2018 UTAH BOARD OF OIL, GAS AND MINING
ENVIRONMENTAL EXCELLENCE AWARDS

Nomination Form

Nominee Information:

Company Name: Dominion Energy Questar Pipeline
Address: 333 South State Street, PO Box 45360
City, State, Zip: Salt Lake City, UT, 84037
Contact Person: Jacob Isaac K. Abraham
Phone: 801-324-3160
Site Name: Various
Location: Clay Basin, Coalville, and Chalk Creek Storage Fields

Activity and Category (Please check one activity and one category):

Activity:
- Oil and Gas
- Minerals
- Coal

Category:
- Environmental improvement to an active mine site, drilling or recovery site, or field
- Outstanding results following applications of innovative environmental technology
- Outstanding final reclamation or site restoration
- Other: Storage Integrity Management Program
Nominated By:

Name  Jacob Isaac K. Abraham
Address  333 South State Street
City, State, Zip  SLC, UT 84037
Phone  801-647-7065

Nomination Summary (attach additional information if necessary)
Dominion Energy Questar Pipeline (DEQP) has over 50 years of operating one of the largest natural gas storage portfolios in the Intermountain Region. Since inception of its operations it philosophy has been grounded in implementing Underground Gas Storage Integrity Management principles to ensure these operations are operated and maintained safely while minimizing risks to the public and environment well before Federal regulations were implemented in December 19th, 2016 by DOT PHMSA.

Return by Wednesday, February 28 to:

Environmental Excellence Awards
Division of Oil, Gas and Mining
1594 West North Temple, Suite 1210
Salt Lake City, Utah 84114-5801
Underground Gas Storage (UGS) Integrity Management

Jacob Isaac K. Abraham
Storage Reservoir Engineer
Dominion Energy Questar Pipeline
07/13/2017
Outline

- Dominion Energy (DE)
- Dominion Energy Questar Pipeline UGS Facilities
- UGS Integrity Timeline
- 2017 Field Integrity Plan
- 2017 Well Integrity Plan
- Conclusions
Dominion Energy Profile
Power and Natural Gas Infrastructure

- Questar Natural Gas Transmission Pipelines
- Electric Generation
- Solar Generation
- Cove Point LNG Facility
- Natural Gas Storage
Dominion Energy West

- Dominion Energy Wexpro: Development & Production
- Dominion Energy Questar Pipeline: Transmission
- Dominion Energy UT ID WY: Distribution
Introduction to DEQP’s UGS

• Dominion Energy Questar Pipeline (DEQP) operates 3 Natural Gas Storage Reservoirs in Utah
  • Clay Basin (Daggett County)
  • Chalk Creek (Summit County)
  • Coalville (Summit County)
• Helps pipelines meet customer demands with readily available and reliable gas supplies

2015 – Clay Basin 46-S Workover
Figure 1. Types of underground natural gas storage facilities

Source: PB-KBB, inc., enhanced by EIA.
Diagram of a UGS Reservoir

T = Total reservoir capacity
TVS = Total volume of gas in storage reservoir
SG = Stored gas (excludes all native gas)
C = Cushion gas
Underground Gas Storage Integrity Timeline

- **Sep 2015**
  - API* concluded 3-year storage integrity study; Issued recommended standards API 1171

- **Feb 2016**
  - PHMSA Advisory Bulletin released – endorsed API 1171

- **Jul 2016**
  - Safe Pipes Act – PHMSA to regulate gas storage

- **Dec 2016**
  - PHMSA Interim Final Rule published 12/19/16

- **Jan 2017**
  - Submitted Petition for Reconsideration to PHMSA 1/18/17

- **Feb 2017**
  - PHMSA Comment Period 2/18/17

- **Jan 2018**
  - Initial Operating, Maintenance, Emergency Preparedness, procedures required 1/18/18

- **2025+**
  - API 1171 full conformance expected

- **Oct 2015**
  - Aliso Canyon Storage leak discovered by SoCal

- **Mar 2016**
  - PHMSA/DOE Interagency Task Force formed

- **Oct 2016**
  - Interagency Task Force Report issued – Expanded scope beyond API 1171

- **July 2017**
  - Initial Annual Report Under IFR Required 7/18/17

- **5/17 - 7/17**
  - PHMSA Selected Eight Pre-Enforcement Sites To Visit

* API: American Petroleum Institute
DEQP’s Storage Integrity Management Program

Field Integrity Plan
- Inventory Studies
  - Inventory Tests
  - Hysteresis Analyses
- Observation Wells
- Gas Sampling
- Monitor 3rd Party Wells
- Measurement & LAUF

Well Integrity Plan
- Well Workovers
  - Casing & Tubing Inspections
- Annular Pressure Monitoring
  - SCA & TCA
- Mechanical Integrity Tests
- Well Leak Surveys
Field Integrity Plan

• Clay Basin Inventory Tests
  • Spring Verification Test
    • Low Inventory
  • Fall Verification Test
    • High Inventory
  • 3rd Party Inventory Analysis / Verification

• Annual Aquifers Inventory Hysteresis Study
  • Coalville & Chalk Creek
  • Observation Well Monitoring
Well Integrity Plan

Annular Pressure Monitoring

- Tracking casing/tubing pressures of DEQP I/W wells
  - SCADA & Chart recorders
- DEQP Reservoir Engineering checks these pressures once a week to verify wellbore isolation
- Cross communication between casing/tubing is evaluated and the associated wells are prioritized on the future workover schedule

2016 – Coalville 9 Workover
Well Integrity Plan (cont.)

Total Active # of Storage Wells in Utah: 60
Target = 8x Well Workovers in Utah per Year

- Retire Tubing & Ancillary Equipment
- Casing Surveillance Logging
- Ultrasonic Inspection Tool (USIT)
- Cement Bond Logging (CBL)
- Cathodic Potential Evaluation Tool (CPET)
- Gamma Ray Neutron (GRN)
- Temperature Logging
- Install New Tubing & Ancillary Equipment
  - 4 wells @ Clay Basin
  - 2 wells @ Chalk Creek
  - 2 wells @ Coalville

2016 – Clay Basin 3 Workover
Well Integrity Plan (cont.)

15x Tubing Inspections (2017)
- Vendor: Baker Hughes
  - High-Resolution Vertilog™ (HRVT)
  - Gamma Ray (GR)
  - Neutron Log
  - Temperature Log
- 9 wells @ Clay Basin
- 3 wells @ Chalk Creek
- 3 wells @ Coalville

2016 – Chalk Creek Logging Ops
DEQP Storage Baseline Integrity Assessment

- Typical DEQP Well Design = Casing, Tubing, Packer Design
  - Cement provides zonal isolation to prevent gas migration from the storage horizon but does not extend to surface
  - 3 or 4 wells without isolated annuli to be worked over in 2017 & 2018
- Active Annular Pressure Monitoring of I/W wells with telemetry
Conclusions

• DE is one of the nation’s largest UGS operators with extensive technical expertise and experience
• DEQP has been engaged for many years in UGS integrity management and is continually assessing its facilities for functional mechanical integrity
• DEQP is currently in the process of reviewing and formalizing a Storage Integrity Management Plan, in consultation with its DE peers, to meet and adhere to the DOT PHMSA’s new UGS Regulations
• DEQP values its continued partnership with the Utah Division of Oil, Gas, and Mining; the Bureau of Land Management; and the Department of Transportation to ensure safe and reliable operations of UGS in the State of Utah
Questions?
QP Storage Reservoir Engineering Update

Jacob Isaac K. Abraham
QP Storage Reservoir Engineering
Dominion Energy
Questar Pipeline LLC
05/10/2017
Outline

- Introduction to UGS Principles
- Questar Pipeline Storage Facilities
- Typical QP Wellhead and Wellbore Design
- Storage Interim Final Rule (IFR)
- Storage IFR Implications
- 2017 Field Integrity Plan
- 2017 Well Integrity Plan
Intro. To UGS Principles

- Questar Pipeline operates 3 Natural Gas Storage Reservoirs in the Utah
  - Clay Basin (Depleted Reservoir)
  - Chalk Creek (Aquifer)
  - Coalville (Aquifer)

- Ensure peak pipeline utilization year round with reliable gas supplies during peak days
Types of underground natural gas storage facilities

Source: PB-KBB, inc., enhanced by EIA.
Why storage of Natural Gas?

Optimization of pipeline capacity by using a storage facility
Natural Gas Daily Usage

Typical natural gas load curve

- Max rate = 136% of average
- Min rate = 39% of average
- Peak demands = 43.2% of total daily delivery

Delivery rate, cu ft/hour

12 PM 1 2 3 4 5 6 7 8 9 10 11 12 AM 1 2 3 4 5 6 7 8 9 10 11 12 PM
T = Total reservoir capacity
TVS = Total volume of gas in storage reservoir
SG = Stored gas (excludes all native gas)
C = Cushion gas

Schematic diagram of a storage reservoir
**Storage Reservoir Engineering Terminology**

1. **Native Cushion Gas** – Native gas within the given storage reservoir was present before the field was converted to storage.

2. **Injected Cushion Gas** – Gas which has been injected (intentionally) by the operator of a given storage facility. This gas is used to re-pressurize the reservoir to enable high deliverability rates from the field during the heating season.

3. **Cushion Gas** – The sum of all native cushion gas and injected cushion gas is collectively known as cushion gas. All of this gas is owned by the operator of the facility. Cushion gas allows the storage facility to operate within its designed operating window.

4. **Working Gas** – Gas injected into the storage facility within its designed operating window. Working gas is injected throughout the summer or offseason by various storage customers to their contracted working gas capacity.
# Questar Pipeline Storage Facilities

## Storage field specifications

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<tr>
<th>Category</th>
<th>Chalk Creek</th>
<th>Coalville</th>
<th>Clay Basin</th>
</tr>
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<td>Summit County, Utah</td>
<td>Daggett County, Utah</td>
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<td>1975</td>
<td>1978</td>
<td>1976</td>
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<td>Depleted gas</td>
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<td>Dakota (5,800')</td>
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<tr>
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<td>1 reciprocating 1,600 HP</td>
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<td>10,000 MMscf</td>
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<td>Maximum operational withdrawal</td>
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<td>65 MMscf/d</td>
<td>720 MMscf/d</td>
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<td>MRD</td>
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<td>N/A</td>
<td>427 MMscf/d</td>
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<td>Maximum designed deliverability</td>
<td>50 MMscf/d</td>
<td>75 MMscf/d</td>
<td>720 MMscf/d</td>
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<tr>
<td>Operational working gas capacity</td>
<td>300 MMscf</td>
<td>692 MMscf</td>
<td>54,000 MMscf</td>
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</table>

*Go to Google Earth for Demonstration*
Typical Storage Wellhead Design

- Upper Master Valve (Tubing)
- Lower Master Valve (Tubing)
- Production Lateral
- Wing Valve
- Production Casing Valve

*All valve types are gate valves*
Typical Storage Wellbore Design

Surface Casing

Production Tubing

Production Casing
Typical Storage Wellbore Design

- Packer Fluid
- Bottom Hole Assembly
- Perforations (SPF)
- Permanent Packer
- Nipples to Set Permanent Plugs
Safety Valves

- QP utilizes surface safety valves (automated master or wing valves) on over 95% of its UGS injection and withdrawal wells.
- On June 29th, 2015 Questar Pipeline authored an internal white paper reviewing subsurface safety valves and has actively been installing them in key wells throughout its storage system since that time.
  - All key injection and withdrawal wells identified will have SSSV at the end of the 2018 workover program.
  - All other key wells will have valves installed by 2019.
  - At the end of 2019 QP will have 19 SSSV in service.
    - 15 I/W; 4 Obs
Underground Gas Storage Integrity
Development of New Regulations

- **Sep 2015**
  - API* concluded 3-year storage integrity study; Issued recommended standards API 1171

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- **2016**
  - PHMSA/DOE Interagency Task Force formed
  - Interagency Task Force Report Issued – Expanded scope beyond API 1171

- **Oct 2015**
  - PHMSA/DOE Interagency Task Force formed
  - Joint Industry Task Force established to provide input

- **Mar 2016**
  - PHMSA/DOE Interagency Task Force formed

- **July 2017**
  - Initial Annual Report Under IFR Required 7/18/17

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* API: American Petroleum Institute
Storage IFR

- On December 19th, 2016 PHMSA released the Storage Interim Final Rule (IFR) which consisted of changes to CFR 49 Parts 191 & 192
- The IFR is intended to make interstate Underground Natural Gas Storage (UGS) jurisdictional and regulated by PHMSA
- The IFR specifically added UGS facilities to all Part 191 and 192 definitions and to existing reporting documents
- The IFR incorporates by reference (IBR) API RP 1171
  - PHMSA has changed all of the conditional wording to mandatory
    - E.g. – Shoulds to Shalls
IFR Implications

- Amendments to existing codes:
  - 49 CFR Part 191
  - Underground Natural Gas Storage Facility Reporting Requirements
    - §191.15 - UGS Incident Reporting
    - PHMSA F7100.2
    - §191.17 – UGS Annual Report
      - PHMSA F7100.4-1 [New] – Due on 7/18/2017
    - §191.22 – 60 Day Pre-notification to PHMSA for all Build/Retire Projects
    - §191.23 – UGS Safety-Related Conditions (SRCs)
IFR Implications (cont.)

- Amendments to existing codes:
  - 49 CFR Part 192
  - New definitions and documents IBR
    - §192.3 - Definitions
      - Added language to include UGS
    - §192.7 – New Documents IBR
      - Paragraphs (b)(10) – API RP 1170
      - Paragraphs (b)(11) – API RP 1171
    - §192.12 – UGS Facilities
      - Must meet all requirements and recommendations of API RP 1171; §§ 8,9,10, and 11 by 01/18/2018
IFR QP Measures to Date

- The IFR has modified the following code sections:
  - Underground Natural Gas Storage Facility Reporting Requirements
    - §191.15 - UGS Incident Reporting
    - §191.23 – UGS Safety-Related Conditions (SRCs)
      - QP issued Training Bulletin on 01/17/2017 to Operations reflecting new UGS reporting criteria
    - §191.17 – UGS Annual Report
      - Due on 07/18/2017
  - §191.22 – 60 Day Pre-notification to PHMSA for all Build/Retire Projects
    - Completed on 01/20/2017 for 2017 workovers
Compliance w/ IFR

- Reporting:
  - QP Pipeline Compliance will issue a training bulletin detailing:
    - Incident reporting now applies to UGS
    - SRC now applies to UGS
    - Develop UGS Specific-SRC form and update SP 8-21-01
  - QP Reservoir Engineering has received the proposed Storage Annual Report from AGA and will start compiling data in February 2017. The Storage Annual Report is due on 07/18/2017
Compliance w/ API RP 1171

- The Storage IFR rule requires full compliance of API RP 1171 §§ 8, 9, 10, and 11 by 01/18/2018
  - Section 8: Risk Management for Gas Storage Operations
  - Section 9: Integrity Demonstration, Verification, and Monitoring Practices
  - Section 10: Site Security and Safety, Site Inspections, and Emergency Preparedness and Response
  - Section 11: Procedures and Training
QP Storage Integrity Management Plan

QP’s Storage Integrity Management Guidelines consists of a macro Field Integrity Program and a micro Well Integrity Program

Field Integrity Plan
- Inventory Studies
  - Inventory Tests
  - Hysteresis Analyses
- Observation Wells
- Gas Sampling
- Monitor 3rd Party Wells
- Measurement & LAUF

Well Integrity Plan
- Well Workovers
  - Casing & Tubing Inspections
- Annular Pressure Monitoring
  - SCA & TCA
- Mechanical Integrity Tests
- Well Leak Surveys
2017 Field Integrity Plan

- Clay Basin Inventory Tests
  - Spring Verification Test
    - Low Inventory
  - Fall Verification Test
    - High Inventory
  - 3rd Party Inventory Analysis / Verification
- Annual Aquifers Inventory Hysteresis Study
  - Coalville, Chalk Creek, and Leroy
  - Observation Well Monitoring
2017 Well Integrity Plan

Annular Pressure Monitoring

- All QP I/W wells have casing/tubing pressures recorded in SCADA
  - 60/73 on SCADA; 13/73 not on SCADA
  - 13 wells not on SCADA have monthly pressure chart recorders
  - Remainder is a proposed 2018 project
- QP Reservoir Engineering checks these pressures once a week to verify wellbore isolation
- Wells where communication is evaluated are prioritized for tubing replacement on the future WO schedule
2017 Well Integrity Plan (cont.)

10x Workovers [Apr. – Aug.]
- Retire Tubing & Ancillary Eqpt.
- Casing Surveillance Logging
  - USIT, CBL, CPET, GRN + Temp
- Install New tubing & Ancillary Eqpt.
  - 4x @ Clay Basin
  - 2x @ Leroy
  - 2x @ Chalk Creek
  - 2x @ Coalville
Why does QPC do Well Workovers?

- What is the design life of an underground storage facility?
  - 10 yrs
  - 30 yrs
  - 50 yrs
  - Answer: ∞

- QPC performs well workovers in order to ensure that its storage wells can continue to safely operate for many years to come.
  - Analyze Casing Integrity
  - Replace Downhole Equipment
  - Assess Tubing Integrity
Typical QP Well Workover

- A typical Well Workover consists of 3 Activities
  - Retire
    - Removal of Packer Fluid
    - Removal of Existing Tubing and Auxiliary Equipment
  - Integrity Inspections (Logging)
    - Function Test wellhead equipment
    - Run Cased Hole Integrity Logs (tethered pigs)
  - Install
    - Function Test wellhead equipment
    - Install new Tubing and Auxiliary Equipment
    - Install new Packer Fluid
    - Conduct Mechanical Integrity Test (Pressure Test)
Typical Well Workover (Retire)
Packer Fluid
Typical Well Workover (Retire)

To: Frac Tank

Work Over Rig Pump
2% KCl H₂O @ 1 bmp

Packer Fluid
Typical Well Workover (Logging)

- USIT - Ultrasonic Imaging Tool
  *Casing Integrity Log
Typical Well Workover (Logging)

- Average USIT velocity is 1,300 ft/hr at the highest tool resolution (1.5” intervals)
- This means that the average run lasts approx. 4 hours.
- Data results are collected in Real Time, and a preliminary analysis of the log is conducted in the field by the Field and Reservoir Engineer
Typical Well Workover (Logging)

- CPET – Corrosion Protection Evaluation Tool
  *Analogous to a close interval survey
  *The CPET tool measures the casing potential and identifies anodic areas (corrosion prone areas)
Typical Well Workover (Logging)

• Average CPET velocity is 360 ft/hr at the highest tool resolution *(0.5’ intervals)*

• This means that the average run lasts approx. 14 hours.

• Data results are collected in Real Time, and a preliminary analysis of the log is conducted in the field by the Field and Reservoir Engineer
  • A total of 3 runs is required
Typical Well Workover (Install)
Typical Well Workover (Install)
Typical Well Workover (Install)

Work Over Rig Pump
- Packer Fluid
  - H₂O
  - Corrosion Inhibitor
  - Oxygen Scavenger
  - Biocide

- MIT (Pressure Test)
  - 1000 psig (surface)
  - Est. BHP 3500 psig

Example: Packer Top = 5770’
2017 Well Integrity Plan (cont.)

20x Tubing Inspections [Sept.]

- Vendor: Baker Hughes
  - HRVT
  - GR
  - Neutron
  - Temperature
- 9x @ Clay Basin
- 5x @ Leroy
- 3x @ Chalk Creek
- 3x @ Coalville
QP Storage IM Baseline Assess.

- Typical QP Well Design = Casing, Tubing, Packer Design (Isolated Annulus)
  - Partial cement (not to surface)
  - 3 or 4 wells without isolated annuli to be worked over in 2017 & 2018
- Active Annular Pressure Monitoring of I/W wells with telemetry
- Data Reconciliation and MWAP verification

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<td>2019 - 2022 (10x Workovers/yr)</td>
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2016 Tubing Inspections 13
2017 Tubing Inspections 20
## Well Integrity Plan Results

### Casing Inspections

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<th>Year</th>
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<th>$P_{\text{burst}}$ (psi)</th>
<th>$P_{\text{burst}} / \text{MAOP}$</th>
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## Well Integrity Plan Results

### Tubing Inspections

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<th>$P_{\text{burst}}$ (psi)</th>
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Questions