Comments on API RP 1170 and 1171

The “States First” Gas Storage Workgroup has reviewed API RP’s 1170 and 1171 with respect to their suitability as a regulatory framework for the underground storage of natural gas and natural gas liquids. While the RP’s contain substantial information and guidance regarding underground storage, it is our belief that they require considerable wording revisions and additions to make them effective as regulation. The following comments represent the opinions of specific reviewers and may or may not represent a consensus opinion of the entire workgroup:

1. The RP’s do not address the issue of Risk Management with sufficient specificity. Notably, there is no recommended practice that describes how much risk is acceptable using systems such as the As Low As Reasonably Practical (ALARP) principle. Further, the API et al. “white paper” (p. 82, Appendix 6.3) specifies that each operator set’s their own risk management objectives in the context of their company’s “capability”. This concept is antithetical to regulatory management; which requires all operators meet an established standard irrespective of their self defined “capabilities”.

2. A number of documents would be required to obtain approval for storage service from a regulator. Given this is a new process, with new rules and a new regulator, then a process would be required to officially permit the facility under the new rules and provide all the documents required in this regulation. Essentially proved that each facility is compliant with the new rules. Existing facilities should go through a re-permitting process to guarantee compliance.

3. The RP’s use the term “should” extensively throughout the documents. This term is inconsistent with regulatory language. In order to be enforceable a regulations use the terms “must” or “shall”. The term “should” is merely suggestive of something that might be done but which is not required. Regulations cannot be enforced on that basis.

4. RP’s should specify level of exposure of facilities: includes proximity to company or public assets, and also any previous safety or process issues at any given storage facility. Likelihood of occurrence (used to calculate risk) is quite high for facilities that have experienced at least one event (e.g. Yaggi, Aliso Canyon, McDonald Island). Such facilities should be subject to a higher level of regulatory scrutiny than those that have not experienced failure events.

5. RP’s should address spill prevention and control plans and some sort of spill retention system around each well.

6. API itself has recognized that the RP’s are “not intended to replace federal, state, or local regulations”. However, if the RP’s are used as the basis for federal regulations that is precisely what they will be doing, at least with respect to federal regulation. Merely referencing or copying sections of the RP’s in a regulation would not provide a proper basis for regulatory control inasmuch as there appear to be gaps that could create regulatory uncertainty or inadequacy. This is clear in many of the sections reviewed by the Gas Storage Workgroup members as outlined in the examples below:

RP 1170:

- 1.2 Applicable Rules and Regulations: There is no mention in this section about the role of the Underground Injection Control (UIC) program within the context of gas storage. For example the solution mining of caverns for
gas storage would typically be considered a Class III UIC activity for which a UIC permit would be required.

- 4.2 Types of Underground Natural Gas Storage: This section addresses only three types of gas storage. It does not include any information on other storage such as in mined caverns, converted mines, and hard rock caverns.

- 4.5 Overview of Major Steps in the Development of Gas Storage Cavern: Same comment as for 1.2 above concerning lack of information about the role of the UIC program.

- 5.2 Site selection Criteria: No mention is made of proximity to sensitive surface and near subsurface features such as in urban areas, near surface water, proximity to pipelines etc…. Further, 5.2.3 needs to discuss state and local regulations on water extraction from surface water and water wells and the use of surface impoundments.

- 5.3 Geologic Site Characterization: This section needs to be expanded to include disposal formations, fresh water zones, and oil and gas formation on the flank of domes. This section should also discuss geophysical well logging program needs such as gamma ray, litho-density, neutron, dipole, caliper and other logs needed to properly analyze salt for geomechanical properties. There is no mention of a requirement to submit geophysical logs, core data or photographs, or cuttings to the regulatory agency. Some of these may be necessary for regulatory evaluation. Clarification is also needed with respect to the relationship between geologic uncertainty and risk.

- 5.4 Geomechanical Site Characterization: The RP lists only two in-situ stress state measures in rock surrounding a salt dome or bedded salt. In-situ stress requires specifying five values not just vertical and one horizontal stress magnitude. Further, a variety of tests including stress, strain, tension, compression, compressive stress and temperature of salt and non-salt formations is needed and such tests need to be submitted to the regulatory agency.

- 5.5 Assessment of Cavern Stability and Geomechanical Performance: This section does not address a standard set maximum pressure equation, but rather discusses how it could be evaluated. This lack of specificity results in regulatory problems when determining what pressure is appropriate for the cavern to ensure integrity still occurs.

- 6.2 Hole Section Design: Does not address the issue of USDW’s encountered after surface casing is run and set. Also does not address specific surface casing setting depth or annular space minimums.

- 6.3 Casing Design: No testing specifications for casing strings or cement jobs are noted. Further, no specifications regarding the use of “used” casings are present.

- 6.4 Wellhead Design: These are good recommendations. However there should be no regulatory requirement for the type of wellhead used other than the use of a BOP and able to withstand the permitted pressure. Regardless, Safety factors should be applied to design calculations to
provide additional margin of mechanical strength. Should comply with API 6A and be rated for maximum operating and test pressures.

- **7.1 Rig and Equipment:** Ensuring the permit holder has the proper rig scheduled is not a duty of the regulator. This task generally falls to the drilling consultant. This section does not discuss the parameters for BOP testing.

- **7.3 Drilling Guidelines:** Within the geological evaluation of the site, there should be a determination if H2S has been present in any formation that will be proposed. If there has been H2S present within the township then monitoring equipment will be required.

- **7.4 Logging:** Based on section 7.4.3 there needs to be a description of when production casing logs should be run. Would they be required initially and or at some schedule timeline developed by the regulating agency? Cement bond logs should be required on all cemented strings to provide a baseline to compare against such logs as may be run in the future. Some consideration should be given as to whether the cement bond logs are run "under pressure".

- **7.6 Cementing:** It should be noted that individual states may have requirements about the types of cement that can be used. Also needs to specify that cement should be either brought to surface on all strings or up into the next string.

- **7.7 Completion:** Within this section there should be a discussion of when the depth of each tubing string should be adjusted.

- **8.2 Cavern Solution Mining Design:** The Nitrogen/Brine interface MIT shall be run once the cavern is built to proposed size. There needs to be a pass/fail criterion set up. Section 8.2.5 states that cavern size needs to be measured by sonar surveys, but there is no discussion to frequency of surveys. In section 8.4.2.8 states that sonar surveys should be run without tubing present and could provide frequency, but should be up to the operator.

- **8.3 Cavern Development Phases:** As part of development, operator should have implemented a subsidence observation grid capable of detecting very small levels of subsidence. This grid should be visited and recorded annually to monitor for subsidence. Further section 8.3.4 should contain a provision stating logs and any test run shall be submitted to regulatory agency.

- **8.4 Equipment:** There should be a requirement for emergency shutdown equipment on wells at all times not just during certain activities. Also, a flow meter or electronic device should be installed to measure amount freshwater injected into the cavern and the amount of brine withdrawn from the cavern.

- **8.5 Instrumentation, Control, and Shut Down:** There should be a requirement for a Supervisory Control and Data Acquisition (SCADA) system and over pressure protection or something equivalent for the cavern.
8.6 Monitoring of the Cavern: Section 8.6.7.4 should have special permit conditions placed on caverns that are located in salt deposits which have a history of methane trapped in the salt. The special permit condition should include a provision to perform more blanket depth test to ensure there is enough protection agency dissolution of the roof.

8.7 Workovers during Solution Mining: There should be a requirement for the inspector to be present once the tubing is removed from the well. The inspector should have authority to require a joint to be replaced. Workover operations should be proposed to and approved by regulator prior to implementing.

8.8 Workover to Configure for Gas Storage Service: Logs or tests capable of detecting roof-production casing seat integrity should be required prior to beginning operations and periodically after. MITs must be witnessed by regulatory authority and should be done anytime that operator believes integrity may have been jeopardized.

8.9 Debrining the Cavern: The RP does not address the issues of Underground Injection Control (UIC) classification of wells used for solution mining or disposal of the brine.

8.10 Existing Cavern Conversions: There is a list of criterion within section 8.10.1 which should be reviewed, however the RP lacks the minimum regulatory framework to show what standards need to be followed in a detailed way. Also the RP fails to describe how the regulatory agency would proceed in the permitting process if one or multiple criterion fail to meet the current standards.

8.11 Cavern Enlargement: The RP does not discuss the protocols for the regulatory approval of cavern enlargement.

9.1 Minimum and Maximum Operating Limits: Minimum and maximum operating pressures should be set or approved by the regulatory agency. RP does not state how minimum and maximum operating pressures are defined. Regulatory agency should oversee these pressures.

9.2 Equipment: Section 9.2.2 should specify that an ESD valve should be installed at or very near the manual valves. These valves should be part of an ESD system that automatically shut in the cavern in the event of an emergency.

9.3 Instrumentation, Control and Shutdown: Production casing annulus should be continuously monitored for pressure changes that may indicate and integrity issue. General cavern components should have control and shutdown devices installed.

9.4 Inspection and Testing: Section should be much more comprehensive and include notification, schedules and test criteria.

9.5 Workovers: Proper well control equipment must be on the wellhead during any workovers and capable of allowing work under pressure.

9.6 Site Security and Safety: No discussion of SSSVs or surface safety valves. All safety valves must be properly calibrated and function tested per API Specification 14A/ISO 10432. Based on the location of the
operation would there be different safety protocol or would there be one standard for all operations?

- **9.7 Operating Administration:** Section 9.7.4 states that records should be kept until facility is decommissioned. However it does not state what would be submitted to the regulatory agency. Records documenting cavern system development, operations, and maintenance should be maintained at least until the gas storage facility is decommissioned. The should include: geomechanical studies; drilling and completion reports and records; solution mining data; workover reports; sonar survey reports; MIT reports; gas temperature and pressure; injection/withdrawal history; instrument inspection and testing; safety (ESD) valve maintenance and testing; and non-destructive testing.

- **10.2 Holistic and Comprehensive Approach:** Section 10.2 states that there is no one best or preferred method to monitor cavern system integrity. However, it should have a requirement that the operator shall demonstrate Cavern System, wellbore cavern, and wellhead integrity.

- **10.3 Integrity Monitoring Program:** At a minimum there should be a base frequency for evaluating integrity of the system and accounting. Section should specify what actions are to be taken and by whom when a red-flag is identified.

- **11.2 Abandonment Design:** There is no mention of permitting requirements for abandoning the Class III well and cavern or for the operator to submit a plugging procedure for approval by the regulatory agency.

- **11.3 Removal of Stored Gas:** Does not include information on how much gas can be left in the cavern?

- **11.7 Sonar Survey:** There is no discussion of limits in bedded salts due to rubble piles.

- **11.8 Long-Term Monitoring:** Greater detail on subsidence monitoring needs to be included. Annual subsidence monitoring is recommended. Release of financial assurance instrument should not be allowed until a demonstration of gas removal, cavern equilibrium and lack of threat to environment or human health and safety is made.
RP 1171

- 3 Definitions and abbreviations: RP lacks definitions for MAOP, Risk Management Plan, cavern storage etc...
- 4.2 Functions of Underground Natural Gas Storage: This is informative but does not belong in a regulation.
- 4.3 History of Underground Natural Gas Storage in Depleted Hydrocarbon Reservoirs and Aquifer Reservoirs: This is informative but does not belong in a regulation.
- 4.4 Geotechnical Aspects of Underground Natural Gas Storage: This section does not contain recommendation about how a regulator should evaluate geotechnical aspects of a storage project.
- 5 Functional Integrity in the Design of Natural Gas Storage Reservoirs: Does not specify need for a permit for a new well or conversion of an oil and gas well to a gas storage well.
- 5.2 Geological Reservoir Characterization: The RP lacks information on what would be required geological information to submit at the time of permitting a new depleted natural gas storage reservoirs project. Section has no discussion of stress characterization.
- 5.3 Engineering Reservoir Characterization: Section does not specify what type of fluid characterization should be required. Additional needs include required tools to characterize reservoir. RP 1171 Section 8.6.1 Table 2 list key items to use. CSA Z341 - 7.2 defines vertical and lateral requirements for AOR and 7.3 list requirements on geologic studies, maps, fluid compatibility and observation wells. Further reservoir analysis from completion and production records is needed.
- 5.4 Containment Assurance of Reservoir Design: Additional design considerations for facilities such as flow erosion, hydrate potential, and disposal operations needed. Analysis needed for corrosive potential for various pressure range scenarios.
- 5.5 Environmental, Safety and Health Considerations in Design: May need to obtain API 51R[2] and API 76[3] as they identify "safeguards" for application is natural gas storage design. This may be covered by Act 238, Natural Gas Safety Act (MPSC).
- 5.6 Record Keeping: What kind of permitting is this section referring to? No mention of MIT’s.
- 6.2 Wellhead Equipment and Valves: Based on specific locations (urban areas, proximity to homes or business, etc.) there may be a regulatory requirement to place an emergency shutdown valves. Does not address general drilling requirements for BOP design and diverter design if conditions warrant, BOP testing requirements and mud design/operations.
- 6.3 Well Casing: Based on geological conditions there may need to be a requirement to set a stronger casing. (I.E. H2S zones or flow zones). There may also be a need to set a mine string based on location. Each wellhead should be equipped to monitor all casing and annular pressures.
6.4 Casing Cementing Practice: Need to reference mill testing and transportation requirements and more detailed specifics for each casing string such as requirements for compression, tension, burst and collapse. Criteria for new versus used casing. Post cementing casing test requirements and Formation Integrity Test requirements.

6.5 Completion and Stimulation: General requirements need to address possible need for specific additives based on local conditions (example - H2S or CO2 environment. Requirements for compressive strength, water loss and zone of critical cement. Specific designs: Surface casing - cement to surface with procedure remediate if necessary; Intermediate and Production casing - cement top requirements. References include CSA Z341 Section 5.4

6.6 Well Remediation: Need to reference casing flow and tubing/packer configurations. Need to require casing test and cement evaluation prior to perforating and any stimulation. Pre-stimulation requirements such as surface equipment testing. During fracturing the monitoring of area wells and casing annulus during pumping and risk management plan if conditions indicate a potential breach.

6.7 Well Closure (Plugging and Abandonment): During the plugging operation each cement plug shall be set across hydrocarbon bearing zones and across the entire storage interval to prevent zonation. Each plug should be tagged to verify location. Storage interval plug should be pressure tested to at least 500 psi.

6.8 Environmental, Safety and Health: There are four API guidance's listed within this section. However most of this section is very broad terms and not specifics. Emergency response plan needs to be updated and submitted to regulatory agency.

6.9 Testing and Commissioning: what pressure would be required to test the production casing? The note describes one method, however there needs to be a standard regulation for this test.

6.10 Monitoring of Construction Activities: There is no mention of regulatory supervision or approval or jurisdiction of state agency over drilling process.

6.11 Record Keeping: This appears to be a comprehensive list of records to be maintained by the operator but does not provide any authority to the regulator regarding submission, review, or actionable items.

7.2 Testing and Commissioning: Does not address how baseline conditions will be established for existing storage fields.

7.3 Reservoir Integrity Monitoring: No discussion of leak detection systems or equipment. There are no provisions for metering the amount of product in or out. What is an acceptable about of discrepancy?

7.4 Mechanical Integrity Monitoring: No requirements for continuous monitoring or for recording of monitoring. No testing schedule or test criteria thresholds.
8.2 Risk Management: Suggest submitting operator's risk management plan to regulator for review, adjustment, and approval with periodic required updates depending on storage dynamics.

8.3 Data Collection and Integration: CSA Z341 provides definitions for common terms in risk management. Recommend defining risk management, hazard, hazard identification, hazard analysis, risk assessment and risk prevention and mitigation.

8.4 Threat and Hazard Identification and Analysis: Needs more specific data for inspecting for risks.

8.5 Risk Assessment: Risk assessment prioritizes risks to know what risk management directives should be followed. Process or methodology is good notwithstanding should and shall and regulatory verification. Discussion of hazard in API 1171 addresses only well, well site and reservoir. CSA Z341 (Annex B.3.1.1) addresses loss of life, injury or illness, harm to the environment, damage to property (adjacent as well) and economic loss…recommend inclusion.

8.6 Preventive and Mitigative (P&M) Measures: Section discussion is at a very high level. Recommend inclusion from CSA Z341 Annex B…3.1.2, 3.1.3, 3.2 and 4.

8.7 Periodic Review and Reassessment: What constitutes or is meant by a multi-disciplinary team is not specified or described. All new threats should be immediately added to risk management plan.

8.8 Record Keeping: Does not contain a specific operator retention period and does not discuss submission to regulatory agency.

9.2 Integrity Demonstration, Verification and Monitoring Practice Overview: at a minimum the regulatory inspector should be notified when operating and maintenance practices occur on each well so that documentation of this activity can occur. How risk assessments are fed back into operations is not described.

9.3 Well Integrity Demonstration, Verification and Monitoring: How will 3rd party wells be verified if operator does not own these wells? There is nothing stating that a regulatory inspector must be present during tests of components

9.4 Reservoir Integrity: How would disputes between storage operator and third party operator if reservoir integrity became an issue? Regulator should be notified of any changes related to reservoir integrity and their effect on storage operations.

9.5 Gas Inventory Assessment: Section needs to specify appropriate and informative time intervals for gas inventory assessments. Does not specify reporting of inventory to regulatory agencies.

9.6 Flow and Pressure Monitoring: "Should" monitor flow rates and pressures of both wells and pipelines as potential reservoir or facility issue. Also "flow conditions" should be monitored for accelerating corrosion problems (wet versus dry, velocity/erosion) public should be site specific.
• 9.7 Integrity Non-Conformance and Response: "Should" document and maintain a program that lists anomalies and action taken. Continual program for addressing differences in actual versus design should be implemented. Integrity non-conformances are not specifically addressed in MPSC certification orders other than a typical requirement to notify MPSC staff of any abnormal operations or integrity issues that could impact public safety.

• 10.6 Emergency Preparedness/ Emergency Response: Emergency response plans were addressed in only a few of the MPSC certification cases. Not typically addressed in previous certification orders, but would likely be addressed in future MPSC certification cases.

• 11.4 Emergency Plans: Procedures for emergency plans have been addressed by the MPSC in a couple of cases, but are not typically addressed in MPSC certification orders. It's likely that going forward, the Commission may address emergency plans in certification orders.

The items listed above are examples only and do not reflect the entirety of the comments submitted to the Gas Storage Workgroup. The spreadsheet submitted with this document and entitled “Analysis of API RP’s 1170 and 1171” contains a complete listing of the comments submitted to the workgroup.