UNDERGROUND GAS STORAGE TECHNOLOGY CONSORTIUM

R&D PRIORITY RESEARCH NEEDS

WORKSHOP PROCEEDINGS

February 3, 2004
Atlanta, Georgia

Underground Gas Storage Technology Consortium R&D Priority Research Needs

OVERVIEW

As a follow up to the development of the new U.S. Department of Energy-sponsored Underground Gas Storage Technology Consortium through Penn State University (PSU), DOE's National Energy Technology Center (NETL) and PSU held a workshop on February 3, 2004 in Atlanta, GA to identify priority research needs to assist the consortium in developing Requests for Proposal (RFPs). Thirty-seven active participants and seven observing energy professionals representing industry, academia, and National Laboratories participated in two parallel facilitated working sessions to develop input to the RFP development process. Two focus questions were presented to the active participants:

1. What research needs to be done to demonstrate technologies to preserve and improve deliverability of *conventional* underground gas storage reservoirs and salt cavern storage facilities?

2. What research needs to be done to develop man-made storage systems and other *non-traditional* methods of natural gas storage in close proximity to demand centers?

PROCESS

Participants were divided into two groups identified as the Blue Group and the Orange Group. Grouping was arbitrary as each of the sessions operated in parallel and addressed the same two focus questions. As the participants were asked the first focus question, idea generation began and thoughts were captured. Following organization and categorization of these ideas, the participants were asked to vote on the ideas to signify those of highest priority. The groups identified near-term and long-term priorities with respect to their generated needs. This process was repeated for the second focus question.

SUMMARY OF RESULTS

The following table contains the highest-priority topics identified by each group. The complete results of each group are presented and discussed in the subsequent sections.

Conventional Storage		Non-Traditional Storage	
Blue Group	**Orange Group**	**Blue Group**	**Orange Group**
Near-term • Handling produced water • Remove wellbore damage for good • Low cost gas measurement system • Smart pipe production casing • Prevent water from encroaching on wellbore **Long-term** • None	**Near-term** • Improved reservoir description • Quality of product shipped/delivered • Study cement bond and integrity longevity • Improve pipe and well casing integrity monitoring • How do you prove integrity • Expansion of existing aquifers **Long-term** • Improve LNG technologies • Implicit gas network – reservoir simulator system • Salt cavern mechanical integrity standards • Progressive souring of reservoirs	**Near-term** • Increase low permeability, low pressure aquifers • Household hydrates • House sized carbon/coal filled storage cells • Cost effective method for creating caverns in hard rock at depth **Long-term** • None	**Near-term** • Underground LNG storage • Low cost lining for mines and caverns • Storage as gas hydrates • Methods for storage in abandoned mines • End-user storage tanks **Long-term** • Storage as gas hydrates • Sorption of gas onto a solid

Blue Group

Conventional Storage

BLUE GROUP	
NAME	**ORGANIZATION**
Michael Adewumi	Penn State
Ken Beckman	International Gas Consulting
Jerry Benson	Isotech Laboratories
Karen Benson	Panhandle Energy
Bob Bretz	New Mexico Tech
Ken Brown	Schlumberger DCS
Jim Castle	Clemsen
Charles Chabannes	Solution Mining Research Inst.
Jim Chown	Michigan Consolidated Gas
Shari Dunn-Norman	University of Missouri – Rolla
Mark Gredell	Duke
Peter Gross	NUI
Floyd Hofstetter	Kinder Morgan
Tim Illson	Advantica Limited
Jim Janson	Puget Sound Energy
Jim Mansdorfer*	Southern California Gas
Richard Mantia	Mississippi River Transmission
Don Vogtsberger	Baker Atlas
Bill Weiss	Correlations Company
OBSERVERS	
Dan Driscoll	DOE/NETL

*** Report out person**

FACILITATOR: KEVIN MOORE, ENERGETICS

Practically all research would be for a near-term (0 – 5 year) time horizon for conventional gas storage. In fact, there was consensus that no long-term assessment was necessary. There was an overriding consensus to emphasize the need for practical research to solve immediate problems for operators using leading edge, but not cutting edge, technology. Moreover, there was general skepticism about deviating from this emphasis and addressing the second question on non-traditional methods. The group noted there is the need for research and DOE-backed demonstration to identify the benefits of overcoming regulatory barriers. However, this was not to be considered within the purview of the DOE effort. One industry representative noted that some of the easiest engineering expansion and upgrade projects for utilities cannot be done because of regulatory barriers – new compressors cannot get approval under the best-available-control-technology criterion.

Conventional research needs from the Blue Group were categorized under nine major headings: Reservoir, Mechanical, Water Issues, Data Management, Formation Damage, Salt Cavern, Drilling and Completion, Regulatory Barriers, and Market. Participants prioritized conventional research needs using four votes each. There were two research needs with eight votes each. One of these needs was near well and wellbore damage: remove it for good including scales, fines, salts, asphalt, etc. The other need with eight votes was for a new approach to handling of produced water. Three other needs received five votes each: prevent water from encroaching on the wellbore and reducing relative permeability, expand smart pipe concepts to production casing to prove concept and a low cost, low maintenance (plus or minus 10 percent) individual well head multiphase gas measurement system. Water issues dominated the voting with two of the top five vote-getters. With respect to the column headings, Reservoir and Mechanical headings got the most total votes, so although none was a top vote-getter, there certainly is evidence that these are very important research areas. In fact some of the cards could have been easily combined to be a top vote-getter.

Non-Traditional Storage

The Blue Group was concerned that the second focus question was deviating from the goal of the consortium to provide immediate practical solutions for gas storage operators. Nevertheless, the group realized that the non-traditional area had the potential for some breakthrough discoveries and applications that must not be overlooked given immediate needs. For example, small scale applications in the home could have a dramatic impact on the thinking of what is needed for research. The timeframe for this second question is therefore longer than the first question, but no distinction was made in the voting prioritization.

Non-traditional research needs from the Blue Group were categorized under nine major headings: Data Management, Refine Existing Technologies (not yet commercial), Field Demonstration, Expand Existing Presently Commercial Feasibility Studies, and Other. Participants prioritized research needs using three votes with a choice between high priority and low priority with respect to the first question. The low priority votes out-weighed the high priority two-to-one supporting the observation that there was more concern for the first question. All votes were counted for prioritization. The number one vote-getter was to increase low permeability and pressure aquifer storage R&D with 11 votes. Two other needs had relatively high votes: small scale household hydrates with eight votes and house sized carbon/coal filled storage cells with seven votes. Developing a cost effective method for creating caverns in hard rock at depth received five votes, and this need is related to the laser made cavern storage need with four votes.

BLUE GROUP

TABLE 1. WHAT RESEARCH NEEDS TO BE DONE TO DEMONSTRATE TECHNOLOGIES TO PRESERVE AND IMPROVE DELIVERABILITY OF *CONVENTIONAL* UNDERGROUND GAS STORAGE RESERVOIRS AND SALT CAVERN STORAGE FACILITIES?

◆ = NEAR-TERM HIGH PRIORITY

RESERVOIR	MECHANICAL	WATER ISSUES	DATA MANAGEMENT	FORMATION DAMAGE
• Develop methods to increase injectivity to provide increased cycling capability and/or reduced fuel usage ◆◆ • Develop technology to maintain existing path from formation to wellbore for gas flow ◆◆◆ • Laboratory research to demonstrate that changing wettability increases gas deliverability ◆ • Develop new innovative technologies to increase capacity of existing storage fields at low cost, e.g., gas wettability ◆ • Lost gas ◆◆ - Condensates - Migration - Fractured reservoirs • Develop technology to enhance/improve formation interconnectivity like multilateral • Field experiments to demonstrate that changing wettability increases deliverability and interpretation fuzzy logic ◆ • New approaches to modeling gas cycling into and out of storage ◆◆◆◆ • Inventory verification –better techniques given changing use of reservoir fields, e.g., average pressure ◆◆◆	• Develop better understanding of max delta temperature casing can withstand without failure of cement or joints ◆◆◆◆ • Develop improved corrosion management methods to enhance availability (especially bacterial control) • Develop new tools/techniques to verify integrity of casing strings, e.g., logging tools ◆◆◆◆ • Research to demonstrate improvements in deliverability by mechanical means such as new coil tubing tools ◆ • Gas to electricity concepts at peak production; borehole factory? Downhole fuel cell ◆◆ • Improve life prediction and integrity prediction for gas storage wells to maintain capacity ◆ • Evaluate atypical compression/reservoir combinations for rapid in/out (4ms) activity - Ultrasonic meters • Expand “smart pipe” concepts to production casing to prove concept ◆◆◆◆◆	• New approach to handling of produced water ◆◆◆◆◆◆◆◆ • Develop cost-effective means of H_2O removal at end of withdrawal season • Develop ways to delay or prevent wells from “watering off” • Prevent water from encroaching on the wellbore and reducing relative permeability ◆◆◆◆◆	• Low cost, low maintenance ±10% individual wellhead gas measurement system – multi-phase ◆◆◆◆◆ • Develop web-based data management tool to store/archive/retrieve and (automatically) analyze routinely collected surveillance data ◆ • Determine what cross technologies and data minding with E&P ◆ • System optimization software that ties together industry well data, hydraulics gathering (pipe line simulation – nodal) comp station characterization and overall system dispatch ◆◆◆◆	• Continue investment in skin damage remediation completion technology N_2/CO_2 • Near well and wellbore damage; remove it for good- scales, fines, salts, asphalt, etc. ◆◆◆◆◆◆◆◆ • How to cost-effectively identify and treat well damage mechanisms – lots of work done, still no good solution • Fundamental research aimed at understanding the fundamental cases of most common damages in reservoirs ◆ • Improved cleanout/stimulation techniques to remediate damage ◆◆ • Wellbore damage ◆ - Near wellbore hydraulics - Liquid banking

BLUE GROUP

TABLE 1. WHAT RESEARCH NEEDS TO BE DONE TO DEMONSTRATE TECHNOLOGIES TO PRESERVE AND IMPROVE DELIVERABILITY OF *CONVENTIONAL* UNDERGROUND GAS STORAGE RESERVOIRS AND SALT CAVERN STORAGE FACILITIES? *(Continued)*

◆ = NEAR-TERM HIGH PRIORITY

MARKET	SALT CAVERN	REGULATORY BARRIERS	DRILLING AND COMPLETION
• Leading edge but not cutting edge technology • Demonstrate and design improved and more efficient commercial utilization of storage; get out of box get marketplace involved ◆	• Develop model to predict water content of gas in salt caverns during withdrawal • Salt casing design; best practices recommendation ◆◆	• Research to identify benefits of overcoming regulatory barriers, e.g., new compressor/ammonia • DOE demos technology to help with specific regulatory barrier	• Develop new methods or materials for completion to enhance production/injection (nanotechnology?) ◆ • Design and improve horizontal drilling techniques and completions tailored specifically for storage injection and withdrawal ◆

BLUE GROUP

Table 2. What Research Needs to be Done to Develop Man-Made Storage Systems and Other Non-Traditional Methods of Natural Gas Storage in Close Proximity to Demand Centers?

◆= High Priority, ✶ = Low Priority

Data Management	Refine Existing Technologies (Not Yet Commercial)	Field Demonstrations	Expand Existing/ Presently Commercial	Feasibility Studies	Other
• Review studies and case histories of existing or proposed projects ◆◆	• Chilled gas storage (wellbore integrity) • Large scale adsorbed natural gas storage ◆ • Chemical storage convert to liquid, store by conventional means, e.g., methanol ◆ ✶✶✶ • Develop cost-effective method for displacing base gas; bladders, inerts, etc. ◆ • LDC system use of line pack upgrades ◆ ✶ • Develop cost effective method in creating caverns in hard rock at depth ◆ ✶✶✶✶	• Conduct field demonstration (field trial) for new methods that appear promising based on prior feasibility analysis ◆◆	• Increase low K,P aquifer storage R&D ◆◆◆◆◆ ✶✶✶✶✶✶	• Coal bed methane gas storage feasibility study ✶✶ • New techniques to seal existing deep hard rock mines; seal spray ✶✶✶ • Air storage in aquifers and depleted reservoirs ✶✶ - status and feasibility • Research and develop effective gas storage using surface water storage reservoirs near large markets ✶✶ • Laser made cavern storage ✶✶✶✶ • Household hydrates (small scale) ◆◆ ✶✶✶✶✶✶ • Small storage containers that can be sited at power plants or other users ◆ • Carbon/coal filled storage cells ✶✶✶✶✶✶✶ - Small storage - House sized	• Regulatory barriers secondary in long term • Demand side management and alternative fuels

ORANGE GROUP

Conventional Storage

ORANGE GROUP	
NAME	**ORGANIZATION**
Steve Bergin	ONEOK
Ilkin Bilgesu	West Virginia University
Steve Caldwell	CEESI
Larry Chorn	CSM
Kerry DeVries	RESPEC
Glenn DeWolf	URS
John Guoynes	Halliburton
Ray Harris	National Fuel
Steve Heath	Williams
Ann Justice	MAPL
Larry Kennedy	El Paso
Larry Lake	University of Texas
Bill Savage	NITEC
Tom Stemmer	BASIC
Richard Stocke	Texas Gas
Andy Theodos*	Columbia Gas
Terry Williams	Buckeye P/L
Joe Young	Sunoco Logistics
OBSERVERS	
Rodney Anderson	DOE/NETL
Steve Foh	GTI
Christina Sames	PRCI

*** REPORT OUT PRESENTER**

FACILITATOR: ALICIA DALTON-TINGLER, ENERGETICS

Conventional research needs from the Orange Group were organized into nine categories: Integrity, Above Ground Equipment, Product Quality and Chemistry, Reservoir Description, Salt Cavern Issues, Deliverability, Subsurface Equipment, Damage, Inventory, and Performance. Participants in this group voted twice on these conventional research needs so that priorities for near-term (0 – 5 years) research and long-term (greater than 5 years) research could be established. For the near-term timeframe, three conventional storage research needs tied as having the highest number of priority votes, while a four-way tie existed for the second highest priority research need. Three of the top seven near-term research needs were included under the Integrity heading and were as follows: Study cement bond and integrity longevity, Improve pipe and well casing integrity monitoring, and How do you prove integrity/How do you know when you've met the requirement for integrity. The other top vote-getters included the following: Improve reservoir description, Research overall quality of product shipped, Salt cavern stability, and Expansion techniques of existing storage like aquifers. When the participants voted for long-term research needs, two ideas tied for the highest priority, and two other ideas were tied for the second highest priority. Two of these four needs, both categorized as Product Quality and Chemistry, were Improved LNG technologies and Progressive souring of gas reservoirs. The other two top vote-getters were Salt cavern mechanical integrity testing standards and Investigate benefit of implicit gas network - reservoir simulator system. The group was later informed that the Blue Group participants did not identify long-term priorities relative to conventional research needs nor did they identify near-term priorities for non-traditional research needs. The Orange Group was asked if they still stood behind their dual-voting, and the participants agreed that there are conventional research needs that are near-term priorities and others that are long-term priorities. The group decided to continue with the dual-voting to represent time frames for their second set of research needs.

Non-traditional Storage

Non-traditional research needs generated by the Orange Group were categorized into the following nine headings: Centralized Storage, Low-pressure Storage, LNG, Distributed Storage, Coating/Liners Materials, Security Safety and Risk, and Optimization Studies. Participants voted to identify top priority non-traditional research needs for the near-term (0 – 5 years) and then again for the long-term (greater than 5 years). Two non-traditional research needs each received nine votes, placing them in a tie for the highest priority need. These needs were Underground LNG storage and Low cost lining for mines and caverns. Second and third highest priorities were identified as Storage as gas hydrates and Methods for storage in abandoned mines, respectively. When the participants voted to identify long-term non-traditional research needs, both of the top vote-getting needs were categorized as Low-pressure Storage – Storage as gas hydrates and Sorption of gas onto a solid. The storage as gas hydrate need was a top vote-getter in both the near- and long-term timeframes as participants believe this needs should achieve significant progress within the 0 – 5 year timeframe and beyond.

ORANGE GROUP

TABLE 1. WHAT RESEARCH NEEDS TO BE DONE TO DEMONSTRATE TECHNOLOGIES TO PRESERVE AND IMPROVE DELIVERABILITY OF *CONVENTIONAL* UNDERGROUND GAS STORAGE RESERVOIRS AND SALT CAVERN STORAGE FACILITIES?

◆ = NEAR-TERM HIGH PRIORITY; ✶ = LONG-TERM HIGH PRIORITY

INTEGRITY	ABOVE GROUND EQUIPMENT	PRODUCT QUALITY AND CHEMISTRY	RESERVOIR DESCRIPTION	SALT CAVERN ISSUES
• Safety equipment for well head and piping • How do you prove integrity? How do you know when you've met the requirement? ◆◆◆◆◆ ✶ • Improve pipe and well casing integrity monitoring ◆◆◆◆◆ ✶ • Log for gas behind pipe; look for gas where it should not be ◆◆ • Improve reliability of well stringers and casings – Improve life • Study cement bond and integrity; longevity ◆◆◆◆◆◆ • Improve methods of casing integrity evaluation ◆ • Materials development to improve reliability and life of casing downhole ◆ ✶✶✶✶	• Design criteria for facility sizing to meet demand upsets (economic and flexible) ◆◆ ✶✶✶✶ • More flow measurement studies; flow assurance; quality assurance ◆◆ • Improve surface facility integrity; high pressure differential • Safety equipment for well head and piping	• Prediction of geochemical changes in reservoir/aquifer ◆ • Fluid compatibility; reservoir fluids and pipeline chemicals ◆ ✶ • Non-damaging scale inhibitor ◆ • Improved LNG technologies ✶✶✶✶✶✶✶ • Research overall quality of product shipped/delivered; determine best practice ◆◆◆◆◆◆ ✶ • Remove fluid from system (cost-effective) ◆ • Liquid detection improvement • Progressive souring of gas reservoirs ◆ ✶✶✶✶✶✶	• Improved reservoir description; characterization of the storage reservoir ◆◆◆◆◆◆ ✶✶	• What will be the impact of clean fuels requirements? (Is there enough storage?) ✶✶✶✶ • Develop sound measurement devices to determine cavern levels (other than meters) ✶✶✶ • Brine disposal: how and where, new technologies ◆◆ - Northeast, Michigan, East • Salt cavern mechanical integrity testing standards ✶✶✶✶✶✶ • Preserve salt caverns – best practices to minimize cavern growth • Salt cavern stability/growth rates, interconnection ◆◆◆◆◆ ✶✶ - Develop guidelines for growing solution-mined caverns (How much is too much?) - Expansion techniques of existing salt cavern storage - Develop guidelines for management of salt caverns (other than past practices)

ORANGE GROUP

TABLE 1. WHAT RESEARCH NEEDS TO BE DONE TO DEMONSTRATE TECHNOLOGIES TO PRESERVE AND IMPROVE DELIVERABILITY OF *CONVENTIONAL* UNDERGROUND GAS STORAGE RESERVOIRS AND SALT CAVERN STORAGE FACILITIES? *(Continued)*

◆ = NEAR-TERM HIGH PRIORITY; ✶ = LONG-TERM HIGH PRIORITY

DELIVERABILITY	SUBSURFACE EQUIPMENT	DAMAGE	INVENTORY	PERFORMANCE
• Maintain/enhance deliverability and injectability ◆◆◆◆ ✶✶✶✶ • Understanding how proper reservoir description impacts deliverability and capacity ◆ • Develop and demonstrate well workover and remediation technologies in aging reservoirs/caverns at low cost with high reliability ◆◆◆◆ • Techniques to get past damage area in storage formation ✶ • Real-time integrated simulation ◆◆ ✶✶✶ • Improving productivity through new completions • Constraints in adding pipeline infrastructure to support storage • Horizontal well stimulation ✶	• Lowest cost P T logging ◆◆ • Better hard rock drilling tools ✶ • Improved methods for obtaining side wall cores • Remote downhole measurement that is cost effective ✶✶✶✶✶	• Long term non-damaging stimulation ◆◆◆ ✶✶✶ • Evaluate the re-occurrence of damage mechanisms	• Investigate CO_2 sequestration for cushion gas reduction ◆ ✶✶✶✶✶	• Define all constraints and rank them • Evaluate improved analytical techniques for infill drilling versus compression to increase deliverability ◆ • Investigate benefit of implicit gas network – reservoir simulator (whole system) ◆ ✶✶✶✶✶✶✶ • Expansion techniques of existing storage ◆◆◆◆◆ - Aquifers, reservoir storage

ORANGE GROUP

Table 2. What Research Needs to be Done to Develop Man-Made Storage Systems and Other Non-Traditional Methods of Natural Gas Storage in Close Proximity to Demand Centers?

◆ = Near-term High Priority; ✶ = Long-term High Priority

Centralized Storage	Low-Pressure Storage	LNG	Distributed Storage	Coatings/Liners Materials	Security Safety and Risk	Optimization Studies
• Hard rock mining technologies guidelines for areas where traditional methods are not an option (Northeast U.S.) • Offshore storage ◆ ✶✶✶✶ • Identify better/cheaper “massive” excavation methods to create “synthetic” caverns (“nuclear” excavation) ◆ ✶✶✶✶✶ - Development of tunnel technology for synthetic caverns • Converting existing liquid storage to natural gas storage ◆◆ • Abandoned subway/sewer storage • Use of laser drilling for storage • Methods for storage in abandoned mines ◆◆◆◆◆◆◆ • Study/investigate use of existing mines for storage of natural gas • Develop dual storage facilities for natural gas and liquid assets	• Development of high volume, low pressure storage • Solid storage (hydrates); other medium ✶✶ • Non metallic UST technology; low temperature ✶✶ • Storage as gas hydrates ◆◆◆◆◆◆◆◆ ✶✶✶✶✶✶✶✶ - Identify a catalyst to create lower cost hydrate storage • Sorption of gas onto a solid ◆◆◆◆◆ ✶✶✶✶✶✶✶✶ - Chemical “sponge” technology - Storage as sorbed layer on nano-particle	• Underground LNG storage ◆◆◆◆◆◆◆◆◆ ✶✶ - Horizontal lateral wells for LNG storage - Shallow mined LNG reinforced storage • Study mixing of different gas compositions – LNG and historical storage working and base gas ✶✶ • Improve liquefication process of LNG ◆◆◆◆ ✶ • Development of small(er) scale LNG facilities ✶✶✶✶✶ • Gas to liquids then liquid to gas ◆◆◆ ✶✶✶✶	• Balloons over Chicago • Peak day balloon technology in the backyard • End user storage tanks ◆ ✶✶✶✶✶✶ • Mobile storage systems (regarding . tanks, trucking, rail, etc.) ◆◆◆ ✶✶✶ • Chilled gas storage in coiled tubing • Local storage for temporary service disruption (i.e., cascades) • Propane-air technologies	• Low cost lining for mines and caverns ◆◆◆◆◆◆◆◆◆ ✶✶✶✶✶ - Hard rock cavern wall sealing material - Spray lining • Identify better materials of construction or construction methods to allow larger man-made containment ◆◆◆◆◆ ✶✶✶ - High Pressure composite material storage vessels	• New security methods to facilitate acceptance • Understanding how to better communicate with communities ◆ • Safety/risk issues need to be considered – anything goes ◆◆◆◆◆◆ ✶✶✶✶✶ - Assess safety and environ–mental issues with identifiable above ground storage	• Development of economic optimization siting models for gas storage ◆◆◆◆◆◆ ✶✶✶✶ • What is market projection of local storage demand over next 10 years? • How much automation (automated control of facility) can be tolerated? (GC/quality/ controls) • What is economic limit in terms of volume? Too small to be of consequence? Threshold minimum volume to be considered ✶✶✶

Underground Gas Storage Technology Consortium
R&D Priority Research Needs

February 3, 2004
Atlanta, Georgia

ATTENDEE LIST

Michael Adewumi
Professor of Petroleum & Natural Gas Engineering
Pennsylvania State University
202 Hosler Building
University Park, PA 16802
Phone: 814-863-2816
Fax: 814-865-3248
Email: m2a@psu.edu

Rodney Anderson
Gas Delivery Reliability Technology Manager
U.S. Department of Energy, NETL
PO Box 880
Morgantown, WV 26507-0880
Phone: 304-285-4709
Fax: 304-285-4403
Email: rodney.anderson@netl.doe.gov

Kenneth L. Beckman
President
International Gas Consulting, Inc.
3200 Wilcrest Drive, Suite 450
Houston, TX 77042-6019
Phone: 713-782-4782
Fax: 713-782-9594
Email: igc@intlgas.com

Jerry Benson
Vice President
Isotech Laboratories, Inc.
1308 Parkland Court
Champaign, IL 61821
Phone: 217-398-3490
Fax: 217-398-3493
Email: jerry@isotechlabs.com

Karen G. Benson
Director of Storage Gas
Panhandle Energy
5444 Westheimer Road
Houston, TX 77055
Phone: 713-989-7483
Fax: 713-989-1186
Email: kgbenson@panhandleenergy.com

Stephen R. Bergin
Manager, Storage and Reserves
ONEOK Gas Storage LLC
100 West Fifth Street
Tuls, OK 74103-4298
Phone: 918-588-7674
Fax: 918-588-7980
Email: sbergin@oneok.com

H. Ilkin Bigesu
Associate Professor
West Virginia University
P.O. Box 6070
Morgantown, WV 26506-6070
Phone: 304-293-7682 x3403
Fax: 304-293-5708
Email: bilgesu@cemr.wvu.edu

Robert E. Bretz
Associate Professor
New Mexico Tech/Petroleum Engineering
Department
801 Leroy
Socorro, NM 87801
Phone: 505-835-5436
Fax: 505-835-5210
Email: bretz@nmt.edu

Ken Brown
Senior Petroleum Engineer
Schlumberger DCS
1310 Commerce Drive, Park Ridge 1
Pittsburgh, PA 15275-1011
Phone: 412-787-5403
Fax: 412-787-2906
Email: kbrown2@pittsburgh.oilfield.slb.com

Stephen H. Caldwell
Vice President
CEESI
54043 Country Road 37
Nunn, CO 80648-9615
Phone: 970-897-2711
Fax: 970-897-2710
Email: scaldwell@ceesi.com

James Castle
Associate Professor
Clemson University
340 Brackett Hall, Box 340919
Clemson, SC 29634-0919
Phone: 864-656-5015
Fax: 864-656-1041
Email: jcastle@clemson.edu

Charles Chabannes
Project Director
Duke Energy Gas Transmission
5400 Westheimer Court
Houston, TX 77056-5310
Phone: 713-627-5743
Fax: 713-627-5658
Email: cchabannes@duke-energy.com

Larry Chorn
Associate Professor of Petroleum Engineering
Colorado Schoolof Mines
225 Alderson Hall, 1500 Illinois
Golden, CO 80401
Phone: 303-273-3903
Fax: 303-273-3189
Email: lchorn@mines.edu

James S. Chown
Senior Reservoir Engineer
Michigan Consolidated Gas Company
2000 2nd Avenue
Detroit, MI 48226
Phone: 313-235-1117
Fax: 313-235-1045
Email: chownj@dteenergy.com

Alicia R. Dalton-Tingler
Facilitator
Energetics - NETL
2414 Cranberry Square
Morgantown, WV 26508
Phone: 304-594-1450 x14
Fax: 304-594-1485
Email: alicia.dalton-tingler@en.netl.doe.gov

Kerry DeVries
Project Engineer
RESEPC
PO Box 725
Rapid City, SD 57709
Phone: 605-394-6400
Fax: 605-394-6456
Email: kldevri@respec.com

Glen B. DeWolf
Principal Project Manger
URS Corporation
9400 Amberglen Boulevard
Austin, TX 78759
Phone: 512-419-5211
Fax: 512-454-8807
Email: glenn_dewolf@urscorp.com

Daniel J. Driscoll
Senior Project Manger
U.S. Department of Energy, NETL
PO Box 880
Morgantown, WV 26507-0880
Phone: 304-285-4717
Fax: 304-285-4403
Email: daniel.driscoll@netl.doe.gov

Shari Dunn-Norman
Associate Professor
University of Missouri - Rolla
129 McNutt Hall
Rolla, MO 65409
Phone: 573-341-4840
Fax: 573-341-4192
Email: caolila@umr.edu

Stephen E. Foh
Program Manger, Underground Storage
Gas Technology Institute
1700 South Mount Prospect Road
Des Plaines, IL 60018-1804
Phone: 847-768-0894
Fax: 847-768-0501
Email: steve.foh@gastechnology.org

Mark E. Gredell
Manager, U.S. Storge
Duke Energy Corporation
5400 Westheimer Court, 3G-20
Houston, TX 77056-5310
Phone: 713-989-3217
Fax: 713-627-5658
Email: megredell@duke-energy.com

Peter Gross
Director, Asset Aggregation Group
NUI
11757 Katy Freeway, Suite 1300
Houston, TX 77079
Phone: 281-854-2036
Fax: 281-854-2236
Email: prgross@nui.com

John Guoynes
Gas Storage Team Leader
Halliburton
1175 Quacker Valley Drive
Traverse City, MI 49686
Phone: 231-223-6932
Fax:
Email: john.guoynes@halliburton.com

Ramon P. Harris, Jr.
General Manager
National Fuel Gas Supply Corporation
6363 Main Street
Williamsville, NY 14221
Phone: 716-857-6884
Fax: 716-857-7310
Email: harrisr@natfuel.com

Steve Heath
Senior Reservoir Engineer
Williams Gas Pipeline
2800 Post Oak Boulevard
Houston, TX 77056
Phone: 713-215-2087
Fax: 713-215-2345
Email: steven.a.heath@williams.com

Floyd P. Hofstetter
Vice President, Storage Management
Kinder Morgan
747 East 22nd Street
Lombard, IL 60148-5034
Phone: 630-691-3660
Fax: 630-691-3531
Email: floyd_hofstetter@kindermorgan.com

Timothy Illson
Senior Corrosion Engineer
Advantica Limited
Ashby Road
Loughborough
Leicestershire, United Kingdom LE11 3GR
Phone: 44(1509) 283289
Fax: 44(1509) 283119
Email: tim.illson@advantica.biz

James A. Janson
Manager, Gas Storage Operations
Puget Sound Energy, Inc.
239 Zandecki Road
Chehalis, WA 98532-8416
Phone: 360-262-3365
Fax: 360-262-0119
Email: jim.janson@pse.com

Ann M. Justice
Findlay Region Manager
Marathon Ashland Pipe Line
539 South Main Street
Findlay, OH 45840
Phone: 419-421-3719
Fax: 419-421-3125
Email: amjustice@mapllc.com

Larry D. Kennedy, Jr.
Manager
El Paso Corporation
2 North Nevada
Colorado Springs, CO 80944
Phone: 719-520-4287
Fax: 719-520-4668
Email: larry.kennedy@elpaso.com

Larry W. Lake
W.A. (Monty) Moncrief Chair, Petroleum Engineering
The University of Texas at Austin
Petroleum & Geosystems Eng. 1
University Stations C0300
Austin, TX 78712-0228
Phone: 512-471-8233
Fax: 512-471-9605
Email: larry_lake@mail.utexas.edu

James Mansdorfer
Storage Engineering Manager
Southern California Gas Co.
9400 Oakdale Avenue
PO Box 2300
Chatsworth, CA 93510
Phone: 818-701-3473
Fax: 818-701-4554
Email: jmansdorfer@semprautilities.com

Richard W. Mantia
Director, Gas Storage Services
Mississippi River Transmission Crop.
9900 Clayton Road
St. Louis, MO 63129
Phone: 314-991-7494
Fax: 314-991-7512
Email: rich.mantia@centerpointenergy.com

Kevin M. Moore
Facilitator
Energetics - NETL
2414 Cranberry Square
Morgantown, MD 26508
Phone: 304-594-1450
Fax: 304-594-1485
Email: kevin.moore@en.netl.doe.gov

Christina Sames
Program Manager
Pipeline Research Council International, Inc.
1401 Wilson Boulevard, Suite 1101
Arlington, A 22209
Phone: 703-387-0190 x105
Fax: 703-387-0192
Email: csames@prci.org

Bill Savage
Director
NITEC LLC
475 17th Street, Suite 850
Denver, CO 80202
Phone: 303-292-9595
Fax: 303-292-9585
Email: bsavage@niteclc.com

Thomas A. Stemmer
Senior Project Manager
Basic Systems, Inc.
10901 Clay Pike Road
Derwent, OH 43733
Phone: 749-685-2511 x302
Fax: 740-685-5516
Email: tstemmer@bsicos.com

Richard C. Stocke
Manager, Gas Storage
Texas Gas Transmission, LLC
3800 Frederica Street
Owensboro, KY 42301
Phone: 270-688-6926
Fax: 270-688-6948
Email: richard.c.stocke@txgt.com

Andrew F. Theodos
Storage Development Strategist
Columbia Gas Transmission Corp.
PO Box 1273
Charleston, WV 25325-1273
Phone: 304-357-2365
Fax: 304-357-3585
Email: atheodos@nisource.com

Donald Vogtsberger
Senior Product Line Manger
Baker Atlas
2397 Traversefield Drive
Traverse City, MI 49686
Phone: 231-947-2810
Fax: 231-922-5099
Email: don.vogtsberger@bakeratlas.com

Robert W. Watson
Associate Professor of Petroleum & Natural Gas
Natural Gas Engineering
Pennsylvania State University
119 Hosler Building
University Park, PA 16802-5001
Phone: 814-865-0531
Fax: 814-865-3248
Email: rww1@psu.edu

William W. Weiss
Founder
Correlations Company
115 Court Street, PO Box 730
Socorro, NM 87801
Phone: 505-838-3876
Fax: 505-838-3876
Email: bweiss@sdc.org

Terrel D. Williams
Supervisor, Pipeline Integrity
Buckeye Gulf Coast Pipe Lines
1200 Smith Street
Houston, TX 77003
Phone: 832-615-8615
Fax: 832-615-8600
Email: twilliams@buckeye.com

Joseph Young
Operations Supervisor
Sunoco Logistics
7155 Inkster Road
Taylor, MI 48180
Phone: 313-292-9842
Fax: 313-292-2130
Email: jyoung@sunocologistics.com