PHMSA - 2016 R&D Forum

Working Group #4

Underground Natural Gas Storage

Overview of Technical and Integrity Issues

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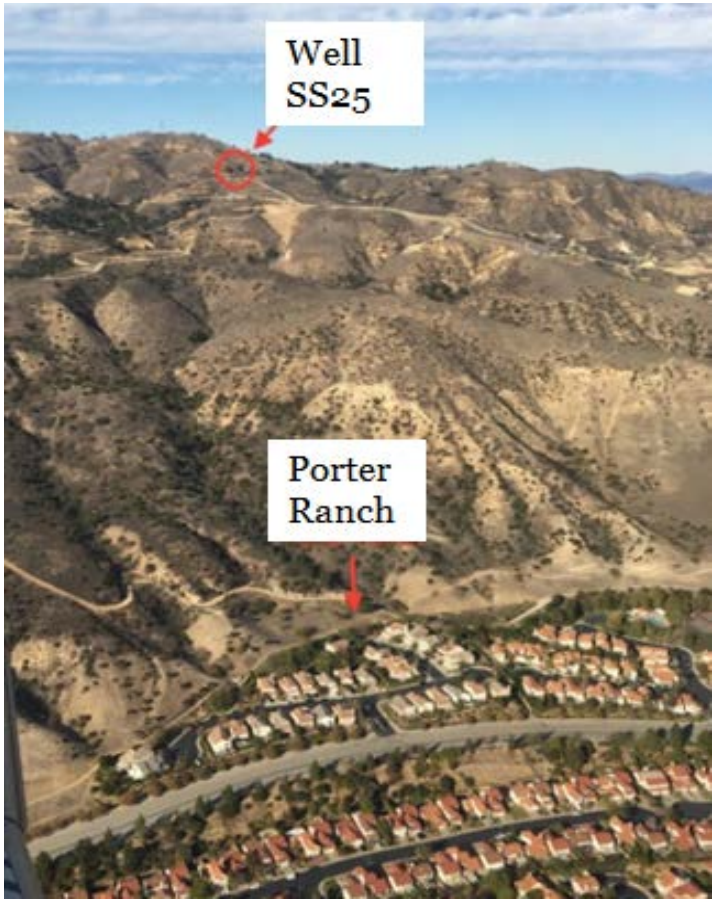
Initial Thoughts on What to Consider

- **Design standards**
- **O&M Standard Practices**
  - Monitoring, evaluation tools and standards
- **Integrity Management**
  - Risk Assessment Tools
- **Leak Detection**
- **Health Effects**

Aliso Canyon - Well SS25

- October, 2015, SoCal Gas' Aliso Canyon Well SS25 developed a natural gas leak
- Well plugged in mid-February 2016
- ~ 5 billion cubic feet of natural gas was released into the atmosphere
- ~ 5,790 households were relocated due to the co-release of natural gas with odorant (mercaptans).
- Cost over $X00-million
- Aliso Canyon Field has 115 wells



Underground Gas Storage

- ~ 400 interstate and intrastate underground natural gas storage facilities currently operate in the U.S.
- ~ 17,000 UGS wells
- ~ 4.7 trillion cubic feet of natural gas working capacity in U.S.

SoCal Gas – Aliso Canyon Field, CA
- Well SS25 – leak Oct. 2015 to Feb. 2016

Underground Gas Storage

- **ADB–2016–02**
- Safe Operation of Underground Storage Facilities for Natural Gas

- Operators of underground storage facilities should review their O&M and ER activities to ensure the integrity of underground storage facilities are properly maintained

Aliso Canyon, CA Field - leak

ADB–2016–02

- O&M processes and procedures should be reviewed and updated at least annually, unless inspections for integrity warrant shorter review periods.
- O&M processes and procedures should include:
  - data collection and integration,
  - risk assessments,
  - monitoring,
  - operational limits,
  - mitigation measures, and
  - record keeping for any underground storage facility threat that could impact public safety, operating personnel, or the environment due to leakage, failure, or abnormal operating conditions .

Underground Gas Storage

- **After Aliso Canyon Leak – What's next?**
  - CA has strengthened their well regulations
  - Rulemaking by PHMSA
    - API RP 1170 and 1171
  - Public Workshops were conducted
  - Task Force issued report on Underground Storage
    - Department of Energy
    - Department of Transportation – PHMSA
    - Others

API RP 1171 and/or 1170 standards

- **Reservoir design**
  - maximum operating pressures and geologic formation and environmental effects
- **Well drilling and completion -**
  - well control practices
- **Operations and Maintenance**
- **Integrity Management**
- **Emergency Preparedness and Response**
- **Training**

How are reservoir/well maximum operating pressures established/maintained?

- **A must----**
- Are they maintained through-out well life
  - injection,
  - withdrawal and
  - stimulation processes?

How are well design and maximum well operating pressures established?

- **Design factors** –
  - How should they be established?
  - What are they? Do you know?
- **Production casing and tubing –**
  - should they have robust design factors and be maintained for well life?
  - last line of defense to protect from a leak or blow-out?
- **Cementing practices –**
  - Height of cement above producing zones
  - Evaluation of integrity

Are well standards established and maintained?

- **Establish and maintain:**
  - Maximum well operating pressure
  - Design safety factors – are they known?
  - Diameter, weight/wall thickness, Grade, coupling type, packer locations, production perforations, internals, and wellhead rating, etc.
- **When maintenance is performed – is data maintained?**

Should wells flow through?

- Tubing only,
- Production casing w/no tubing, or
- Through tubing and production casing

- When is it safe to flow through any of these examples?
  - How should be the well casing and/or tubing **condition/standards for maintaining safety**?

How is well production casing and tubing designed for hoop stresses?

- What is the well design safety factor?
- Is it a set safety factor maintained for the life of the well?
- Should wells have different safety factors for:
  - flow in tubing only?
  - flow in production casing?
  - For integrity management assessments?
  - For populated or high consequence areas?

Safety Valves

- **How many wells have safety valves?**
  - Surface safety valves
  - Subsurface safety valves
- **When are these safety valves needed?**
- How often should they be tested?

Mechanical Integrity Test

- **How often should a well production casing and tubing mechanical integrity test be conducted?**
  - ≤ 5-years, ≤10-years, ≤ 15-years, ≤-20 years, other
- **What type tests should be conducted?**
  - Noise and temperature logs:
  - Caliper log:
  - HR-MFL log (corrosion)
  - Cement Bond
  - Pressure test – at what pressure range and when?

Safe Operating Pressures?

- How should safe operating pressures be established or evaluated from a caliper log, HR-MFL Log or pressure tests?
  - Using design factors of casing or tubing
  - Remaining wall thickness or Other Methods
- Should safe pressures be established based upon some form of Barlow's Equation, B31G or R-STRENG, when an accurate corrosion log is used to find corrosion or other casing/tubing defects?
- What should be the pressure and hold time for a pressure test?

Overview of PHMSA July Public Workshop

- **Integrity Management Principles (importance of):**
  - Risk assessments (with valid system information)
  - Design factors – needed based upon casing string type
  - Anomaly evaluation – how should they be evaluated?
  - Documentation
- **Assessment tools:**
  - Numerous ones are available;
  - Need to use them; and in particular, the correct tool for the threat;
  - Currently, there are varying degrees of use.

R&D Efforts/Priorities
CA PUC Perspective

- Subsurface leak prediction and detection
  - Tools/Logs
  - Evaluation and safe pressure
- Efficacy of subsurface safety valves or a replacement device
- Through-tubing casing evaluation
- Health effects of exposure to methane and odorants

Final Thoughts

- **Design standards**
  - Safety factors
  - Single or Dual Barriers
  - Subsurface safety valves
- **O&M evaluation tools and standards**
  - Logging Tools – MFL, Cement Bond, Temperature, etc.
  - Safe pressure, safety factors
  - Remediation Tools
- **Integrity Management**
  - Risk Assessment Tools
    - High versus Low Pressure Wells
    - High Volume versus Low Volume Wells
- **Leak Detection**
  - Surface, Well head and Tubing Strings
- **Health Effects -** exposure to methane and odorants

Thank You

811 Know what's below. Call before you dig.