Prevention First - 2012

Solutions for Terminals “New” and “Existing”

Piping Analysis in Elastic Regime

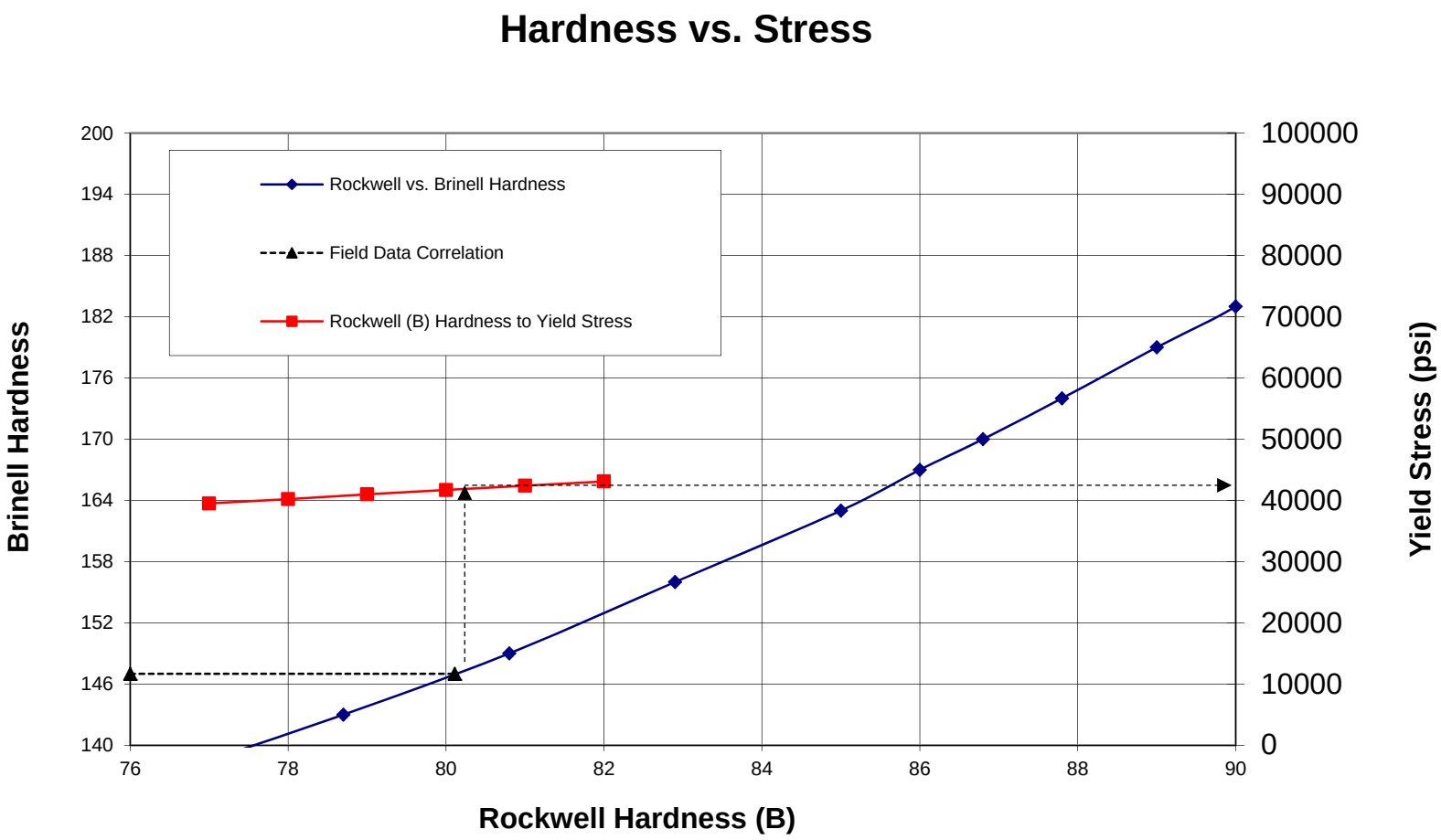
Pipe Stress Analysis Approach

- Existing Terminals:
  - Benefit of actual operating data
    - Design pressure of 275 psig, operates ~100 psig, find maximum incidental pressure
    - Actual operating temperatures (including solar radiation) as opposed to maximum design temperature
    - What is the current condition of the pipe?

Pipe Condition Considerations

- "Not on paper"
- Pipe wall thickness, corrosion rate and remaining service life
- Corrosion allowance
- Actual pipe grade?
  - Pipe material certs or original specifications do not always exist
  - Brinell hardness testing to verify pipe grade

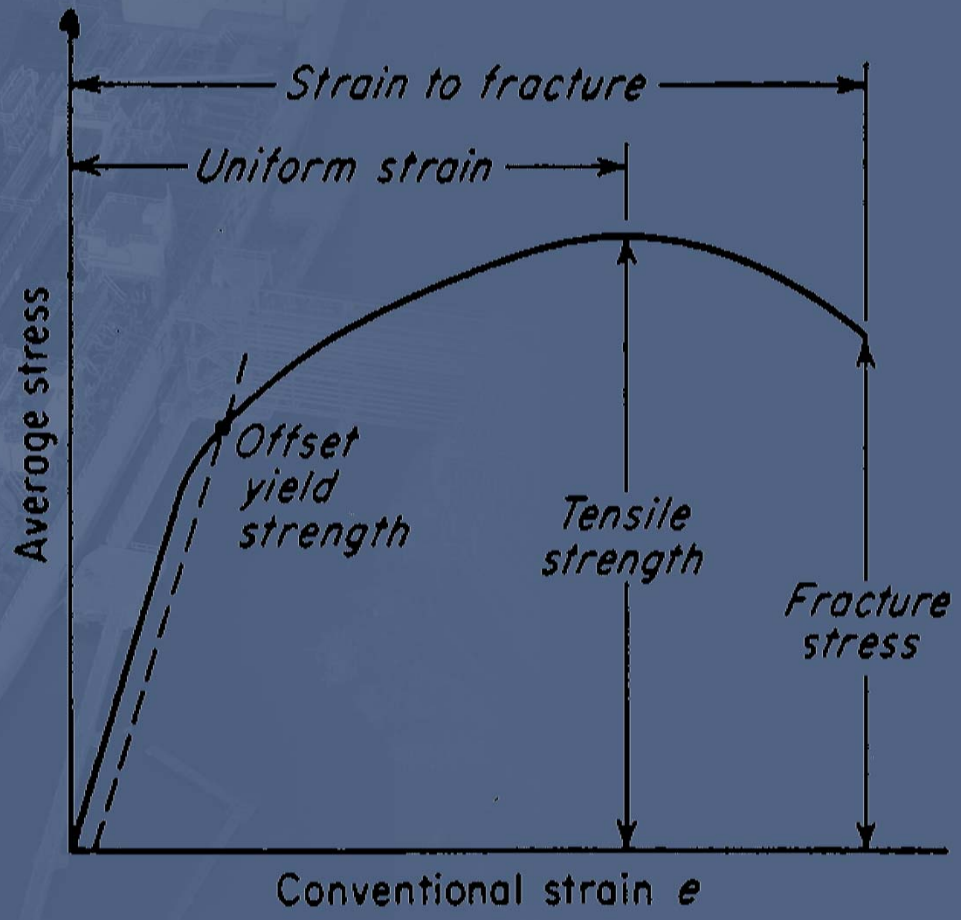
Brinell Hardness Testing vs Pipe Grade



"One Time Faulted Events" vs "Occasional Loads"

- ASME B31.3 and B31.4 limit occasional loads to a percentage of pipe yield strength
  - Limited to CBC accelerations? Or actual structural interaction?
- Allowance by ALA and ASME B31E to inelastic behavior for one time faulted events
  - What is a one time faulted event?
  - How is it different from an occasional load?
  - Applies to cyclic events only…what is cyclic?

Stress vs Strain



American Lifelines Alliance (ASME B&PV Code)

- When the piping is elastically analyzed the ALA suggests the following ASME B&PV Code Section III, Div. 1 stress limits:
  - $P_m < 70\% S_U$
  - $P_L + P_b < 105\% S_U$
  - S_U : minimum ultimate strength of the material, psi
  - P_m : primary membrane stress, psi
  - P_L : primary general or local membrane stress, psi
  - P_b : primary bending stress, psi

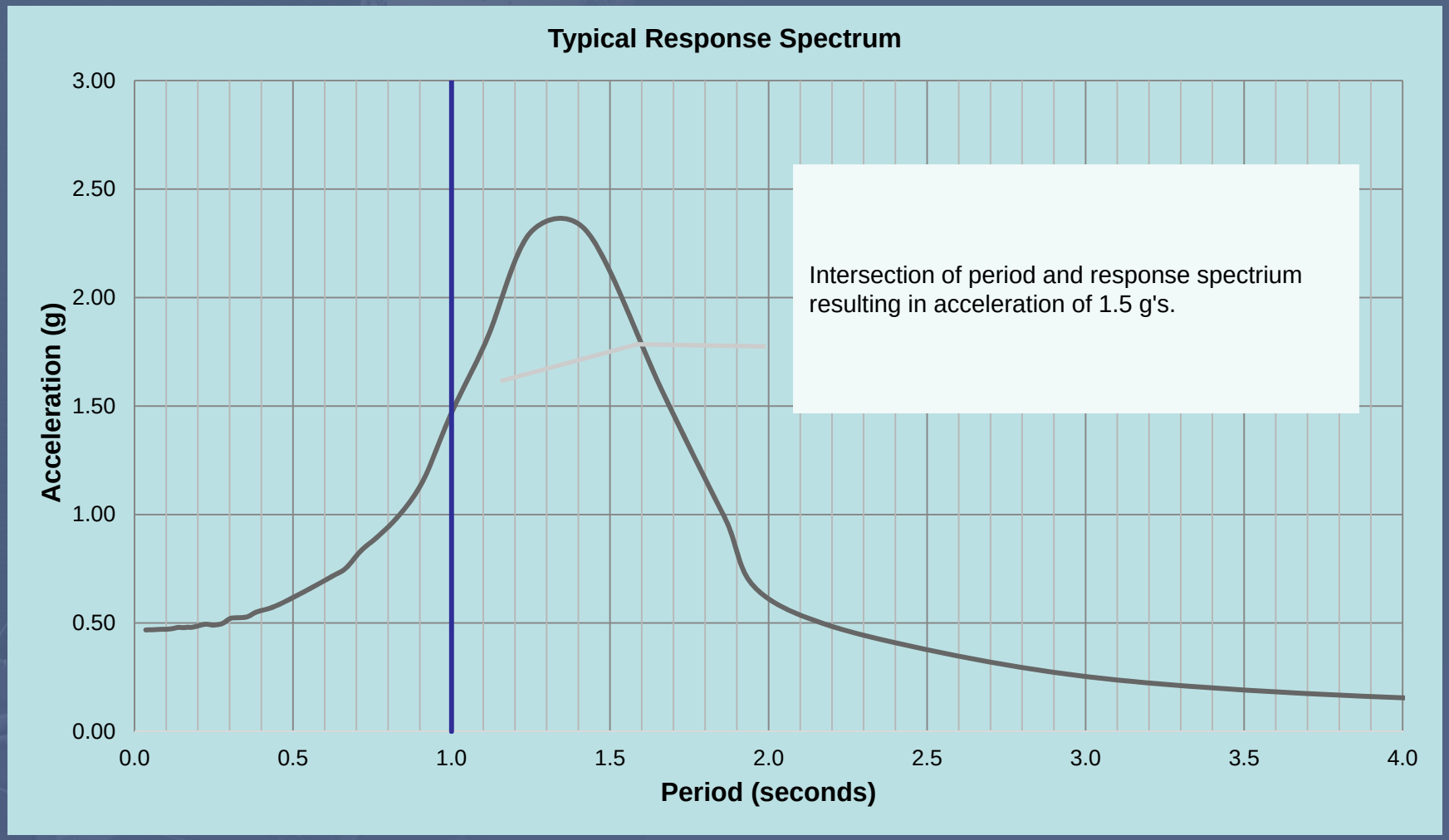
Pipe – Structure Interaction

- MOTEMS brings this to light
- Seismic Displacements and Inertial Loads
  - Static analysis for maximum differential displacements, and separate analysis for anticipated seismic accelerations
- Changing the structural analysis conditions
  - With pipe connected to structure, it forms a part of the structural mass, increasing displacements

Response Spectrum Analysis

- New terminals require a time history or response spectrum analysis; can be used to define the actual pipe – structure interaction
  - The structure has a natural period, and goes back at forth at a certain period
  - The pipe has a natural period, and will “excite” or resonate when closer to the structure natural period
  - Pipe restraints and mass participation effects

Responding to the Response Spectra



New Terminal Design

- Designing a new terminal allows you to change both the structural response, and the piping response
  - Make structure more rigid or flexible
  - Manipulate mass of piping or location of valves, add / delete restraints, “cut out” mode shapes
  - Minimize accelerations and keep displacements manageable

Summary

- Existing terminals allow the benefit of analyzing towards actual operating conditions, and remaining service life.
- New terminals offer interaction of structural design and easier integration of piping modifications
- All evaluation techniques result in same thing: we're smarter, with less at risk

moffatt & nichol




Questions?