New Federal Regulations for Underground Storage of Natural Gas

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Authors – Elizabeth K. Reilly, Ph.D., P.E., PMP, Nicoli M. Ames, Ph.D., P.E., L. Brun Hilbert, Jr., Ph.D., P.E.

The regulatory landscape of underground natural gas storage changed with the passing of the 2016 PIPES Act. PHMSA has since exercised its federal authority to regulate all underground natural gas storage facilities. PHMSA has incorporated by reference API Recommended Practices 1170 and 1171 by law (49 CFR 191 and 192). These API recommended practices, now mandatory, are intended to serve as a foundation for minimum standards for both inter- and intra- state underground gas storage (UGS) facilities. Operators of UGS facilities must fully understand these new regulations to determine how their implementation impacts the costs and operations of their facilities.

This article describes these new recommended practices and regulations, their interactions, and the potential impacts on the UGS industry.

PHMSA’s New Underground Gas Storage Regulations

In June 2016, the “Protecting our Infrastructure of Pipelines and Enhancing Safety Act of 2016” (PIPES Act) mandated PHMSA to regulate UGS facilities.¹ This law directed PHMSA to issue regulations for all, interstate and intrastate, underground natural gas storage facilities within two years and to consider industry standards, and economic impacts. PHMSA responded to this mandate on December 19, 2016, by publishing an Interim Final Rule (IFR) in the Federal Register² that established federal regulations for the downhole components of underground natural gas storage facilities. This rule became effective as part of the Code of Federal Regulations (CFR) on January 18, 2017.

Underground gas storage facilities are now subject to inspection by either PHMSA, or a PHMSA certified state entity.

New Reporting Requirements

Through the IFR, PHMSA has added reporting requirements for underground natural gas storage facilities in 49 Code of Federal Regulation (CFR) Part 191. Four types of reports are required from UGS operators:

- **Annual Reports**: Includes operator information, facility location, well information, and facility operational data, such as: gas storage volumes and pressures; well depths; gas injection and withdrawal rates; and maintenance information related to facility safety.

- **Incident Reports**: Events that involve a release of gas in addition to a death, significant personal injury, significant property damage, or unintentional loss of more than 3 MMCF of natural gas.

- **Safety-Related Condition Reports**: Findings that may compromise the safety, reliability, or integrity of a well or reservoir, such as: casing or tubing corrosion; cracks or other material defects; abnormal environmental loads such as earthquakes, floods, and landslides; leaks; over-

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¹ Pub. L. 114-183
² Vol. 81, No. 243
pressurization events; or anything that compromises the structural integrity or reliability of an underground natural gas storage facility.

**National Registry information:** Operators must obtain an Operator Identification Number (OPID) from PHMSA.

**Incorporation of API Recommended Practices as Requirements**

Prior to issuing the IFR, PHMSA held public discussions in 2016 with operators and industry groups, and released reports documenting studies of underground gas storage. PHMSA concluded that two recently adopted industry recommended practices (RPs) from the American Petroleum Institute (API) should be incorporated by reference into the federal pipeline safety regulations through the IFR:

- **API RP 1170 “Design and Operation of Solution-mined Salt Caverns Used for Natural Gas Storage”** contains recommendations for solution-mined salt cavern facilities used for natural gas storage service and covers geomechanical assessments, cavern well design and drilling, solution mining techniques and operations, including monitoring and maintenance practices. This RP includes the cavern well system from the emergency shutdown (ESD) valve though the well, including wellhead, casing, tubing, cement, and completion techniques. It also covers the design and construction of the cavern itself.

- **API RP 1171 “Functional Integrity of Natural Gas Storage in Depleted Hydrocarbon Reservoirs and Aquifer Reservoirs”** applies to natural gas storage in depleted oil and gas reservoirs and aquifer reservoirs, and focuses on design, construction, operation, monitoring, maintenance, integrity management, and documentation practices. This RP applies to both existing and newly constructed facilities.

PHMSA has amended 49 CFR Part 192 to incorporate API RPs 1170 and 1171 in their general entirety and specific sections. Section 192.12 addresses underground natural gas storage facilities.

Subparts (a) and (c) of CFR 192 require that every solution-mined salt cavern and depleted hydrocarbon or aquifer reservoir used for gas storage constructed after July 18, 2017 must meet “all requirements and recommendations” of API RP 1170 and 1171, respectively. This wording implies that the entirety of the API RPs would be interpreted by PHMSA as requirements, not merely recommendations.

Subpart (b) requires that solution-mined cavern gas storage facilities constructed after July 18, 2017 adhere to API RP 1170 Chapters 9, 10, and 11 as detailed below.

**RP 1170 Chapter 9** covers recommended practices for gas storage operations, which include wellhead and emergency shutdown (ESD) valves at the surface, Supervisory Control and Data Acquisition (SCADA) systems, and alarms and controls set from the data acquired by the SCADA system. Chapter 9 also recommends an Overpressure Protection (OPP) System to mitigate excessive pressures on the surface and subsurface components, including the cavern, and fire and gas detection systems.

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Chapter 9 includes recommendations for points of pressure monitoring to ensure safety and prevent overload. RP 1170 also recommends that pressures be monitored at the wellhead at least at the tubing, production casing, the annulus of the casing outside of the production casing (intermediate or surface casing), hanging strings, and logging valve. There are also recommendations for inspection and testing of the SCADA system (calibration), ESD valves (periodic testing), and other components. Chapter 9 includes recommendations for workover operations, site security, safety, operations and maintenance, emergency plans and procedures, record-keeping, and training.

RP 1170 Chapter 10 covers cavern integrity monitoring:

“Once in operation and throughout its life, the cavern system shall be monitored to ensure the continuance of functional integrity.”

The chapter includes a table summarizing integrity monitoring methods. The methods are subdivided into scopes applied to system components: cavern system, wellbore, cavern, and wellhead. The cavern system includes monitoring pressures (SCADA data) and diesel blanket depth (interface logging); wellbore monitoring includes logging of the tubing, casing and wellbore (e.g. CBL, temperature and noise logs, caliper logs, corrosion logs, etc.); cavern monitoring includes sonar logs, in situ pressure and temperature; and the wellhead (e.g. ultrasonic wall thickness, pressure monitoring). Annex B of RP 1170 provides more detailed descriptions of the methods and tools used for determining system integrity.

RP 1170 Chapter 11 covers the subject of solution-mined salt cavern abandonment. This subject has taken some added importance since the failure of a cavern and sinkhole at the Napoleonville salt dome in Louisiana, which occurred after the cavern was plugged and abandoned. RP 1170 recognizes that some operators elect to simply shut in a cavern, rather than abandon it. Note that the following recommendations in RP 1170 will be required in 49 CFR 192. RP 1170 recommends that, before final plugging and abandonment, the following actions should be taken: a nitrogen mechanical integrity test of the wellbore should be performed; remove all downhole equipment; perform casing inspection logs (CBL, caliper, corrosion log, etc.); conduct a sonar survey of the cavern; and perform long-term monitoring.

Subpart (d) requires that depleted hydrocarbon and aquifer gas storage facilities constructed after July 18, 2017 adhere specifically to API RP 1171 Chapters 8, 9, 10, and 11 as detailed below.

RP 1171 Chapter 8 covers risk management for gas storage operations and provides recommendations for a risk management plan (RMP), which is now mandatory. The RMP should address data sources (geological, operating history, etc.), threat and hazard identification, risk assessment of the facility, periodic review and reassessment, and record keeping. While most gas storage facilities have an RMP, RP 1171 outlines best practices and guidelines for a written RMP that are now requirements.

RP 1171 Chapter 9 covers integrity demonstration, verification, and monitoring practices. The objective is that the “operator shall maintain functional integrity of storage wells and reservoirs.” Recommendations include using risk-based evaluations of wellbore integrity and storage formation, based on the RMP developed according to Chapter 8. Wellbore integrity should be determined and evaluated using well historical records and logging tools, similar to those described in RP 1170 for salt caverns (and as are standard for hydrocarbon wells). Reservoir integrity should be determined and then monitored using geological records, monitor (observation) wells, pressure data monitoring, and gas composition measurement. Gas inventory, flow rate and pressure data tracking is important for not only financial reasons, but also for monitoring the integrity of the reservoir or aquifer. As with salt caverns, recordkeeping and maintenance is required.

RP 1171 Chapter 10 covers site security and safety, site inspections, and emergency preparedness and response. The recommendations include site inspections, signage, ingress and egress, emergency preparedness/emergency response, blowout contingent plan, and cyber security. Finally, RP 1171 Chapter 11 covers procedures and training.

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Additional Considerations

The DOE and DOT issued a report stating that storage wells with a single barrier, or single point of failure, have a higher risk of gas breaching from the wellbore to the environment. Single barrier wells are those in which there is only one barrier between stored gas and the environment outside the wellbore. For example, a well with a casing string that is not cemented to the surface, through which gas is injected and withdrawn through that casing, is considered to have a single point of failure in the section of casing above the cement top. Considering the same well, if the gas was injected and withdrawn through a tubing string with a packer inside of the casing, then it would be considered a double barrier wellbore. Neither API RP 1170 nor 1171 include specific references to the number of “barriers” for wellbores. Both do, however, make reference to best practices for cementing of casing, and injection and withdrawal through tubing. PHMSA requires new wells to incorporate more than a single barrier, but allows operators a period of time to modify existing wells with a single barrier. Some states, such as Texas and Louisiana, already require some form of double barriers for storage wells. Texas requires a tubing and packer system for UGS wells in depleted reservoirs, and both Texas and Louisiana require double casing string for UGS wells in salt caverns.

Recommendations on the use of subsurface safety valves (SSSVs) have become an important subject of discussion amongst regulators, such as PHMSA, and operators. Section 9.3.2 of RP 1171 Chapter 9 includes:

“Surface and subsurface safety valve systems, where installed, shall be function-tested at least annually. The tests shall be conducted in accordance with manufacturer's recommendations and the operator's procedures. A closed storage well safety valve system shall be manually opened at the site of the valve after an inspection and not opened from a remote location.”

While RP 1171 does not include a recommendation on the use of SSSVs, some state and regulatory agencies are considering making their use mandatory. Their use has been considered as an additional barrier to the escape of stored gas, but their reliability has been the subject of recent discussion and research efforts. SSSVs require maintenance and might require regular repair of hydraulic lines. In sand formations, SSSVs have the potential to become plugged or eroded by formation sand. Additionally, workover tasks on SSSVs might increase the likelihood of unintended releases of natural gas.

About Exponent

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10 Texas Administrative Code, Title 16, Part 1, §3.96 and §3.97.

11 Louisiana Administrative Code, Title 43, Part XVII, §317.