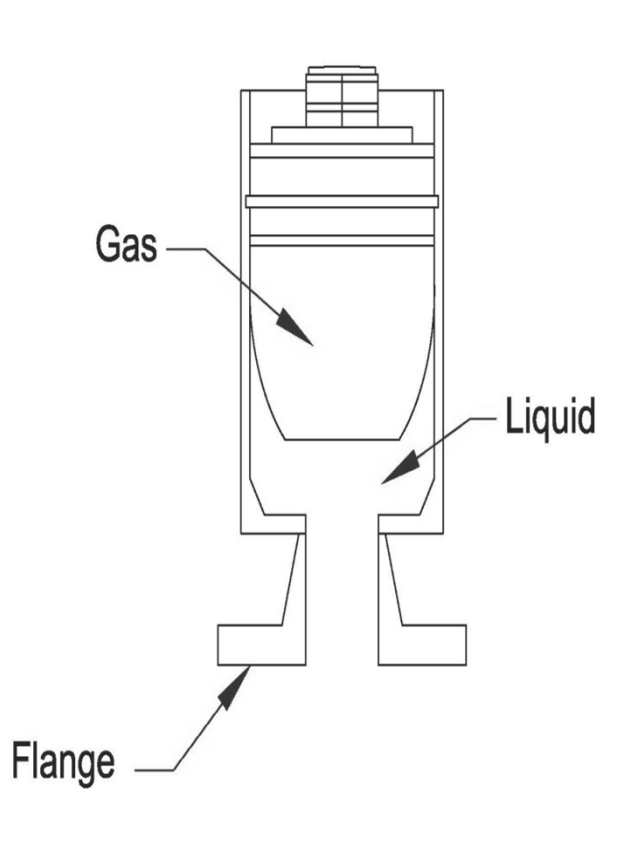
700-4550 psig (48-314 barg) discharge pressure

Existing & Proposed Dampeners

- Duplex Pumps (existing)
  - 2 L Pre-charged to 80% of 4000 psig
  - **Ineffective for most of pressure range**
- Triplex Pumps (proposed)
  - 1 L Pre-charged to 80% of 4550 psig
  - **Ineffective for most of pressure range**



General Comments: Gas-Liquid Dampeners



- Pre charge gas filled bladder to fixed percentage of line pressure
- Pre-charged gas creates relatively large effective liquid volume to absorb pulsations
- Gas volume acts as spring compressing and expanding with line pressure changes

Dampener Pre-Charge vs. Line Pressure

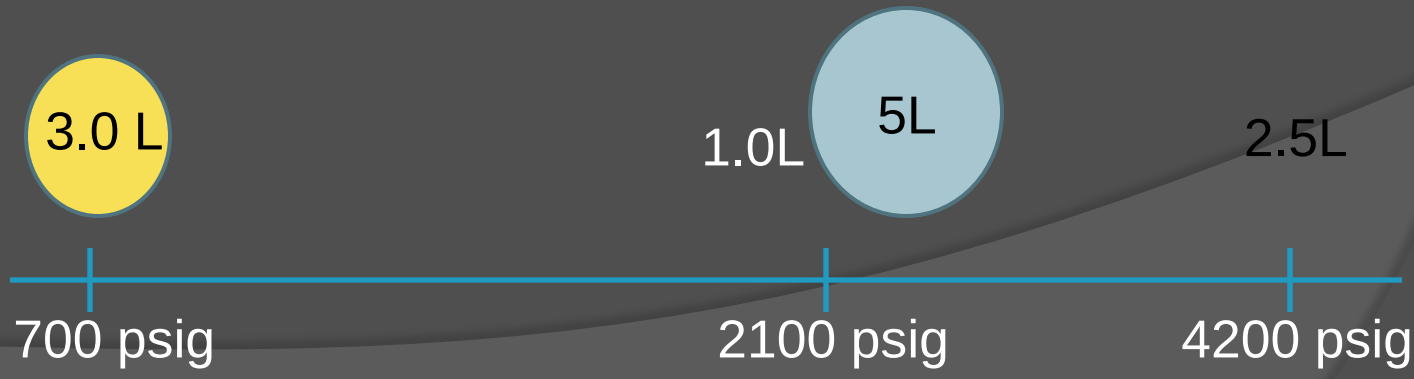
- If pre-charge pressure ≥ line pressure
  - Gas volume of a dampener is largest
  - However, not effective because not opened/active

- When pre-charge pressure < line pressure
  - Pressure compresses bladder in dampener
  - Gas volume, and therefore effective volume, is decreased
  - Decrease of volume is directly proportion to increase in line pressure --- per ideal gas law

Dampener Size as Line Pressure Increases

- Operating dampener over large pressure range
  - Larger volume needed for low pressure because
  - Decreased gas volume at high pressure

- Examples:
  - 3.0 L gas volume at 700 psig becomes 1.0 L gas when line pressure reaches 2100 psig
  - 5.0 L gas volume at 2100 psig becomes 2.5 L gas when line doubles (4200 psig)



Reasoning Leading to Solution

Space not available for all liquid filter

↓

Orifices alone not effective enough

↓

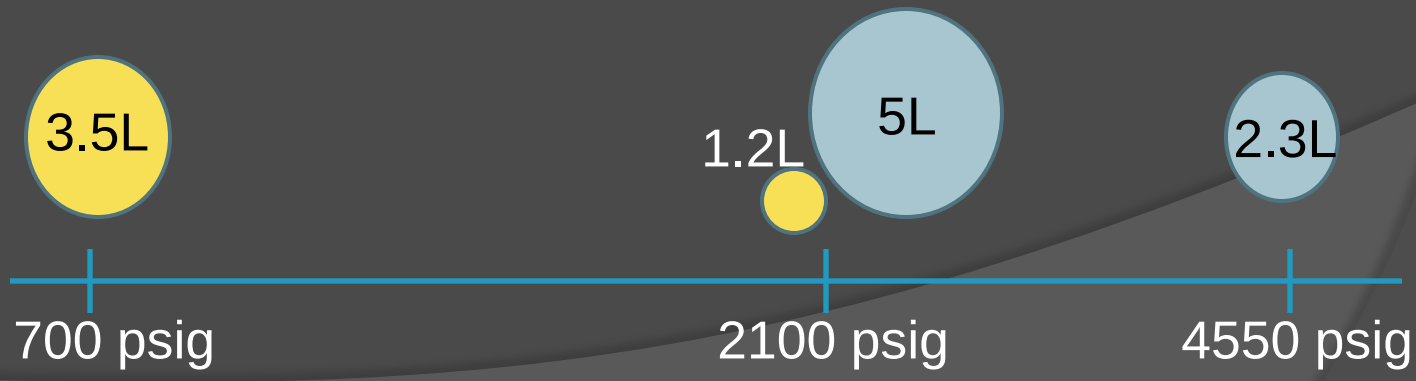
If ratio of pre-charge pressure to line pressure to high, bladder may fail

↓

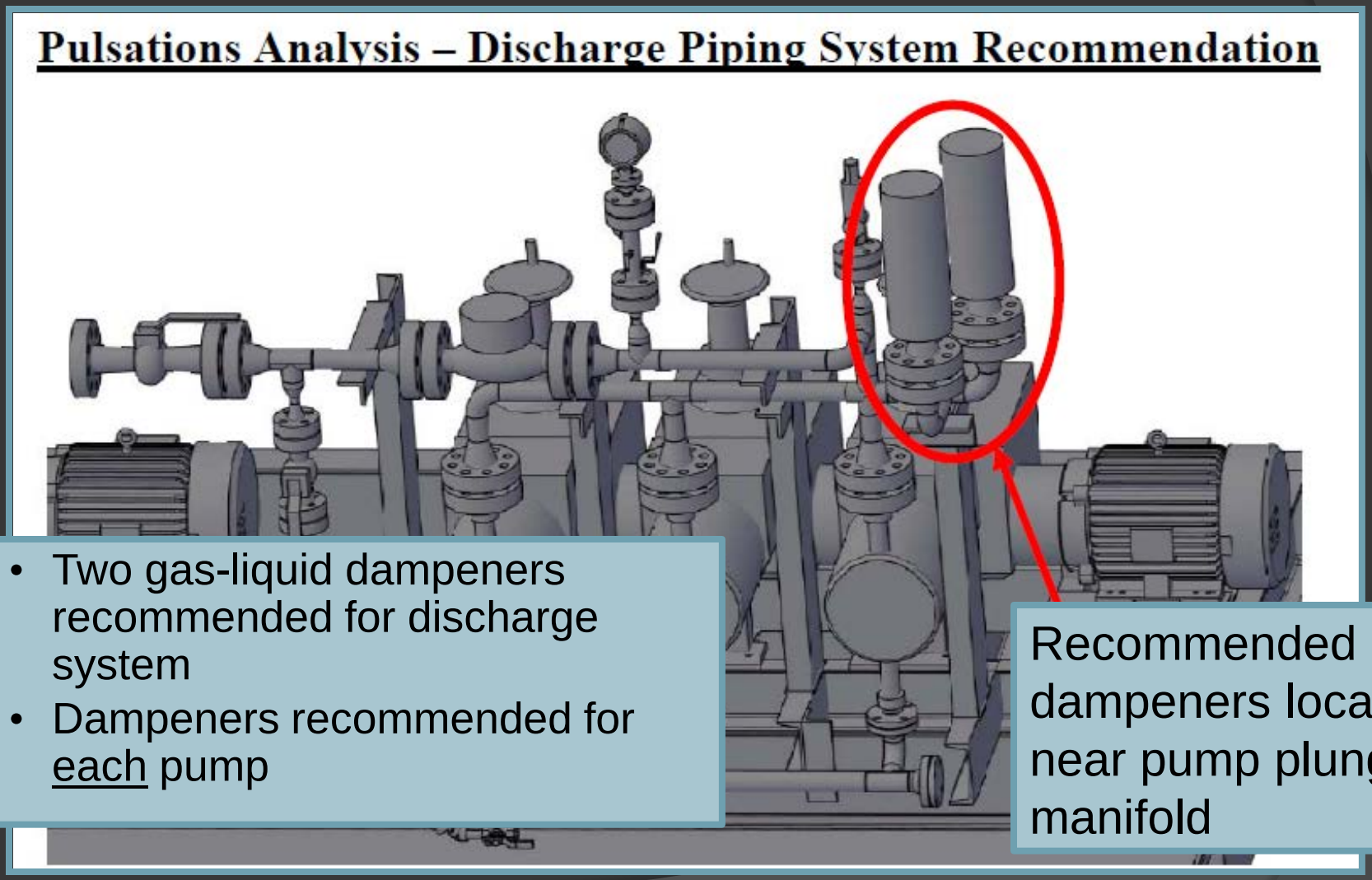
Large discharge pressure operating range requires multiple dampeners

Solution

- Due to wide pressure range for this application, **two** dampeners recommended
  - One pre-charged to 80% of low operating pressure (then it closes off, or is protected to prevent bladder failure)
  - Other pre-charged to 80% of medium line pressure so it operates over higher pressure range



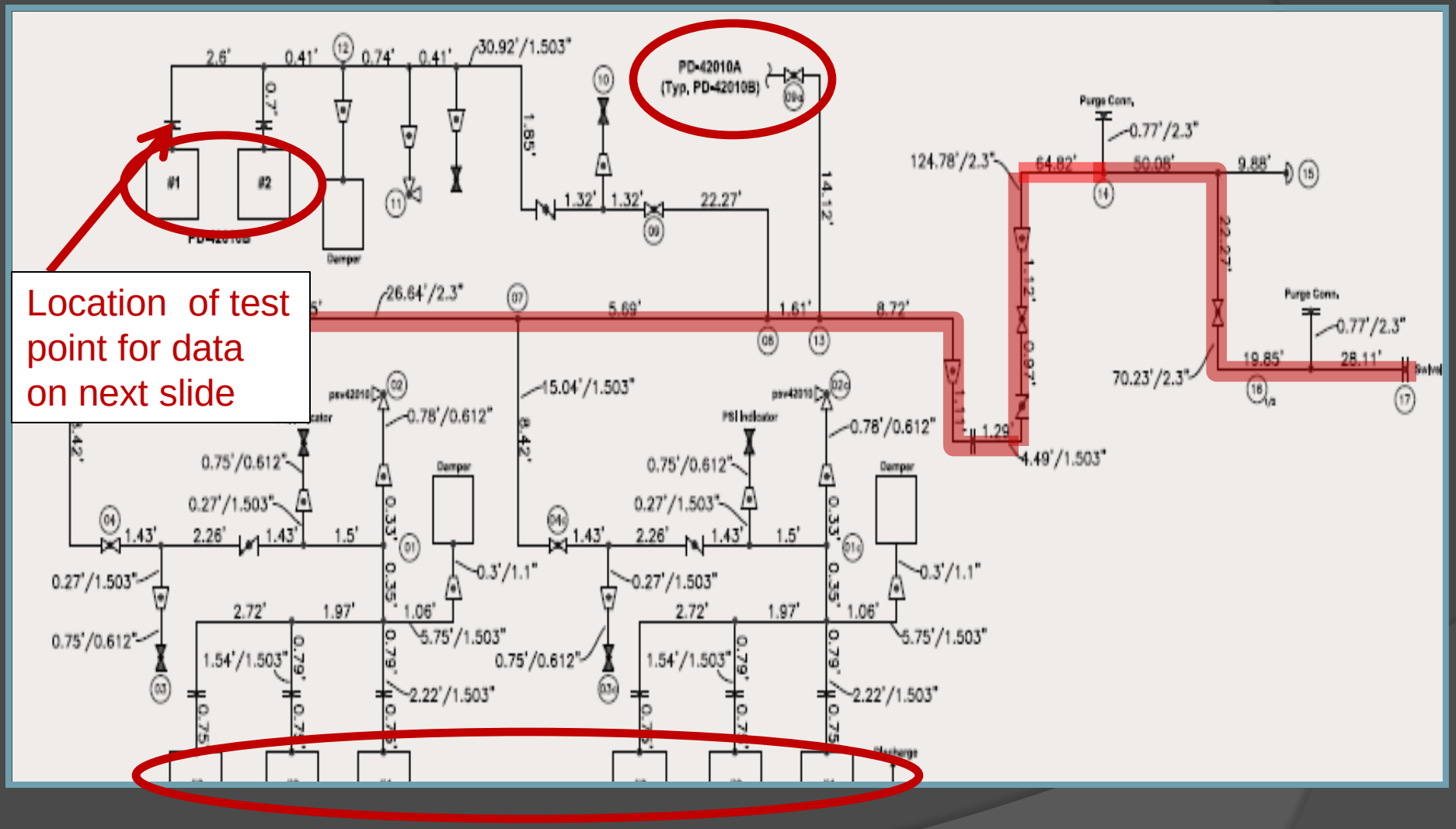
Two Dampener Installation



- Two gas-liquid dampeners recommended for discharge system
- Dampeners recommended for <u>each</u> pump

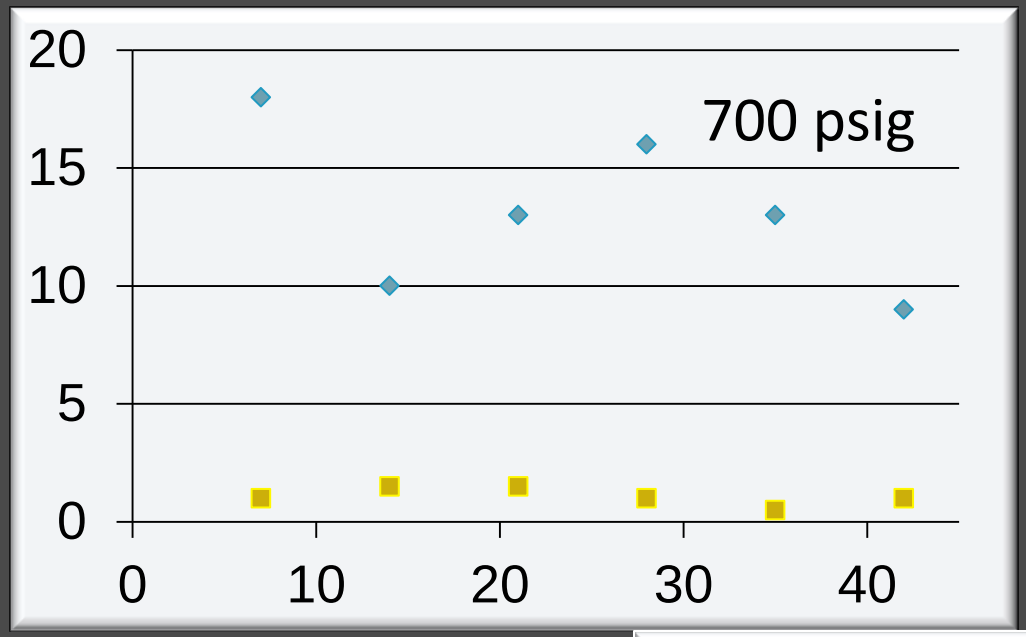
Recommended dampeners located near pump plunger manifold

Pump Discharge Piping System



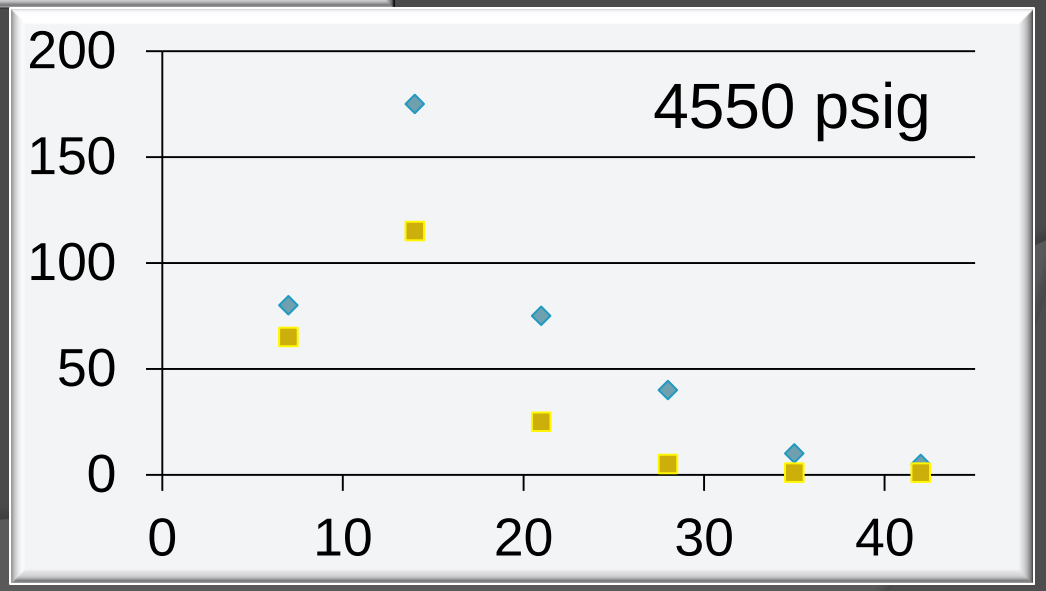
1-D Pulsation Model Schematic Developed

Pulsation Reduction Data: New Triplex



Single Dampener
Two Dampeners

- X-axis – Hz
- Y-axis – psi pk-pk



Summary

- Only 1 dampener not sufficient for existing or new pumps
- Install 2 or more dampeners for system with large pressure range
  - 1 for lower end of pressure range
  - 1 for upper end of pressure range

QUESTIONS OR COMMENTS?