



U.S. Department of Transportation  
Pipeline and Hazardous Materials  
Safety Administration

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**Underground Natural Gas Storage**  
**Facility Safety Site Assessment Report**

**October 20, 2017**

*PHMSA thanks the volunteer Underground Natural Gas Storage operators who participated in this assessment. Please note that the observations and findings included in this report have been drawn solely from the eight operators visited by the PHMSA team during May-July of 2017. PHMSA believes the selected operators do represent a cross-section of Underground Natural Gas Storage operators in the United States.*



## Introduction ...

On December 19, 2016, PHMSA published in the Federal Register an Interim Final Rule ("IFR") that revised the Federal pipeline safety regulations to address critical safety issues related to downhole facilities, including wells, wellbore tubing, and casing, at (UGS) underground natural gas storage facilities. This IFR incorporates, by reference, two American Petroleum Institute ("API") Recommended Practices ("RP"s): (1) API RP 1170, "*Design and Operation of Solution-mined Salt Caverns used for Natural Gas Storage*," issued in July 2015; and (2) API RP 1171, "*Functional Integrity of Natural Gas Storage in Depleted Hydrocarbon Reservoirs and Aquifer Reservoirs*", issued in September 2015. Certain aspects of the IFR made non-mandatory provisions within API RP 1170 and API RP 1171 mandatory for UGS operators to follow. PHMSA plans to use the forthcoming Final Rule to address comments and other considerations from the IFR, and revise the requirements detailed in the IFR accordingly. PHMSA expects to issue a Final Rule in early 2018.

Within a June 2017 notice in the Federal Register, PHMSA stated: in the interim, and for one year after the publication of a Final Rule, PHMSA will not issue any enforcement citations to operators for failure to meet any provisions that are non-mandatory in API RP 1170 and API RP 1171 but that were converted to mandatory provisions by the IFR. Despite this stay of enforcement, PHMSA still reserves the right to exercise its other authorities, if necessary, to address any emergencies that present an imminent hazard or specific conditions that are or would be hazardous to life, property, or the environment.

In preparation for the development of PHMSA's UGS inspection and enforcement efforts, PHMSA and additional subject matter experts formed a team to conduct facility safety site assessments at a cross-section of UGS operators from May to July 2017. Since this work was conducted prior to the January-2018 compliance date, the site assessments were not inspections; and no deficiencies, notices, reports, or enforcement actions were made by PHMSA from the site assessments. The purpose of these facility safety site assessments was to obtain information from operators to compile a summary of typical and best UGS industry practices, gather feedback from operators regarding the technical aspects of the referenced recommended practices, and to assess the level of progress being made by operators towards compliance with the pending requirements of the IFR. The results of these site assessments are being used in the development of inspection materials, enforcement guidance, and consideration during the overall development of the UGS program.

The facility safety site assessments included UGS operations located in Colorado, Mississippi, Texas, Michigan, Louisiana, Illinois, and California (table on last page of this report). The site assessments included five depleted reservoirs, one aquifer, and three salt cavern facilities. Representatives from associated state regulatory agencies were invited to attend the PHMSA site



assessments and participated in periodic breakout discussions with the PHMSA team during the assessments.

Because the site assessments were conducted at operating facilities, the PHMSA team focused primarily on the operating and maintenance aspects of the API RPs during the site assessments. The PHMSA team had high-level discussions with the UGS operators regarding procedures, documentation and operating practices. A detailed review of written documentation of plans, procedures, individual well and operating data was not conducted.

The facility safety site assessment questions focused on four main categories:

- a) Procedures and Training
- b) Site Security and Safety, Site Inspections, and Emergency Response
- c) Integrity Demonstration, Verification, and Monitoring
- d) Risk Management

Each site assessment typically took 2½ days to complete, including ½ day for a field site tour hosted by each operator. The main observations and findings of the site assessments are summarized below.

## General Observations ...

1. As of the date of our site assessments, none of the eight UGS operators had completed their preparations for the pending regulatory requirements. However, most operators had scheduled to complete their compliance preparations by the January 2018 deadline imposed by the IFR.
2. Although the IFR states that all requirements (mandatory statements) and recommendations (non-mandatory statements) in the API RPs are now mandatory, many of the UGS operators have taken the approach of prioritizing compliance with the requirements in the API RPs, prior to considering how to comply with the recommended items in the API RPs.
3. The relationships of the eight UGS operators with their respective state regulators are generally very positive. These relationships address permitting and licensing for wells, and include safety regulations in some states. The operators and the state agencies have ongoing communication with one another, and it was apparent that both the operators and the state agencies have prioritized maintaining open and constructive dialogue.
4. UGS industry demographics are skewed towards older workers nearing retirement age. This demographic trend supports the need for written, codified operating plans, procedures, and training, as required in the IFR.
5. Although the recent Interagency Task Force on Natural Gas Storage Safety recommended the phasing out of wellbores with single point of failure in favor of tubing and packer completions<sup>1</sup>,

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<sup>1</sup> Final Report of the Interagency Task Force on Natural Gas Storage Safety, *Ensuring Safe and Reliable Underground Natural Gas Storage*, October 2016.



there is no industry consensus on well completions among UGS operators. Some operators have pulled all tubing out of their injection/withdrawal wells to directly access the final cemented casing string for inspection, testing, and monitoring purposes. Other operators have installed hanging tubing in their injection/withdrawal wells for well control "kill string" and water handling "siphon string" purposes. Still other operators use tubing and packer completions, as recommended by the Interagency Task Force. Subsurface safety valves are not typically used by operators, except in isolated circumstances, and more prevalent in some reservoirs in Illinois and California.

6. Smaller operators are relying heavily on third-party contractors to develop their compliance plans. The third-party contractors appear to be knowledgeable regarding the services for which they are being contracted.
7. Operators reported varied internal regulatory compliance practices for the new regulations. Smaller organizations tend to rely on a specific "point person" to coordinate their compliance efforts, while larger organizations tend to use a committee approach to ensure their compliance efforts are complete and on schedule.
8. The most effective organizational practices employed by operators include frequent communication between management, operations, and commercial teams, with regular, recurring meeting times. Even some of the larger UGS operating organizations held weekly morning meetings involving all disciplines to prepare for the upcoming week's operations, maintenance efforts and commercial activities.
9. The most effective organizations also foster good cross-understanding of management, operations, and commercial roles and requirements among the wide array of their personnel. This cross-understanding has been developed via regular meetings, formal and informal training, and job assignment rotations within the organization.
10. Based on PHMSA's initial, high-level review conducted during the eight site assessments, UGS facility design characteristics are generally aligned with the provisions in the API RP's.
11. All of the eight operators are working towards compliance with the API RP's, and many are in the process of conducting a gap analysis to determine areas of needed improvement.
12. Given the high level of acquisition and divestiture activity within the UGS industry, maintaining continuity of safety compliance efforts as assets change hands could be a challenge for industry and regulators. PHMSA will include acquisition and divestiture as a risk factor for inspection planning.

## **Procedures and Training ...**

In 1996, LRL Sciences, Inc. ("LRL") was commissioned by the U.S. Department of Transportation to conduct a survey of UGS operators and summarize the results of that survey in a report. In the LRL survey, UGS operators identified the highest priority areas that may contribute to safety or environmental problems as being Operating Procedures, Maintenance, and Job Training. Between 45% and 55% of survey respondents named these three areas as having the highest priority and



highest potential for contributing to a safety problem. Given this background, the following items summarize PHMSA's main observations during the eight site safety assessments associated with Procedures and Training:

1. Almost all the UGS operators rely on some informal verbal operations and maintenance (O&M) procedures and training. Most operators were performing an adequate job in O&M tasks and procedures, and all operators were in the process of identifying gaps and formalizing all their O&M procedures into written format to comply with the new regulations.
2. The most effective training conducted by operators typically consisted of a combination of web-based, classroom, and on-the-job training in the field.
3. In general, formalized training procedures, and capturing the knowledge of experienced employees in written format, were areas needing improvement observed among many of the operators.
4. UGS operators who have existing PHMSA-regulated pipeline assets are generally applying their existing, formalized pipeline O&M plans and procedures to UGS operations, which should help bring UGS into compliance more quickly.
5. Procedures to verify the training of third-party gas storage well contractors are generally not formalized.
6. Although some large contractors have formal, industry standard training procedures and records for their employees, other contractors rely on the UGS operator's procedures in lieu of a formalized, internal program.
7. Training verification for third-party contractors was a common concern of the UGS operators visited. According to some of these UGS operators, gas storage is looked upon as a lower-priority market than upstream exploration and production for many oil and gas contractors. UGS operators oftentimes do not have the leverage to compel these contractors to adopt stricter training verification procedures.
8. Some operators have implemented a badge that can be scanned to identify the types of work and procedures that employees and contractors are trained to perform.
9. UGS operators generally make very strong efforts to orient contractors whenever they come onsite to work, including formalized site check-in, safety orientation videos and training, and daily tailgate meetings prior to and during contractor work activities.
10. During specific instances when UGS operators have had to initiate emergency response activities, existing emergency response plans and procedures were helping make response efforts highly effective in actual practice.
11. UGS operators typically review their plans and procedures on at least an annual basis to ensure that their processes are comprehensive and current.

## Site Security and Safety ...



1. The eight UGS operators are generally using comprehensive site security and safety practices, including maintaining emergency shutdown ("ESD") switches at or near wells; fencing in good repair around wellheads and/or the entire storage facility site; fire protection and fire suppression; security cameras; bollards or Jersey barriers around wellheads; wind socks; and detailed site access control plans.
2. Most of the eight operators have ESDs that actuate with a "pull" action, rather than a "push" action, to avoid inadvertent ESD actuation. In addition, operators are moving towards having ESDs that actuate slowly (15 to 30 seconds) to avoid gas or water hammer effect on piping.
3. The most thorough ESD testing practice that was observed occurred during flowing well conditions, rather than during static well conditions.
4. Most of the operators maintain prominent signage associated with their wells, including an emergency contact number.
5. Most of the operators maintained comprehensive emergency preparedness/emergency response plans. Operators make sure that employees are well-versed in emergency procedures, with some operators providing field staff with laminated emergency response reference cards that are also posted in control room areas and in maintenance trucks.
6. Blowout contingency plans are typically in place at these UGS facilities, with some operators involving third-party blowout control contractors in the development of their blowout contingency plan.
7. Desktop and live emergency drills are commonly conducted on a regular basis and at least annually. Many operators involve local first responders in their emergency drills.
8. Community education typically involves the periodic issuance of informational pamphlets to neighboring residents. In PHMSA's view, the industry may be well-served by also holding periodic open houses and/or nearby educational sessions for the community.

## **Integrity Verification and Monitoring ...**

1. The eight UGS operators routinely monitor their wells, caverns, reservoirs, and surface facilities for functional integrity using a variety of methods.
2. Risk-based integrity evaluations were previously less commonly used by the eight UGS operators, although an increasing number of UGS operators are employing risk-based approaches to integrity management, partially attributed to the upcoming regulations.
3. The availability and completeness of original well design and completion records, including records of offset and third-party wells, varied widely between facilities. These UGS operators typically incorporate data availability, vintage, and reliability considerations into their integrity management programs.
4. The most effective third-party monitoring was done by operators who collaborated with state regulatory databases that identify third-party construction and well activities on a real-time basis. Some state agencies maintain a dashboard of drilling and workover activity listed by



county, which enables operators to anticipate and monitor when third-party encroachments might occur.

5. The eight UGS operators are actively working towards digitizing their hard copy well records into a searchable, electronic database format, which is a prudent practice.
6. Supervisory Control and Data Acquisition ("SCADA") monitoring of individual well flows and pressures, including water production and annular pressures, are the most effective means of reservoir and cavern surveillance. Some facilities still only capture manual readings on a regular basis, which are then usually keyed into a database for longer term analysis.
7. Semi-annual reservoir and cavern shut-in tests are not universally employed as a means of inventory verification. Facilities that do not use semi-annual shut-in tests typically monitor reservoir inventory on a frequent (daily or weekly) basis, using observation wells that have been completed in the storage reservoir. Frequent monitoring of reservoir pressure appears to be a highly effective means of integrity verification and monitoring.
8. Operators that employed frequent (daily to weekly) monitoring of data trends in pressure and flow were also best equipped to identify many abnormal operating conditions early, allowing for a more rapid selection and initiation of response efforts.
9. Observation wells located within storage reservoirs and at reservoir and salt dome flanks are commonly used by UGS operators. These observation wells are less commonly connected to a SCADA system. Manual readings of these well pressures are often used to monitor observation well conditions, particularly for observation wells not located within the storage reservoir or observation wells that do not normally exhibit significant pressure changes.
10. Salt cavern operators typically participate in a subsidence monitoring program on their salt domes. Reservoir operators rarely monitor for subsidence, despite some reservoirs experiencing surface elevation changes due to overlying aquifer changes. Some reservoirs in the western United States have experienced meaningful elevation changes over time due to aquifer depletion, or due to the inadvertent charging of an aquifer with storage gas.
11. Many gas storage facilities are cathodically protected at the surface using anode beds and/or rectifiers. Storage wellbores are typically insulated from the surface cathodic protection system. The use of cathodic protection on wellbores by UGS operators is dependent upon historical operating experience with corrosive soil and reservoir conditions.
12. The eight UGS operators have historically conducted mechanical integrity testing of their wellbores in accordance with state regulations. Wellbore mechanical integrity issues are typically addressed by UGS operators as soon as practicable after they are discovered.
13. UGS operators tend to rely primarily on wellbore logging and pressure testing to demonstrate wellbore integrity, rather than other methods. The use of corrosion coupons is evaluated by UGS operators on a case-by-case basis.
14. Salt cavern operators follow industry cavern spacing guidelines and/or use detailed geo-mechanical modeling to determine adequate cavern spacing. Reservoir UGS operators commonly use detailed reservoir modeling studies to verify and monitor for reservoir integrity.
15. The eight UGS operators calibrate and test gauges, transmitters, and safety devices on at least an annual basis to ensure that data collection is accurate and complete.



16. The eight UGS operators tend to keep injection rates low when approaching Maximum Allowable Operating Pressure ("MAOP") on caverns and reservoirs, to avoid pressure excursions above MAOP.
17. Operating and integrity management records are usually retained for at least the operating life of the facility, with many operators specifying an additional period of time after the useful life of the facility.

## **Risk Management ...**

1. At the time of the eight site assessments, the UGS operators had not yet completed tabulated their risk assessment processes and a threat/consequences matrix. In general, operators believed they were on track to have those items completed by the January 2018 regulatory date.
2. Several operators are in the data collection phase of the risk assessment process. Accurate and complete data collection efforts will be important to the overall success of an operator's risk management program.
3. As referenced in various PHMSA FAQs, it is critical that the risk evaluation period be initiated, even if some data has not yet been obtained. It is expected that each operator's procedures, implementation plans, and schedules will evolve into a more detailed, comprehensive and documented robust program as the operator's program matures.
4. The operator's initial implementation plan and general timeline must be established by January 18, 2018, based upon site-specific information known by the operator at that time. The plan and timeline will likely change over time as new data is collected and evaluated during the on-going risk analysis process. Operators are expected to revise their risk management plan and timeline as new integrity information is acquired from assessments outlined in API RP 1170 and 1171.
5. One of the challenges in completing the risk matrix for large operators is in adjusting the risk matrix to provide an adequate comparison between different projects in the operator's portfolio. This is a particularly difficult issue when comparing the risk associated with salt cavern projects to reservoir projects being operated by the same company.
6. Another observation was that some operators may not be using a sufficiently wide enough differentiation in risk and consequence levels between wells and assets to provide an adequate risk ranking differentiation.
7. Unless otherwise compelled, some operators intend to complete their risk assessments in the field in a 5 to 8-year time period. Some operators also noted the possibility of assessing fewer wells at the beginning of the time period and push a higher quantity of work into the latter half of the time period. This could inadvertently delay needed preventative, mitigative and remediation work; and could create a workover rig, services, manpower, and equipment availability problem during the latter stages of the 8-year risk assessment timeframe.





8. Operators intend to review the content and effectiveness of their risk management programs on at least an annual basis.

## Operator Input ...

During the course of the eight site assessments, several topics regarding the PHMSA regulatory process and technical requirements were raised by the UGS operators, as summarized below:

1. Despite the approaching deadline for UGS operators to file an Annual Report in mid-2017, the Annual Report form had not yet been officially released at the time of the PHMSA site visits. This concern was alleviated on October 2, 2017 when PHMSA published an announcement in the Federal Register that the Office of Management and Budget approved the Annual Report form 7100.4-1. The first annual report is now due from UGS operators on March 15, 2018 and will collect information from the 2017 calendar year.
2. UGS operators are required to notify PHMSA, no less than 60 days prior, of certain events such as construction of a new facility, well drilling or well workover. During the site assessments, several operators expressed concern over the 60-day notice period for reporting well drilling and workover projects. Although PHMSA will waive the 60-day notice period for appropriate emergency well activities, PHMSA is also allowing UGS operators to report multiple well activities within the same storage field in a single notification. PHMSA is also considering modifications to the 60-day notice requirement.
3. Several UGS operators requested that PHMSA consider not making certain "should" statements in API RP 1170 and API RP 1171 mandatory, as is presently the case in the IFR. PHMSA is already considering the "should" provision, and plans to use the forthcoming Final Rule to revise the requirements detailed in the IFR accordingly.
4. Training verification of third-party contractors was a common concern of the UGS operators that PHMSA visited.
5. Several operators had questions regarding the demarcation point for UGS inspections vs. PHMSA and state partner agencies' historical DOT Part 192 inspections of pipelines and surface facilities. PHMSA is further studying the demarcation point.



## 2017 Facility Safety Site Assessments Schedule, Type and Location

Month	Week of	Facility Type	State Location
May	15	Reservoir	Colorado
June	12	Salt Dome	Mississippi
June	19	Salt Dome	Texas
June	26	Reservoir	Michigan
July	10	Reservoir & Salt Dome	Louisiana
July	10	Aquifer	Illinois
July	17	Reservoir	Colorado
July	31	Reservoir	California

A mixed subset of PHMSA Team members conducted each assessment, affording an equal amount of time for each assessment