Technical Progress Report for the
Gas Storage Technology Consortium

Quarterly Report for the Period
January 1, 2006-March 31, 2006

By

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DISCLAIMER

ABSTRACT

Gas storage is a critical element in the natural gas industry. Producers, transmission and distribution companies, marketers, and end users all benefit directly from the load balancing function of storage. The unbundling process has fundamentally changed the way storage is used and valued. As an unbundled service, the value of storage is being recovered at rates that reflect its value. Moreover, the marketplace has differentiated between various types of storage services, and has increasingly rewarded flexibility, safety, and reliability. The size of the natural gas market has increased and is projected to continue to increase towards 30 trillion cubic feet (TCF) over the next 10 to 15 years. Much of this increase is projected to come from electric generation, particularly peaking units. Gas storage, particularly the flexible services that are most suited to electric loads, is critical in meeting the needs of these new markets.

In order to address the gas storage needs of the natural gas industry, an industry-driven consortium was created – the Gas Storage Technology Consortium (GSTC). The objective of the GSTC is to provide a means to accomplish industry-driven research and development designed to enhance operational flexibility and deliverability of the Nation's gas storage system, and provide a cost effective, safe, and reliable supply of natural gas to meet domestic demand.

This report addresses the activities for the quarterly period of January 1, 2006 through March 31, 2006. Activities during this time period were:

- Organize and host the 2006 Spring Meeting in San Diego, CA on February 21-22, 2006;
- Award 8 projects for co-funding by GSTC for 2006;
- New members recruitment; and
- Improving communications.

TABLE OF CONTENTS

DISCLAIMER ii
ABSTRACT iii
TABLE OF CONTENTS iv
LIST OF TABLES v
1.0 INTRODUCTION 1
2.0 EXPERIMENTAL 1
3.0 RESULTS and DISCUSSION 2
3.1 2006 Spring Meeting 2
3.2 New Members 4
3.3 Upcoming Meetings 4
3.4 Communications 5
3.5 Upcoming Activities 5
4.0 CONCLUSIONS 5
5.0 REFERENCES 5
6.0 APPENDICES 5
6.1 Appendix A: 2006 Spring Meeting Agenda 6
6.2 Appendix B: 2006 Project Executive Summaries 9

LIST OF TABLES

Table 1. 2006 Project Summary 3

1.0 INTRODUCTION

Gas storage is a critical element in the natural gas industry. Producers, transmission and distribution companies, marketers, and end users all benefit directly from the load balancing function of storage. The unbundling process has fundamentally changed the way storage is used and valued. As an unbundled service, the value of storage is being recovered at rates that reflect its value. Moreover, the marketplace has differentiated between various types of storage services, and has increasingly rewarded flexibility, safety, and reliability. The size of the natural gas market has increased and is projected to continue to increase towards 30 trillion cubic feet (TCF) over the next 10 to 15 years. Much of this increase is projected to come from electric generation, particularly peaking units. Gas storage, particularly the flexible services that are most suited to electric loads, is critical in meeting the needs of these new markets.

In order to address the gas storage needs of the natural gas industry, an industry-driven consortium was created – the Gas Storage Technology Consortium (GSTC). The objective of the GSTC is to provide a means to accomplish industry-driven research and development designed to enhance operational flexibility and deliverability of the Nation's gas storage system, and provide a cost effective, safe, and reliable supply of natural gas to meet domestic demand. Consortium technology development is conduced in the general areas of well-bore and reservoir, operations, mechanical, and salt caverns. Consortium members elect an Executive Council that is charged with reviewing projects for consortium co-funding. Proposals must address improving the production performance of gas storage and must provide significant cost share. The process of having industry develop, review, and select projects for funding ensures that the consortium conducts research that is relevant and timely to industry. Co-funding of projects using external sources of funding is sought to ensure that consortium funds are highly leveraged.

2.0 EXPERIMENTAL

A description of experimental methods is required by the DOE for all quarterly technical progress reports. In this program, Penn State is responsible for establishing and managing an industry-driven stripper well consortium. Technology development research awards are made on a competitive basis. Technical reports from the individual researchers are required to contain an

experimental discussion section and are submitted to consortium members and DOE for their review. Therefore, this section is not applicable to the Penn State contracted activities.

3.0 RESULTS and DISCUSSION

This report addresses the activities for the reporting period from January 1, 2006 through March 31, 2006. During this time period efforts were directed toward the following activities:

- Organize and host the 2006 Spring Meeting in San Diego, CA to review and select projects for GSTC co-funding;
- New members recruitment;
- Planning of the fall technology meetings; and
- Improving communications.

3.1 2006 Spring Meeting

The GSTC organized and hosted its 2006 Spring Meeting on February 21-22, 2006 at the Catamaran Resort Hotel, San Diego, CA. The agenda for this meeting is provided as Appendix A. The meeting experienced the largest attendance (50+) at a meeting to date. The meeting was dedicated to reviewing the proposals that were submitted to the GSTC for co-funding. In addition, a special presentation was given by the California Energy Commission on CEC funding opportunities. The Principal Investigators of the proposed projects provided a 25-minute presentation, followed by a question and answer session. Of the 15 proposals submitted, the Executive Council recommended 8 proposals for GSTC co-funding for a total of $887,027. Table 1 summarizes these projects. Appendix B contains a one page Executive Summary for the 2006 projects. The breakdown for the approved projects is as follows:

- Committed funding from GSTC $ 887,027
- Funding commitment from applicant $ 680,569
- Total project funds $1,567,596

TABLE 1: 2006 PROJECT SUMMARY

Title	Company City, State	Project Cost Summary			
		Total	GSTC	Applicant	Committed Funding
Effects of Tensile Loading on the Remaining Strength of Corroded Casing	Kiefner and Assoc. Arlington, VA	$259,800	$155,880	$103,920	$155,880
Protocol Evaluation for Scale Prevention and Remediation in Gas Storage Reservoirs and Formulations	Colorado School of Mines Golden, CO	$402,600	$237,600	$165,000	$237,600
Wellbore Cement Bond Integrity	U. of Texas Austin Austin, TX	$398,923	$237,591	$161,332	$237,591
State-of-the-Art Assessment of Alternative Casing Repair Methods	Edison Welding Institute Columbus, OH	$75,000	$45,000	$30,000	$45,000
Predicting and Mitigating Salt Precipitation	Correlations Co. Socorro, NM	$200,000	$120,000	$80,000	$120,000
Storage Field Wellbore Flow Data Containing Water and Hydrates	Colorado Engineering Experiment Station Nunn, CO	$261,988	$157,193	$104,795	$23,878
Brine String Integrity-Case History Survey and Model Evaluation	PB Energy Storage Houston, TX	$46,280	$27,768	$18,512	$27,768
Technology Feasibility Evaluation of Non-Intrusive Optical Detection, Monitoring and Preliminary Characterization of Casing Cement Leaks for Gas Wells	URS Group, Inc. Austin, TX	$56,320	$39,310	$17,010	$39,310
	Grand Total	$1,700,911	$1,020,342	$680,569	$887,027

3.2 New Members

The GSTC membership continues to grow and broaden in its diversity. During this quarter, 10 new members were added. Recruiting additional members throughout 2006 will continue.

- Edison Welding Institute
- Enbridge Gas Distribution
- Equitans
- Gulf South Pipeline
- Impact Technologies
- Kiefner and Associates
- Pacific Gas and Electric
- PB Energy Storage Services
- Shell Pipeline
- URS

3.3 Upcoming Meetings

The SWC is in the preliminary planning stage to organize two fall meetings in 2006.

San Francisco, CA. The first meeting will be held at the Serrano Hotel in San Francisco, CA in conjunction with the AGA Underground Storage Committee Fall Meeting on October 4, 2006. The meeting is still in the planning stage and will be organized to showcase selected GSTC research projects.

Pittsburgh, Pennsylvania. The second event will be held in the northeastern US in Pittsburgh, PA at the Embassy Suites Pittsburgh International Airport hotel. The meeting will be in conjunction with the Pipeline Research Council International (PRCI) Underground Storage Technical Planning Committee meeting and the Stripper Well Consortium (SWC) technology transfer meetings. The PRCI meeting will be on November 7, 2006. The GSTC meeting will be held on November 8, 2006, immediately following the PRCI meeting. The SWC technology transfer session will follow on November 9, 2006. The scheduling of back-to-back meetings will fit with the plans to strengthen the interactions between SWC, GSTC, and PRCI. This will expand the cross-fertilization of the two consortiums and allow delegates to conveniently attend all meetings. The meeting is still in the planning stage and will be organized to showcase selected GSTC research projects.

3.4 Communications

The GSTC website continues to be updated and redesigned (http://www.energy.psu.edu/gstc). The first electronic newsletter announcing the new project awards and upcoming events has been drafted. The newsletter will improve communication between the spring and fall meetings and increase the visibility of the Consortium. It is anticipated this newsletter will be distributed 3-5 times per year, in addition to being available on the website.

3.5 Upcoming Activities

During the next quarter the GSTC will:

- Work towards getting the subaward contracts in place for the 8 new projects;
- Continue to finalize the 2006 calendar;
- Continue planning for the fall technology transfer meetings; and
- Continue web redesign and updates.

4.0 CONCLUSIONS

During this reporting period, the GSTC provided $887,027 to co-fund 8 projects. These projects build upon 12 other projects that the Consortium has co-funded in previous funding cycles. The GSTC is preparing for two regional technology transfer meetings, one in the southwest (California region) and one in the northeast (Pennsylvania region) in the October/November time frame. The GSTC has laid a solid foundation for continued membership growth and industrial-relevant technology transfer.

5.0 REFERENCES

A listing of referenced materials is required by the DOE for each quarterly technical progress report. This technical progress report for the GSTC did not utilize any reference material.

6.0 APPENDICES

Appendix A: 2006 Spring Meeting Agenda
Appendix B: 2006 Project Executive Summaries

APPENDIX A:
2006 SPRING MEETING AGENDA

GSTC MEETING AGENDA
Catamaran Resort Hotel
3999 Mission Boulevard
San Diego, CA
20-22 February 2006

20 February 2006	
6:00-8:00 PM	**Evening Reception and hors d'oeuvres**

21 February 2006	
7:00-8:00 AM	**Breakfast Buffet**
8:00 – 8:30	Registration
8:30 – 9:00	**Introductions, Welcoming Comments, State of the GSTC**
9:00 – 9:30	Underground Gas Storage Hydrate Mitigation System *Presenter: Gas Technology Institute*
9:30 – 10:00	Brine String Integrity-Case History Survey and Model Evaluation *Presenter: PB Energy Storage Services*
10:00 – 10:30	**Break**
10:30 – 11:00	Ultrasonic Guided Waves for Monitoring Natural Gas Well Casing Integrity *Presenter: The Pennsylvania State University*
11:00 – 11:30	Low-Cost Enhanced Storage Well Completions Using High Power Lasers *Presenter: Gas Technology Institute*
11:30 – 12:00	Storage Field Wellbore Flow Data Containing Water and Hydrates *Presenter: Colorado Engineering Experiment Station*
12:00 – 1:00PM	**Lunch**
1:00 – 2:00	GSTC Collaboration Opportunities CA Energy Commission

	Proposal Continuations
2:00 – 2:30	Predicting and Mitigating Salt Precipitation *Presenter: Correlations Company*
2:30 – 3:00	Wellbore Cement Bond Integrity *Presenter: University of Texas at Austin*
3:00 – 3:30	**Break**
3:30 – 4:00	Technology Feasibility Evaluation of Non-Intrusive Optical Detection, Monitoring and Preliminary Characterization of Casing Cement Leaks for Gas Wells *Presenter: URS Group*
4:00 – 4:30	Pilot Study of Improved Methods for Desalination of Produced Waters from Underground Gas Storage *Presenter: Clemson University*
4:30 – 5:00	Protocol Evaluation for Scale Prevention and Remediation in Gas Storage Reservoirs and Formulations *Presenter: Colorado School of Mines*
5:30 – 7:30	**GSTC Evening Reception and hors d'oeuvres (outdoors-weather permitting)**

22 February 2006	
7:00 – 8:00AM	**Breakfast Buffet**
8:00 – 8:30	Reservoir Delineation Using a 2D Seismic Grid for the Development of an Offshore Gas Storage Field *Presenter: Schlumberger Data Consulting Field*
8:30 – 9:00	Advanced ASJ Drilling System *Presenter: Impact Technologies*
9:00 - 9:30	Effects of Tensile Loading on the Remaining Strength of Corroded Casing *Presenter: Kiefner and Associates*
9:30 – 9:45	**Break**
9:45 – 10:15	State-of-the-Art Assessment of Alternative Casing Repair Methods *Presenter: Edison Welding Institute*
10:15 – 10:45	Brine Disposal Improvements: Description of Produced Water Management Strategies in Oil and Gas Industry with Potential for Gas Storage Industry *Presenter: Texas Engineering Experiment Station/Texas A&M University*
10:45 – 11:00	**Closing Comments/Meeting Adjourned**
11:15	GSTC Executive Council Meeting and Working Lunch

APPENDIX B:
2006 PROJECT EXECUTIVE SUMMARIES

Effects of Tensile Loading on the Remaining Strength of Corroded Casing

Submitted by
Kiefner and Associates, Inc.

Executive Summary

Decisions by storage operators to repair or replace well casing with metal loss require an accurate assessment of the degree of metal loss and the ability to determine the effect of that loss on the remaining strength of the casing. A new generation of logging tools has increased the ability to accurately size metal-loss defects in casing. Current assessment tools such as B31-G and RSTRENG are based solely on internal pressure. The service loads on a casing can include axial loading and external pressure. As a result, the predicted failure pressure has been shown to be very conservative. There are two issues that need to be addressed if the ability to evaluate metal-loss defects in borehole casing and tubing is to keep pace with the recent developments in logging tools.

- First, the database used to validate any new criterion for borehole casings and tubing needs to be extended to incorporate tests that include axial loading and internal pressure.
- Second, a new criterion for the evaluation of metal loss in casings and tubing that incorporates the actual stress applied to these components needs to be developed.

We view the development of an evaluation criterion, the second objective listed above, as the main deliverable of this project. The purpose of any experiments is to develop and validate this criterion. Since the testing is essential to the validation of any criterion, we will address it first.

Test plan. A well-thought-out test plan is critical to the successful completion of this test program. The test matrix will be developed with input from five storage operators. We will submit a written test plan to the project sponsors for approval within 1 month of initiating this project. The experimental test matrix will include the key variables that will be used by any assessment criterion. In order to keep the test matrix at a reasonable size, we will focus on determining the limiting values of these parameters and include them in the test matrix. This means focusing on a range of corrosion defects that will fail at or below typical operating parameters of the casing. We feel that a matrix of eight to ten tests will be sufficient to meet the objective of this project. Important variables that we will consider in the test design are the design of the specimen, the order of loading on the specimen, and the data that will be collected during the test. Fully documented test results will be a deliverable of this project.

Tool for predicting remaining strength of corroded casing. We propose basing this criterion on the API 579 Fitness-for-Service (FFS) Level 2 assessment of corrosion modified as necessary to account for the parameters of this problem. The advantage of this approach is that it will be based on an industry-accepted criterion and it uses calculations that can be readily implemented in a spreadsheet or computer program. The Level 2 analysis includes supplemental loadings so it accounts for the biaxial stress state and the possibility of different failure modes based on these stresses. Assuming that the criterion is validated by the test results, the criterion will require some modification to incorporate the data obtained from an inline inspection of a casing. In some cases, a more detailed analysis may be warranted. In these cases, we propose developing

guidelines for a Level 3 finite-element analysis (FEA) based on equivalent stiffness for the corroded area. This will eliminate the need for explicitly modeling the complete geometry of the corroded area. An algorithm for calculating the remaining strength of corroded casing based on API 579 Fitness-for-Service Level 2 criteria along with guidelines for performing a more detailed Level 3 analysis based on a finite-element analysis shell model will be a project deliverable.

Protocol for Mitigation and Remediation of Scale Formation in Gas Storage Reservoirs and Wellbores

EXECUTIVE SUMMARY

The near-wellbore porous media and the wellbore represent the underground natural gas storage operator's linkage with his inventory. As such the health of the wellbore is a critical feature of the performance of the storage system. Scale commonly forms in wellbores and many in the industry believe it also forms in the porous media near the wellbore. Scale may be halite-, sulfate-, or carbonate-based, but the literature suggests that halite scale is the common problem for gas storage operations.

There is a limited public technical information regarding methods for mitigating or remediating scale, particularly from independent third-party evaluations. Technical literature focuses on the chemical nature of the precipitation and dissolution processes for a single chemical species, under one reservoir condition (T, P), with one chemical treatment approach. The utility of the technical literature to gas storage operators is limited.

We propose a comprehensive laboratory study of the deposition and removal of chemical scale under reservoir conditions in both sandstone porous media and carbon steel tubing, using existing products and treatment methods. Storage operators will be canvassed to determine reservoir operating conditions (T, P), gas – water ratios during injection and production operations, water salinity (concentration and composition), and wellbore architecture (dimensions, tubing metallurgy, inhibitor treatments) and flow rates. We will also develop a historical accounting of scale management practices and their quantitative efficiencies associated with the reservoir/wellbore conditions.

Three experimental apparati will be constructed to develop an empirical understanding of the deposition and dissolution of scale in sandstone and on carbon steel. Deposition potential and deposition rate will be measured first. Subsequent to developing an understanding of when and how much, we will test existing products for their effectiveness at removing the scale. Effectiveness will be quantified in terms of amount of scale removed as a function of treatment time and volume.

The research project will deliver a report documenting the effectiveness of products available under the range of conditions and salt compositions seen in gas storage operations.

I. Public Executive Summary

Technical, economic, environmental, and safety considerations underscore the pressing need by gas storage operators to understand the ways in which elements of a well bore and cement sheath interact during drilling, completion, and production operations. Research proposed here is for continuation of GSTC-supported research designed to develop a better understanding of cement hardening, cement adhesion, and the effects of cyclic pressure and temperature-related stresses on these processes. It is our belief that this understanding will assist in the development of improvements in cement/casing/formation seals, and of better techniques for assessments of seal quality with down-hole logging tools.

A detailed survey of available information about cement quality, cementing casing, and tools used to monitor bond quality has begun. Suites of laboratory tests are being carried out to quantify what happens, when, where, and in what magnitudes and orientations, during casing, cement, and formation interactions. Testing will be carried out in bench-top simulations of well-bores in blocks of reservoir rock, as well as in sophisticated test chambers designed to realistically simulate the down-hole environment. These tests investigate behavior in cement slurry during set up, assess temperature and pressure variations on cement-casing bonding, and investigate the effects of cyclic differential thermal and pressure-induced stresses on cement-casing adhesion and axial wave amplitudes and their correlation to cement bond integrity. These tests are carried out in sophisticated triaxial testing facilities that have been developed and used over four decades of research in this laboratory, and in bench-top test apparatus developed specifically for this testing program. Measurements will continue in all these systems, and an additional scale model testing system will be developed during this second program year.

Research in this project is being carried out in concert with an ongoing research consortium, Life-Of-Well Rock, Fluid, and Stress Systems. This collaboration provides substantial leveraging of funds, coordination of research with industrial needs, access to state-of-the-art developments in cementing and well logging techniques, and recipes for cement formulations in current use. Development of analytical and numerical simulators, having the capability and versatility to honor processes and parameters from testing activities, are slated for development over an estimated two years in the Life-Of-Well cementing project, beginning 1 January 2007. Simulations will treat temperature effects such as thermal expansion and variations in stiffness and strength. Measurements of mechanical and thermal properties of the various borehole elements measured in simulated bore-hole conditions will be incorporated. Microscopic processes such as micro-fracture, grain-boundary sliding, and cementation in a granular material will be simulated with discrete element (DEM) models, which are designed specifically treat processes associated with grain-to-grain interactions. These simulations will assist in the design of test configurations for experimental measurements.

Following this second one-year research program, proposals will be submitted for investigations of improvements of techniques for down-hole assessments of cement-bond integrity with down-hole logging tools, with direct collaboration of industrial partners.

PUBLIC EXECUTIVE SUMMARY

State-of-the-Art Assessment of Alternative Casing Repair Methods

Principal Investigator: Mr. William A. Bruce, P.E.
Edison Welding Institute, Inc. (EWI)
1250 Arthur E. Adams Drive, Columbus, Ohio 43221
Ph. (614) 688-5059, Fax (614) 688-5001, Email bill_bruce@ewi.org

Background

Natural gas storage well casings occasionally require repair as the result of deterioration over time. Currently-used repair methods are costly and often create flow restrictions and subsequent operational limitations. Alternative repair methods for natural gas storage well casings are required to lower the costs of casing repairs and to reduce operational constraints.

Objective

The objective of this project is to survey current state-of-the-art repair technologies to identify better alternatives to currently-used methods for casing repair.

Statement of Work

The statement of work can be summarized as follows:

- Review of design requirements
- Review of service loads and service environments
- Review of damage mechanisms
- Review of existing/currently-used repair technologies
- Review of candidate alternative repair methods
- Assessment of alternative repair method capabilities
- Development of recommendations
- Reporting

Budget and Duration

The project is estimated as a 12 month, $75,000 effort. The portion of the estimated cost that is being cost shared by PRCI is $30,000.

Anticipated Results

If effective alternative casing repair methods can be identified, their use will reduce the costs of repair and reduce operational constraints following repair.

Contractor Information

Based in Columbus, Ohio, EWI is North America's leading engineering and technology organization dedicated to welding and materials joining. EWI's staff provides materials joining assistance, contract research, consulting services, and training to over 3,300 member company locations representing world-class leaders in the aerospace, automotive, defense, energy, government, heavy manufacturing, medical, and electronics industries. Cost sharing contribution is being provided by Pipeline Research Council International Inc. (PRCI).

PUBLIC EXECUTIVE SUMMARY

Storage operations often involve the production of brines along with stored gas or liquid products. As the produced brine encounters changing pressure and temperature in the wellbore, wellhead, and gathering system, salt can precipitate. A number of products claim that they prevent or remove salt precipitates. However, the effectiveness of these products varies from situation to situation for reasons not well understood. There is a need to determine how to choose methods that will be effective for particular sets of conditions.

The objectives of the proposed study are to assess the effectiveness of current methods to prevent and mitigate salt precipitate and to provide guidance on making choices. Both laboratory experimental work and engineering analyses will be applied to meet the objectives.

The scope of work will include assessing the effectiveness of current methods of preventing and mitigating salt precipitate, analyzing successes and failures of current field applications to determine the reasons for salt deposition, and developing guidance that storage operators can use to choose methods that have the highest chance of success for their systems. The system will include wellbores, wellheads, and gathering lines.

Assessing the effectiveness of current methods will involve working with storage operators who have had both good and bad results in preventing or mitigating salt precipitation. Pertinent data will be collected and are expected to include (but not necessarily be limited to) the products used and system variables (pressure, temperature, brine composition, application method, well completions, and system configuration).

Analysis will involve evaluating the successes and failures and attempting to relate them to the products used as well as the system variables. The products will be described in generic chemical classes rather than specific formulations. Laboratory experiments will be developed to physically model the water chemistry involved in salt precipitation. These experiments will provide a baseline for evaluating commercially available products that inhibit salt formation. The laboratory work will also be the basis for numerically modeling the thermodynamics of salt precipitation.

The results of the proposed work will provide protocols for the selection and application of salt precipitate methods that will make storage operators more successful in preventing or remediating precipitate problems.

Three benefits are expected from more effective salt precipitate prevention and remediation:

- Development of a numerical model to predict salt precipitation at points of pressure-temperature-water chemistry-water source change in a gas storage facility;
- Lower costs for treatments by reducing the number of ineffective treatments; and
- Increased operational efficiency by reducing down time required for treatments.

The deliverable from this project will be a report that addresses the effectiveness of available prevention and mitigation methods and provides guidance to operators on choosing the best methods for gas storage facility applications.

GSTC PROPOSAL

Storage Field Wellbore Flow Data Containing Water and Hydrates

Executive Summary

The objective of this project is to obtain full-scale experimental flow data on the development of hydrate blockages in natural gas storage field wellbores and valves. The measured data will closely simulate actual hydrate flow conditions in the wellbore when hydrate blockages occur. The experimental results will be used to identify and minimize blockage problems in the wellbore and valves.

High pressure natural gas flow data will be measured over a range of flow rates with hydrates in the wellbore at the CEESI Hydrate Flow Test Facility (HFTF). The measurements include flow rate, temperature, pressure, and in-situ flow visualization monitors. The data will be compiled, compared and analyzed with data provided from gas storage fields. The results will improve wellbore operation procedures, safety and hydrate remediation in the wellbore.

1.0 PUBLIC EXECUTIVE SUMMARY

Brine strings are essential components of both natural gas and liquid hydrocarbon storage caverns. Both the natural gas and liquid hydrocarbon storage industries are well aware that a limit exists for the fluid velocity in the injection tubulars in their storage caverns. If the brine injection or brine withdrawal velocity is gradually increased, eventually, the hanging tubular will experience flow-induced vibration, resulting in the potential for the hanging tubulars to bend and/or break off. Additionally, in both types of storage, salt falls can impact the brine string integrity.

The magnitude of the velocity limit for flow-induced vibration of the hanging tubulars in salt caverns is not known. In the absence of a clearly defined method for determining the maximum allowable fluid velocities in the hanging tubulars, industry has attempted to adopt a conservative maximum flow velocity based on "industry experience." Sometimes this works and sometimes it does not. The objective of this project is to better define the causes of brine string failure and failure mitigation technologies. The project will (1) compile case histories of brine string failures in solution mining, liquid hydrocarbon storage, and gas cavern dewatering; (2) evaluate case histories with models (proposed in the literature) for brine string failure; and (3) develop recommendations for maximizing brine string integrity.

Public Executive Summary

Gas losses from underground storage are an economic loss and are undesirable for other reasons. One source of leaks is the deterioration of the exterior casing cement between outer casing and the inside of the borehole. Cracks and separation of the cement along the outer casing wall are other pathways. The rate of loss can be a measure of the integrity degradation of both casings and casing cement. The rapid and cost effective detection and measurement of leaks and leak rates for both active and abandoned wells has value to the industry. Improved methods have economic, environmental, safety, and operational benefits.

This proposal, entitled **Technical Feasibility Evaluation of Non-Intrusive Optical Detection, Monitoring and Preliminary Characterization of Casing Cement Leak for Gas Wells**, is for a trial feasibility evaluation of Tunable Diode Laser (TDL) remote sensing for determining gas loss emissions in active or abandoned wells and from other gas field locations. Measured data on methane concentrations will be input to a modified gas release model template customized to the proposed application. The TDL has been used in other venues but to our knowledge has not been applied nor the results of this use been integrated into gas storage operations as a useful tool that supports multiple objectives; economic, reliability, environmental, and safety. A field test is proposed at a volunteer facility where leakage is suspected or known, and the emission data used to yield an emission and leak size estimate. This will lay the foundation for developing a preliminary protocol for monitoring changes in well tightness over time as influenced by operational cycles. This project will determine if the proposed methodology and proposed protocol is worthy of further development based on technical and economic factors.