ASME B31.3 Process Piping

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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

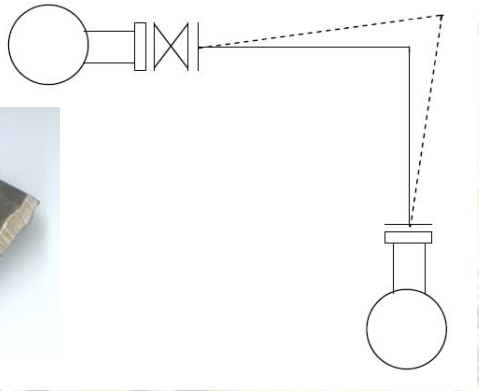
What are we trying to achieve?

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

January 17 1994 Northridge Earthquake

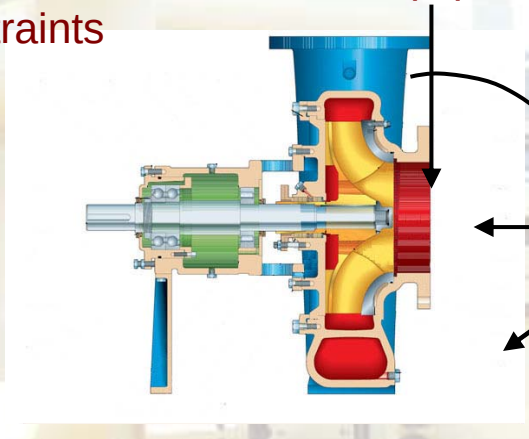
What are we trying to achieve?

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

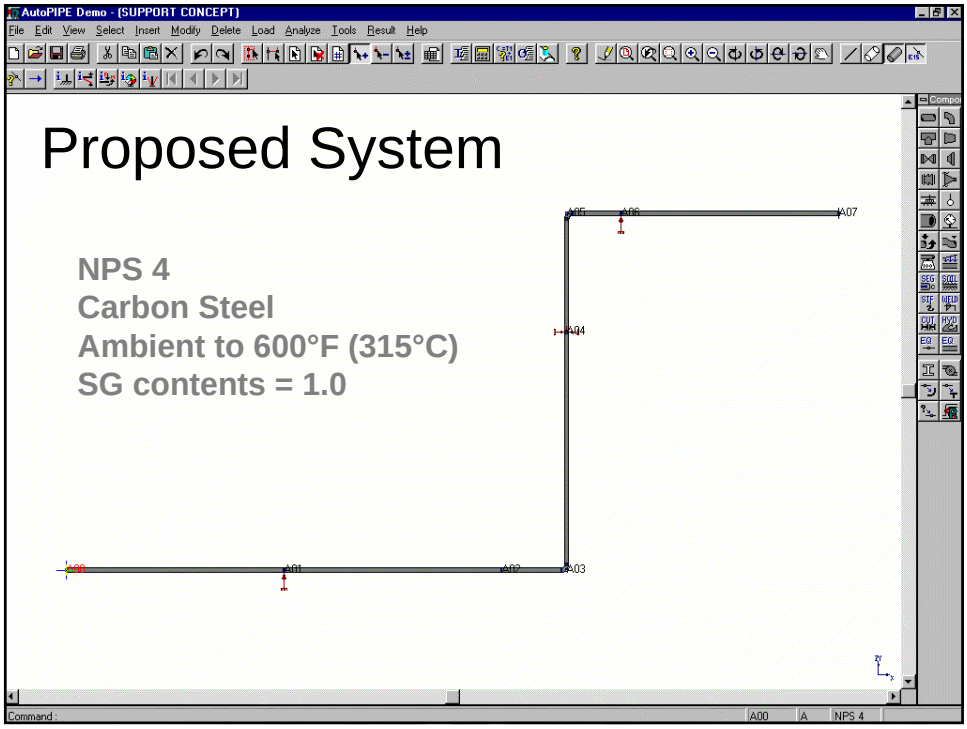
- make the piping look well supported to the facility engineers and operators
- prevent collapse of the piping
- prevent leaks due to fatigue cracks
- prevent joint leakage caused by excessive forces , and
- prevent failure or malfunction of attached equipment caused by excessive reactions

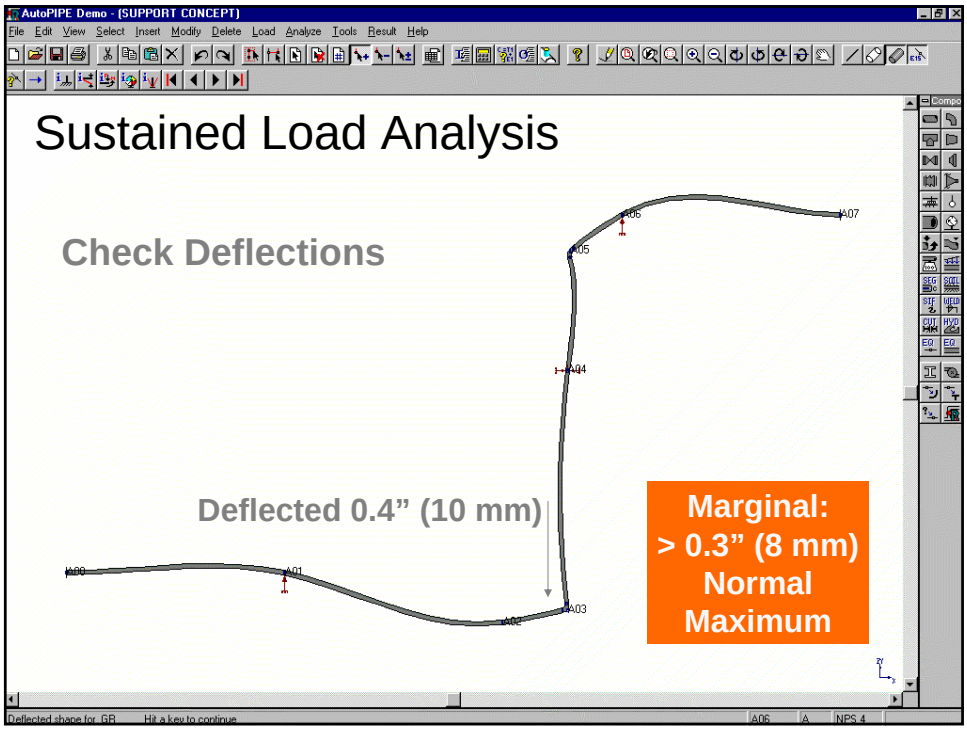
Flexibility Analysis Example

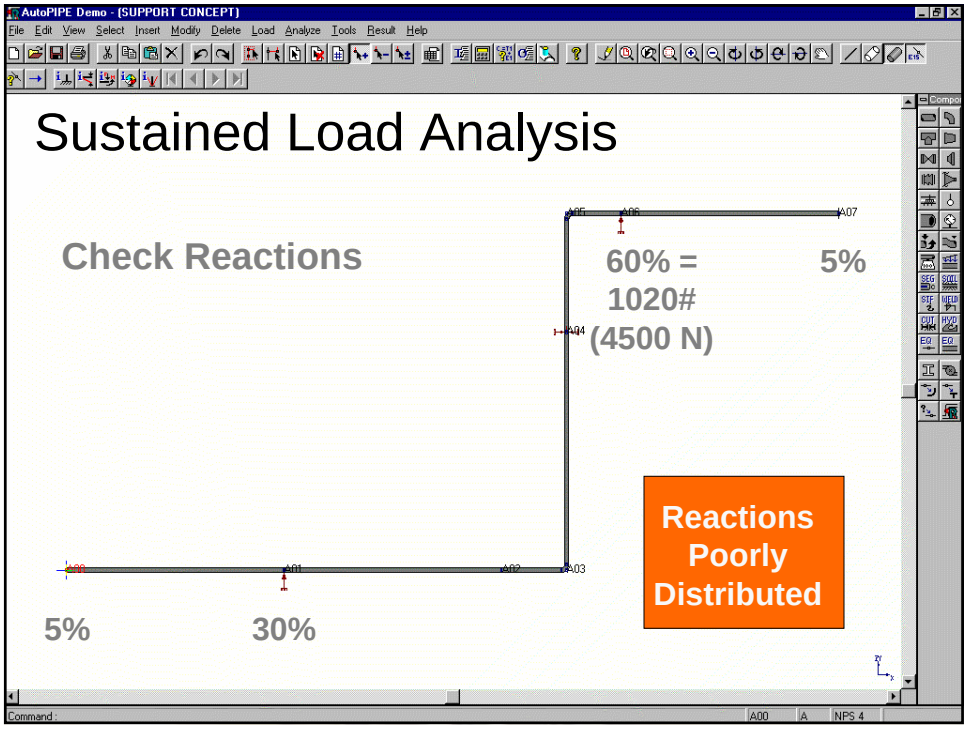
A two step analysis is shown.

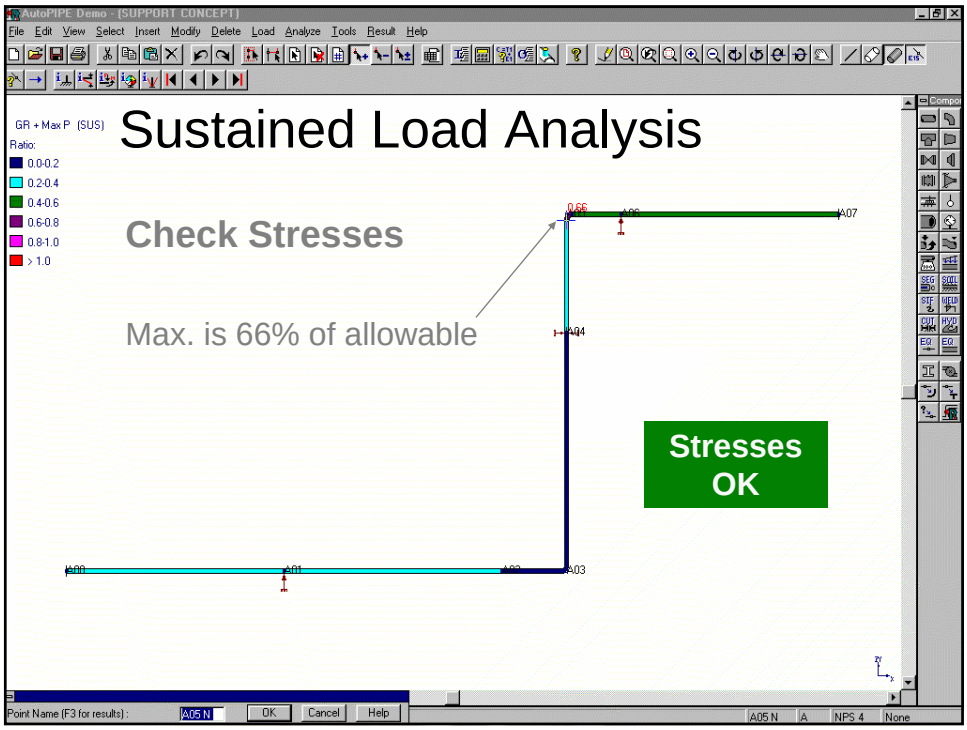
1. Weight and Pressure Loads – verify proper support and check reactions

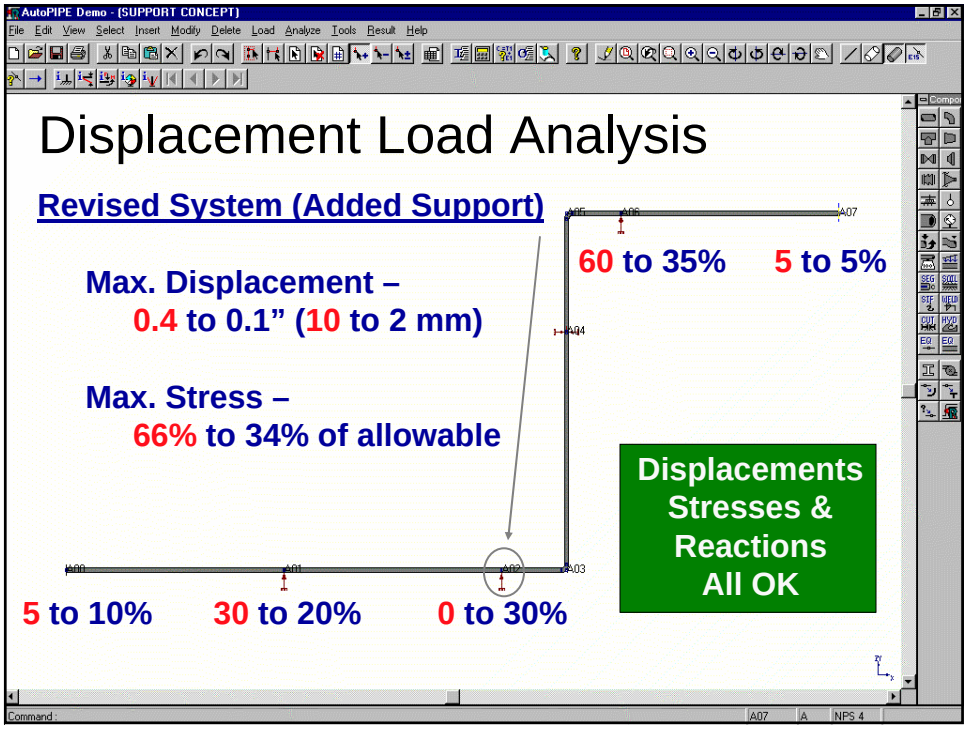
2. Thermal Expansion Load – verify adequate flexibility and check reactions

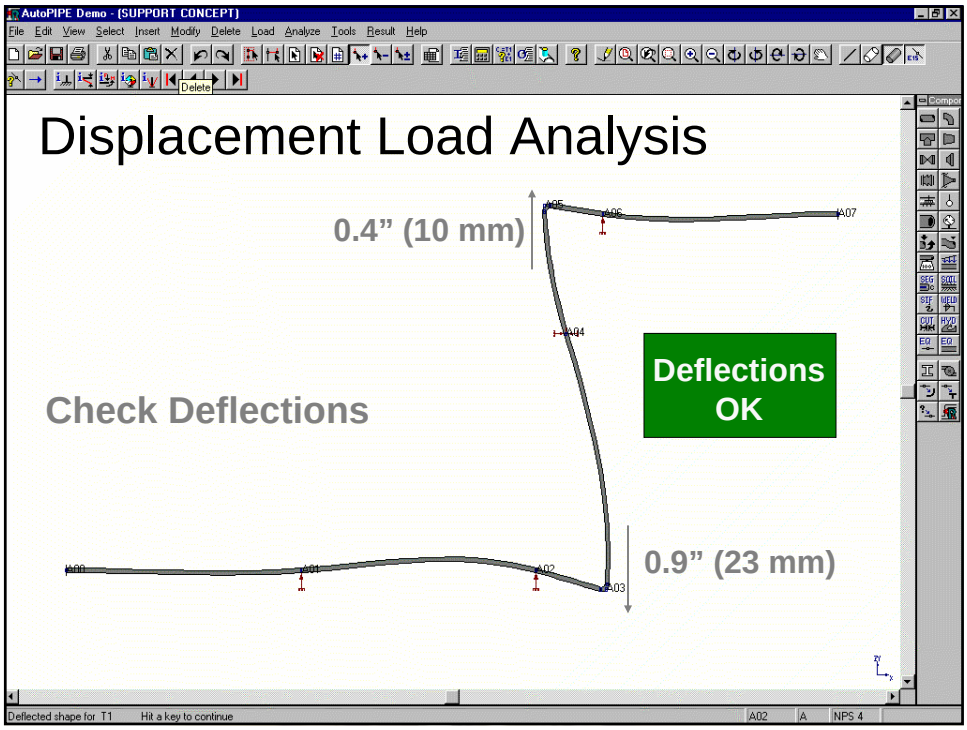

AutoPIPE Demo - [SUPPORT CONCEPT]
Proposed System
NPS 4
Carbon Steel
Ambient to 600°F (315°C)
SG contents = 1.0

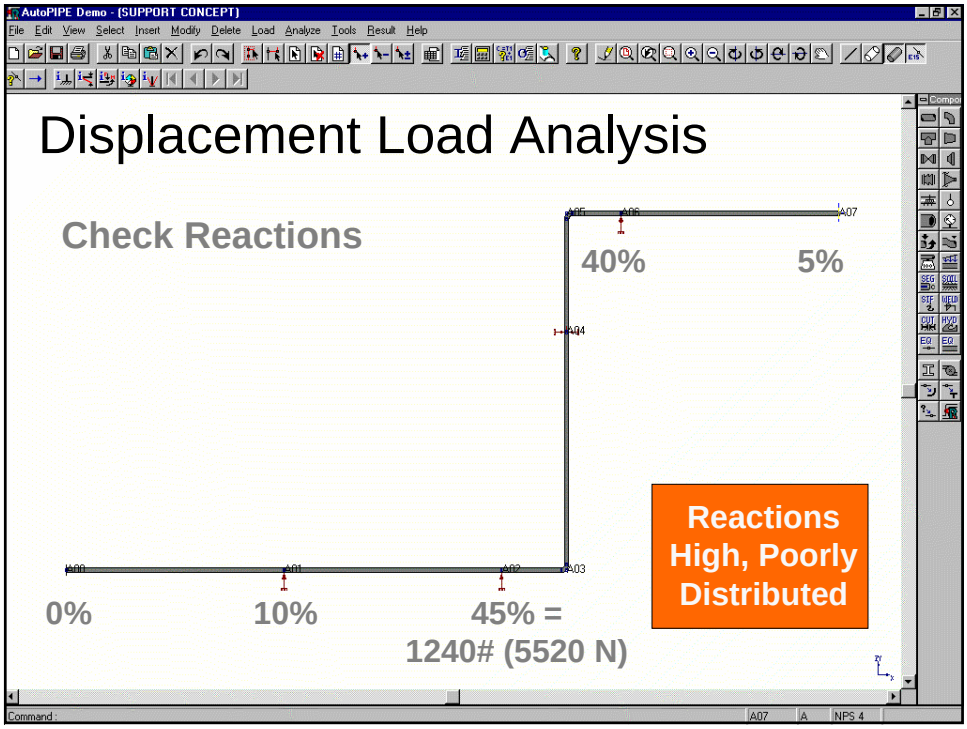

AutoPIPE Demo - [SUPPORT CONCEPT]
Sustained Load Analysis
Check Deflections
Deflected 0.4” (10 mm)
Marginal:
> 0.3” (8 mm)
Normal
Maximum

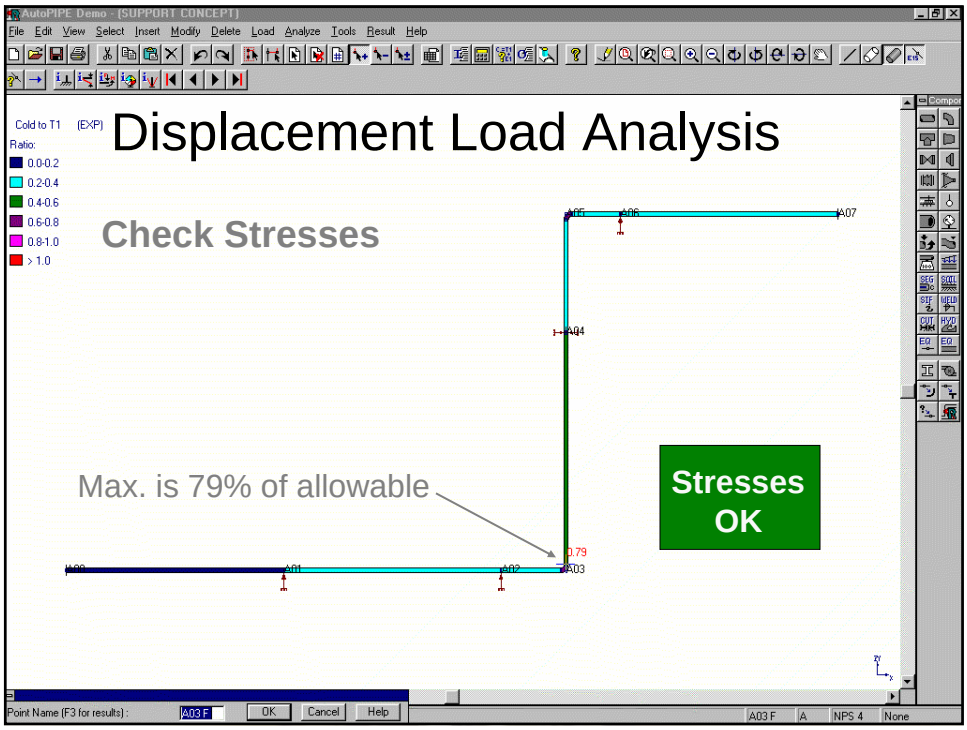

AutoPIPE Demo - [SUPPORT CONCEPT]
Sustained Load Analysis
Check Reactions
60% =
1020#
(4500 N)
5%
5%
30%
Reactions
Poorly
Distributed

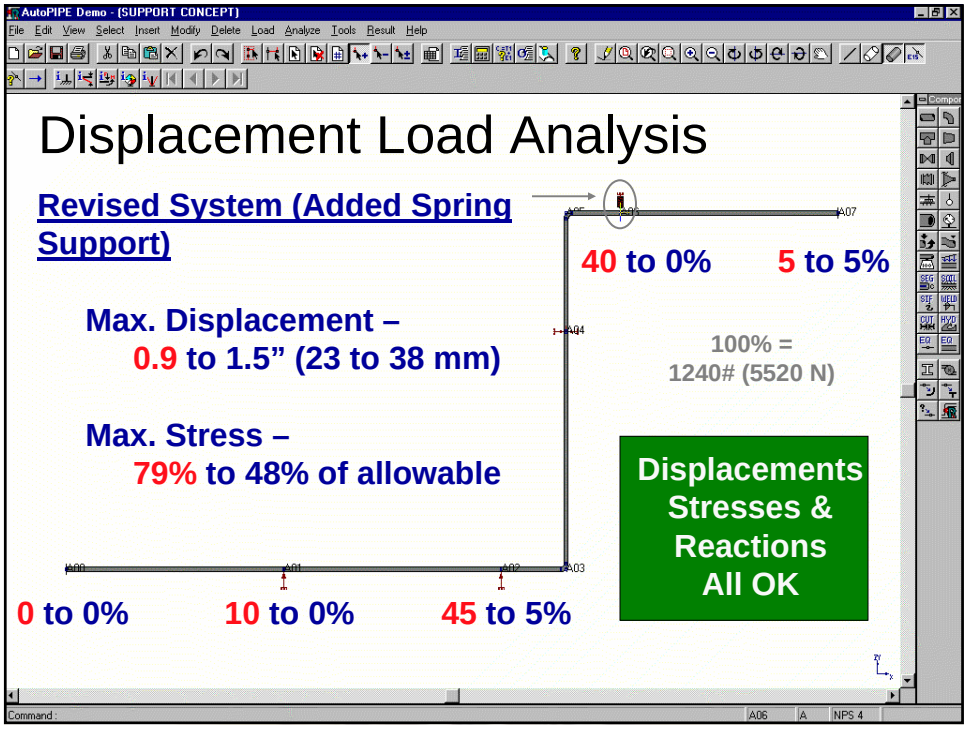

AutoPIPE Demo - [SUPPORT CONCEPT]
GR + Max P (SUS)
Ratio:
0.0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1.0
> 1.0
Sustained Load Analysis
Check Stresses
Max. is 66% of allowable
Stresses
OK


AutoPIPE Demo - (SUPPORT CONCEPT)
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%
Displacements
Stresses &
Reactions
All OK
5 to 10%
30 to 20%
0 to 30%


AutoPIPE Demo - (SUPPORT CONCEPT)
Displacement Load Analysis
0.4” (10 mm)
Deflections
OK
Check Deflections
0.9” (23 mm)


AutoPIPE Demo - [SUPPORT CONCEPT]
File Edit View Select Insert Modify Delete Load Analyze Tools Result Help
Displacement Load Analysis
Check Reactions
40%
5%
0%
10%
45% =
1240# (5520 N)
Reactions High, Poorly Distributed
Command :
A07
A
NPS 4


AutoPIPE Demo - [SUPPORT CONCEPT]
File Edit View Select Insert Modify Delete Load Analyze Tools Result Help
Cold to T1 (EXP)
Ratio:
0.0-0.2
0.2-0.4
0.4-0.6
0.6-0.8
0.8-1.0
> 1.0
Displacement Load Analysis
Check Stresses
Max. is 79% of allowable
0.79
Stresses OK
Point Name (F3 for results) :
A03 F
OK
Cancel
Help
A03 F
A
NPS 4
None



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