Piping Development Process

1. Establish applicable system standard(s)
2. Establish design conditions
3. Make overall piping material decisions
   - Pressure Class
   - Reliability
   - Materials of construction
4. Fine tune piping material decisions
   - Materials
   - Determine wall thicknesses
   - Valves
5. Establish preliminary piping system layout & support configuration
6. Perform flexibility analysis
7. Finalize layout and bill of materials
8. Fabricate and install
9. Examine and test
6. Flexibility Analysis

- What are we trying to achieve?
- Flexibility Analysis Example

The Material in This Section is Addressed by B31.3 in:

Chapter II  - Design
What are we trying to achieve?

1. Provide adequate support;

2. Provide sufficient flexibility; and

3. Prevent the piping from exerting excessive reactions

What are we trying to achieve?

1. Provide adequate support to resist loads such as pressure, weight, earthquake and wind

January 17 1994 Northridge Earthquake
What are we trying to achieve?

2. Provide sufficient **flexibility** to safely accommodate changes in length resulting from temperature variations

What are we trying to achieve?

3. Provide sufficient support and flexibility to prevent the piping from exerting excessive reactions on equipment and restraints
What are we trying to achieve?

And we do that in order to:

- make the piping look well supported to the facility engineers and operators
- prevent collapse of the piping
- prevent leaks due to fatigue cracks
- prevent joint leakage caused by excessive forces, and
- prevent failure or malfunction of attached equipment caused by excessive reactions

Flexibility Analysis Example

A two step analysis is shown.

1. Weight and Pressure Loads – verify proper support and check reactions

2. Thermal Expansion Load – verify adequate flexibility and check reactions
Proposed System

NPS 4
Carbon Steel
Ambient to 600°F (315°C)
SG contents = 1.0

Sustained Load Analysis

Check Deflections

Deflected 0.4” (10 mm)

Marginal:
> 0.3” (8 mm)
Normal
Maximum
Sustained Load Analysis

Check Reactions

60% = 5%
1020# (4500 N)

5% 30%

Reactions Poorly Distributed

Sustained Load Analysis

Check Stresses

Max. is 66% of allowable

Stresses OK
Displacement Load Analysis

Revised System (Added Support)

Max. Displacement –
0.4 to 0.1” (10 to 2 mm)

Max. Stress –
66% to 34% of allowable

60 to 35%  5 to 5%

5 to 10%  30 to 20%  0 to 30%

Displacements Stresses & Reactions All OK

Check Deflections

0.4” (10 mm)

Deflections OK

0.9” (23 mm)
Check Reactions

40% 5% = 1240# (5520 N)

Reactions High, Poorly Distributed

Check Stresses

Max. is 79% of allowable

Stresses OK
Displacement Load Analysis

Revised System (Added Spring Support)

Max. Displacement – 0.9 to 1.5” (23 to 38 mm)

Max. Stress – 79% to 48% of allowable

Displacements Stresses & Reactions
All OK

Flexibility Analysis

Is the process of calculating the strains, and resultant stresses and forces in a piping system to determine if the system

- has adequate support
- has sufficient flexibility to safely accommodate changes in length resulting from temperature variations
- exerts sufficiently low reaction forces at restraints and equipment