Pipeline Research Council International, Inc.

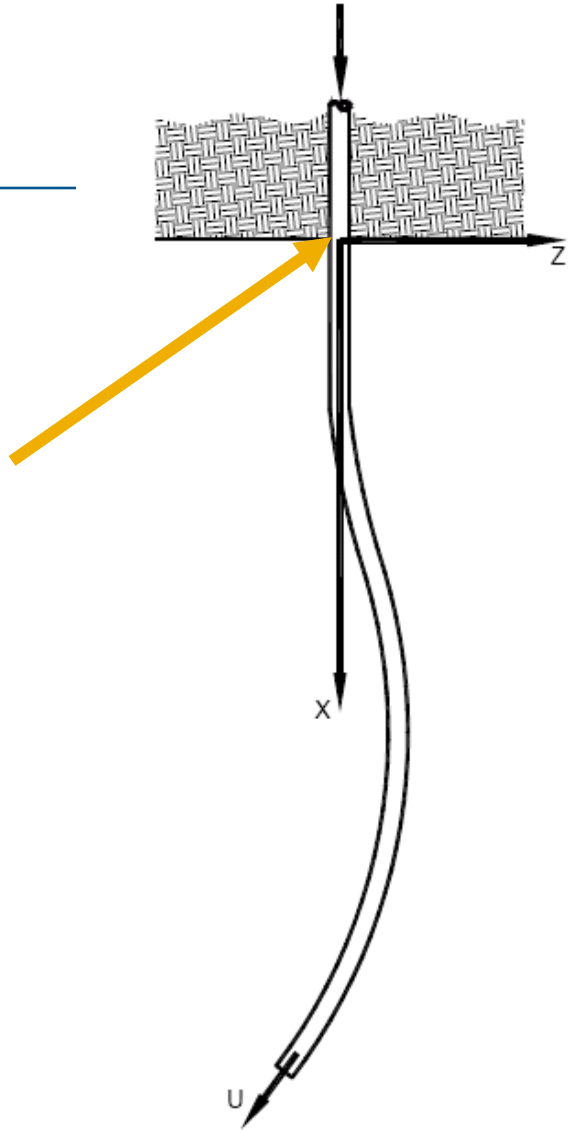
Underground Storage Technology Issues

PHMSA R&D Forum
July 18, 2012
Arlington, VA

Mike Whelan, PRCI

Current Research Program - PRCI

- **Salt Cavern Brine String Integrity**
  - Flow-Induced Vibration Mitigation
    - Field test planned with Enterprise Products – 4Q/2012
  - Goal: Determine Maximum Safe Velocities for fluid injection and withdrawal
    - Employ heavily instrumented brine string to map its movement & location as a function of fluid velocity
- **Prior study concluded:**
  - Mathematical models of (flutter) vibration did not explain case histories of brine string failures
  - Installation of “Stiff” centralizer(s) might help mitigate flow induced vibration failures



Today's models don't adequately explain failures

Current Research Program - PRCI

- **Effect of Downhole Geo-mechanical Stresses on Downhole MFL performance**
  - Many lateral and tensile stresses
- **Cement Degradation Mechanisms**
  - Cement performance a key aspect of well integrity
  - Zonal isolation and mechanical support to the casing
- **Cement Bond Log Tool Evaluation**
  - Determine quality of the cement bond behind the well casing
  - Prototype tool of Baker-Hughes to be tested

Consensus Standards Initiative

- Development of API Recommended Practices for Salt Cavern storage and Reservoir (depleted oil & gas formations) storage has been initiated. ANSI approved process
- Expected timeline to completion: 2 to 3 years
- Multi-Stakeholder Task Forces being formed
- Best Practices worldwide will be evaluated, including all aspects of storage integrity management from design to development through operations to abandonment

Building Confidence in Pipeline Safety

Underground Gas Storage Team Update

May 2012

Action Plan

Underground Gas Storage

A. **Develop recommended practices for integrity, risk management and emergency preparedness for underground gas storage in oil/gas reservoirs and aquifers**

B. **Develop recommended practices for integrity, risk management and emergency preparedness for underground gas storage caverns**

To further enhance the safety of the nation's underground gas storage infrastructure and;

- **To provide a sound technical reference for state and federal regulatory bodies that recognizes the geographic and geological diversity of the country's facilities**
- **Timeline: 2 to 3 years**
- **Final Product: API consensus standards developed under ANSI approved process**
- **Executive Co-Champions: Vern Meier (TCPL) & Fred Metzger (K-M)**

Progress Update

1. Review existing storage regulations and standards (completed – June 2011)
2. Develop regulation/standards comparison matrix (completed – July 2011)
3. Meet with AGA/USC (completed – May/June 2011)
4. Update survey on operators' storage integrity management program practices (survey completed August 3; data analysis – completed 2011)
5. Develop draft language for best practices/federal regulations governing storage well and reservoir integrity monitoring / management (Completed October 2011)
6. Joint INGAA/ AGA – USC meeting (Ft Worth Sept 13 – 14, 2011)
7. Develop PHMSA ANPRM responses (completed Dec 2011)
8. Engage PHMSA (Oct-Dec 2011, ongoing)

Progress Update

9. Submit Standards Resource & Research Request (SRRR) to API (Completed March 2012)
10. API Operations Technical Group approval (Completed – April 2012): RP 1170 & RP 1171 designated
11. Select Committee Chairpersons (Completed – April 2012) Oil & Gas Reservoir Committee (S. Nowaczewski – TransCanada, M. Rowan – DTE); Storage Cavern Committee (S. Rouze – Spectra)
12. Recruit Committee Membership (ongoing)
13. Committee Kick Off (OGRC – July 25, SCC – Aug 15)
14. Standards Development (August 2012 – Jan 2014)

Draft Consensus Standards

- **Maximum Volume**
- **Maximum Pressure, including "Delta-Pressure"**
- **Storage Project Design**
  - Geologic Definition, Field Description, Evaluation of Wells within Area of Review
  - Well site location and spacing, Drilling Design and Well Design
  - Additional Design Considerations for Aquifer Storage
  - Well Casing Requirements (surface, intermediate, production
  - Well Cementing Requirements
- **Storage zone penetrations by other wells**

Draft Consensus Standards

- **Testing and Commissioning**
- **Wellhead requirements**
- **Valves** (well isolation valves required, ESD valves not required)
- **Well stimulation/completion**
- **Integrity Demonstration/Verification and Monitoring**
- **Gas Inventory Monitoring**
- **Cathodic Protection**
- **Corrosion Control**
- **Site security systems, Well-site Inspections, and Emergency Response**