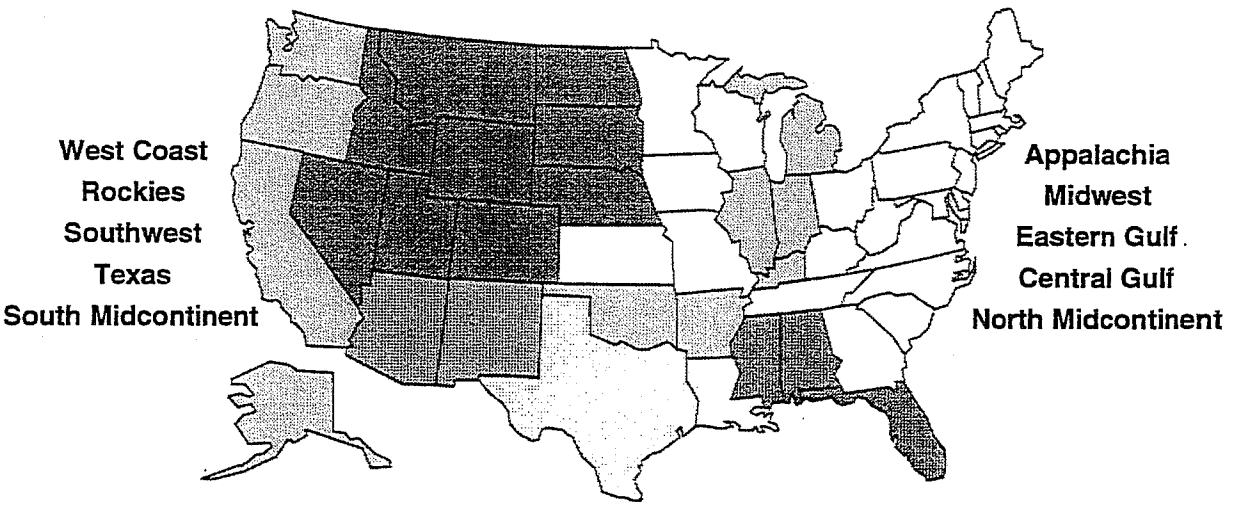
TECHNOLOGY AND RELATED NEEDS OF U.S. OIL AND NATURAL GAS PRODUCERS

Results of Exploration and Production
Problem Identification Workshops in Ten Regions



PTTC

PETROLEUM TECHNOLOGY TRANSFER COUNCIL

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Disclaimer

The following is a report of information prepared by the Petroleum Technology Transfer Council (PTTC) and submitted to the U.S. Department of Energy through its management and operating contractor, BDM-Oklahoma Inc., as part of PTTC's partnership in oil and gas technology transfer with DOE. The material enclosed herein consists of information gathered by its regional subcontractors from oil and natural gas producers in a series of problem identification workshops. PTTC makes no claims and shall not be held responsible for the information herein. As this is a draft, PTTC reserves the right to amend and revise these interim findings without recourse from BDM or DOE.

DEDICATION

This report is dedicated to the memory of the late James E. Russell, an independent producer from Abilene, Texas, a pioneer in the application of improved exploration and production technologies, the founding chairman of the Petroleum Technology Transfer Council, and a respected friend of America's oil and gas exploration and production community. His leadership, vision, and insight helped to make these workshops and their resulting benefits possible. He will be sorely missed.

ACKNOWLEDGMENTS

Petroleum Technology Transfer Council wishes to acknowledge the contributions of the U.S. Department of Energy (through BDM-Oklahoma Inc.), the Gas Research Institute, the PTTC regional lead organizations, several state governments, and the industry associations and organizations that have funded or helped to facilitate this effort. A debt of gratitude is owed to the many individuals across the country who served as facilitators for these workshops. In particular, Dr. Lanny Schoeling of the Kansas University Energy Research Center has made a significant contribution to defining the problem identification process not only for Kansas, but also in developing a model for all regions. In addition, PTTC gained much from the Texas Independent Producers and Royalty Owners Association, which began its series of problem identification workshops before the PTTC's formation. Special thanks are due to John Benton, PTTC Technical Manager, and Lance Cole of BDM-Oklahoma, for their dedication to making the workshops and their analysis as effective as possible. PTTC also wishes to acknowledge the efforts of ICF Resources Inc. in helping to identify the problem identification process, and analyze the results of the 32 workshops. Finally, PTTC wishes to acknowledge and thank the more than 600 producers and industry representatives across the country who participated in the workshops and shared their thoughts, problems, and concerns.

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EXECUTIVE SUMMARY

The Petroleum Technology Transfer Council (PTTC) is a national non-profit organization that serves as the technology clearinghouse for the oil and natural gas exploration and production industry -- mainly independents. Its mission is to accelerate the flow of technology information to producers and to provide input to the technology and research and development (R&D) community about the technical problems, needs, and priorities of petroleum producers.

To help focus future technology transfer efforts on the industry's highest priority national and regional needs, PTTC -- together with its regional lead organizations, the Texas Independent Producers and Royalty Owners Association (TIPRO), and the Kansas University Energy Research Center (KUERC) -- has conducted 32 "problem identification workshops" in ten oil and gas producing regions of the United States. The results of these workshops, held between 1991 and 1995, are being made available to the industry technology and service companies, and the R&D community. This should help accelerate public and private research and technology transfer efforts toward the highest-priority areas.

The results of these workshops identify a broad array of technical barriers, technology needs, and related concerns in all categories of petroleum exploration and production (E&P) operations in all producing regions of the nation. In many of these areas, technologies and solutions already exist that can be brought to bear to address the problems under current economic conditions. In some cases these technologies need to be improved to increase their efficiency or reduce their costs.

These findings underscore a clear and fundamental message previously voiced by technology transfer studies of the Interstate Oil and Gas Compact Commission (IOGCC), the National Petroleum Council (NPC), and numerous other organizations. That message is that current technology transfer mechanisms have not been able to increase the awareness, use and

adaptation of cost-effective technologies by vast segments of the oil and gas producing industry, and especially independent producers.

The results of PTTC's regional problem identification workshops indicate technology marketing efforts of service and supply companies should take into account specific regional needs. The PTTC, NPC and IOGCC studies reveal significant problems yet to be addressed by private-sector technology providers, especially in the area of providing education for the application of the technologies. The value of outreach programs similar to PTTC's regional resource centers (combining private sector, state and federal government, and university efforts) is clearly demonstrated.

These findings make it clear that investments must continue to be made in public, private and collaborative R&D for the technologies of tomorrow. Perhaps even more strongly, these findings demand that the industry, public and private funders of research, and commercial providers of technology need to invest in a more targeted and aggressive course of technology transfer. The mission of technology transfer efforts must be to accelerate and expand producers' awareness, understanding, access to, and acceptance of current and emerging technologies that are cost-effective. With technology transfer, industry can apply technologies to improve exploration successes, detect bypassed and unswept resources, replace and add new reserves, extend the economic life of marginal wells, defer abandonments, and enable the maximum economic production of America's oil and natural gas resources while protecting the environment. Without effective technology transfer, the full value of our public and private sector investments in R&D may never be realized.

In this report, the results of the PTTC workshops have been categorized and presented according to major areas of industry oil and gas E&P operations. These include exploration, reservoir management, drilling and completion, production, and environmental protection and compliance. The results also address specific producers' needs for cost-effective environmental regulation and improved technology transfer functions.

In summary, the findings of the PTTC workshops identify several broad problems and needs, including:

1. **Inadequate well and reservoir level geologic and production data, case studies, and analogs to enable effective analysis and implementation of existing and emerging technologies.** (Example: Significant lack of production histories, completion data and well records in Appalachian Basin.)

2. **Insufficient producer access to or awareness of regulations and requirements for environmental compliance and associated financial liabilities.** (Example: Operators in Pennsylvania were not provided adequate information and training in preparing operating permits for the new air quality compliance regulations. In addition, the EPA bonding requirements for underground injection permits are onerous and inflexible.)

3. **Insufficient availability of or awareness of tools, technologies, and approaches for cost effective environmental protection and regulatory compliance.** (Example: Although no specific example exists, the proliferation of various government rules and regulations from a multitude of agencies makes compliance a difficult task regardless of locale.)

4. **Inadequate producer awareness, and understanding of and access to advanced seismic and remote sensing technologies for exploration and reservoir development.** (Example: Operators in the Midcontinent and Rockies have not been well-informed about applications of advanced seismic techniques. It is likely that these technologies may be more useful and cost-effective than is currently perceived by smaller regional producers.)

5. **Insufficient awareness of availability, performance, and economics of improved drilling and completion technologies such as horizontal drilling, coiled tubing, slimhole, air drilling and extended reach drilling.** (Example: Operators in the Rockies have expressed a desire to know how to determine if their fields might be candidates for horizontal drilling and if so, what are the most cost-effective methods.)

6. **Need for cost-effective, environmentally safe technologies to manage water channeling, reduce water cut, increase recovery, and address related corrosion, scale, and other problems.** (Example: Operators in the LA Basin are not aware of recent advances in gel technologies that may help reduce the producing water cut from older, mature waterfloods and water-drive reservoirs.)

7. **Inadequate education in and understanding of applications of reservoir management, logging, simulation, and characterization tools.** (Example: A number of producers in the Midcontinent and other regions have expressed a desire to learn more about how to make effective use of simulation software published by

the Department of Energy. The documentation that exists is not easy to understand and can lead to misapplication of the software.)

8. **Inadequate awareness, applications, performance, and economics of currently available technologies and operating approaches to remediate well, reduce operating costs, and improve or sustain economic production, including primary, secondary, and improved oil and natural gas recovery technologies.** (Example: Producers in Wyoming, Kansas, Louisiana and other states where large numbers of wells are electrified would benefit greatly from improvements in artificial lift mechanisms that would decrease electricity usage. Operators in Texas could benefit from additional knowledge in cost-effective fracture-treatment design.)

9. **Need for improved technology transfer mechanisms to inform producers objectively about the availability, application, history, potential costs and benefits, and potential performance of technologies that address their priority problems and needs.** (Example: This problem is so widespread that a specific example is not too useful. In general, the initial willingness to accept and utilize a technology is determined by the number of case studies presented that clearly demonstrate its usefulness.)

These results, defining needs and regional priorities of producers, have been compared and correlated with two other recent studies on R&D Needs by the NPC and the Research Committee of IOGCC. Where these studies overlap, the findings are mutually supportive. The NPC and IOGCC studies independently validate the findings of PTTC. The PTTC workshops, however, identified many specific technology needs and regulatory concerns that were not identified by either of the other two reports.

The PTTC problem identification process built on regional technology forums conducted earlier by TIPRO and KUERC, before the PTTC's formation. The analysis of the PTTC problem identification workshops presents the needs of producers not only by category, but also by region and regional priorities. This report provides a highly valuable tool to be used by America's research institutions and technology providers to target focused technology transfer efforts to the specific topics and regions where they are needed the most. PTTC urges them to respond through the PTTC network to meet the urgent needs of the industry and the nation.

I. BACKGROUND

Independent producers are taking a greater role in the domestic oil and natural gas exploration and producing (E&P) industry. They are picking up where some larger integrated companies are leaving off in the lower 48-states conventional resource base. They are also increasingly active in conventional and deepwater offshore E&P, in remote and frontier onshore areas, and in unconventional oil and gas resources. To continue their expansion in domestic E&P operations, independent producers must be aware of the technologies currently available to meet these challenges and understand their costs, benefits, and applications. This includes having access to data and analytical tools as well as to the technologies themselves, covering all areas -- exploration, development, drilling and completion, production, and environmental compliance and remediation.

While technology-savvy producers see opportunity in the nation's known remaining and undiscovered petroleum resources, they must be aware of current technologies and deploy them to exploit these opportunities. They must also ensure that their future needs are met in the areas of research, development, and demonstration (RD&D). Because independents typically do not perform or fund RD&D, they especially need an ongoing dialogue with the private sector research community and service industry that advances and encourages use of new technologies. Independents also need a conduit to provide effective input to the planning of publicly-funded geoscience research and technology transfer. Recently, independents have had increased involvement with industry and public/private R&D consortia. These collaborative relationships can be nurtured and expanded, yielding benefits to all parties. Increasingly, producers must also work with government to ensure that cost-effective, science-based regulation and policies enable the domestic industry to continue responsible development of the nation's oil and gas resources and foster energy security.

To achieve these goals, problem identification is the essential first step in conveying industry's technical barriers, needs, and priorities to the public and private R&D community.

THE PETROLEUM TECHNOLOGY TRANSFER COUNCIL

The Petroleum Technology Transfer Council (PTTC) is a national, non-profit organization formed by the oil and natural gas industry to accelerate the dissemination of upstream technologies to domestic producers. PTTC performs several essential roles in achieving its mission:

- PTTC identifies technology-related needs and priorities of industry-- primarily for independents.
- PTTC identifies technology solutions and other available information from a broad range of public and private sources to address these priority needs.
- PTTC helps to communicate these solutions and information to appropriate target audiences through regional resource centers, focused technology workshops, an electronic information system on the Internet, and other appropriate mechanisms and outreach efforts.
- Where solutions are not readily identifiable or transferable, PTTC communicates the industry's needs back to the public and private R&D community to help focus research, technology, regulatory, and policy actions on priority needs and issues.

PROBLEM IDENTIFICATION WORKSHOPS

Under the auspices of PTTC, a series of problem identification workshops have been held with oil and natural gas E&P personnel in ten regions of the nation. These workshops, undertaken by PTTC and its regional lead organizations (RLOs), are the first step of the process of ensuring that: (1) current technologies are known to producers and swiftly and effectively deployed, and (2) future research and technology development efforts are focused on meeting the highest priority needs of the industry.

The purpose of the problem identification workshops has been to identify and prioritize the major technical problems encountered by E&P companies, and especially independents, in their efforts to discover new petroleum resources and to efficiently and economically produce known resources. These problems may be stated as technical barriers, technology needs, or other related economic and technical obstacles faced in complying with regulatory requirements.

The resulting statements of problems, needs, and priorities that have been generated from these workshops will be used by PTTC to:

(1) Identify existing technologies that can help address the priority needs, and speed that information to producers through various technology transfer mechanisms;

(2) Identify "gaps" where technology does not exist to adequately or economically meet producer needs; and

(3) Provide industry input to the public and private R&D community as to producers' priority needs for E&P related research, regulation, and public policy.

APPROACH TO WORKSHOPS AND ANALYSIS OF RESULTS

Thirty-two problem identification workshops were held from 1991 to 1995 in 10 regions throughout the nation, as shown in Figure 1 and detailed in Table 1. Before the PTTC's formation in early 1994, there were two series of problem identification workshops held in Texas and Kansas. Although these workshops were not performed directly under the auspices of PTTC, their important results are incorporated in this report.

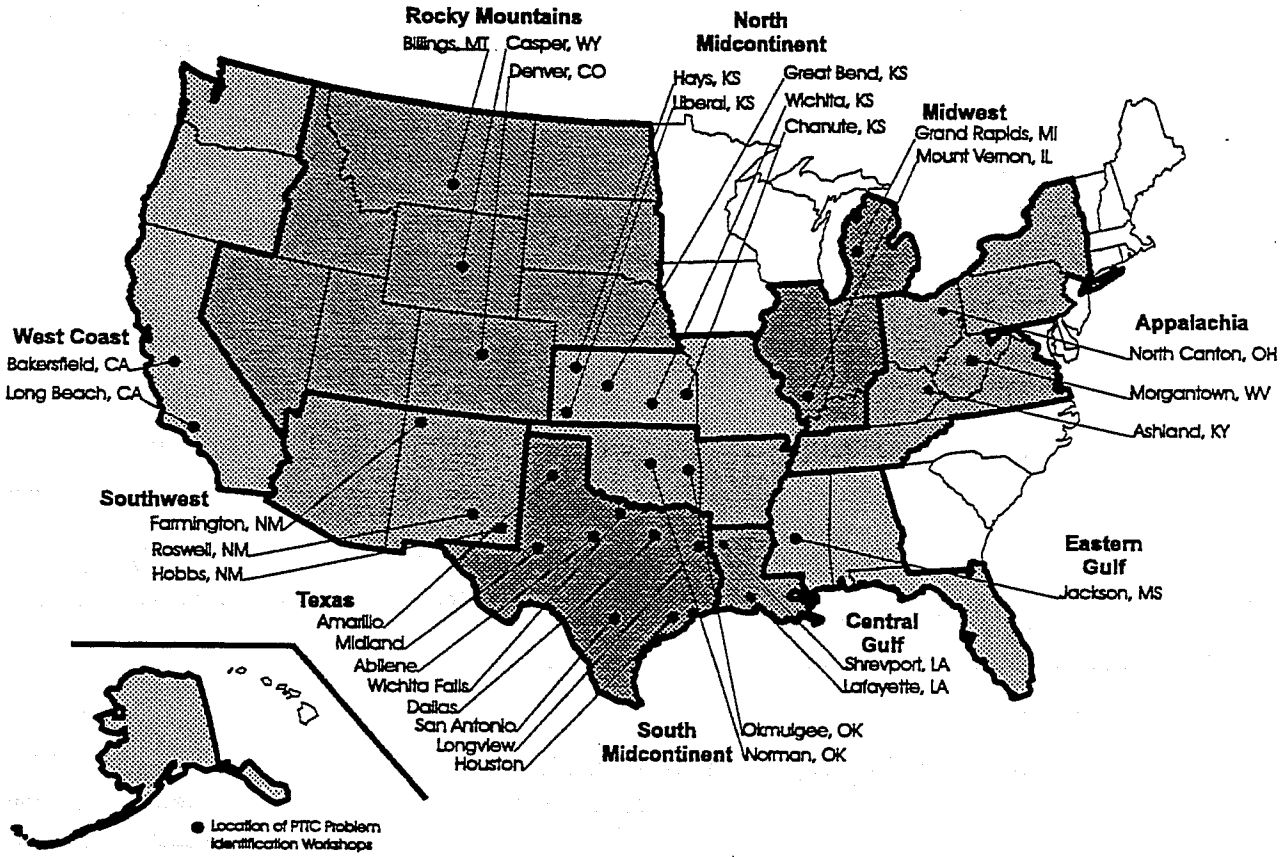
- The first workshop series was held in eight locations throughout Texas in 1991. These "technology forums" were conducted by the Texas Independent Producers and Royalty Owners' Association (TIPRO) and the University of Texas, Bureau of Economic Geology with funds provided by the industry, the State of Texas, and the U.S. Department of Energy (DOE).

- A second series of problem identification workshops was held in 5 locations across Kansas by the Kansas University Energy Research Center (KUERC) in 1992-1993 under a DOE grant.

- In 1994 and 1995, there were 18 more workshops held across eight other producing regions of the nation by the PTTC regional lead organizations in cooperation with the regional oil and gas industry associations. These locations were selected to ensure that independents in all of the diverse operating settings in each region could participate.

Figure 1.

Locations of PTTC Problem Identification Workshops



Collectively, these workshops covered nearly all of the nation's major reservoirs and geological plays in the 33 states that have oil and/or gas production. In 1996 and beyond, PTTC hopes to conduct additional problem identification workshops in some of the states that were not included in this initial series.

The technical approach to performing the workshops evolved over time -- building successively on lessons learned from the previous workshops -- and varied to better represent each region. In each workshop, industry participants were asked to identify key technical problems and barriers in specific categories, prioritize the needs within categories wherever possible, and then prioritize the categories. A copy of the guidelines for performance of these workshops is included in **Appendix A** of this report. In general, producers were asked in each

Table 1
Locations and Dates of PTTC Regional Problem Identification Workshops

PTTC Region	Workshop Location	Workshop Date
Appalachia	Morgantown, WV	May 16, 1995
	North Canton, OH	September 6, 1995
	Ashland, KY	September 21, 1995
Central Gulf	Lafayette, LA	November 1, 1994
	Shreveport, LA	November 29, 1994
Eastern Gulf	Jackson, MS	August 22, 1995
Midwest	Mount Vernon, IL	October 14, 1994
	Grand Rapids, MI	September 21, 1995
North Midcontinent ★	Wichita, KS	1992-93
	Chanute, KS	1992-93
	Liberal, KS	1992-93
	Hays, KS	1992-93
	Great Bend, KS	1992-93
Rocky Mountains	Denver, CO	June 21, 1995
	Casper, WY	August 17, 1995
	Billings, MT	October 3, 1995
South Midcontinent	Norman, OK	January 28, 1995
	Okmulgee, OK	March 21, 1995
Southwest	Farmington, NM	August 24, 1994
	Roswell, NM	August 30, 1994
	Hobbs, NM	August 31, 1994
Texas ★★	Wichita Falls, TX	1991
	San Antonio, TX	1991
	Midland, TX	1991
	Longview, TX	1991
	Houston, TX	1991
	Dallas, TX	1991
	Amarillo, TX	1991
	Abilene, TX	1991
West Coast	Long Beach, CA	September 12, 1995
	Bakersfield, CA	September 13, 1995

★ Workshops held by Kansas University Energy Research Center, prior to formation of PTTC
★★ Workshops held by TIPRO and TX Bureau of Economic Geology, prior to formation of PTTC

workshop to identify and prioritize problems and/or needs in four categories:

(1) Exploration and drilling

(2) Reservoir management

(3) Completion and production

(4) General and regulatory

These results were then reported back to PTTC in a series of reports written by the RLOs. The resulting statements of needs, prioritized at the regional level, were extracted from the reports submitted by the RLOs. These results were compiled in a database of more than 600 PTTC-generated entries, which is being used as the basis of this study.

The data gathered by the PTTC regional lead organizations through the workshops are complemented by the results of two other recent studies, one performed by the NPC on RD&D needs of the entire domestic upstream and downstream petroleum industry[1] and another by the IOGCC Research Committee that broadly addresses industry geoscience issues and needs[2]. Collectively, the PTTC, NPC, and IOGCC results total over 850 records in the database of industry problems and needs.

The PTTC workshops, by contrast, looked at RD&D, technology transfer, and (to a more limited extent) regulatory concerns, but within the narrower range of topics that affect independent E&P companies. Where the studies overlap, however, there is substantial concurrence about RD&D and technology needs. Together these studies provide essential input to help focus near-term technology transfer efforts and to define future research, technology, regulatory, and policy efforts.

The PTTC, NPC, and IOGCC problem statements were coded to identify a unique subset that could be synthesized and aggregated into a set of national results and conclusions about high priority problems, and technology barriers. Although the national data set does not

[1] *Research, Development and Demonstration Needs of the Oil and Gas Industry,* National Petroleum Council, Washington, D.C., August 1995.
[2] *Visions of the Future: Technology and Inventional Needs of the Independent Petroleum Industry,* Interstate Oil and Gas Compact Commission -- Research Committee, Oklahoma City, OK, August 1995.

support an official prioritization at the national level, limited regional prioritizations are made within the PTTC workshop results. These prioritizations are reflected in the Regional Results section in Chapter IV of this report.

The PTTC results were also identified, categorized, and cross-referenced with the findings of the NPC and the IOGCC studies. The categories were modified slightly in the database to more effectively link and compare results with these other studies. The categories of problems and needs identified and analyzed are as follows:

(1) Exploration Technology and Data

(2) Reservoir Management and Development

(3) Drilling and Completion Issues

(4) Production

(5) Environmental Technology and Regulation

(6) Technology Transfer

This report details the findings of the PTTC regional problem identification workshops. These results, along with the comparison of the results with the NPC and the IOGCC studies, offer a significant tool for PTTC, industry research and service organizations, and state and federal research and technology transfer programs. Communicating these needs back to the R&D community should encourage more focused efforts on the highest national and regional priorities of the industry. These efforts will contribute to efficiently exploring and producing our nation's vital oil and natural gas resources while protecting the environment. They will also help to sustain a viable domestic and international exploration, production, technology and services industry that meets U.S. energy needs, provides jobs, stimulates economic activity, and sustains America's competitive leadership in oil and gas technology.

II. SUMMARY FINDINGS AND CONCLUSIONS

Nearly all the workshops identified similar kinds of problems in several subject areas. There were some variations among regions, reflecting different basins, geology, and development experience. The results of the PTTC workshops reveal major needs in the areas of exploration and production technology and R&D, as well as concerns related to technology transfer and public regulation of oil and gas E&P operations.

The major problem areas identified across all of the 10 PTTC regions are:

(1) **Inadequate well and reservoir level geologic and production data, case studies, and analogs to enable effective analysis and implementation of existing and emerging technologies.** This problem cuts across virtually all of the categories analyzed. It limits the ability of producers to identify viable producing areas, to evaluate the potential of technology applications, and to plan and monitor the implementation of reservoir management and advanced E&P strategies. Producers require low-cost, high-quality data, including reservoir and production data, as well as analogs and case histories of reservoir development and technology applications. (Example: Significant lack of production histories, completion data and well records in Appalachian Basin.)

(2) **Insufficient producer access to or awareness of regulations and requirements for environmental compliance and associated financial liabilities.** The nation's E&P industry is conscientious about protecting the environment and complying with the laws and regulations imposed by local, state, and federal government. Producers need better mechanisms to be aware of regulatory requirements, identify acceptable and cost-effective means for compliance, and to manage the costly burden of reporting to multiple regulators. (Example: Operators in Pennsylvania were not provided adequate information and training in preparing operating permits for the new air quality compliance regulations. In addition, the EPA bonding requirements for underground injection permits are onerous and inflexible.)

(3) **Insufficient availability of or awareness of tools, technologies and approaches for cost effective environmental protection and regulatory compliance.** Producers need improved awareness and access to cost-effective technologies that enable them to economically comply with environmental, occupational safety, and other regulations and standards. Principal among these concerns are the economic management and disposal of produced waters, naturally occurring radioactive materials (NORM), drilling muds, and cuttings. (Example: Although no specific

example exists, the proliferation of various government rules and regulations from a multitude of agencies makes compliance a difficult task regardless of locale.)

(4) **Inadequate producer awareness, and understanding of and access to advanced seismic and remote sensing technologies for exploration and reservoir development.** Nearly every region identified a need for better understanding of powerful but complex technologies and approaches for seismic and remote sensing to detect the presence of hydrocarbons. (Example: Operators in the Midcontinent and Rockies have not been well-informed about applications of advanced seismic techniques. It is likely that these technologies may be more useful and cost-effective than is currently perceived by smaller regional producers.)

(5) **Insufficient awareness of availability, performance, and economics of improved drilling and completion technologies such as horizontal drilling, coiled tubing, slimhole, air drilling and extended reach drilling.** Drilling and completion technologies are changing and improving with the increased interest in horizontal and deviated drilling, slim-hole, air drilling, coiled tubing, and related cementing, packing, and completion technologies. This also applies to the detection of natural fractures and the design, control, and monitoring of induced fracturing techniques. These technologies offer the potential to reduce costs dramatically. Producers need to understand the applications, potential, and relative costs of these technology strategies in their reservoirs and operations. (Example: Operators in the Rockies have expressed a desire to know how to determine if their fields might be candidates for horizontal drilling and if so, what are the most cost-effective methods.)

(6) **Need for cost-effective, environmentally safe technologies to manage water channeling, reduce water cut, increase recovery, and address related corrosion, scale, and other problems.** Many reservoirs and wells could continue economic production with current and emerging technologies to prevent or reduce channeling in waterflood operations and high-water cut in the production stream. Producers need to be aware of and understand current technologies, their applications, and associated problems including scale, corrosion, and other factors. Technologies need to be advanced to address these problems and make the water-shut off, profile modification, and related technologies more economic and effective. (Example: Operators in the LA Basin are not aware of recent advances in gel technologies that may help reduce the producing water cut from older, mature waterfloods and water-drive reservoirs.)

(7) **Inadequate education in and understanding of applications of reservoir management, logging, simulation, and characterization tools.** Technology advances have made reservoir characterization a powerful tool in visualizing the reservoir, including geological features, heterogeneities, and remaining hydrocarbon resources. Broader application of these powerful reservoir characterization technologies is constrained by inadequate data and tools for analyzing old logs and data. There are also significant time and cost requirements for training and use. Producers need to be aware of the power and application of these technologies and resources available to them. Continued advances are

required to improve the effectiveness, reduce the cost, and enhance the usefulness of these tools. (Example: A number of producers in the Midcontinent and other regions have expressed a desire to learn more about how to make effective use of simulation software published by the Department of Energy. The documentation that exists is not easy to understand and can lead to misapplication of the software.)

(8) **Inadequate awareness applications, performance, and economics of currently available technologies and operating approaches to remediate well, reduce operating costs, and improve or sustain economic production, including primary, secondary, and improved oil and natural gas recovery technologies.** Producers need improved awareness, understanding, and access to technologies and strategies that can reduce the cost of primary production, improve the economics and effectiveness of artificial lift operations, and economically increase ultimate recovery through secondary and improved recovery processes. These include augmented waterflooding, infill drilling, and natural gas, thermal, chemical, and microbial recovery processes. Key factors include performance predictability, economic assessment, and implementation strategies. (Example: Producers in Wyoming, Kansas, Louisiana and other states where large numbers of wells are electrified would benefit greatly from improvements in artificial lift mechanisms that would decrease electricity usage. Operators in Texas could benefit from additional knowledge in cost-effective fracture-treatment design.)

(9) **Need for improved technology transfer mechanisms to inform producers objectively about the availability, application, history, potential costs and benefits, and potential performance of technologies that address their priority problems and needs.** Virtually all regions identified a need for more aggressive technology transfer approaches to objectively inform producers about available and emerging technologies, their potential applications, costs and benefits, and sources for additional information. (Example: This problem is so widespread that a specific example is not too useful. In general, the initial willingness to accept and utilize a technology is determined by the number of case studies presented that clearly demonstrate its usefulness.)

These overall results indicate that PTTC could develop technology transfer approaches for several cross-cutting problem areas applicable in more than one region, with only subtle modifications. However, in many regions, technologies and other solutions need to be identified and presented in a highly targeted manner to the sectors of the E&P community that can apply them to improve production, compliance, and profitability.

This report identifies a broad array of technical barriers, technology needs, and related concerns in all E&P categories and in all producing regions of the nation. In many of these areas, technologies and solutions already exist that can be brought to bear to address the

problems under current economic conditions. In some cases these technologies need to be improved to increase their efficiency or reduce their costs.

These results, which define needs and regional priorities of producers, have been compared and correlated with two other recent studies by NPC and IOGCC. Where these studies overlap, the findings are mutually supportive, and independently validate the findings of the PTTC. The PTTC workshops, however, identified many specific technology needs and regulatory concerns that were not identified by either of the other two reports, mainly as a result of the differences in the scope of these studies.

A clear and fundamental message has been previously voiced by technology transfer studies of the IOGCC, the NPC, and numerous other organizations. That message, which is underscored in this report, is that current technology transfer mechanisms do not effectively reach vast segments of the oil and gas producing industry -- especially independent producers.

For the first time, the report of the PTTC problem identification workshops presents a national perspective on the needs of producers not only by category, but also by regional priorities. This report offers a timely and highly valuable tool to be used by America's research institutions and technology providers to target technology transfer efforts to the specific subjects and regions where they are needed the most.

III. PROBLEMS AND NEEDS BY E&P OPERATING CATEGORY

PRESENTATION OF RESULTS

Many of the regions identified common problems and needs in the various operating categories analyzed. For each of the categories, the results were analyzed to identify an aggregate set of high priority and unique statements of problems and/or needs. These were then compiled and presented here in two ways: For each category, a table shows the unique, high priority problem statement and the specific PTTC region(s) in which it was identified as a problem or need. This is followed by a brief discussion of each of the major issues. Following the discussion, a second table reflects all of the unique problem statements by category and cross-references them to similar findings in the NPC report. (The codes for the NPC links are shown in the Appendix.)

In the following chapter, results are provided by region, reflecting the findings and conclusions of the workshops, either workshop-by-workshop, or summarized for the entire region, depending on how the data were compiled by the PTTC regional lead organizations.

EXPLORATION PROBLEMS AND NEEDS

Many of the problem identification workshops analyzed exploration and drilling problems as a single category. For the purposes of this report, exploration and drilling problems were broken out into separate categories. The exploration problems/needs are addressed below, followed by a separate discussion of drilling and completion problems.

Domestic oil and natural gas producers, and especially independents, are increasingly challenged in their efforts to discover new resources to replace produced reserves and meet demand. Numerous technologies have emerged over the past decade to improve their ability to detect the presence or likelihood of hydrocarbons. These include three dimensional (3-D) seismic and other remote sensing technologies, as well as geochemical analyses and advanced

geostatistical analysis methods. These methods offer not only the ability to detect new, previously undiscovered reservoirs, but also to detect hydrocarbon-bearing horizons that may have been overlooked or bypassed in known fields. When combined with traditional exploration methods, analogs, and data, these methods offer significant new potential for successful exploration in known basins and plays, as well as in remote and frontier areas.

As shown in Table 2a, across the nation, producers identified the following problems and needs as major exploration issues:

- Basin studies, case histories, and reservoir data
- 3-D seismic applications
- Access to 2-D and 3-D seismic data
- Training in new exploration techniques -- 3-D seismic planning/interpretation, aeromagnetics, gravity, and geochemical survey
- Natural fracture detection techniques
- Cost and lack of training in high quality analytical tools for visualization and characterization
- Exploration economics and analysis tools

a. **Insufficient basin studies, case studies, and reservoir data.** Eight of the 10 PTTC regions identified the lack of basin studies, reservoir data, and/or analogs as one of their top exploration problems. Explorationists typically work on the basis of analogy because structures of similar geologic age, lithology, depositional history, and other features will typically yield similar hydrocarbon resources. To explore by analogy, it is necessary to have data on known reservoirs, basins, and plays, exploratory efforts, and development and production successes and failures. These data and analogs are essential in calibrating and analyzing the results of new detection technologies. In some cases, data do not exist on exploration or field development histories. In other cases, however, the data exist but are not accessible due to the lack of a common public or commercial repository.

b. Insufficient 3-D seismic studies and data. As technology has improved to enable reservoir visualization through the mathematical interpretation of 3-D seismic data, the demand and the need for this data increases. All of the regions except the South Midcontinent region indicated the lack of economical land 3-D seismic data as one of their top exploration problems and needs This appears to be more of an economic problem than a technical one, as the upfront cost of shooting 3-D seismic is very high. Encouraging producers to work together to jointly shoot 3-D seismic and share the resulting data would help reduce the costs and increase the amount of data available.

Table 2a. Exploration Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Training in new exploration techniques -- 3-D seismic planning/ interpretation, aeromagnetics, gravity, and geochemical survey	X	X	X	X	X	X		X	X	X	9
Basin studies, case histories, and reservoir data	X	X	X	X		X		X	X	X	8
3-D seismic applications	X	X		X	X	X		X	X		7
Access to 2-D and 3-D seismic data	X	X	X			X		X	X	X	7
Cost and lack of training in high quality analytical tools for visualization and characterization	X		X	X				X			4
Natural fracture detection techniques	X					X			X		3
Exploration economics and analysis tools	X					X					2

c. Insufficient operator understanding and education in 3-D seismic, application of logging tools, and geochemistry. With these improvements in visualization and interpretation technology, there is an increasing need for producers to understand how to use and analyze the data and apply the results in their respective operations.

d. Training in new exploration techniques: To apply these emerging exploration technologies, including 3-D seismic, new aeromagnetic survey techniques, geochemistry, and geostatistical methods, producers need access to cost-effective training and continuing education that will keep them at the cutting edge of technology. The North Midcontinent and Midwest regions both expressed the lack of education in 3-D seismic, application of logging tools, and geochemistry among their top five problems. Six other regions also identified it as an important need. PTTC technology workshops covering 3-D seismic interpretation and advanced log analysis are beginning to address these needs. There is a huge resource base of training materials and expertise available for constructing these types of workshops. PTTC will help to mobilize these resources in the regions through its regional resource centers.

e. Cost and lack of training in analytical and visualization tools: Four PTTC regions identified an additional barrier that must be overcome to accelerate widespread use of advanced exploration technologies. Beyond the need for training in the methods and benefits of improved exploration technologies, producers are deterred by the relatively high cost and steep learning curve posed by the technologies needed to interpret this new data and convert for conventional analysis. Many producers will opt to use consultants to perform this task rather than invest capital, time and energy to learn and perform such analysis internally. Others, however, will learn the analytical approaches if they can reduce the capital investment needed to acquire the rapidly advancing technology that is becoming obsolete. PTTC is providing limited access to these resources through its regional resource centers and generous contributions of technology and software from various manufacturers. Other sources include pay-per-use analytical centers offered by several of the software and equipment vendors.

f. Additional exploration problems and needs: Numerous additional exploration needs were identified at various levels of specificity by the regions. Among these are:

- Information on exploration-related service providers and information sources
- A computerized exploration economics analysis package
- Velocity variance data
- Inability to accurately identify formation tops

- Inadequate research on source rock

The PTTC workshops findings correlate strongly with the problem categories identified by the NPC report on RD&D needs. There are direct correlations in nine specific problem areas identified by the PTTC. These correlations, as well as additional exploration technology areas identified by the NPC, are shown in Table 2b.

Table 2b. Producers' Identified Exploration Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
35			Exploration/Data	Insufficient compiled/interpreted data availability or accessibility (*including published materials)	1-1, 1-15, 2-1
172			Exploration/Data	Electronic access to data on service providers, books and journal articles, software. data, images)	
747			Exploration/Data	Critically compiled oil and gas data bases	
2			Exploration/Tech	Digital computer exploration economics package (could include locations of pipelines, field, digitized logs and tops, producing formations, drilling parameters, regs, mines, etc)	1-2, 2-33
38			Exploration/Tech	Lack of available training in new exploration techniques	
174			Exploration/Tech	Natural fracture detection	1-16
221			Exploration/Tech	3-D seismic applications	1-3, 1-6, 1-11, 1-13
223			Exploration/Tech	Velocity variances by formation and aerially	
225			Exploration/Tech	Inability to accurately pick formation tops	
258			Exploration/Tech	Communication of ideas	
261			Exploration/Tech	Aeromagnetic survey techniques	1-8
262			Exploration/Tech	Gravity survey techniques	1-8
263			Exploration/Tech	Cross-well tomography	2-10
264			Exploration/Tech	Geochemical surveys	1-7, 2-23
289			Exploration/Tech	Inadequate research on source rock	1-7
294			Exploration/Tech	Lack of on-line access to statistics, technology information, performance data, oil and gas commission data	
405			Exploration/Tech	Cost of Technology (imaging methods, information exchange, formation micro-scanner, Borehole VSP, Aeromag surveys)	
432	1-5		Exploration/Tech	Sequence stratigraphy techniques	
436	1-9		Exploration/Tech	Fault seal analysis	
437	1-10		Exploration/Tech	Multi-component Seismic Techniques	
611		IG-9	Exploration/Tech	Seismic and advanced modeling, interpretation and reprocessing of 2-D seismic on workstations	

DRILLING/COMPLETION PROBLEMS AND NEEDS

Massive volumes of oil and natural gas have been made economically accessible by dramatic advances in drilling/completion technologies that have reduced costs over the past decade. These include advanced techniques in horizontal and deviated drilling; slim-hole drilling, coiled tubing drilling, pneumatic (air) drilling, and deepwater offshore drilling. Such breakthroughs are making it possible not only to confirm and develop new discoveries, but also to economically produce from previously unswept zones of known fields and reservoirs. For many of these technologies, measurement-while drilling (MWD) technologies have also improved the ability to monitor and control the direction and accuracy of the drill bit while transmitting important downhole information back to the drilling team.

These technologies also have extensive economic applications for low-cost natural gas resource development. This new capability is augmented by parallel advances in completion technology, allowing multiple completions from a single well, improved completions in unconsolidated formations, and improved perforation, cementing, and stimulation.

In addition to the drilling and completion technology itself, producers require better information, data, and analytical tools to assist in the decision as to where to drill. This includes tools and data to identify natural fracture orientation and hydraulic fracture geometry.

As shown in Table 3a, across the nation, producers identified the following categories as their most important drilling/completion problems and needs:

- Improved technology, information, case studies, and analogs on slimhole, coiled tubing, horizontal, and deviated well drilling and applications
- Training in improved drilling and completion technology
- Improved stimulation, perforation, and cementing technology
- Improved fracturing technology/analysis technology (design, directional control and diagnostics)
- Low environmental impact drilling technologies and fluids

- Measurement-while-drilling (MWD) in slim-hole, horizontal, and coiled tubing operations
- Improved downhole imagery and logging tools

a. Improved technology, information, training, case studies, and analogs on slim-hole, coiled tubing, horizontal, and deviated well drilling technologies. All regions except the South Midcontinent region identified the need for improved drilling techniques. In general, insufficient understanding and economic access to current improved drilling technologies are a critical problem for independent producers.

Table 3a. Drilling/Completion Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Improved technology, information, training, case studies, and analogs on slimhole, coiled tubing, horizontal, and deviated well drilling	X	X	X	X	X	X		X	X	X	9
Training in improved drilling and completion technology	X	X	X		X	X	X	X	X	X	9
Improved stimulation, perforation, and cementing technology	X	X	X		X			X	X	X	7
Improved fracturing technology/analysis technology (design, directional control and diagnostics)	X					X		X	X		4
Low environmental impact drilling methods, fluids, muds	X					X			X		3
MWD drilling in slim-hole, horizontal, and coil-tubing operations						X	X	X			3
Formation damage control	X					X	X				3
Temporary plugging techniques					X					X	2
Squeeze cementing using coiled tubing		X					X				2

b. Improved stimulation, and other completion technologies: Seven of the 10 PTTC regions also identified improved stimulation, perforation, cementing and other completion

technologies as a major need. This includes new squeeze cementing techniques made possible through the use of coiled tubing applications.

c. Improved fracturing technology and fracture analysis technology. Four regions, including Appalachia, the Rocky Mountains, Southwest, and Texas identified the need for advancements in fracturing and fracture diagnostics technology to improve the directional control, length, and height of hydraulic fractures.

As with many of the improved exploration techniques described above, producers require objective sources of in-depth information about the applications, cost, benefits, and pitfalls of applying new drilling/completion technologies in current or planned field operations. Drilling, completion, fracturing, and other stimulation services are typically provided by expert service companies and contractors with specialized training, equipment, and experience. However, producers need sufficient understanding and training in these technologies to evaluate the application design and determine its likely outcome.

d. Additional drilling/completion problems and needs: Several regions identified other related problems and needs as being of high priority, including:

- Lower environmental impact drilling methods, fluids, and drilling muds
- MWD applications in slim-hole, horizontal drilling and coiled tubing operations
- Formation damage control and remediation technologies
- Temporary plugging and abandonment technologies for shut-in marginal wells
- Handling of formation waters
- Information on improved packer technology
- Setting specific drilling protocols and performance specifications
- Underbalanced drilling techniques
- Chemical treatments and other techniques to reduce corrosion, scale, and paraffin

Significant gains have been made in these areas over the past decade. PTTC technology workshops can begin to address these problems by bringing the providers of improved drilling and completion techniques into the regions where the technology is most needed and applicable. Short-courses, workshops, video-training courses, and other services are becoming broadly available through the PTTC network. These resources can help producers learn where and how horizontal, directional, and other innovative drilling, completion, and stimulation technologies are applicable. PTTC programs can also help them analyze the relative costs and benefits of new technologies compared to conventional development techniques.

More than half of the problems and needs identified by the PTTC regions correlate directly with technology issues addressed by the NPC report. There are direct correlations in 12 specific problem areas identified by the PTTC. These correlations, as well as additional drilling and completion technology areas identified, are shown in Table 3b.

Table 3b. Producers' Identified Drilling/Completion Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
6			Drilling/Completion	Slimhole drilling methods	3-9
7			Drilling/Completion	Faster drilling methods costing less money per foot drilled	3-8, 3-10, 3-13
9			Drilling/Completion	Methods to quantify stimulation effectiveness and improved understanding of perforation technology with over/under balance	3-8
10			Drilling/Completion	Cost effective methods to identify hydraulic fracture geometry and natural fracture orientation.	
11			Drilling/Completion	Reduced cost and improved technology in horizontal drilling, treatment, completion and production	
39			Drilling/Completion	Unconventional drilling techniques/applications in basin, preferred areas, or zones.	
42			Drilling/Completion	Coiled tubing.	3-12
43			Drilling/Completion	Deviated wells	3-1, 3-13, 4-26
51			Drilling/Completion	How to handle formation waters	2-23, 2-8, 4-2
119			Drilling/Completion	Information needed on cement squeezes, frac packs, water packs, acid pre-packs, high rate water packs, and efficient reservoir drainage	
123			Drilling/Completion	Need for drilling protocols and performance specifications	
184			Drilling/Completion	Better fracture designs	3-3, 4-25
185			Drilling/Completion	Reduced corrosion and paraffin	4-3, 4-4, 4-5
230			Drilling/Completion	Low quality coalbed methane wells	
246			Drilling/Completion	Barriers to access for drilling	
314			Drilling/Completion	Chemical costs high for scale, corrosion, paraffin	
315			Drilling/Completion	Underbalanced drilling	
316			Drilling/Completion	Formation damage control	3-10, 3-5
317			Drilling/Completion	Improved casing to resist salt zone	
318			Drilling/Completion	Salt zone washouts	3-20
319			Drilling/Completion	Avoidance/remediation of casing collapse	3-8
369			Drilling/Completion	Inadequate information on value, uses, successes, profitability of 3-D seismic applications	
398			Drilling/Completion	Stimulation containment	3-3, 4-11
733			Drilling/Completion	Improved temporary plugging techniques	
479	3-2		Drilling/Completion	Drilling fluid design	
481	3-4		Drilling/Completion	Cementing	
482	3-5		Drilling/Completion	Perforating and wellbore cleanup	
484	3-7		Drilling/Completion	Multi-lateral technology	
488	3-11		Drilling/Completion	Measurements while drilling (MWD)	

DEVELOPMENT/RESERVOIR PROBLEMS AND NEEDS

Reservoir characterization entails the combination of qualitative descriptive methods with quantitative analytical techniques. This allows the creation of a digital model of the reservoir, its physical attributes and heterogeneities, and the flow of fluids through it. The model can then be used to visualize the reservoir as well as the possible changes in the reservoir attributable to various potential development approaches.

The participants in the PTTC problem identification workshops recognized the need for improvements in reservoir characterization tools and related analytical approaches so that they can be increasingly used as essential tools in more comprehensive approaches to reservoir development. This indicates an increasing willingness to use multi-disciplinary teams to define the limits of the reservoir, identify the producing zones, and design and implement the most effective development or redevelopment approach.

Over the past two decades, major advances have been made in reservoir characterization, modeling, visualization, and simulation. Advances have also been made in modeling the performance of drilling, stimulation, and production technologies in the reservoir. Together, these technologies present a powerful tool for planning reservoir development. The reservoir characterization and modeling process is highly data intensive, which makes it even more imperative to have state-of-the-art computer technologies available to the industry.

As shown in Table 4a, all 10 PTTC regions identified development and reservoir issues as a very high priority. Within this category, they identified the following as major problems or needs:

- Inadequate data access and quality, or incomplete, missing, or lost reservoir, production and other data.
- Cost-effective access to reservoir simulation software, data, analogs, and case studies.

- Reservoir description/characterization techniques for heterogeneity, clays, geometry, technology, deposition, porosity, and permeability.
- Characterization techniques for natural fractures -- FMI, VSP, Microseismic, DST, tracers.
- Improved logging and analysis methodologies.
- Producer education in primary, secondary, and improved recovery operations to optimize reservoir performance.
- Identification of overlooked pay zones.
- Databases and electronic retrieval for log and map data.
- Reservoir scale seismic applications.

a. Insufficient Reservoir Information and Data. As noted in the discussion of exploration issues, all of the PTTC regions identified the lack of reservoir information

Table 4a. Development/Reservoir Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South Midcontinent	Southwest	Texas	West	Total
Data - restricted access, missing, lost, incomplete, reservoir, production and other data	x	x	x	x	x	x	x	x	x	x	10
Cost-effective access to reservoir simulation software, data, analogs and case studies	x	x	x	x		x	x	x	x	x	9
Reservoir description/characterization techniques for heterogeneity, clays, geometry, lithology, deposition, porosity, permeability	x			x	x	x	x	x	x	x	8
Characterization techniques for natural fractures - FMI, VSP, Microseismic, DST, tracers	x			x		x	x	x	x		6
Improved log analysis methodologies		x		x	x	x		x	x		6
Identification of overlooked payzones				x		x	x		x	x	5
Databases and electronic retrieval for log and map data	x	x				x			x		4
Reservoir scale seismic applications	x					x		x	x		4

and data availability in their top five reservoir problems. This concern encompasses both incorrect and poor quality data reported to public repositories, as well as missing or incomplete data. It also includes inadequate or inaccessible private company records and data which, if available, could significantly advance the mission of high quality reservoir characterization and improved reservoir management.

The main impact of the inadequacy of reservoir and well information is that operators are unable to take advantage of the potential of existing, state-of-the-art reservoir management practices, analytical tools and technologies in their efforts to maximize a field's productive life. Reservoir and well data are being lost in increasing quantities as major companies restructure, consolidate, or shift operations geographically.

b. Cost-effective access to reservoir simulators, characterization and analytical tools. All of the regions identified among their top five reservoir problems the lack of effective access to and use of reservoir management and simulation tools. This problem, which is both economic and technical, is a major obstacle to determining and implementing optimum recovery processes in their regions. Many reservoir management and simulation technologies exist that can that help to optimize recovery processes. However, they may be too expensive for producers to use either because of the cost of the technologies or the cost of acquiring the data to implement the technologies.

Recognizing this problem, PTTC has been engaged in discussions with several major developers and providers of reservoir simulation software to make some of these technologies accessible on at least a demonstration basis through the PTTC regional resource centers. Another solution may be to make these tools and the requisite training in their use, available for operators on a pay-per-use basis.

c. Lack of adequate field case studies. All the regions except the Midwest and North Midcontinent regions identified the lack of field case studies as a major barrier to operators' application of state-of-the-art reservoir management technologies and approaches. This problem is both economic and technical in nature. The exploration and producing industry operates largely on the basis of analog -- what was true or worked well in one setting is likely to

hold true and work well in another well or reservoir in the same setting. As a rule, operators do not feel confident with technologies that are not supported by documented field examples presenting positive results.

Case studies of older projects can be expensive, especially if proper documentation and data collection processes were not followed. Many case studies already exist, both in the public domain and in the files of various producers throughout the nation. They also exist in the extensive archives of the oil and gas related professional societies. Regrettably, few of these archives are sorted or packaged in compendia related to specific settings or applications of specific technologies. Although it would be cost-prohibitive for PTTC to attempt this packaging effort, the regional resource centers will provide producers easier access to such sources.

d. Inadequate logging tools, and well testing tools. All the regions except two ranked inadequate logging tools, and well testing tools as a major problem. Although specific logging tools were not identified, there are a number of newer log types on the market (less than 15 years old) that help provide better reservoir information. Running these logs may be cost-prohibitive in a case where a field has a low estimated ultimate recovery (EUR) on a per-well basis. The same problem may occur for well testing tools. The problem of cost may apply to only one region. For instance, injection profile logs in Oklahoma cost about 1/4 to 1/5 as much as those in West Virginia. By improving these technologies -- and producers' awareness of and cost-effective access to them -- producers will be better able to detect reservoir limits, identify bypassed reserves, improve formation evaluation, increase drainage from primary production, improve characterization of fractures, detect formation damage and channeling behind pipe. Addressing this problem, which is both economic and technical, should generally reduce operating costs and improve production efficiency.

More than half of the reservoir related problems and needs identified by the PTTC regions correlate directly with technology issues addressed by the NPC report on RD&D needs. There are direct correlations in seven specific problem areas identified by the PTTC. These correlations, as well as additional development and reservoir technology areas identified by PTTC and the NPC are shown in Table 4b.

Table 4b. Producers' Identified Development/Reservoir Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
57			Development/Res	Insufficient data, bad quality, and restricted access, acquisition costs - all data types	
58			Development/Res	Incomplete and insufficient production data -- requires consistent state standards	
62			Development/Res	Incorrect completion reports	
65			Development/Res	Lack of production data by well	
69			Development/Res	Inadequate technical understanding of res. char techniques	
72			Development/Res	Inability to separate data commingled production (i.e. fluid production, thief zones, etc)	
88			Development/Res	Instruction in operational management to reduce overall costs of production	
91			Development/Res	Improved databases and electronic retrieval for log and map data	
154			Development/Res	Need for education in decision-making on options, methods, and evaluation after primary and secondary operations	
168			Development/Res	Affordable producer access to data and analytical hardware and software	
178			Development/Res	Ability to design and remediate fracture treatments and methods	
179			Development/Res	Efficient reservoir monitoring techniques for oil and gas recovery efficiency	2-29, 2-30
180			Development/Res	Improved recovery through produced water reduction and disposal, stimulation, and tertiary recovery techniques	2-1-2, 2-4, 2-6-9, 2-14, 2-18, 2-20-21, 2-25, 4-13
197			Development/Res	Overlooked pay zones	1-13, 1-4, 1-5, 2-1-4, -6, 2-8, 2-9, 2-14, 2-18, 2-20-21, 2-25, 4-13
201			Development/Res	Lack of adequate case studies in reservoir management	
232			Development/Res	Shaly sandstone log analysis in San Juan Basin	2-23
250			Development/Res	Reservoir simulation software	2-1, 2-26, 2-6, 2-25
278			Development/Res	Decreasing major co R&D	
280			Development/Res	Stratigraphic reservoir in-fill drilling	
282			Development/Res	Scaling up pilots to field scale	
295			Development/Res	Use of 3-D seismic for reservoir characterization (including shear wave and pitfalls as well as promises)	1-4, 1-6, 1-12, 1-13, 1-14, 2-2
296			Development/Res	Detection of reservoir limits and bypassed reserves	
297			Development/Res	Identification of natural fractures	
341			Development/Res	Improved log analysis methodologies and case studies for newer logs, formation evaluation	2-15, 2-16, 2-17, 2-20
342			Development/Res	Provide access to lost reservoir data at time of acquisitions or divestitures	

Table 4b (cont.) Producers' Identified Development/Reservoir Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
365			Development/Res	Improve drainage on primary production	2-1-3, 2-6, 2-5, 2-8, 2-20, 2-25
388			Development/Res	Misperception of value and benefits of reservoir data and databases	
400			Development/Res	Characterization of natural fractures System (FMI, VSP, Microseismic, DST, Tracers), fracture stimulation, acidifying	1-16, 1-14, 2-4, 2-7, 2-9, 2-21, 2-25, 3-3
416			Development/Res	Reservoir description/characterization -- heterogeneity, clays, geometry, lithology, deposition, porosity, permeability	1-3, 1-11, 1-13, 2-1, 2-2, 2-3, 2-6, 2-12, 2-14, 2-25
631			Development/Res	Formation evaluation behind casing	2-15, 2-17
694			Development/Res	Channeling behind pipe	2-8, 2-15, 2-31, 2-34, 4-13, 11-3, 11-5
771			Development/Res	Reservoir-scale seismic applications	2-1, 2-3, 1-25-27
449	2-6		Development/Res	Geostatistical reservoir descriptions	
450	2-7		Development/Res	Outcrop analog studies	
454	2-11		Development/Res	Advanced attribute processing	
456	2-13		Development/Res	Cuttings analysis	
459	2-16		Development/Res	Deep investigation techniques	
466	2-23		Development/Res	Formation water chemistry	
471	2-28		Development/Res	Expert systems applications	
474	2-31		Development/Res	Advanced well testing and interpretation	
475	2-32		Development/Res	Material balance applications	
477	2-34		Development/Res	Expendable well bore instrumentation	
607		IG-5	Development/Res	Integrated geological, geophysical and petroleum engineering staff approach	
609		IG-7	Development/Res	Downhole imagery	
615		IG-13	Development/Res	Logging tools with advanced data acquisition and transmission capability	

PRODUCTION PROBLEMS AND NEEDS

Production problems and needs relate directly to the surface, well, and subsurface equipment and operations that are required to extract oil and/or natural gas from the reservoir. Under current conventional technologies, the ultimate recovery efficiency for oil averages about 35 percent. That means that almost two-thirds of all oil resources ever discovered is abandoned in the reservoir for the lack of availability or application of economic technologies to produce it. Since the advent of waterflooding in the 1950s, producers have sought new and innovative ways to increase production efficiency, increase ultimate recovery, reduce costs, and sustain economic operations from marginal wells. Independent producers operate the majority of stripper wells in the United States, producing less than 15 BOE per day per well.

Production processes rank high among the key problems and needs faced by independents, including well maintenance, reducing electricity costs, improved primary, secondary, and advanced recovery technologies, and reservoir management issues and strategies. As shown in Table 5a, the major production issues identified by producers include:

- Corrosion, scale, and paraffin prevention and remediation.
- Inadequate understanding/training in potential, applications, and economics of improved oil and gas recovery technologies.
- Sustaining economic production from marginal wells.
- Pump optimization and approaches to improve artificial lift and reduce electricity costs.
- Lack of case studies, analogs.
- Water channeling and shut-off technologies.
- Water quality problems (iron sulfide, bacteria, corrosion).
- Waterflooding and pressure maintenance.
- Clean-up/disposal of produced waters.
- Severe shortage of trained/experienced field personnel.
- Mechanical integrity testing and wellbore remediation techniques.

- Casing leaks.

Table 5a. Production Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Corrosion, scale, and parrafin production and remediation	X	X	X	X	X	X	X	X	X	X	10
Water channeling and shut-off technologies		X	X	X	X	X	X	X	X	X	9
Inadequate understanding/training in potential, applications, and economics of improved oil and gas recovery technologies	X	X	X	X	X	X	X		X	X	9
Clean-up/disposal of produced waters		X	X	X	X		X	X	X		7
Pump optimization and other approaches to improve artificial lift and reduce electricity costs			X		X	X	X	X	X		6
Severe shortage of trained/experienced field personnel	X	X	X	X				X	X		6
Lack of case studies, analogs			X	X		X	X	X	X		6
Sustaining economic production from marginal wells	X	X		X		X	X	X			6
Waterflooding and preasure maintenance		X	X	X		X	X	X			6
Water quality problems (iron sulfide, bacteria, corrosion)			X	X	X		X	X			5
Mechanical integrity testing and well remediation technology		X	X	X	X	X					5
Casing Leaks		X	X	X			X				4
Low gravity and heavy oil production technology			X					X		X	3
Gas lift and compression technologies									X		1

a. Corrosion/scale/paraffin problems. All regions listed corrosion/scale/paraffin problems in their top production problems. These obstacles have a significant economic impact

on oil and gas production, not only by impairing productivity, but also by increasing operating expenses. A number of technologies exist to control corrosion and scale problems, but they tend to have the problem of only working in certain reservoirs or fields.

It would be useful to encourage producers and service companies to work together to study the problem on a larger basis through a joint industry study. PTTC could serve as the primary dissemination point for communicating the results and technology advances to the domestic producing community.

b. Applications and economics of improved oil and natural gas recovery technologies. Nine PTTC regions identified the need for improved understanding and training in evaluating the potential of current improved oil and gas recovery technologies. These include:

- Advanced primary production strategies including the use of reservoir description and characterization techniques
- Improved waterflooding and pressure maintenance technologies
- Advanced secondary recovery techniques such as targeted infill drilling, polymer-augmented waterflooding, permeability profile modification, and horizontal-deviated drilling.
- Improved recovery technologies, such as gas, thermal, and chemical recovery processes.

Many of these technologies have been refined to allow single well applications, in addition to full field applications. With sustained low oil prices, many chemical and thermal EOR processes remain uneconomic. At the same time, waterflooding and advanced secondary recovery technologies may be economic. Continuing advances in many of these technologies can improve their efficiency or reduce their cost, thus making them more economic in specific applications. Producers need more effective means of identifying the available technologies that could be applied economically in their own reservoirs to improve production. These methods can include performance prediction models, seminars, workshops, case studies, and

other materials that demonstrate the effectiveness of a technology and approach applied in the reservoir at the field scale.

c. **Sustaining economic production from marginal wells.** Many producers operate on the economic basis of a single well. As the wells become uneconomic, they are shut in and ultimately plugged and abandoned. Alternatively, they may be converted to injection wells for improved recovery processes. As marginal wells become uneconomic and are abandoned, resources in the immediate vicinity of the well bore may be abandoned permanently and future access to the reservoir is restricted.

Without the complexity or expense of many of the "improved" recovery technologies, numerous techniques and strategies are available now to reduce the operating costs of marginal wells. These range from inexpensive wellbore clean-up processes to new coiled-tubing workover technologies that reduce maintenance and operating costs. In addition, pump optimization technologies can reduce pumping time and related electricity costs. Producers need an effective way of identifying and considering these technologies for application in their wells. They also need new low-cost technologies and applications to sustain the economic life of producing wells.

d. **Water channeling problems, high water-cuts, and shut-off techniques.** The Central Gulf and North Midcontinent regions listed channeling problems and high water-oil ratios among their top five problems. This increases pumping costs, reduces oil production, and creates a problem with produced water disposal. (Problems associated with production and disposal of produced waters are addressed in more detail in the environmental technology section of this report.) Control of water down-hole can be addressed with existing technologies. Recent advances in the use of cross-linked gels and micro-fine cements have greatly improved the success rates of down-hole water shutoff treatments.

e. **Waterflooding and pressure maintenance.** Although waterflooding technologies have been in use since the 1950s, many producers still choose not to apply this technology, even in reservoirs where it can be highly conducive to increasing production rates and ultimate recovery. Recent advances including polymer augmentation have increased the effectiveness of

this technology dramatically. Waterflooding workshops, manuals, and other technology transfer mechanisms need to be stepped up to continue operator use of this technology. Similarly, gas injection and other reservoir pressure maintenance technologies continue to advance. Six PTTC regions indicated that producers need to be aware of the application and the potential of these technologies.

f. **Water quality and clean-up problems.** Problems with water quality were identified as a high priority need by five PTTC regions. Frequently waster supplies in the areas of the waterflood project are of poor quality, containing high levels of particulates, iron sulfide, and bacteria. These can cause problems when injected into the reservoir or when mixed with polymers. Cost effective clean-up technologies are needed to improve injection water quality.

g. **Lack of trained and experienced technical personnel.** Six of the 10 PTTC regions ranked lack of experienced personnel among their top five production problems. Low and unstable oil and gas prices world-wide and the severe production decline in the lower-48 states have caused massive reductions in the E&P work-force. Most U.S. college and university degree programs in petroleum engineering and related geosciences are training a higher proportion of foreign nationals than Americans, many of whom will return to their native countries to apply their education. Attrition rates in U.S. companies have hit the technology sector hard, both in R&D and field operations, as senior personnel have been retired early, expensive experienced personnel have been terminated, and junior personnel with limited experience have been retained.

Solutions to this problem on a field level may be accomplished through wider use of the American Petroleum Institute's programmed learning courses. In addition, short courses in field production management can be organized that would utilize retired field personnel as instructors. PTTC will be monitoring the results of the training in this area being done by the Oklahoma Commission on Marginally Producing Oil and Gas Wells. Solutions to this problem at the professional level may be more difficult, since technical professionals with field experience are in limited supply. Also, increasingly complex software requires much training that will limit the number of people in the industry who have obtained the necessary skill.

Emphasis on stronger continuing education programs within the professional societies may help mitigate this problem.

h. Casing leak problems. Four PTTC regions identified casing leak problems in their top production problems. These problems include inadequate technologies -- and insufficient understanding of the technologies that do exist -- for prevention, detection, and repair of casing leaks. Several technologies have been recently developed and implemented that can help solve this problem. Information on their application, effectiveness, and costs need to be packaged in a form useful to independents, including case studies and evaluation tools.

i. Insufficient wellbore data and clean-up technology. All regions except the North Midcontinent expressed the lack of wellbore information and technologies for remediation, (i.e., stimulation and well cleanup) in the top production problems. Where wellbore information does not exist, it can be difficult to obtain, especially in cases where a well is old or has changed hands two or three times and the data have been lost. There needs to be an attempt to locate as many sources of wellbore information as is feasible. One method may be to contact the original operators of older wells to see if they may have records in "dead" storage that they would like to donate to state oil and gas agencies as opposed to continuing to pay rent on storage space.

Remedial workover technologies can be difficult to obtain. This is particularly true with independents who tend to withhold information from each other if it might provide a company with a perceived competitive advantage over others. Where the technologies do not exist, it may be possible to encourage petroleum and service companies to work together on a common project to improve remedial workover results. The PTTC's role would possibly be to act as a facilitator and to provide technical support via DOE, GRI and national lab contributions.

As with the other categories, most of the production related problems and needs identified by the PTTC regions correlate directly with technology issues addressed by the NPC report. There are direct correlations in 17 specific production-related problem areas identified by PTTC. In many cases, the PTTC regions identified technology problems at a greater level of specificity than did the NPC study, which had a broader focus. These correlations, as well as additional production technology areas identified by PTTC and NPC are shown in Table 5b.

Table 5b. Producers' Identified Production Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
85			Production	Specialty treatments for well remediation (e.g. plastic gravel packs and pre-packs on coil tubing)	
86			Production	Methods to shut off water channeling	
87			Production	Controlling coning of produced waters	4-16, 2-2, 2-5-6, 2-8, 2-14, 2-20-21, 2-4, 2-23-25
132			Production	Production of low gravity oil	1-4, 2-1-3, 2-10, 2-12, 2-14, 2-29, 2-30, 4-11, 4-16-24
133			Production	Dehydration of low-pressure, low volume gas	8-1
134			Production	Artificial lift efficiency and pump optimization	3-6, 4-7, 4-9, 4-10, 4-25
144			Production	Produced water quality problems (i.e., iron sulfide, bacteria, corrosion problems)	2-8, 2-21-24, 4-2-4, 4-6, 11-2
145			Production	Mechanical integrity of wells (casing leaks, fresh water dumped in producing zones, inexpensive remediation)	3-6, 4-3,. 4-4, 4-5, 4-13
146			Production	Inadequate understanding of corrosion, and paraffin/aspaltine problems	3-6, 4-3, 4-5
164			Production	Knowledge of remaining oil and improved recovery processes and economics	4-17, 4-16, 4-27, 4-21-24
196			Production	Stimulation, formation damage, acidization, and fracturing technologies, reservoir fluid incompatibility design	1-16, 2-1, 2-2, 2-5, 2-9, 2-14, 2-18, 2-23, 2-24, 2-25, 3-3
211			Production	Gas measurement technologies	9-4, 9-5
213			Production	Maintaining production from marginal and low volume gas wells	
275			Production	Submersible pump design, maintenance	
283			Production	Heavy oil recovery	
304			Production	Drainage optimization	
333			Production	Reduce electric use/costs by improving efficiency (may include energy audits as performed by Caterpillar and DOE)	
334			Production	Improve efficiency of field equipment, automation, aging infrastructure	3-6, 3-8
336			Production	Improved waterflood design conformance control, and technology	2-1-6,2-8, 2-14, 2-19, 2-20-25, 4-1, 4-16
376			Production	Profile control	
403			Production	Secondary recovery technologies (e.g., Injecting, recovery efficiency, modeling, data on similar projects, Remaining oil in place, fluid properties/variations)	

Table 5b cont. Producers' Identified Production Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
627			Production	Water Production Volumes	2-8, 2-25, 2-32, 4-2, 4-6, 11-2-4
702			Production	Casing leaks	3-4, 3-12, 11-5, 10-2
708			Production	Problem identifying corrosion/scale	3-2, 3-5, 4-2-5
713			Production	Bacteria and chemical problems	3-2, 4-10
731			Production	Improved polymer technology, i.e., without corrosion problems	4-3
736			Production	Improved sweep efficiency technology	2-1, 2-2, 2-4, 2-6, 2-20, 2-21, 2-25, 2-30, 4-16-27
774			Production	Performance prediction	
794			Production	Advanced EOR processes	2-30, 4-16-25
498	4-8		Production	Gas lift analysis	
502	4-12		Production	Gas compression techniques	
504	4-14		Production	Remote control and data analysis	
617		IG-15	Production	Field tests and demonstrations	
622		IG-20	Production	Advanced pressure maintenance programs	

ENVIRONMENTAL TECHNOLOGY PROBLEMS AND NEEDS

Environmental issues are a major and growing concern in the domestic oil and gas industry. The primary challenge in this area is to sustain oil and gas E&P operations economically, while protecting the environment and complying with a broad range of local, state, and federal environmental, safety, and health regulations and associated reporting requirements. The PTTC workshops identified a broad range of the industry's technology and regulatory problems. For the purpose of this report, technology and regulatory needs are discussed separately. A discussion of environmental regulatory concerns follows this section.

Two key issues relate to the need for improved environmental protection and compliance technologies:

Cost of environmental compliance. Seven of the 10 PTTC regions, listed the cost of compliance with regulations and liability issues in their top five environmental problems. Producers must seek and apply the least-cost technology that meets the standards of compliance established by regulation. Economics play a significant role in solving the E&P problems discussed above and in the resolution of the environmental technology problems and needs discussed below. If the cost of acquiring technology can be minimized, it can become useful to a larger percentage of the producer community.

Unawareness of cost-effective remediation technologies. The other major obstacle to effective application of environmental protection and remediation technologies is a lack of producer awareness of the availability, effectiveness, and cost of remediation technologies to comply with regulations and overcome environmental issues. Several of the PTTC regions identified this problem among their top problems.

Producers identified seven major environmental compliance technology needs and priorities as shown in Table 6a.

- Management, handling and disposal of produced waters
- Cost-effective technology for tank-bottom remediation/disposal

- Bioremediation and chemical methods to cleanse saturated soils.
- Lower-environmental impact drilling methods, fluids, muds.
- Cost-effective Disposal methods for drilling fluids, muds, and cuttings.
- Cost-effective compliance technologies for NORM.
- Compliance approaches for Clean Air Act requirements and Cost effective vapor recovery and disposal.

a. **Management, handling and disposal of produced waters:** All 10 PTTC regions identified the management, handling, and disposal of produced waters as a major economic and technical challenge in conducting their operations. This issue ranked particularly highly among the regions with offshore oil and gas operations, as well as onshore areas. New cost effective technologies are needed to reduce water production and to treat produced waters for safe and cost-effective disposal in injection wells or through other economic methods. Associated with this issue is the need identified in three regions for effective water reuse and reclamation techniques.

b. **Cost-effective technology for tank-bottom remediation/disposal:** Four PTTC regions identified the need for effective treatment of tank bottoms to facilitate their disposal. Emerging bio-remediation techniques offer a solution to this costly problem. Producers require more information on the costs, benefits, and performance of these technologies.

c. **Bioremediation and chemical methods to cleanse saturated soils:** Technologies are needed for effectively remediating small spills and soils saturated by hydrocarbons or produced waters and brines.

d. **Lower-environmental impact drilling methods, and fluids:** Many regions seek lower environmental drilling operations as a way to reduce costs and improve the acceptability of drilling operations to the general public. These issues include reducing the areal extent of the drill site "footprint", reducing truck traffic and size requirements, and using portable mud pits or fully removable pit liners at the surface level. Recent developments in air drilling and coiled tubing applications can reduce the footprint and overall environmental impacts. Drilling

muds and fluids typically contain small amounts of heavy metals, chemicals, hydrocarbons, and other impurities that may be considered toxic or hazardous by some environmental authorities. Research and development is needed to generate new muds and fluids that eliminate these concerns.

Table 6a. Environmental Technology Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Management, handling and disposal of produced waters	X	X	X	X	X	X	X	X	X	X	10
Cost-effective technology for tank-bottom remediation/disposal	X			X			X	X			4
Pit closure methods	X			X	X			X			4
Effective water reuse and reclamation approaches	X	X				X					3
Low-impact drilling methods, fluids, muds	X					X			X		3
Cost-effective compliance technologies for NORM disposal		X		X				X			3
Disposal methods for drilling fluids and muds						X			X	X	3
Compliance approaches for Clean Air Act requirements		X				X				X	3
Bioremediation and chemical methods to cleanse saturated soils	X			X							2
Cost effective vapor recovery and disposal compliance								X		X	2

e. Cost-effective disposal methods for drilling fluids, and cuttings: Producers need information and technology to cost effectively dispose of drilling muds and fluids recovered from drilling and completion operations.

f. **Cost-effective compliance technologies for NORM:** The handling, treatment, and disposal of produced waters, muds, cuttings, and other well apparatus contaminated with naturally occurring radioactive materials -- or NORM -- is a major new issue facing producers. PTTC regions with Gulf Coast and offshore operations are particularly affected by new regulations establishing "zero discharge" limits for produced waters and other materials affected by NORM. Producers require new, cost effective methods and technologies for handling, managing, and disposing of NORM affected materials.

g. **Compliance approaches for Clean Air Act requirements and cost effective vapor recovery and disposal:** Four PTTC regions identified needs for cost-effective technologies and approaches for compliance with local and federal clean air standards and emissions restrictions. These include gaseous emissions as well as vapor recovery, reuse and disposal concerns. These have particular relevance in thermal recovery processes for low gravity oil. Vapor recovery and disposal concerns include detection and handling of hydrogen sulfide gas.

Most of the environmental technology related problems identified by the PTTC regions correlate directly with problem areas identified by the NPC report. There are direct correlations in 16 specific production-related problem areas identified by the PTTC, as shown in Table 6b.

Table 6b. Producers' Identified Environmental Technology Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
26			Environmental/Tech	Chemical methods to expedite cleansing of brine from saturated soils, similar to effects of rainfall)	11-12
28			Environmental/Tech	Lower-impact drilling methods (e.g., closed system foam drilling, ph foamers and defoamers to decrease pit water volume. Need to reduce salt water production without inhibiting oil/gas production.	11-1
29			Environmental/Tech	Bio-remediation cleanup of oil saturated soil, and information on producers and contractors who have successfully used this technology.	11-12
101			Environmental/Tech	Inadequate understanding of NORM regulations and disposal	11-15
102			Environmental/Tech	Treatments for tubulars against produced water corrosion	
107			Environmental/Tech	NORM disposal in well bores	11-15
108			Environmental/Tech	Protection of shallow and fresh water aquifers from NORM	
109			Environmental/Tech	Mercury	
113			Environmental/Tech	Pipelines and gathering systems	
187			Environmental/Tech	Drilling Fluid disposal	11-1
190			Environmental/Tech	Understanding and compliance approaches for air emissions regulations	11-7
219			Environmental/Tech	Mapping vulnerable areas for pit closure regulation	
220			Environmental/Tech	Successes and failures of pit closure methods	
253			Environmental/Tech	Environmental compliance costs/technology for tank bottoms, tank vapors.	11-2, 11-11, 11-3
321			Environmental/Tech	H2S from water	8-3
322			Environmental/Tech	Ways to re-use water	11-11
325			Environmental/Tech	Low-cost, effective reclamation	11-4
354			Environmental/Tech	Improve drilling mud disposal	11-1
356			Environmental/Tech	Inadequate technologies for cost-effective treatment and disposal of produced waters, including alternative approaches and conformance control	11-2
362			Environmental/Tech	Costly air emissions control requirements	11-7
378			Environmental/Tech	Cost effective vapor recovery and disposal (including Hydrogen Sulfide gas)	11-10, 11-7
419			Environmental/Tech	Disposal well requirements	11-1
592	11-5		Environmental/Tech	Leak detection	
593	11-6		Environmental/Tech	Hydrological modeling	
595	11-8		Environmental/Tech	Advanced computation models to predict dispersion, transformation, fate of air pollutants	
596	11-9		Environmental/Tech	Model transport and remediation of contaminants in ground water and soils	
600	11-13		Environmental/Tech	Catalyst recycling	

ENVIRONMENTAL REGULATORY PROBLEMS AND NEEDS

All of the PTTC regions have identified a broad range of environmental regulatory concerns. Although these may not be directly expressed as technology needs and concerns, they address the economic effects of regulation on exploration and production operations. These concerns fall into five major areas as shown in Table 7a and discussed below:

- Lack of common, accessible current information on federal and state environmental regulations, reporting requirements and inadequate producer education
- Costs of record-keeping and reporting to meet local, state, and federal reporting requirements
- Relative costs and environmental benefits of regulations
- General regulatory complaints and concerns

a. Lack of common, accessible current information on federal and state environmental regulations, reporting requirements and inadequate producer education. Producers in all 10 regions identified the need for common, current, accessible information on federal and state regulations, technical compliance and reporting requirements, and report forms. Many producer lack essential information and education in environmental issues and regulations (i.e., definitions and understanding of regulations and environmental issues). This was identified as the number one problem in Louisiana (Central Gulf Region), and in Illinois (Midwest). It was also communicated as a lower priority area in the North Midcontinent region, along with producers expressing confusion over the definition of rules and regulations. The Southwest region had a problem with access and definition of regulations, and the South Midcontinent region expressed a need for a list of toxic chemicals.

Six PTTC regions specifically identified an urgent need for guidelines and information on NORM rules and compliance approaches in their top regulatory problems.

Table 7a. Environmental Regulatory Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Lack of common, accessible current information on federal and state environmental regulations, reporting requirements	X	X	X	X	X	X	X	X	X	X	10
Reporting/record keeping costs	X		X		X	X	X	X		X	7
Guidelines for NORM compliance	X	X	X	X			X	X			6
Inadequate training/education of inspectors and regulators	X	X			X		X			X	5
Produce or plug requirements /expensive abandonment and plugging rtests and costs	X					X	X			X	4
Inadequate and inconsistent enforcement/regulation	X		X	X							3
Lack of cost-benefit testing of regulations before implementation					X	X				X	3
Responsibility for cleaning/plugging idled orphan wells.	X					X	X				3
Wetlands issues (permits, access, improper classification)	X	X									2
Injection Rules	X				X						2
Excessive Clean Air Act restrictions on minor emissions	X						X				2
Zero discharge requirements for produced waters		X	X								2
Toxic chemical restrictions							X				1

b. Costs of record-keeping and reporting to meet local, state, and federal reporting requirements. Seven PTTC regions identified costs of record keeping and reporting as a key obstacle. Too much paperwork was listed as a concern in their top five regulatory problems.

c. Relative costs and environmental benefits of regulations. Many industry sources question the relative costs and benefits of certain regulatory requirements and have expressed

the need for cost-benefit testing of environmental regulations before their implementation. These costs should include both energy and economic costs, as well as relative environmental benefits.

d. General regulatory complaints and concerns. Several regions also expressed concerns about inadequate and inconsistent enforcement of environmental regulations. They perceive the training of inspectors and regulators as inadequate, particularly as it relates to actual field operations and practices of the producing industry and the limits imposed by technology and economics.

e. Specific regulatory issues. Several specific regulatory issues and concerns were also noted, including: excessive Clean Air Act restrictions on minor emissions; improper classification of lands as wetlands; requirements for NORM information to be placed on deeds; zero discharge requirements for produced waters; toxic chemical restrictions; produce or plug requirements /expensive abandonment tests; and chain of financial responsibility for cleaning/plugging idled orphan wells.

A more detailed list of environmental regulatory issues and correlations to the NPC findings is provided in Table 7b.

Table 7b. Producers' Identified Environmental Regulatory Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
21			Environmental/Reg	Consider Ohio underground injection rules for use in other App states	11-3
23			Environmental/Reg	Need a common information source of current information for all state, federal environment regulations, including who to report to (e.g., EPA vs. OH D.O.G)	
24			Environmental/Reg	Clean Air Act Title V restrictions on minor emissions from venting of tanks and wells, exhaust from gas powered pump motors and compressors, and minimize restrictions on minor noise emissions.	11-7
25			Environmental/Reg	Land improperly classified as wetlands (e.g., deciduous forest with small wetland communities vs. areas that usually have standing water)	
30			Environmental/Reg	State drilling permits should identify ground water horizons including depths and estimated flow rates.	
32			Environmental/Reg	Modify disposal regulations for drill cuttings in PA to require pits to be solidified before burial.	
33			Environmental/Reg	Eliminate NRC requirement for NORM information to be put on well deed	
74			Environmental/Reg	Inadequate and inconsistent enforcement of regulations	
75			Environmental/Reg	Inadequate inspector training, understanding of oil/gas operations and industry	
77			Environmental/Reg	Lack of timely information on constantly changing environmental requirements	
78			Environmental/Reg	Multiple regulators/enforcers of same issues	
79			Environmental/Reg	Lack of easy access to regulations	
80			Environmental/Reg	Need for consolidated regulations and a start-up checklist for producers is needed	
82			Environmental/Reg	Responsibility for plugging/cleaning orphaned wells/sites	
100			Environmental/Reg	Zero discharge regulations for produced waters	11-2
110			Environmental/Reg	Wetlands permits and access	
160			Environmental/Reg	Inadequate understanding of NORM and nuclear regulations and compliance approaches	
204			Environmental/Reg	Cost/burden of regulatory record keeping	
205			Environmental/Reg	Toxic chemical restrictions	11-1
206			Environmental/Reg	Produce or plug requirements	
324			Environmental/Reg	Role of EPA as primary regulator	
330			Environmental/Reg	Improve warning/timing of pending laws and regs	
350			Environmental/Reg	Require cost-benefit testing of regulations to determine cost-effectiveness and reasonableness before implementation	11-14
351			Environmental/Reg	Agency staff too lean to enable swift turn around of permits after reporting	
357			Environmental/Reg	Consolidation of reporting forms to reduce cost and time requirements	

TECHNOLOGY TRANSFER PROBLEMS AND NEEDS

In addition to the specific technology and regulatory needs expressed above, participants in virtually all of the problem identification workshops expressed a need for improved channels of information among one another and with technology providers such as service companies, labs, consultants and others. The key objectives of such a technology transfer system, as stated by the producers, are to receive information faster, more completely, and more objectively. Independents want to have the appropriate tools to evaluate information in the context of the needs and strategies of their own specific businesses and operations.

Specific technology transfer needs identified by the PTTC regions include the following, as detailed in Table 8a:

- Electronic information systems for data and information transfer
- Task-based index of local, state, and federal regulations and reporting requirements
- Improved access to and ability to share drilling, completion, production, and reservoir data
- Case studies of technology applications that improved profitability
- Improved operator awareness, understanding of, and access to current, state-of-the-art E&P and related environmental technologies
- Affordable training, seminars, and workshops in technology and in application and use of analytical tools
- Increased opportunities to interact with service company personnel to learn about new approaches and technology, their successes, failures, and applications
- Improved input to public and private entities on RD&D needs and related regulatory and policy issues

a. Electronic information systems for data and information transfer. Increasingly independent producers are using electronic information systems to share technology problems, needs, experiences, successes and failures with one another. Service companies, research organizations and other technology provider are also using such systems to communicate the availability and performance of new technologies. Independent producers need increased

information about the use of the Internet and other electronic networks and training in how they can be used to identify information and share experiences. PTTC has already made significant progress in this area by the development of an electronic information system on the Internet, and through the development of a series of regional workshops on the use of personal computers and information systems for independents.

Table 8a. Technology Transfer Problems and Needs by Region

Problem	Appalachia	Central Gulf	Eastern Gulf	Midwest	North Midcontinent	Rockies	South MidContinent	Southwest	Texas	West	Total
Task-based index of regulations and reporting requirements	X	X	X	X	X	X	X	X	X	X	10
Electronic information systems for data/information transfer	X	X	X	X	X	X	X	X	X	X	10
Improve access to and ability to share drilling, completion, production, and reservoir data	X	X	X	X	X	X	X	X		X	9
Case studies of technologies that improve profitability			X		X	X	X	X		X	6
Operator awareness, understanding, and access to state-of-the-art, recent, and emerging technologies	X	X		X	X			X			5
Low-cost training, seminars, and workshops		X	X		X		X				4
Increased opportunities and consortia to share E&P experiences, successes, failures, and opportunities	X		X			X					3
Training in applications and use of analytical tools and software	X	X						X			3
Increased interaction with service companies	X		X								2
Improved coordination/cooperation between industry and government						X	X				2

b. Task-based index of local, state, and federal regulations and reporting requirements. As noted in the environmental regulatory discussion above, producers are

painfully aware that local, state and federal petroleum regulations are proliferating and changing constantly. Producers have identified the need for a electronic compendium of the regulations and reporting requirements that affect them on a state-by-state basis. Several regions also identified the need for a task based index that would inform them of specific actions they need to perform to comply with regulations, depending on the specific exploration or production operation they seek to perform. PTTC recognizes the significant value in such a system to the producing community if it can be provided and maintained current in a cost-effective manner.

c. Improved access to and ability to share drilling, completion, production, and reservoir data. Echoing the results in several other categories, most regions identified the need for effective mechanisms to share data and information. A variety of mechanisms are possible for this, including centralized data repositories, user-friendly electronic databases, electronic atlases, and data transfer mechanisms through the Internet and the PTTC home pages. In addition to raw data and statistics, this category also encompasses reservoir analog data, case studies, and other real world information needed by producers. A major issue here is the quality and usefulness of the data, taking into consideration the formatting required to make it readable by currently available analytical tools.

d. Case studies of technology applications that improved profitability. Most producers want more than the word of the theoretical researcher or the technology vendor that a prescribed technology or solution is going to be effective -- both technically and economically -- in his specific well, reservoir, or related operation. Many regions identified the desire for compendiums of case studies that relate to specific technologies and describe their application in the reservoir, reasons for success or failure, pitfalls to avoid, and their ultimate impact on the bottom line.

e. Improved operator awareness, understanding of, and access to current, state-of-the-art E&P and related environmental technologies. Producers have broadly identified the desire for seminars, workshops, demonstrations, and other technology transfer functions

focused specifically on environmental compliance technologies -- their applications, cost, performance, acceptability, and risks, and economic impacts on profitability.

f. **Affordable training, seminars, and workshops in technology and in application and use of analytical tools.** Over the past decade a new world of analytical tools has evolved to assist E&P companies in managing data, evaluating prospects, characterizing the reservoir, designing field applications, and assessing the performance of improved recovery technologies, among others. There is a high learning curve involved in deciding which technologies to use, learning to operate them, and apply them cost-effectively. Producers have also discovered new exploration, production and environmental compliance technologies. Before they can be applied however -- either by the producer or the producer's service company -- producers need sufficient training in their applications, potential, economics, and risk. Most regions have identified the need for highly focused workshops to teach producers about the technologies that address the key problems and opportunities presented by the regions.

g. **Increased opportunities to interact with service company personnel to learn about new approaches and technology, their successes, failures, and applications.** Because service companies conduct much of the research and ultimately develop most of the new technology that is being applied in the reservoir, producers need additional mechanisms to learn about technologies from the service companies, outside the direct sales environment. This can be accomplished through round-table discussions, lectures, seminars, field-trips, and other venues where producers and service company personnel can discuss needs on a one-to-one basis. The technical forums on the PTTC Internet home page also serve this function, as do many similar resources available on the Internet.

h. **Improved input to public and private entities on RD&D needs and related regulatory and policy issues.** As reflected by the participation of producers in the PTTC problem identification workshops, producers seek improved mechanisms to communicate their technologies and needs to the industry, academic, and public sector research communities. Through a continuous effort of periodic problem identification functions, surveys, and effective

oil and gas outreach efforts, producers hope their needs will be heard and identified as priorities for R&D and technology transfer investments.

Additional technology transfer results and problems identified in the regions are reflected in Table 8b.

Table 8b. Producers' Identified Technology Transfer Needs

ID	NPCID	IOGID	Category	Problem	NPC Link
12			Tech Transfer	Better ability to access and share experiences (successes and failures)	
13			Tech Transfer	Improve ability to share drilling, completion, and production data	
14			Tech Transfer	Training on data retrieval systems and methods	
15			Tech Transfer	Improve operator knowledge of existing and newly developed technology	
54			Tech Transfer	Availability of and training in use of software	
56			Tech Transfer	Lack of service company experience in App basin and limited personnel resources	
98			Tech Transfer	Educate exploration departments in drilling economics, coil tubing technologies, and current regulations in shallow tight gas sands	
141			Tech Transfer	Need for interaction with service companies	
142			Tech Transfer	Need workshops to present new technologies	
191			Tech Transfer	Inadequate case histories of successful and unsuccessful applications of production technologies	
200			Tech Transfer	Inadequate dissemination of government information to producers	
210			Tech Transfer	Low-cost training and seminars	
337			Tech Transfer	Provide EOR process information and technology to independents to reduce costs of application, candidate reservoir ID	4-16-21, 4-23, 4-24
344			Tech Transfer	Provide easy, user-friendly access to information, lists of service providers, databases, etc	
345			Tech Transfer	Consortia for sharing of information and technology	
346			Tech Transfer	Improve cooperation/coordination between industry and government	
360			Tech Transfer	Locate and publicize location and accessibility of public domain data	
387			Tech Transfer	Task-based index of regulations	
724			Tech Transfer	Access to reservoir simulators	

IV. PTTC FINDINGS BY REGION

The previous chapter identified unique needs and priorities according to subject category. The following section provides the results of the PTTC workshops on a regional basis. To the extent that the data furnished by the regional lead organizations, these data are shown on a workshop-by-workshop basis. However, in certain regions where multiple workshops were held, the results were aggregated and presented for the entire region.

The following results identify problem statements reported by the regions and reflect prioritizations made by the participants and their regional lead organizations. In most cases, the regions prioritized categories of problems and then provided a ranked list of problems and needs within each category.

The following lists attempt to reflect these prioritizations as faithfully as possible based on the materials received from the regions. Additional information is available, however, in the individual reports of the regions which can be obtained by contacting the regional lead organizations or the PTTC national headquarters.

The findings of this report make it clear that investments must continue to be made in public, private and collaborative R&D for the technologies of tomorrow. Moreover, there needs to be more investment in a targeted and aggressive course of technology transfer. The mission of these efforts must be to accelerate and expand producers' awareness, understanding, access to, and acceptance of current and emerging technologies that are cost-effective. With effective technology transfer, industry can apply these technologies to improve exploration successes, detect bypassed and unswept resources, replace and add new reserves, extend the economic life of marginal wells, defer abandonments, and enable the fullest possible economic production of America's oil and natural gas resources while protecting the environment. Without effective technology transfer, the full value of our public and private sector investments in R&D may never be realized.

Appalachia Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
1	Exploration/Data	Need for a location of available seismic data in 2-D and 3-D. Need access to data, application and analysis of current exploration technology.	1-1	North Canton, OH
2	Exploration/Tech	Digital computer exploration economics package (could include locations of pipelines, field, digitized logs and tops, producing formations, drilling parameters, regs, mines, etc)	1-2	North Canton, OH
3	Exploration/Data	Access to information about available case histories and field studies, and data available from other RLOs and in-state	1-3	North Canton, OH
4	Exploration/Data	Educate producers on how to find and access available data.	1-4	North Canton, OH
5	Exploration/Tech	Results and data from deep stratagraphic tests in region.	1-5	North Canton, OH
6	Drilling/Completion	Slimhole drilling methods	2-1-1	North Canton, OH
7	Drilling/Completion	Faster drilling methods costing less money per foot drilled	2-1-2	North Canton, OH
8	Drilling/Completion	Ability to drill salt sections above Medina formation	2-1-3	North Canton, OH
9	Drilling/Completion	Methods to quantify stimulation effectiveness and improved understanding of perforation technology with over/under balance	2-2-1	North Canton, OH
10	Drilling/Completion	Cost effective methods to identify hydraulic fracture geometry and natural fracture orientation.	2-2-2	North Canton, OH
11	Drilling/Completion	Reduced cost and improved technology in horizontal drilling, treatment, completion and production	2-2-3	North Canton, OH
12	Tech Transfer	Better ability to access and share experiences (successes and failures)	2-3-1	North Canton, OH
13	Tech Transfer	Improve ability to share drilling, completion, and production data	2-3-1	North Canton, OH
14	Tech Transfer	Training on data retrieval systems and methods	2-3-2	North Canton, OH
15	Tech Transfer	Improve operator knowledge of existing and newly developed technology	2-3-2	North Canton, OH
16	Tech Transfer	Improve ability to identify pay zones in carbonate reservoirs; database of log interpretation constants (i.e. Rw, n, etc.)	2-3-4	North Canton, OH
17	Development/Res	Need well pressure data (initial and on-going) shut in psi v. time, ongoing prod data v. time.	3-1	North Canton, OH
18	Development/Res	Need indexes by state, well, etc of available data (e.g., wells, location, permit numbers, logs, cores, well records, improved recovery projects, fractures, geol/petrographic studies, PVT, gravities, horizontals, etc)	3-2	North Canton, OH
19	Tech Transfer	Assistance in using lithological correlations, and drainage areas and recovery factors.	3-3	North Canton, OH
20	Development/Res	Approaches to access data and information compiled by state agencies, PTTC, associations, and technical societies, from surveys and presented at their meetings.	3-4	North Canton, OH
21	Environmental/Reg	Consider Ohio underground injection rules for use in other App states	4-1	North Canton, OH
22	Environmental/Reg	Gauge response/fines to size/magnitude of spills or infractions.	4-2	North Canton, OH
23	Environmental/Reg	Need a common information source of current information for all state, federal environment regulations, including who to report to (e.g., EPA vs. OH D.O.G)	4-3	North Canton, OH
24	Environmental/Reg	Clean Air Act Title V restrictions on minor emissions from venting of tanks and wells, exhaust from gas powered pump motors and compressors, and minimize restrictions on minor noise emissions.	4-4	North Canton, OH

ID	Category	Problem	Reg Priority	PIW Location
25	Environmental/Reg	Land improperly classified as wetlands (e.g., deciduous forest with small wetland communities vs. areas that usually have standing water)	4-5	North Canton, OH
26	Environmental/Tech	Chemical methods to expedite cleansing of brine from saturated soils, similar to effects of rainfall)	4-6	North Canton, OH
27	Environmental/Tech	Standardize procedures for plugging of oil and gas and coal mines (especially in Ohio)	4-7	North Canton, OH
28	Environmental/Tech	Lower-impact drilling methods (e.g., closed system foam drilling, ph foamers and defoamers to decrease pit water volume.) Need to reduce salt water production without inhibiting oil/gas production.	4-8	North Canton, OH
29	Environmental/Tech	Bio-remediation cleanup of oil saturated soil, and information on producers and contractors who have successfully used this technology.	4-9	North Canton, OH
30	Environmental/Reg	State drilling permits should identify ground water horizons including depths and estimated flow rates.	4-10	North Canton, OH
31	General/Data	Catalog brine chemistry, scaling tendencies, and compatibilities by area and formation for Appalachian Basin.	4-11	North Canton, OH
32	Environmental/Reg	Modify disposal regulations for drill cuttings in PA to require pits to be solidified before burial.	4-12	North Canton, OH
33	Environmental/Reg	Eliminate NRC requirement for NORM information to be put on well deed	4-13	North Canton, OH
34	Exploration/Data	Insufficient raw data quality and availability	1-1	Ashland, KY
35	Exploration/Data	Insufficient compiled/interpreted data availability or accessibility (including published materials)	1-2	Ashland, KY
36	Exploration/Data	Insufficient or non-cost effective geophysical data collection techniques	1-3	Ashland, KY
37	Exploration/Tech	Lack of pipeline infrastructure in remote areas	1-4	Ashland, KY
38	Exploration/Tech	Lack of available training in new exploration techniques	1-5	Ashland, KY
39	Drilling/Completion	Unconventional drilling techniques/applications in basin, preferred areas, or zones.	2-0-0	Ashland, KY
40	Drilling/Completion	Slim-hole drilling	2-1-1	Ashland, KY
41	Drilling/Completion	Horizontal drilling	2-1-2	Ashland, KY
42	Drilling/Completion	Coiled tubing.	2-1-3	Ashland, KY
43	Drilling/Completion	Deviated wells	2-1-4	Ashland, KY
44	Drilling/Completion	Applications for multiple open or lost circulation zones.	2-1-5	Ashland, KY
45	Drilling/Completion	Formation-specific completion information	2-2-1	Ashland, KY
46	Drilling/Completion	Optimize perforation, stimulation , design, and completion fluids	2-2-2	Ashland, KY
47	Drilling/Completion	Make more shared information available	2-2-3	Ashland, KY
48	Drilling/Completion	Cementing information on adequate coverage	2-2-4	Ashland, KY
49	Drilling/Completion	Cementing information on handling lost circulation zones	2-2-5	Ashland, KY
50	Drilling/Completion	Optimal tubing setting depth in wells with multiple completed formations	2-5-1	Ashland, KY
51	Drilling/Completion	How to handle formation waters	2-3-1	Ashland, KY
52	Drilling/Completion	How to optimize tools, air pressure, and volumes	2-3-2	Ashland, KY
53	Tech Transfer	Isolation of independents from technology	2-4-1	Ashland, KY
54	Tech Transfer	Availability of and training in use of software	2-4-2	Ashland, KY
55	Tech Transfer	Training in use of software	2-4-3	Ashland, KY
56	Tech Transfer	Lack of service company experience in App basin and limited	2-4-5	Ashland, KY

ID	Category	Problem	Reg Priority	PIW Location
		personnel resources		
57	Development/Res	Insufficient data, bad quality, and restricted access, acquisition costs - all data types	3-1-0	Ashland, KY
58	Development/Res	Incomplete and insufficient production data -- requires consistent state standards	3-1-1	Ashland, KY
59	Development/Res	Data missing or improperly reported on well completion reports	3-1-2	Ashland, KY
60	Development/Res	Lack of core or sample data interpretation -- not catalogued	3-1-3	Ashland, KY
61	Development/Res	Unavailability of offset data (logs, production data)	3-1-4	Ashland, KY
62	Development/Res	Incorrect completion reports	3-1-5	Ashland, KY
63	Development/Res	Drillers logs incomplete, unreliable - lack of studies or comparable data	3-1-6	Ashland, KY
64	Development/Res	No central repository for core data	3-1-7	Ashland, KY
65	Development/Res	Lack of production data by well	3-1-8	Ashland, KY
66	Drilling/Completion	No compilation/repository of reservoir-specific completion techniques	3-2	Ashland, KY
67	Development/Res	No legal requirement to disseminate production information/coring techniques	3-3	Ashland, KY
68	General/Data	Lack of formation evaluation information (no testing, cores, DST by zone, pressures)	3-4	Ashland, KY
69	Development/Res	Inadequate technical understanding of res. char techniques	3-5	Ashland, KY
70	Development/Res	Lack of tools, techniques, testing technology to improve understanding and make economic in low-volume wells	3-6	Ashland, KY
71	Development/Res	No standards for well testing on state reports	3-7	Ashland, KY
72	Development/Res	Inability to separate data commingled production (i.e. fluid production, thief zones, etc)	3-8	Ashland, KY
73	Development/Res	Lack of compiled or interpreted information on individual reservoirs (reservoir studies, production, Rw's, Lithology)	3-9	Ashland, KY
74	Environmental/Reg	Inadequate and inconsistent enforcement of regulations	4-1-0	Ashland, KY
75	Environmental/Reg	Inadequate inspector training, understanding of oil/gas operations and industry	4-1-1	Ashland, KY
76	Environmental/Reg	Inconsistent enforcement	4-1-2	Ashland, KY
77	Environmental/Reg	Lack of timely information on constantly changing environmental requirements	4-2-0	Ashland, KY
78	Environmental/Reg	Multiple regulators/enforcers of same issues	4-2-1	Ashland, KY
79	Environmental/Reg	Lack of easy access to regulations	4-2-2	Ashland, KY
80	Environmental/Reg	Need for consolidated regulations and a start-up checklist for producers is needed	4-2-3	Ashland, KY
81	Environmental/Reg	Inconsistent standards for different industries	4-2-4	Ashland, KY
82	Environmental/Reg	Responsibility for plugging/cleaning orphaned wells/sites	4-2-5	Ashland, KY
83	General/PR	Need for improved industry public relations on the good job the industry performs	4-3-1	Ashland, KY
84	General/PR	Improved operator and public education on what is scientifically important for environmental protection	4-3-2	Ashland, KY
388	Development/Res	Misperception of value and benefits of reservoir data and databases	1-1	Morgantown, WV
389	General/Data	User friendliness of computer databases(e.g. graphic interfaces, data formats, user education, guidelines and regulations, dial-up, vs on disk)	1-2	Morgantown, WV
390	General/Data	Data Integrity (e.g. education, error checking)	1-3	Morgantown, WV

ID	Category	Problem	Reg Priority	PIW Location
391	General/Data	Scope, accessibility problems due to data centralization (standard formats, comprehensiveness, accessibility, scope of queries, graphical interfaces)	1-4	Morgantown, WV
392	General/Data	Problems in data capture/acquisition (e.g., Need to encourage/enable electronic submission of data with easy-to-use software)	1-5	Morgantown, WV
393	General/Data	Information availability and accessibility (e.g., network access to databases, access to engineering and geology software and training, trading data for computer time, etc)	1-6	Morgantown, WV
394	Drilling/Completion	Effectiveness of hydraulic fracturing	2-1	Morgantown, WV
395	Drilling/Completion	Horizontal drilling technology availability and cost effectiveness	2-2	Morgantown, WV
396	Drilling/Completion	Slimhole drilling applications	2-3	Morgantown, WV
397	Drilling/Completion	Fluid removal and disposal	2-4	Morgantown, WV
398	Drilling/Completion	Stimulation containment	2-5	Morgantown, WV
399	Drilling/Completion	Methods to select restimulation containment wells	2-6	Morgantown, WV
400	Development/Res	Characterization of natural fractures System (FMI, VSP, Microseismic, DST, Tracers), fracture stimulation, acidifying	3-1	Morgantown, WV
401	Development/Res	Techniques for Formation Heterogeneity Determination	3-2	Morgantown, WV
402	Development/Res	Lack of understanding/appreciation of benefits of reservoir characterization and reservoir management (e.g., make data and results easily available)	3-3	Morgantown, WV
403	Production	Secondary recovery technologies (e.g., Injecting, recovery efficiency, modeling, data on similar projects, Remaining oil in place, fluid properties/variations)	3-4	Morgantown, WV
404	Exploration/Data	Lack of regional depositional, diagenetic, and tectonic models (e.g., information compiled./synthesized, updates of earlier studies, seismic, workshops, Aeromag data)	4-1	Morgantown, WV
405	Exploration/Tech	Cost of Technology (imaging methods, information exchange, formation micro-scanner, Borehole VSP, Aeromag surveys)	4-2	Morgantown, WV

Eastern Gulf Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
122	Exploration/Data	Availability and archiving of basin/ well data and associated data sets	1-1	Jackson, MS
123	Drilling/Completion	Need for drilling protocols and performance specifications	1-2	Jackson, MS
124	Exploration/Tech	Inadequate understanding/awareness of remote sensing and other indirect indicators of petroleum accumulation.	1-3	Jackson, MS
125	Production	Need for current information on waterflooding and pressure maintenance	1-4	Jackson, MS
126	Exploration/Tech	Accelerated and expanded awareness of advances in exploration technology	1-5	Jackson, MS
127	Exploration/Data	Need an index of available geophysical data in the region	1-6	Jackson, MS
128	Exploration/Data	Need more information on oil and gas operations in Mississippi	1-7	Jackson, MS
129	Production	Casing leaks, corrosion, and associated problems	2-1	Jackson, MS
130	General/Econ	Lease operating costs	2-2	Jackson, MS
131	Production	Saltwater disposal processes and costs	2-3	Jackson, MS
132	Production	Production of low gravity oil	2-4	Jackson, MS
133	Production	Dehydration of low-pressure, low volume gas	2-5	Jackson, MS
134	Production	Artificial lift efficiency and pump optimization	2-6	Jackson, MS
135	Production	Coordination and consolidation of industry data	2-7	Jackson, MS
136	General/Training	Lack of sufficiently trained field personnel	2-8	Jackson, MS
137	Environmental/Reg	Understanding and compliance with NORM regulations	3-1	Jackson, MS
138	Environmental/Reg	Confusion over authority to regulate E&P waste	3-2	Jackson, MS
139	Environmental/Reg	Inconsistent oil and gas regulations in the region	3-3	Jackson, MS
140	Tech Transfer	Lack of opportunities for E&P professionals to discuss and share new technologies and methods	4-1	Jackson, MS
141	Tech Transfer	Need for interaction with service companies	4-2	Jackson, MS
142	Tech Transfer	Need workshops to present new technologies	4-3	Jackson, MS
143	Tech Transfer	Inadequate case studies of successes and failures	4-4	Jackson, MS

Central Gulf Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
85	Production	Specialty treatments for well remediation (e.g. plastic gravel packs and pre-packs on coil tubing)	1-0	
86	Production	Methods to shut off water channeling	1-0	
87	Production	Controlling coning of produced waters	1-0	
88	Development/Res	Instruction in operational management to reduce overall costs of production	2-0	
89	Development/Res	Remote wellhead monitoring systems to reduce manpower	2-0	
90	Development/Res	Improved electronic measurement devices (i.e. bottom hole pressure and pressure transient analysis) transmitted by cellular fax and satellite communications	2-0	
91	Development/Res	Improved databases and electronic retrieval for log and map data	2-0	
92	Development/Res	Enable producers to file and retrieve data electronically	2-0	
93	Exploration/Tech	Education on 3-D seismic interpretation and methods	3-0	
94	Exploration/Tech	Information on 3-D lines in Louisiana	3-0	
95	Exploration/Data	Information on successful applications of 3-D in LA	3-0	
96	Exploration/Tech	Availability of software for 3-D interpretation	3-0	
97	Tech Transfer	Educate exploration departments in current regulations	4-0	
98	Tech Transfer	Educate exploration departments in drilling economics, coil tubing technologies, and current regulations in shallow tight gas sands	4-0	
99	Tech Transfer	Educate exploration departments in coil tubing technologies in shallow tight gas sands	4-0	
100	Environmental/Reg	Zero discharge regulations for produced waters	5-1	
101	Environmental/Tech	Inadequate understanding of NORM regulations and disposal	5-2	
102	Environmental/Tech	Treatments for tubulars against produced water corrosion	5-3	
103	Environmental/Tech	Handling large volumes of water in injection wells	5-4	
104	Environmental/Reg	Electronic access to rules and regulations of DEQ,DNR, EPA, Coast Guard and Corps of Engineers	5-5	
105	Environmental/Reg	Inadequate operator understanding of regulations	5-6	
106	Environmental/Reg	Inadequate agency personnel understanding of day to day industry operations	5-7	
107	Environmental/Tech	NORM disposal in well bores	5-8	
108	Environmental/Tech	Protection of shallow and fresh water aquifers from NORM	5-9	
109	Environmental/Tech	Mercury	5-10	
110	Environmental/Reg	Wetlands permits and access	5-11	
111	Environmental/Tech	Air emissions	5-12	
112	Environmental/Tech	Oil spills	5-13	
113	Environmental/Tech	Pipelines and gathering systems	5-14	
114	Drilling/Completion	Open hole horizontal drilling in depleted reservoirs	6-1	
115	Drilling/Completion	Over-burden pressure problems in horizontal drilling	6-2	
116	Drilling/Completion	Lateral extent of horizontal wellbores in unconsolidated reservoirs	6-3	
117	Drilling/Completion	Data on prospects, costs, practices and performance of horizontal wellbores	6-4	

ID	Category	Problem	Reg Priority	PIW Location
118	Drilling/Completion	Data needed on successful and unsuccessful completions projects in horizontal and conventional wells	7-1	
119	Drilling/Completion	Information needed on cement squeezes, frac packs, water packs, acid pre-packs, high rate water packs, and efficient reservoir drainage	7-2	
120	Drilling/Completion	Information database for coil tubing drilling, completion, and workovers	7-3	
121	Drilling/Completion	Educate producers on coil tube use in squeeze cementing and sand control	7-4	

Note: Workshops were held in Shreveport, LA and Lafayette, LA.

ID	Category	Problem	Reg Priority	PIW Location
624	Development/Res	Lack of well information	1-1-1	Wichita 1
625	Production	Casing Leaks	1-1-2	Wichita 1
626	Environmental/Tech	Water Disposal	1-1-3	Wichita 1
627	Production	Water Production Volumes	1-1-4	Wichita 1
628	Production	Lifting Costs of Excess water production	1-1-5	Wichita 1
629	Development/Res	Reservoir Characterization	1-1-6	Wichita 1
630	Development/Res	Presence of old unmarked plugged wells	1-1-7	Wichita 1
631	Development/Res	Formation evaluation behind casing	1-1-8	Wichita 1
632	Production	Injection profile control	1-1-9	Wichita 1
633	Development/Res	Converting producing wells to injectors	1-1-10	Wichita 1
634	Development/Res	Multiple zone wells and completions	1-1-11	Wichita 1
635	Environmental/Reg	Cost of Regulatory Compliance	2-1-1	Liberal
636	Environmental/Reg	RCRA compliance	2-1-2	Liberal
637	Development/Res	Lack of well information	2-1-3	Liberal
638	Environmental/Reg	Inconsistencies in regulations	2-1-4	Liberal
639	Environmental/Reg	Classification of Salt water as hazardous	2-1-5	Liberal
640	Production	Water production	3-1-1	Great Bend
641	Production	High Lifting costs of produced water	3-1-2	Great Bend
642	Environmental/Reg	Costs of reg compliance	3-1-3	Great Bend
643	General/Training	Lack of experienced personnel	3-1-4	Great Bend
644	Production	Casing Leaks	3-1-5	Great Bend
645	Environmental/Tech	Water disposal sites and disposal volume	3-1-6	Great Bend
646	Environmental/Reg	Cost of Compliance	4-1-1	Chanute
647	Development/Res	Water quality	4-1-2	Chanute
648	Production	Sweep efficiency of waterfloods/channeling	4-1-3	Chanute
649	General/Data	Lack of information/data	4-1-4	Chanute
650	Tech Transfer	Inadequate education of field/technical personnel	4-1-5	Chanute
651	Environmental/Reg	Costs of regulatory compliance	5-1-1	Hays
652	Production	Water production and lifting costs	5-1-2	Hays
653	Production	Need to improve economics of polymer treatments	5-1-3	Hays
654	Production	Casing leaks	5-1-4	Hays
655	Development/Res	Identification of infill-drilling potential	5-1-5	Hays
656	Development/Res	Lack of reservoir and well data	6-1-1	Wichita 2
657	Tech Transfer	Education of field and technical personnel	6-1-2	Wichita 2
658	Environmental/Reg	Permanent liability on leases.	6-1-3	Wichita 2
659	Environmental/Reg	Inappropriate and inconsistent regulation	6-1-4	Wichita 2
660	Environmental/Tech	Water disposal	6-1-5	Wichita 2
661	Environmental/Reg	Confusion/inconsistencies in regulations	1-1-1	Wichita
662	Environmental/Reg	Liability of the operator	1-1-2	Wichita
663	Environmental/Reg	Right-to-know laws	1-1-3	Wichita

ID	Category	Problem	Reg Priority	PIW Location
664	Environmental/Reg	Lack of unitization laws	1-1-4	Wichita
665	Environmental/Reg	Disposal/pit-pond regulations	1-1-5	Wichita
666	Environmental/Reg	Cost to comply with regulations	2-1-1	Liberal
667	Environmental/Reg	Regulatory laws political, not scientific	2-1-2	Liberal
668	Environmental/Reg	RCRA Compliance	2-1-3	Liberal
669	Environmental/Reg	Need for qualified personnel able to define problems	2-1-4	Liberal
670	Environmental/Reg	Fear of saltwater being classified as hazardous waste	2-1-5	Liberal
671	Environmental/Reg	Inconsistencies in rules and regulations	3-1-1	Great Bend
672	Environmental/Reg	Cost to comply with regulations	3-1-2	Great Bend
673	Environmental/Reg	Plugging well regulations	3-1-3	Great Bend
674	General/Reg	Lack of education on regulations (KCC and operators)	3-1-4	Great Bend
675	Environmental/Reg	Problems/wells need to be looked at on a case-by-case basis	3-1-5	Great Bend
676	Environmental/Reg	Cost to comply with regulations	4-1-1	Chanute
677	Environmental/Reg	Inappropriate forms	4-1-2	Chanute
678	Environmental/Reg	Inconsistencies in rules and regulations	4-1-3	Chanute
679	Environmental/Reg	Injection well permits	4-1-4	Chanute
680	Environmental/Reg	Old plugged well regulations	4-1-5	Chanute
681	Development/Res	Lack of reservoir information	1-1-1	Wichita
682	Development/Res	Chemical problems and costs	1-1-2	Wichita
683	Tech Transfer	Knowledge of reservoir producing mechanisms/solutions	1-1-3	Wichita
684	Development/Res	Communication between zones	1-1-4	Wichita
685	Development/Res	Availability of logging tools	1-1-5	Wichita
686	Development/Res	Reservoir characterization	2-1-1	Liberal
687	Development/Res	Lack of information	2-1-2	Liberal
688	Development/Res	Reservoir management	2-1-3	Liberal
689	Development/Res	Skin damage	2-1-4	Liberal
690	Development/Res	Depletion	2-1-5	Liberal
691	Development/Res	Water production - high WOR	3-1-1	Great Bend
692	Development/Res	Lack of reservoir information	3-1-2	Great Bend
693	Development/Res	Reservoir characterization - identifying bypassed oil	3-1-3	Great Bend
694	Development/Res	Channeling behind pipe	3-1-4	Great Bend
695	Development/Res	Commingled production	3-1-5	Great Bend
696	Development/Res	Water quality	4-1-1	Chanute
697	Development/Res	Reservoir characterization	4-1-2	Chanute
698	Development/Res	Channeling and sweep efficiency	4-1-3	Chanute
699	Development/Res	Heterogeneities	4-1-4	Chanute
700	Development/Res	Lack of information	4-1-5	Chanute
701	General/Training	Lack of personnel experienced in production of equipment	1-1-1	Wichita
702	Production	Casing leaks	1-1-2	Wichita
703	Production	Water disposal	1-1-3	Wichita
704	Production	Information on wells	1-1-4	Wichita
705	Production	Chemical treatments	1-1-5	Wichita

ID	Category	Problem	Reg Priority	PIW Location
706	General/Training	Lack of experienced personnel	2-1-1	Liberal
707	Production	Casing leaks	2-1-2	Liberal
708	Production	Problem identifying corrosion/scale	2-1-3	Liberal
709	Production	Water disposal	2-1-4	Liberal
710	Production	Chemical costs	2-1-5	Liberal
711	Production	Water disposal/lifting costs	3-1-1	Great Bend
712	Production	Casing leaks/old wellbores	3-1-2	Great Bend
713	Production	Bacteria and chemical problems	3-1-3	Great Bend
714	Production	Landowner demands	3-1-4	Great Bend
715	Production	Insurance	3-1-5	Great Bend
716	Production	Chemical problems	4-1-1	Chanute
717	Production	Water quality	4-1-2	Chanute
718	Production	Lack of efficient equipment	4-1-3	Chanute
719	Production	Poor quality workovers	4-1-4	Chanute
720	General/Training	Inexperienced personnel	4-1-5	Chanute
721	Development/Res	Access to more reservoir/well information	1-2-1	Wichita
722	Drilling/Completion	Improved cementing technology	1-2-2	Wichita
723	Development/Res	Improved logging technology	1-2-3	Wichita
724	Tech Transfer	Access to reservoir simulators	1-2-4	Wichita
725	Tech Transfer	Education on currently available technology	1-2-5	Wichita
726	Tech Transfer	Access to reservoir simulators	2-2-1	Liberal
727	Exploration/Tech	Better 3-D seismic imaging	2-2-2	Liberal
728	Drilling/Completion	Improved completion techniques	2-2-3	Liberal
729	Development/Res	Better logging techniques	2-2-4	Liberal
730	Drilling/Completion	Better drilling techniques	2-2-5	Liberal
731	Production	Improved polymer technology, i.e., without corrosion problems	3-2-1	Great Bend
732	Development/Res	Improved reservoir characterization techniques	3-2-2	Great Bend
733	Drilling/Completion	Improved temporary plugging techniques	3-2-3	Great Bend
734	Drilling/Completion	New casing repair techniques	3-2-4	Great Bend
735	Production	Improved chemical treatment technologies	3-2-5	Great Bend
736	Production	Improved sweep efficiency technology	4-2-1	Chanute
737	Development/Res	Reservoir characterization technology	4-2-2	Chanute
738	General/Data	A better information base	4-2-3	Chanute
739	Production	Improved water quality technology	4-2-4	Chanute
740	Production	Improved knowledge and technology in chemical treatments	4-2-5	Chanute
741	Production	Effective water control technology, i.e., polymers, etc.	5-2-1	Hays
742	Production	Equipment to reduce lifting costs	5-2-2	Hays
743	Tech Transfer	Educational workshops and case studies	5-2-3	Hays
744	Drilling/Completion	Horizontal well technology	5-2-4	Hays
745	Development/Res	Improved case hole logging	5-2-5	Hays

Midwest Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
144	Production	Produced water quality problems (i.e., iron sulfide, bacteria, corrosion problems)	1-1	
145	Production	Mechanical integrity of wells (casing leaks, fresh water dumped in producing zones, inexpensive remediation)	1-2	
146	Production	Inadequate understanding of corrosion, and paraffin/asphaltine problems	1-3	
147	Production	Need for cost-effective tech to remediate paraffin/asphaltine problems	1-4	
148	Production	Understanding the problem well (pump analysis and optimization)	1-5	
149	Production	Decreasing number of well qualified personnel	1-6	
150	Development/Res	Inadequate data (not reported to state or shared by producers)	2-1	
151	Development/Res	Inadequate producer education on reservoir characterization--particularly in carbonate reservoirs	2-2	
152	Development/Res	Lack of producer education in well testing, DSTs, other techniques, and evaluation of results.	2-3	
153	Development/Res	Lack of accurate reservoir information	2-4	
154	Development/Res	Need for education in decision-making on options, methods, and evaluation after primary and secondary operations	2-5	
155	Exploration/Data	Need for basin-specific geologic case studies	3-1	
156	Exploration/Tech	Examples of application of new technology, including books or how-to manuals, focused workshops	3-2	
157	Environmental/Reg	Inadequate understanding of environmental regulations and remediation technologies	4-1	
158	Environmental/Tech	Bioremediation of soils and groundwater	4-2	
159	Environmental/Reg	Imbalanced regulatory enforcement	4-3	
160	Environmental/Reg	Inadequate understanding of NORM and nuclear regulations and compliance approaches	4-4	
161	General/Reg	Costs, liabilities, and time consumption of environmental compliance and reporting	4-5	
162	General/Data	Data availability	5-1	
163	General/Data	Access to operator information	5-2	
164	Production	Knowledge of remaining oil and improved recovery processes and economics	5-3	
165	General/Reg	Knowledge of regulations and compliance costs	5-4	
166	General/Econ	High costs of oil field services vis a vis oil prices	5-5	
167	Drilling/Completion	Alternative, lower cost , higher benefit drilling options	5-6	
168	Development/Res	Affordable producer access to data and analytical hardware and software	5-7	
169	Production	Lack of understanding of economics of improved oil recovery	5-8	
170	Tech Transfer	Lack of timely publications on new technologies, regulations, advances, and application successes and failures	5-9	

Note: Workshops were conducted in Mt. Vernon, IL and Grand Rapids, MI.

ID	Category	Problem	Reg Priority	PIW Location
191	Tech Transfer	Inadequate case histories of successful and unsuccessful applications of production technologies	1-1	Norman, OK
192	Production	Inadequate technologies for waterflooding	1-2	Norman, OK
193	Production	Electricity costs and problems associated with field operations	1-3	Norman, OK
194	Production	Plugging regulations and requirements for shut-in wells	1-4	Norman, OK
195	Production	Artificial lift technologies and optimization	1-5	Norman, OK
196	Production	Stimulation, formation damage, acidization, and fracturing technologies, reservoir fluid incompatibility design	1-6	Norman, OK
197	Development/Res	Overlooked pay zones	2-1	Norman, OK
198	Development/Res	Inadequate reservoir information	2-2	Norman, OK
199	Development/Res	Improved fracture stimulation	2-3	Norman, OK
200	Tech Transfer	Inadequate dissemination of government information to producers	2-4	Norman, OK
201	Development/Res	Lack of adequate case studies in reservoir management	2-5	Norman, OK
202	Development/Res	Single well EOR and other tertiary recovery technologies	2-6	Norman, OK
203	Environmental/Tech	Costs and technologies for environmental liability and compliance	3-1	Norman, OK
204	Environmental/Reg	Cost/burden of regulatory record keeping	3-2	Norman, OK
205	Environmental/Reg	Toxic chemical restrictions	3-3	Norman, OK
206	Environmental/Reg	Produce or plug requirements	3-4	Norman, OK
207	Environmental/Reg	Need for regulatory compliance checklist for producers	3-5	Norman, OK
208	Tech Transfer	Inadequate information/technology transfer	4-1	Norman, OK
209	General/Data	Electronic access to data	4-2	Norman, OK
210	Tech Transfer	Low-cost training and seminars	4-3	Norman, OK
211	Production	Gas measurement technologies	4-4	Norman, OK
212	General/Reg	Compliance requests from OCC	4-5	Norman, OK
406	Production	Ways to reduce electrical costs in field operations	1-1	Okmulgee, OK
407	Production	Reducing costs of production	1-2	Okmulgee, OK
408	Production	Removing scale and paraffin to improve flow at low costs	1-3	Okmulgee, OK
409	Production	Access to information, e.g., case histories, performance studies	1-4	Okmulgee, OK
410	Production	Water disposal techniques	1-5	Okmulgee, OK
411	Production	Corrosion, casing leak remedies (e.g., chemicals, cathodic protection, etc.)	1-6	Okmulgee, OK
412	Development/Res	Identifying overlooked pay zones	2-1	Okmulgee, OK
413	Development/Res	Improved recovery efficiency -- acidizing and fracturing	2-2	Okmulgee, OK
414	Development/Res	Waterflood design -- reservoir description, pattern design, injection and production rates, facility design	2-3	Okmulgee, OK
415	Development/Res	Clay problems -- acid damage from clay swelling and fines migration	2-4	Okmulgee, OK
416	Development/Res	Reservoir description/characterization -- heterogeneity, clays, geometry, lithology, deposition, porosity; permeability	2-5	Okmulgee, OK
417	Environmental/Reg	Inadequate education, training, and experience of regulators in oil and gas operations	3-1	Okmulgee, OK
418	Environmental/Tech	Cost of environmental compliance	3-2	Okmulgee, OK
419	Environmental/Tech	Disposal well requirements	3-3	Okmulgee, OK
420	Environmental/Reg	Lack of flexibility in enforcement and interpretation of the rules	3-4	Okmulgee, OK
421	Environmental/Reg	Better explanation of EPA/OSHA requirements--what's needed to comply?	3-5	Okmulgee, OK

ID	Category	Problem	Reg Priority	PIW Location
422	Environmental/Reg	Run it or plug it rules unfair	3-6	Okmulgee, OK
423	General/PR	Negative public perception of industry	4-1	Okmulgee, OK
424	General/PR	Lack of community outreach to educate on importance of oil and natural gas	4-2	Okmulgee, OK
425	General/Econ	Inability of independent producers to maximize well head oil prices.	4-3	Okmulgee, OK
426	General/Reg	Chain of custody – liability for site clean-up, property sales, and environmental cleanup	4-4	Okmulgee, OK
427	Environmental/Tech	Waste disposal of solids, bottoms, associated junk	4-5	Okmulgee, OK

Southwest Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
213	Production	Maintaining production from marginal and low volume gas wells	1-1	Farmington, NM
214	Production	Commingling (of Picture Cliffs and Dakota reservoirs)	1-2	Farmington, NM
215	Production	Water removal from low volume gas wells	1-3	Farmington, NM
216	Production	Compression sizing for marginal wells	1-4	Farmington, NM
217	Environmental/Tech	Commingling of Picture Cliffs and Dakota reservoirs	2-1	Farmington, NM
218	Environmental/Reg	Reporting methods to regulatory agencies (OCD, MMS, BLM)	2-2	Farmington, NM
219	Environmental/Tech	Mapping vulnerable areas for pit closure regulation	2-3	Farmington, NM
220	Environmental/Tech	Successes and failures of pit closure methods	2-4	Farmington, NM
221	Exploration/Tech	3-D seismic applications	3-1	Farmington, NM
222	Exploration/Tech	3-D seismic planning and grid layout	3-2	Farmington, NM
223	Exploration/Tech	Velocity variances by formation and aerially	3-3	Farmington, NM
224	Exploration/Tech	Visualization of facies changes, fracturing etc with 3-D seismic	3-4	Farmington, NM
225	Exploration/Tech	Inability to accurately pick formation tops	3-5	Farmington, NM
226	Drilling/Completion	Fines plugging with horizontal drilling	4-1	Farmington, NM
227	Drilling/Completion	Lack of data from offset wells, bit curves, etc	4-2	Farmington, NM
228	Drilling/Completion	Water blocking with stimulation treatments	4-3	Farmington, NM
229	Drilling/Completion	Fracture design and simulation	4-4	Farmington, NM
230	Drilling/Completion	Low quality coalbed methane wells	4-5	Farmington, NM
231	Development/Res	Inadequate core data from reservoirs	5-1	Farmington, NM
232	Development/Res	Shaly sandstone log analysis in San Juan Basin	5-2	Farmington, NM
233	Development/Res	Shaly sandstone log analysis in San Juan Basin	5-4	Farmington, NM
258	Exploration/Tech	Communication of ideas	1-1	Hobbs, NM
259	Exploration/Data	Access to exploration data	1-2	Hobbs, NM
260	Exploration/Tech	3-D seismic technology	1-3	Hobbs, NM
261	Exploration/Tech	Aeromagnetic survey techniques	1-5	Hobbs, NM
262	Exploration/Tech	Gravity survey techniques	1-6	Hobbs, NM
263	Exploration/Tech	Cross-well tomography	1-7	Hobbs, NM
264	Exploration/Tech	Geochemical surveys	1-8	Hobbs, NM
265	Drilling/Completion	Cementing technology	2-1	Hobbs, NM
266	Drilling/Completion	Barium scale removal/prevention	2-2	Hobbs, NM
267	Drilling/Completion	Coil tubing	2-3	Hobbs, NM
268	Drilling/Completion	Stimulation design/simulation	2-4	Hobbs, NM
269	Drilling/Completion	Extreme overbalanced perforating	2-5	Hobbs, NM
270	Drilling/Completion	Real-time stimulation monitoring BHP	2-6	Hobbs, NM
271	Production	Water control techniques	3-1	Hobbs, NM
272	Production	Barium sulfate scale treatment	3-2	Hobbs, NM
273	Production	Low pressure wells	3-3	Hobbs, NM
274	Production	Electric power costs	3-4	Hobbs, NM
275	Production	Submersible pump design, maintenance	3-5	Hobbs, NM
276	Production	Surface and downhole corrosion control	3-6	Hobbs, NM

ID	Category	Problem	Reg Priority	PIW Location
277	Development/Res	Lack of adequate state production data (e.g., ON-GARD)	4-1	Hobbs, NM
278	Development/Res	Decreasing major co R&D	4-2	Hobbs, NM
279	Development/Res	Reservoir characterization	4-3	Hobbs, NM
280	Development/Res	Stratigraphic reservoir in-fill drilling	4-4	Hobbs, NM
281	Development/Res	Inability to relate old logs to new wells	4-5	Hobbs, NM
282	Development/Res	Scaling up pilots to field scale	4-6	Hobbs, NM
283	Production	Heavy oil recovery	4-7	Hobbs, NM
284	Environmental/Reg	Error elimination in submission of electronic forms	5-1	Hobbs, NM
285	Environmental/Tech	Lack of adequate scientific basis for regulations	5-2	Hobbs, NM
286	Environmental/Tech	Treatment of NORM	5-3	Hobbs, NM
287	Environmental/Tech	Produced water disposal, secondary projects.	5-4	Hobbs, NM
234	Exploration/Tech	High cost of workstations prohibitive to small companies	1-1	Roswell, NM
235	Exploration/Tech	Inadequate understanding on limitations of PC-based 3-D seismic software	1-2	Roswell, NM
236	Exploration/Data	Lack of formation velocity data	1-3	Roswell, NM
237	Exploration/Data	Access to LandSat data	1-4	Roswell, NM
238	Production	Rod part wear, paraffin and scale build-up	2-1	Roswell, NM
239	Production	Access to economical automation systems	2-2	Roswell, NM
240	Production	Lack of trained/experienced personnel	2-3	Roswell, NM
241	Production	Stimulation/Reservoir fluid incompatibility	2-4	Roswell, NM
242	Production	Stimulation design/simulation	2-5	Roswell, NM
243	Production	Lack of post-stimulation evaluation	2-6	Roswell, NM
244	Drilling/Completion	Inadequate slimhole MWD tools	3-1	Roswell, NM
245	Drilling/Completion	Expense of drilling optimization software	3-2	Roswell, NM
246	Drilling/Completion	Barriers to access for drilling	3-3	Roswell, NM
247	Drilling/Completion	Lack of adequate drilling data	3-4	Roswell, NM
248	Drilling/Completion	Inability to control direction/extent of frac job	3-5	Roswell, NM
249	Development/Res	Stimulation design	4-1	Roswell, NM
250	Development/Res	Reservoir simulation software	4-2	Roswell, NM
251	Development/Res	Lack of reservoir data (e.g. porosity, perm, pay)	4-3	Roswell, NM
252	Development/Res	Availability/access to pilot/case history studies	4-4	Roswell, NM
253	Environmental/Tech	Environmental compliance costs/technology for tank bottoms, tank vapors.	5-1	Roswell, NM
254	Environmental/Tech	Reservoir fluids management	5-2	Roswell, NM
255	Environmental/Tech	Cavern Location Techniques	5-3	Roswell, NM
256	Environmental/Tech	Remediation techniques (e.g. what works, what doesn't)	5-4	Roswell, NM
257	Environmental/Reg	Awareness/access to regulations (NTLs, Fed Reg, etc)	5-5	Roswell, NM

Rockies Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
171	Exploration/Tech	Access to 3-D basin modeling programs for paleo-restoration, visualization, seismic, log, rock analysis.	1-1	Denver, CO
172	Exploration/Data	Electronic access to data on service providers, books and journal articles, software. data, images	1-2	Denver, CO
173	Exploration/Tech	Cost/quality of 3-D seismic data acquisition	1-3	Denver, CO
174	Exploration/Tech	Natural fracture detection	1-4	Denver, CO
175	Exploration/Tech	Risk assessment methodologies	1-5	Denver, CO
176	Development/Res	Reservoir characterization at all scales	2-1	Denver, CO
177	Development/Res	Integrated reservoir data management/analysis systems	2-2	Denver, CO
178	Development/Res	Ability to design and remediate fracture treatments and methods	2-3	Denver, CO
179	Development/Res	Efficient reservoir monitoring techniques for oil and gas recovery efficiency	2-4	Denver, CO
180	Development/Res	Improved recovery through produced water reduction and disposal, stimulation, and tertiary recovery techniques	2-5	Denver, CO
181	Drilling/Completion	Improved methods for slim hole drilling, coiled tubing, multiple zone completions, and solids removal	3-1	Denver, CO
182	Drilling/Completion	Reduced formation damage through clay stabilization fluids, better drilling fluids, and mud management	3-2	Denver, CO
183	Drilling/Completion	Near bit MWD and data transmission	3-3	Denver, CO
184	Drilling/Completion	Better fracture designs	4-1	Denver, CO
185	Drilling/Completion	Reduced corrosion and paraffin	4-2	Denver, CO
186	Environmental/Tech	Inadequate understanding/awareness of environmental regulations and cost-effective compliance approaches	5-1	Denver, CO
187	Environmental/Tech	Drilling Fluid disposal	5-2	Denver, CO
188	Environmental/Reg	Environmental liability	5-3	Denver, CO
189	Environmental/Tech	Need for cost effective compliance technology	5-4	Denver, CO
190	Environmental/Tech	Understanding and compliance approaches for air emissions regulations	5-5	Denver, CO
288	Exploration/Data	Lack of source rock analysis and oil typing library	1-1	Billings, MT
289	Exploration/Tech	Inadequate research on source rock	1-2	Billings, MT
290	Exploration/Data	Inadequate case studies of successes/failures in gravity, magnetics, and geochemistry	1-3	Billings, MT
291	Exploration/Tech	Need for lower cost 3-D seismic	1-4	Billings, MT
292	Exploration/Data	Improve awareness of data and samples availability	1-5	Billings, MT
293	Exploration/Data	Lack of interlibrary loan service for samples	1-6	Billings, MT
294	Exploration/Tech	Lack of on-line access to statistics, technology information, performance data, oil and gas commission data	1-7	Billings, MT
295	Development/Res	Use of 3-D seismic for reservoir characterization (including shear wave and pitfalls as well as promises)	2-1	Billings, MT
296	Development/Res	Detection of reservoir limits and bypassed reserves	2-2	Billings, MT
297	Development/Res	Identification of natural fractures	2-3	Billings, MT
298	Development/Res	Value added case studies to reflect benefits of new logging tools	2-4	Billings, MT
299	Development/Res	Low-cost technologies for old well log interpretation	2-5	Billings, MT
300	Development/Res	Library of examples for shaley sand log interpretation	2-6	Billings, MT
301	Development/Res	Rw Library through the Internet	2-7	Billings, MT
302	Development/Res	Improved estimates needed for Sw	2-8	Billings, MT

ID	Category	Problem	Reg Priority	PIW Location
303	Production	Improved enhanced recovery technologies	3-1	Billings, MT
304	Production	Drainage optimization	3-2	Billings, MT
305	Production	Identification of potential CO2 candidates	3-3	Billings, MT
306	Production	More information on cost-effective thermal recovery	3-4	Billings, MT
307	Production	Sour waterfloods, chemical costs, microbial - what works	3-5	Billings, MT
308	Production	Reduction of electric power costs	3-6	Billings, MT
309	Production	Improved articiial lift efficiencies in existing equipment and new wells	3-7	Billings, MT
310	General/Econ	Reduced operating costs for stripper wells to extend life, defer abandonment; shut in wells	3-8	Billings, MT
311	Production	Improve recovery efficiency in swept zones	3-9	Billings, MT
312	Production	Improve sucker rod strength in deep zones	3-10	Billings, MT
313	Production	More efficient motors and artificial lift	3-11	Billings, MT
314	Drilling/Completion	Chemical costs high for scale, corrosion, paraffin	4-1	Billings, MT
315	Drilling/Completion	Underbalanced drilling	4-2	Billings, MT
316	Drilling/Completion	Formation damage control	4-4	Billings, MT
317	Drilling/Completion	Improved casing to resist salt zone	4-5	Billings, MT
318	Drilling/Completion	Salt zone washouts	4-6	Billings, MT
319	Drilling/Completion	Avoidance/remediation of casing collapse	4-7	Billings, MT
320	Drilling/Completion	Application of mud motors	4-8	Billings, MT
321	Environmental/Tech	H2S from water	5-1	Billings, MT
322	Environmental/Tech	Ways to re-use water	5-2	Billings, MT
323	Environmental/Tech	Cleanup, disposal, and salt precipitation of produced water	5-3	Billings, MT
324	Environmental/Reg	Role of EPA as primary regulator	5-4	Billings, MT
325	Environmental/Tech	Low-cost, effective reclamation	5-5	Billings, MT
326	General/Econ	Stripper well incentives	5-6	Billings, MT
327	Environmental/Reg	Improve electronic filing, interstate compatibility, roles of federal government	5-7	Billings, MT
328	Environmental/Reg	Lack of consistency/continuity among agencies	5-8	Billings, MT
329	Environmental/Reg	One-stop shopping to help producers understand regulations	5-9	Billings, MT
330	Environmental/Reg	Improve warning/timing of pending laws and regs	5-10	Billings, MT
331	Environmental/Reg	Make regulations available electronically on Internet	5-11	Billings, MT
332	Environmental/Reg	Understanding of regs and frequency of change	5-12	Billings, MT
333	Production	Reduce electric use/costs by improving efficiency (may include energy audits as performed by Caterpillar and DOE)	1-1	Casper, WY
334	Production	Improve efficiency of field equipment, automation, aging infrastructure	1-2	Casper, WY
335	Production	Reduce lifting costs	1-3	Casper, WY
336	Production	Improved waterflood design conformance control, and technology	1-4	Casper, WY
337	Tech Transfer	Provide EOR process information and technology to independents to reduce costs of application, candidate reservoir ID	1-5	Casper, WY
338	Production	Improve cost effectiveness of corrosion control, paraffin, and salt problems	1-6	Casper, WY
339	Production	Improve waterflooding technology	1-7	Casper, WY
340	Production	Improved used pipe inspection and handling	1-8	Casper, WY
341	Development/Res	Improved log analysis methodologies and case studies for newer logs, formation evaluation	2-1	Casper, WY

ID	Category	Problem	Reg Priority	PIW Location
342	Development/Res	Provide access to lost reservoir data at time of acquisitions or divestitures	2-2	Casper, WY
343	Development/Res	Improved reservoir characterization technologies	2-3	Casper, WY
344	Tech Transfer	Provide easy, user-friendly access to information, lists of service providers, databases, etc	2-4	Casper, WY
345	Tech Transfer	Consortia for sharing of information and technology	2-5	Casper, WY
346	Tech Transfer	Improve cooperation/coordination between industry and government	2-6	Casper, WY
347	Environmental/Reg	Inadequate knowledge and education for environmental regulation and compliance	3-1	Casper, WY
348	Environmental/Reg	Need on-line access to regulations and reporting procedures	3-2	Casper, WY
349	Environmental/Reg	Improve notification of new laws and regs and changes to existing laws/regs	3-3	Casper, WY
350	Environmental/Reg	Require cost-benefit testing of regulations to determine cost-effectiveness and reasonableness before implementation	3-4	Casper, WY
351	Environmental/Reg	Agency staff too lean to enable swift turn around of permits after reporting	3-5	Casper, WY
352	Environmental/Reg	Inconsistent processing of permit applications	3-6	Casper, WY
353	Environmental/Reg	Consider potential downside of federal government decentralization	3-7	Casper, WY
354	Environmental/Tech	Improve drilling mud disposal	3-8	Casper, WY
355	Environmental/Reg	Inadequate recognition of growing environmental, legal, medical, and technical problems of ground water contamination	3-9	Casper, WY

Texas Workshop Results

ID	Category	Problem	Reg Priority	PIW Location
746	Exploration/Tech	High-resolution seismic imaging	1-1	
747	Exploration/Data	Critically compiled oil and gas data bases	1-2	
748	Exploration/Tech	PC-based seismic modeling	1-3	
749	Exploration/Tech	Computer-aided mapping systems	1-4	
750	Exploration/Tech	Improved hydrocarbon trap models	1-5	
751	Exploration/Data	Regional atlas play compilations	1-6	
752	Development/Res	Behind-the-pipe logging	2-1	
753	Development/Res	Permeability logging techniques	2-2	
754	Development/Res	Reservoir property identification	2-3	
755	Development/Res	Deep investigation logging	2-4	
756	Development/Res	Borehole imaging tools	2-5	
757	Development/Res	Formation water chemistry catalog	2-6	
758	Drilling/Completion	Hydraulic fracture diagnostics	3-1	
759	Drilling/Completion	Advanced fracture applications	3-2	
760	Drilling/Completion	Perforating and wellbore cleanup	3-3	
761	Drilling/Completion	Near-wellbore cleanup treatments	3-4	
762	Drilling/Completion	Improved cement remediation	3-5	
763	Exploration/Tech	Cost-effective 3-D seismic data	4-1	
764	Exploration/Tech	Access to interactive workstations	4-2	
765	Exploration/Tech	Amplitude Versus Offset (AVO)	4-3	
766	Exploration/Tech	Seismic attribute processing	4-4	
767	Exploration/Tech	Vertical Seismic Profiling (VSP)	4-5	
768	Exploration/Tech	Crosswell Profiling Applications	4-6	
769	Development/Res	Reservoir/field PC-based data bases	5-1	
770	Development/Res	Computer-based 3-D geological modeling	5-2	
771	Development/Res	Reservoir-scale seismic applications	5-3	
772	Development/Res	Advanced reservoir analog models	5-4	
773	Development/Res	Core analysis and imaging	5-5	
774	Production	Performance prediction	6-1	
775	Development/Res	Simulation Process modeling	6-1-1	
776	Development/Res	Geostatistical reservoir descriptions	6-1-2	
777	Development/Res	Material balance applications	6-1-3	
778	Development/Res	Procedures for data scale-up	6-1-4	
779	Development/Res	PC-based single-well simulations	6-1-5	
780	Development/Res	Expert systems applications	6-1-6	
781	General/Data	Oil and gas data bases	6-2	
782	Production	Production mechanics	6-3	
783	Production	Wellbore mechanics	6-3-1	
784	Production	Injection water treatment	6-3-2	
785	Production	Produced water treatment	6-3-3	

ID	Category	Problem	Reg Priority	PIW Location
786	Production	Corrosion control	6-3-4	
787	Production	Scaling inhibitors	6-3-5	
788	Production	Paraffin control/removal	6-3-6	
789	Production	Separation of oil/water/gas	6-3-7	
790	Production	Beam pump analysis	6-3-8	
791	Production	Gas lift behavior	6-3-9	
792	Production	Submersible pump mechanics	6-3-10	
793	Production	Rod/tubing wear	6-3-11	
794	Production	Advanced EOR processes	6-4	
795	Production	Microbial EOR	6-4-1	
796	Production	Thickeners for CO2	6-4-2	
797	Production	Modification of Reservoir fluid mobilities	6-4-3	
798	Production	Improved miscible contact/displacement	6-4-4	
799	Production	Viscosity reduction of heavy oils	6-4-5	
800	Production	In situ generation of foams/emulsions	6-4-6	
801	Development/Res	High velocity gas-flow modeling	6-4-7	
802	Environmental/Reg	Environmental regulations	6-5	
803	Environmental/Reg	Compilation and synthesis of governmental regulations	6-5-1	
804	Environmental/Tech	Disposal methods for drilling fluids	6-5-2	
805	Environmental/Tech	Treatment and disposal of produced fluids	6-5-3	
806	Environmental/Tech	Screening procedures for injection wells	6-5-4	
807	Environmental/Tech	Risk analysis of disposal methods	6-5-5	
808	Drilling/Completion	Drilling design	6-6	
809	Drilling/Completion	Horizontal wellbores	6-6-1	
810	Drilling/Completion	Dual/triple tubing completions	6-6-2	
811	Drilling/Completion	Drilling fluid polymers	6-6-3	
812	Drilling/Completion	Multiphase wellbore flow modeling	6-6-4	
813	Drilling/Completion	Pre-frac stress testing	6-6-5	
814	Drilling/Completion	Acidizing	6-6-6	
815	Production	Production operations	6-7	
816	Production	Waterfloods	6-7-1	
817	Production	CO2/miscible floods	6-7-2	
818	Production	Steam floods	6-7-3	
819	Production	Micellar/polymer floods	6-7-4	
820	Production	Gels and polymers for improved sweeps	6-7-5	
821	Development/Res	Near-well profile control	6-7-6	

Note: Workshops were conducted in various cities throughout Texas.

ID	Category	Problem	Reg Priority	PIW Location
356	Environmental/Tech	Inadequate technologies for cost-effective treatment and disposal of produced waters, including alternative approaches and conformance control	1-1	Long Beach, CA
357	Environmental/Reg	Consolidation of reporting forms to reduce cost and time requirements	1-2	Long Beach, CA
358	Environmental/Reg	Lack of integrated index/database for reporting requirements	1-3	Long Beach, CA
359	Tech Transfer	Improve access to available production, reservoir, and regulatory data (e.g. make ACTI 110 results more user-friendly)	1-4	Long Beach, CA
360	Tech Transfer	Locate and publicize location and accessibility of public domain data	2-1	Long Beach, CA
361	Production	Aging domestic E&P infrastructure	2-2	Long Beach, CA
362	Environmental/Tech	Costly air emissions control requirements	2-3	Long Beach, CA
363	Production	Defer/reduce costly well abandonment/ clean-up costs	2-4	Long Beach, CA
364	Development/Res	Improved identification/detection of by-passed oil	3-1	Long Beach, CA
365	Development/Res	Improve drainage on primary production	3-2	Long Beach, CA
366	Development/Res	Improved recovery in low gravity oil reservoirs	3-3	Long Beach, CA
367	Tech Transfer	Access to case studies of technology applications that improved profitability	3-4	Long Beach, CA
368	Drilling/Completion	Inadequate awareness access to information on horizontal drilling and low-cost horizontal applications	4-1	Long Beach, CA
369	Drilling/Completion	Inadequate information on value, uses, successes, profitability of 3-D seismic applications	4-2	Long Beach, CA
370	Drilling/Completion	Inadequate information awareness of potential of coiled tubing applications	4-3	Long Beach, CA
371	Environmental/Reg	Lack of air emissions control and regulatory consistency	5-1	Long Beach, CA
372	General/PR	Negative public opinion of oil industry	5-2	Long Beach, CA
373	Environmental/Reg	Inadequate technical education or experience of regulators in making or enforcing regulation applying to oil and gas operations	5-3	Long Beach, CA
374	Environmental/Reg	Regulations not based on sound science or industry knowledge	5-4	Long Beach, CA
375	Environmental/Tech	Identify technologies to reduce treating and disposal costs, alternative disposal methods, and conformance controls	1-1	Bakersfield, CA
376	Production	Profile control	1-2	Bakersfield, CA
377	Production	Accurate automated rate tests for low gravity heavy oils	1-3	Bakersfield, CA
378	Environmental/Tech	Cost effective vapor recovery and disposal (including Hydrogen Sulfide. gas)	1-5	Bakersfield, CA
379	Development/Res	Identifying producing zones (difficult to determine which zones of a thick pay are producing)	2-1	Bakersfield, CA
380	Development/Res	Cost of accessing and acquiring reservoir data	2-2	Bakersfield, CA
381	Development/Res	Inadequate reservoir characterization techniques	2-3	Bakersfield, CA
382	Production	Thermal recovery techniques for recovering bypassed oil	2-4	Bakersfield, CA
383	Development/Res	Integrating geologic data with reservoir models	2-5	Bakersfield, CA
384	Environmental/Reg	Lack of local, state and federal regulatory standardization (too many regulations, not enough standardization)	3-1	Bakersfield, CA
385	General/PR	Continued negative public perception of the oil industry	3-2	Bakersfield, CA
386	Environmental/Reg	Lack of cost-benefit analysis for regulatory compliance impacts before implementing regulations	3-4	Bakersfield, CA
387	Tech Transfer	Task-based index of regulations	3-5	Bakersfield, CA

APPENDIX A -GUIDELINES FOR PTTC PROBLEM IDENTIFICATION WORKSHOPS

Background

Problem identification (PI) workshops are essential for identifying the critical technical problems that operators face in a given geographical region and reservoir setting. The results of problem identification workshops can help to identify the needs and priorities of operators for existing upstream exploration and production technology . They can also provide important input as to producers' needs and priorities for focused public and private technology research and development.

The PTTC intends to use the same general approach to conduct problem identification workshops in each region. By using a common format and approach, the workshops conducted throughout the nation will be directly comparable, allowing the development of a national view of the needs and priorities of oil and gas explorers and producers. The common approach will also provide a common data set by which the PTTC can evaluate the effectiveness of the overall problem identification process. The PTTC approach, described in the following guidelines, has been derived from the experience of the TIPRO forums and problem identification workshops conducted by the University of Kansas.

Location: The workshops should be conducted in various locations or subregions throughout the region of interest. Problem identification workshops should be conducted in convenient locations nearby oil and gas E&P operations in each region. This will enable the largest number of active producers to attend and participate. Locations should also be selected that reflect the diversity of the region's resource base. Subregions may be categorized by 1) reservoir classifications and 2) operator size/type. (In Kansas, for example, workshops were held in locations near the Lansing-Kansas City formations and in cities near the Arbuckle recognizing that the geology and therefore the technical problems and priorities may be very different.

Workshops should be conducted at facilities that enable a large group of people to convene comfortably and communicate with one another without interruptions. Hotels, conference centers, or academic institutions can provide ideal settings.

Workshop Participants: By definition, operators must play a major role in identifying the problems. Their experience provides essential insight into most of the significant problems in a specific reservoir class or setting. Once the significant problems related to exploration and production have been identified, needs can then be identified and prioritized, and action can be taken to introduce operators to available solutions through a focused technology transfer program.

- It is suggested that the total number of operators participating in the workshop be no less than 30 and no more than 60 per workshop, allowing the group to be broken up into smaller subgroups. This is an ideal workshop size and can be easily accommodated.

- It is essential that the right kinds of individuals be targeted to participate in the PI workshop. Field superintendents and field personnel are usually most knowledgeable about equipment and operating problems. Engineers and geologists are more knowledgeable about exploration problems, reservoir characterization problems, well completions, and conventional and improved recovery processes. All types of industry personnel should be asked to participate.

- The participants should reflect industry demographics. Representatives of larger operators may have a broader perspective in a specific play or reservoir type. Smaller operators

may have unique insight about operating marginal wells. Service companies, consultants, and other petroleum-related personnel can also be represented. To get the full perspective, the participants must be comprised of the large and the small, engineers and geologists, and supervisors and field personnel.

- To encourage attendance and participation, operators should be assured that no information will be released about problems in specific fields or reservoirs or company holdings.

- Potential workshop participants can be identified by contacting regional cooperating associations of IPAA or regional chapters of industry professional societies (SPE, AAPG, SIPES, SEG, etc.). The PTTC also expects to have an industry database in the near future.

- Once a workshop date and location has been established, an invitation should be mailed to potential participants. The invitation should provide enough information about the goals and focus of the workshop to allow participants to think about the problems that they will want to raise in the workshop. The invitation may be mailed directly by the RLO or by the local industry association as an in-kind contribution. Notices should also appear in local industry newsletters.

Workshop Staff: The staff of a workshop should include a leader, trained facilitators, and strong note-takers to record the action and results.

- Effective problem identification workshops require facilitators to manage the discussion process, ask the key questions, and keep the discussion focused on E&P and related environmental compliance technical issues. While drawing out the concerns of the participant, however, the facilitator must not direct or influence the content of the discussion or its conclusions. A facilitator is needed for each subgroup of the workshop.

- Facilitators should ideally have some technical background in oil and gas E&P in order to ask questions that stimulate focused discussion. They should also have strong and positive interpersonal skills to ensure that the presence of a few strong personalities does not skew the results of the workshop.

- A note-taker or rapporteur should also be available in each workshop to record the discussion.

Workshop Materials: Few materials are required for a problem identification workshop. Large poster paper, markers, and tape should be mounted on the walls or on easels and used to capture problems and needs as they are discussed. Alternatively, overhead projectors and transparencies may serve this purpose.

Workshop Format: The format of a half-day problem identification workshop consists of the following:

- General introduction
- Group discussion of the major problem areas to be explored
- Division of the participants into subgroups according to problem or technology areas, i.e.:
  - Exploration
  - Surface operations (completion practices, wellbore problems, and surface

problems.)
  - -- Reservoir operations (reservoir characterization, recovery processes, etc.)
  - -- Environmental compliance (air, produced waters, muds and chemicals, spill control, etc)
- Subgroup discussion and prioritization of problems
- Subgroup discussion of potential technology solutions for priority problems
- Rejoining the groups
- Presentation and discussion of group results and priorities
- Workshop evaluation

Introduction: The moderator or lead facilitator should begin the workshop by stating the workshop goal of identifying and prioritizing problems that can be addressed through technology transfer. The moderator should then pose two broad questions in an open-ended fashion to generate free thinking and not influence the answers:

1) What are the problems that must be addressed to increase exploration and sustain production from existing reservoirs in the next 12 months to 5 years?

2) What technology would you need to address the problems?

The first question provides the basis for breaking the group into subgroups according to specific problem categories, i.e., regulatory problems, production problems, and reservoir problems, environmental compliance, etc, as determined by the group. Members of each sub-group should be self-selected, but the moderator should try to balance the groups.

Subgroups: A facilitator in each subgroup should begin by asking the participants what kinds or reservoirs they are operating in and what kind of problems they are encountering. The subgroup may need to be further divided to reflect different operating conditions (i.e., reservoir classes). Responses in each sub-group should be captured by the facilitator on a flip-chart and recorded by a note-taker in each group. Participants should be encouraged to openly discuss the problems and their importance. Once a complete list of problems has been developed, the facilitator should ask the participants to rank the problems in order of importance relative to finding more oil, increasing or sustaining production, or economically protecting the environment. If the group wants discussion, the facilitator should not discourage it. However, the facilitator should keep the group discussion focused on the question.

Once the problems are identified and prioritized, each subgroup should develop a list of potential technology needs that could resolve the problems. These should be rated and ranked relative to the problem they seek to address. The end result of each subgroup should be a ranked list of priority problems, each with suggested technology responses, if any.

Regrouping: Once each sub-group has completed its work, the full group should be reconvened and each group should present its results as prioritized by category. The participants should be asked to prioritize problems from all of the categories to develop a list of "overall problems". They may also be asked to rank the importance of each problem area relative to the others.

Workshop Results: The results of the workshop should be a ranked list of overall technical problems as well as the lists of the problems identified in each problem sub-group along with the technologies suggested as possible solutions for each problem area.

Workshop Evaluation: Upon completion of the workshop, participants should be asked to complete a short questionnaire to evaluate the effectiveness of the workshop in identifying problems that could be resolved through more effective transfer of available technology or that need to be addressed by the research community through development of new technology.

Workshop Deliverable(s): Completion of the workshop entails three deliverables:

- Workshop Report
- Financial Report
- Workshop Summary for publication

Upon completion of the workshop, the moderator should meet with the individual group facilitators and note-takers and ask each of them to write up the notes from each subgroup. The facilitator should receive the write-ups within a week and integrate them with the notes of the joint sessions of the meetings, The facilitator should also prepare an overall summary of the workshop including a presentation of the problems identified, suggested solutions, and the relative ranks and priorities of the problems identified by the operators. The report should also include a summary of the evaluations of the workshop. Copies of the workshop report, an accounting of the finances of the workshop, and the evaluation forms should be sent to the director of the regional Producer Advisory Group and to the PTTC Executive Director. The workshop report should be sent to all participants in the workshop. A summary should also be published in the regional newsletters.

Applications of Results: The results of the workshops should be used to plan focused technical workshops aimed at introducing operators to available technical solutions to resolve the priority problems identified by the operators in the region or producing environment. These results will also be used to help define the technical content and focus of materials, equipment, personnel, and analytical tools to be included in the development of a regional technology resource center.

NPC RD&D TECHNOLOGY AREAS

1. EXPLORATION
1-1 3D Basin Modeling
1-2 Risk Assessment Methods
1-3 High resolution seismic depth imaging
1-4 Specialized seismic processing
1-5 Sequence stratigraphy techniques
1-6 Workstation seismic modeling
1-7 Geochemical analysis
1-8 Airborn/satellite remote imaging
1-9 Fault seal analysis
1-10 Multi-component Seismic Techniques
1-11 3-D Paleostructural resolution
1-12 Amplitde versus offset (AVO) in 3-D
1-13 3-D Visualization tools
1-14 Advanced seismic acquisition
1-15 Geographic Information Systems (GIS)
1-16 Geophysical Fracture detection methods

2. DEVELOPMENT
2-1 Advanced reservoir analog models
2-2 Computer based 3-D.geological modeling
2-3 Development-scale seismic applications
2-4 Tracers (biological/chemical/radioactive)
2-5 Core analysis/imaging
2-6 Geostatistical reservoir descriptions
2-7 Outcrop analog studies
2-8 Fluid rock interaction
2-9 Rock physics
2-10 Cross-well geophysical imaging
2-11 Advanced attribute processing
2-12 Seismic/log/core calibration
2-13 Cuttings analysis
2-14 Reservoir property identifcation
2-15 Through casing logging
2-16 Deep investigation techniques
2-17 High resolution borehole imaging logs
2-18 Specialized core analysis
2-19 Characterization of rock wettability
2-20 Permeability logging techniques
2-21 Tracer techniques
2-22 CT scanning and NMR imaging
2-23 Formation water chemistry
2-24 Fluid sampling and analysis
2-25 Advanced reservoir simulation modeling
2-26 Workstation single well simulations
2-27 Procedures for data scale up
2-28 Expert systems applications
2-29 Time lapse seismic imaging
2-30 Advanced monitoring of EOR processes
2-31 Advanced well testing/interpretation
2-32 Material balance applications
2-33 Decision and risk analysis
2-34 Expendable well bore instrumentation

3. DRILLING & COMPLETION
3-1 Horizontal wellbore applications
3-2 Drilling fluid design
3-3 Advanced fracture techniques
3-4 Cementing
3-5 Perforating and wellbore cleanup
3-6 Well productivity
3-7 Multi-lateral technolohy
3-8 Innovative bit and tubular technology
3-9 Slim hole drilling
3-10 Under balanced drilling
3-11 Measurements while drilling (MWD)
3-12 Coiled tubing technology
3-13 Unconventional drilling technology

4. PRODUCTION
4-1 Injection Water Treatment
4-2 Produced water treatment
4-3 Corrosion control
4-4 Scaling inhibitors
4-5 Paraffin control/removal
4-6 Oil/water/gas separation
4-7 Beam pump analysis
4-8 Gas lift analysis
4-9 Sumersible pump analysis
4-10 Rod/tubing wear evaluation
4-11 Stimulation techniques
4-12 Gas compression techniques
4-13 Recompletion techniques
4-14 Remote control and data analysis
4-15 Compact processing on offshore platforms
4-16 Modification of reservoir fluid mobilities
4-17 Miscible contact/displacement
4-18 Viscosity reduction of heavy oils
4-19 In-situ generation of foams/emulsions
4-20 Thickeners for CO2 floods
4-21 Micrbial EOR processes
4-22 High velocity gas flow modeling
4-23 Thermal processes
4-24 Combution processes
4-25 Near well bore stimulation
4-26 New directional drilling
4-27 Advanced recovery of natural gas

5. DEEPWATER OFFSHORE
5-1 Produced fluid disposal
5-2 Extended reach drilling or production
5-3 Extended reach control systems
5-4 High pressure systems
5-5 Flowlines
5-6 Flow metering
5-7 Subsea equipment
5-8 External corrosion protection
5-9 Risers
5-10 ROV Systems
5-11 Drilling
5-12 Workover
5-13 Water/gas injection
5-14 Hydrate prevention
5-15 Multi-phase pumps
5-16 Structures

6. ARCTIC REGION
6-1 Transportation
6-2 Exploration
6-3 Development
6-4 Drilling
6-5 Production
6-6 Deepwater Offshore
6-7 Mobile Ice

7. OIL PROCESSING/REFINING
7-1 Catalysts with improved selectivities, yields, lifetimes
7-2 Hydrogen production and recover
7-3 Plant and process reliability
7-4 Unconventional process technology
7-5 New materials of construction
7-6 Reactor engineering and modeling
7-7 Catalyst manufacturing technology
7-8 Risk assessment methodology
7-9 Solid acid catalysts
7-10 Alternatives to olefin alkylation process
7-11 Techniques for integration of environmental solutions in process/plant design
7-12 Improved on-line NDE inspection technology
7-13 Predicting useful remaining life of aging equipment
7-14 Robotics for safety applications
7-15 Worker safety systems
7-16 Energy efficiency of processes
7-17 Energy efficiency of equipment
7-18 Energy efficiency of separations
7-19 Separations technology
7-20 Determining chemical compositions of crudes, refinery intermediates & products.
7-21 New approaches to refining heavy feeds
7-22 Processing synthetic fuels
7-23 Conversion of methane to liquid fuels
7-24 Relating chemical compositions to process and product performance
7-25 Advanced computational modeling of processes/reactions
7-26 Adv control/information systems
7-28 Environmental characteristics of new hydrocarbon fuel compositions

8. GAS PROCESSING
8-1 Gas dehydration
8-2 Acid gas removal
8-3 H2S scavenger technology
8-4 Natural gas liquid separation
8-5 Nitrogen separation
8-6 Trace constituent (arsenic, Hg, etc) removal
8-7 Sulfer recovery
8-8 Separation of high concentrations of impurities (nitrogen, CO2, H2S ...)

9. GAS GATHERING
9-1 Compression
9-2 Leak detection
9-3 Plastic pipe (higher pressure rating)
9-4 High pressure measurement
9-5 Multi-phase metering

10. GAS STORAGE
10-1 Well deliverability restoration
10-2 Leak detection and mitigation
10-3 Reservoir management
10-4 Gas migration control
10-5 Base gas minimization techniques
10-6 Inert base gas research
10-7 Unconventional development techniques

11. ENVIRONMENTAL/REGULATORY
11-1 Disposal methods for drilling fluids
11-2 Treatment and disposal of produced fluids
11-3 Screening procedures for injection wells
11-4 Risk and reclamation analysis of disposal methods
11-5 Leak detection
11-6 Hydrological modeling
11-7 Compliance with CAAA stationary source issue
11-8 Advanced computation models to predict dispersion, transformation, fate of air pollutants
11-9 Model transport and remediation of contaminants in ground water and soils
11-10 "Effluent and emission monitoring, minimization, and control"
11-11 Recycling waste/ byproduct streams
11-12 Remediation technology
11-13 Catalyst recycling
11-14 Provide scientific basis for risk-based regulation
11-15 NORM disposal

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