Pipeline Safety R&D Planning Workshop
Washington, D.C.
11/27/01

Workshop Introduction

Ellen Engleman, Administrator, Research and Special Projects Administration (RSPA), opened the meeting by describing her background and philosophy on regulation and government research and development. She stated that all government R&D should be done in partnership with government providing 50% of the R&D funds and others providing the remaining funds. It is only through joint funding that all partners have the same vested interest in the outcome. Ms. Engleman expressed her excitement about the potential to improve the safety and security of the pipeline infrastructure through new technology developed from well-planned R&D. The events of September 11 have clarified that we must increase the emphasis of our R&D and pipeline security to realize this potential.

Stacey Gerard, RSPA Associate Administrator for Pipeline Safety, offered her thanks to the participants for accepting the invitation to participate in this Workshop. She stated the purpose of the meeting is to broaden the R&D planning process to include a larger group of stakeholders, and to consider Congressional interest in the planning and conduct of R&D. Safety, security, and reliability of supply are all important. Ms Gerard expressed an interest in extending the group to include additional international participation (beyond the Canadian Nuclear Energy Board which was represented) in the future. The outcome is to be a R&D "blueprint" that will be dynamic and will be maintained fresh or "evergreen."

Christina Sames of OPS, the project manager, noted that we started the process by involving key people who are responsible for pipeline safety, conduct pipeline research, create pipeline standards, or represent those involved in pipeline safety or research. This group developed into the pipeline R&D Blueprint Planning Team. Ms Sames indicated that OPS intends to put all the planning information on the internet. This will include an expanded matrix of current, recently completed, and planned R&D.

R&D Planning Matrix

Steve Gauthier of the Gas Technology Institute (GTI) began the technical discussion by presenting the R&D Matrix. This matrix was developed by GTI, AOPL and PRCI as part of the preparation for the workshop. It represents a view of ongoing and planned R&D assembled into one document. It is intended to be a living document. Gauthier recognized that the matrix is not yet complete.

Critical factors impacting the need for R&D include the rapidly growing demand for energy and uncertainty in the availability of fuel supply for electricity generation. The pipeline infrastructure is aging and there is a need to extend the operating life of the pipe that is currently in the ground as well as to install new pipelines.

Gauthier noted that the pipeline industry has an excellent safety record. There have been very few accidents, but those that occur have been very visible. This leads to public concerns about pipeline safety and makes siting new pipelines difficult. It affects the regulatory posture. We have to deal with phenomena such as NIMBY (not in my back yard) and BANANA (build absolutely nothing anywhere near anybody).

Gauthier's presentation is available online at http://primis.rspa.dot.gov/

Critical Infrastructure Security

Ellen Engleman made several comments while introducing General John McBroom, Director of the Office of Emergency Operations at DOE, and his talk on critical infrastructure security. Energy infrastructure is the lifeblood of our economy. We must protect it at all costs. DOT has put significant attention into the FAA as a result of the events of 9/11, but is also working on surface transport. Disaster management is under RSPA and Miss Engleman is involved. The Operations Center has been manned 24/7 since 9/11. There is a National Infrastructure Security Committee, consisting of all DOT Administrators. This group meets regularly with the Secretary's Chief of Staff. There are also Direct Action Groups, where we have reached out to industry.

General John McBroom, summarized the recent history of terrorism against US facilities and operations, including the bombings of the Khobar Towers, several US Embassy bombings, and the USS Cole.

General McBroom observed that DOE is "discombobulated." There is a single point of contact for weapons issues. There are 11 different Energy offices. The agency is trying to adjust itself to one-stop shopping.

Homeland security requires a federal/state/industry team. The federal government will principally support the states. The states will support industry. General McBroom's basic philosophy is that it is the job of staff to support those in the field. We need to be helping people in the field do their job. The Federal role must add value. Overall security standards are going to be a requirement. Either industry will develop these standards, or the Government will impose them.

Dealing with the threat of terrorism requires both actions to prevent terrorist acts and an enhanced ability to respond to these acts by quickly fixing our infrastructure when we need to. That response capability needs to be developed as an industry, not just by individual companies.

In response to a question on inconsistencies between regulations adopted at the state and Federal levels, General McBroom noted that national standards are needed not state-by-state variants.

Stacey Gerard stated that after 9/11, industry task forces were asked what actions should be taken at each of five levels of alert. Ms Gerard noted that she expects that actions associated with the minimum alert level, at which we will always be, will become minimum requirements.

General McBroom's presentation is available online at http://primis.rspa.dot.gov/

George Tenley, President of Pipeline Research Council International (PRCI), made a presentation on the drivers for R&D. Mr. Tenley noted that data alone is not what we need. We need to work in a continuum: data ⇨ information ⇨ knowledge ⇨ wisdom. The role of technology is threefold: identify the problem (not the symptom), assess/understand the problem, and prevent or control impact of the problem. Research planners must ask three questions and measure success against them: What should we do? Why should we do it? How should we do it?

Security is an enormous driver, but it won't be elaborated upon here. There are three other types of R&D drivers: operations drivers, "external" drivers, and business drivers. Operations drivers include: tools to determine and enhance the state of the infrastructure (need "better, faster, cheaper"techniques); analysis and tools for the new and replacement infrastructure; and establishing technical basis for standards and regulations. "External" drivers include: the concerns and needs of a government paradigm shift in federal regulation (shift from a compliance checklist to QA audit need to assure government regulators are more knowledgeable about "pipelining"); interacting with the Regulatory System; public interest and industry commitment; the political situation. Business drivers include: preserve, enhance, and extend the life of "hard assets"; maximize asset value and shareholder return; maximize value by minimizing liabilities.

Mr. Tenley noted that government funding is needed to motivate and enable industry-sponsored R&D. Mr. Tenley's presentation is available online at http://primis.rspa.dot.gov/

Ellen Engleman commented that we are focused and committed to supporting technology development. We don't have unlimited funds. Cost-sharing is an imperative for future work. A concept she has seen used is "other transaction authority" (see www.darpa.mil for a description). Lola Ward, RSPA's contract's person, is the in-house expert. This concept allows industry to contract with government in a more "normal" manner. Companies would work under GATT rather than FAR and other government acquisition regulations. Miss Engleman strongly supports this approach as a better way of doing business with the government. She encouraged people to look at technology that can affect both safety and security. She also recommended that people look outside the industry to find technologies that can be customized and applied for pipelines.

Miss Engleman noted that on September 25, 2001, DOT published a broad agency announcement (BAA) seeking white papers on new concepts for dealing with security issues. The response period closed on November 21. DOT received 602 white papers. That is a phenomenal response. There is a multi-modal, multi-agency technical review team now going over the papers. They will share, to the extent possible, concepts related to pipelines.

Alison Silverstein, advisor to FERC Chairman Wood, described FERC's role as siting and assuring the functioning of the market for gas. Pipelines are hard to defend from physical or cyber assault. They are more vulnerable to drunks and contractors than to terrorists. Ms. Silverstein invited industry to look to the future – designing for safety and security first. Having a goal of a safe/secure pipeline at the design stage will make it happen. Getting there requires the goal. It is more than shoveling gadgets. The industry needs more robust, resilient, fault tolerant,

self-healing pipe. We need faster reaction/recovery and "more graceful" failures (that will allow time to find and fix). We need better hardware and software, different policies, different ways to fund, and to regulate. We need to move ahead so that the next pipeline that is brought to FERC for siting is secure from the start.

State and Public Expectations Panel

Ruth Kretschmer, Commissioner, Illinois Commerce Commission, (representing the National Association of Regulatory Utility Commissioners - NARUC) discussed her perspective on R&D expectations. She noted that rules and regulations are drafted in Washington but implemented in the states. States inspect the majority of the pipelines, both intrastate and interstate. Pipelines are the safest mode of transportation. Unfortunately, the failures are spectacular and remembered for a long time. Commissioner Kretschmer recalled the accident at Bellingham, Washington resulting in three deaths, a fine of three million dollars ($3M), and criminal indictments. She also recalled the gas pipeline rupture at Carlsbad, New Mexico, resulting in 12 deaths (5 children), an 86 ft. crater, and a fine of $2.5M. Incidents like these demonstrate the need for R&D on technologies to enhance real-time monitoring, quicker response, emergency shutdown, better inspection and monitoring.

Commissioner Kretschmer stated that issues associated with the integrity of interstate pipeline are not the same as those for smaller, intrastate lines having numerous bends and curves.

In July, a NARUC work group issued a final report projecting a need for 38,000 more miles of interstate pipeline and 255,000 miles more distribution pipeline. Providing adequate service to metro areas has always been a challenge. We need to assure that these new supplies are safe.

She noted that technologies that can reduce third-party damage-related incidents should have high priority. The most critical need is prevention of third-party damage. NARUC supported the common ground study and one-call for that purpose. Illinois strongly supports one-call, but still has had 6300 hits in a recent year. Improvements are needed. Directional boring is making the problem worse. Accurate pipe location and depth are needed. Boring head sensors that warn of imminent contact would be useful. Sensors on the pipe for incipient damage detection/prevention should be considered.

R&D alone won't do it if excavators don't follow the rules. Most hits don't occur in the country. They occur in metro areas where lives are at stake. Example: aggressive excavation in Chicago area dinged a 24-inch main resulting in an explosion and fire that destroyed a 16 story old-age home. Fortunately, due to the insistence of the City firemen, the home had been evacuated before the explosion.

Corrosion is the second-leading cause of pipeline failure. Catastrophic failures show internal and external corrosion are still problems. We need improved ILI, real-time monitoring, and

inspection technology for use in intrastate lines, for which current pig technology is not possible.

How do we decide what R&D to undertake? We should use knowledgeable people with access to good data to rank projects and make rankings available to all stakeholders. Form a committee of experts to examine one topic area as an example, then expand the exploration drawing on the lessons of the pilot.

Doug Kilpatrick, Pipeline Safety Director, Washington Utilities and Transportation Commission began with recollections of the rupture in Bellingham, Washington. Typical of this kind of event, the memories of people in the local area persist long after the event. The UTC was directed by the legislature, after the accident, to implement a state agreement with OPS. That was done in 2000.

Following the Bellingham rupture, a consortium of cities and counties along the Olympic pipeline route and citizens groups organized. These groups are now a strong force for change in pipeline safety practice.

The greatest need is protecting existing pipelines rather than conducting R&D in support of new pipelines. There are three areas that can be productively addressed with R&D: leak detection, third-party damage, and human factors related to pipelines.

Mr. Kilpatrick pointed out the need for leak detection capable of detecting seepage leaks, especially in high consequence areas. If left to be discovered by surface monitoring or water quality, they can cause significant damage and high cost. Low-level leak detection needs to become a standard industry practice, either because it is cost-effective or by Rule. There is a need for zero leak tolerance coupled with a good response plan. Existing seepage detection systems are too expensive to be backfit on existing pipelines. They are not useful except in concentrated areas, like tank farms. Research needs to develop innovative, low-cost leak detection technologies or practices.

Third-party damage should be detectible for a range of conditions from actual strikes to changed loading associated with land movement. Real-time monitoring techniques are needed. Techniques ranging from motion detection through satellite surveillance are being considered. Operators need to have confidence that issues/events reported are real.

Human factors include operator interaction with control systems. Operators are the first line of defense. How do they react to the increasing number of alarms? Operations support people need rapid training following system upgrades. Tools are needed to support the abnormal. This area is different from other topics on the matrix. It is not hardware, but more psychological. A commenter noted that human factors might best be addressed through technology transfer from other industries where the issue has been treated for years.

Bob Leonberger, Missouri Public Service Commission, Chair of NAPSR, noted that states work closely with operators than federal regulators, and should be more knowledgeable of issues and needs. They can't, however, regulate in a vacuum. For the same reasons, we can't decide on

R&D in a vacuum. Some states are actively involved in ongoing R&D. Missouri is not very involved in R&D.

The NAPSR perspective is that much R&D is being done for interstate lines. There is significant ILI development for long, straight lines. There is a need to develop for inspection techniques for distribution piping. Direct assessment (DA) is important because local distribution company (LDC) lines may never be piggable. We need R&D to substantiate that DA methods and processes are valid. DA methods may be different in urban than in rural areas. Safety of underground storage facilities must become a higher priority, with technologies including aerial detection being candidates to detect leaks and encroachment.

For the future, we need to prioritize projects and have a mechanism for broad stakeholder review.

Chief John Eversole, formerly of the Chicago Fire Department and currently with the International Association of Fire Chiefs, commented from his personal experience on the needs of the fire Departments. Operators need to know the local fire department people. On your worst day, you'll call and ask them to make your problem go away.

We must include the concept of advance planning for emergencies. If you wait until an event happens, you've waited too long to plan. It is important that the fire department knows your business. It is important to establish a means for communication and control. Chief Eversole cited an example of the Westgate incident in the Chicago area, in which overpressure to a small area resulted in 37 structure fires in 45 minutes.

Firefighters need meaningful training. The propane industry recently developed and distributed a training program designed to provide what firefighters need. They don't need lots of details and equations. They simply need to know what to do and what not to do.

Discussion of Presentations

Human factors, as an issue, doesn't get much attention. Jeff Wiese noted that there is a coordinating team in DOT on which Richard Huriaux sits. Much of the effort is focused on fatigue and shift work. Human factors are a well-developed area which should probably be seen as a technology transfer issue rather than a topic for major new R&D.

Ruth Kretschmer questioned the panel: Is the public willing to pay more for safe pipelines, or do they think its safe enough already? The responses were uniform: Doug Kilpatrick said that in WA, they are definitely willing; Chief Eversole noted that the cost of added safety is a small add-on on a per-product basis; Bob Leonberger indicated that the willingness of the public to pay more is directly related to their recent experience with local incidents.

Ruth Kretschmer stated that she expects all gas utilities to seek an increase in rates for public safety. The regulatory decision on whether to allow these costs will be based on public fears and the attitude of states and federal government. In the past, state governments wanted to know all

details about safety provisions. States need to understand that we don't need to know all the details. She believes that public is willing to pay more for safety and security.

Breakout Session Results

Objectives

The Workshop participants were assigned to one of four separate groups, each having a facilitator and note taker, to accomplish the following:

- To determine the priorities for the R&D activities summarized in the matrices. This was accomplished by asking each participant to identify her/his highest priority activity as well as the next two priority activities. The reasons these activities were chosen were to be enumerated.

- To identify any gaps in coverage of needed R&D by the matrices. These gaps could be either ongoing R&D activities which were omitted from the matrices or R&D needs for which there is no ongoing or planned R&D.

- To suggest the future objectives for the R&D Planning process and ideas on how to attain these objectives.

Not all four groups formally evaluated the R&D activities to determine priorities. One group chose to discuss priorities in general and then to explore the other Workshop objectives.

R&D Priorities

The R&D areas that were described on the matrices and were evaluated in the Workshop are shown on Table 1. The scores received by each of these R&D areas are displayed in Table 2.

The top priority projects from the matrices used to describe ongoing R&D are summarized below:

C1	Improved ILI	(20,13)∗
C3	Real-Time TPD Detection	(13,12)
C4	Real-Time ROW Monitoring	(5,12)
B5	Enhanced Risk Data Integration	(7,9)
B3	External Corrosion Characterization	(6,3)
B1	Pipe Location Techniques	(4,1)
B7	Improved Strength Characterization	(4,0)
B2	Characterize SCC	(2,2)
B4	Characterize Internal Corrosion	(2,2)
A2	Higher Strength Steel	(1,5)
A5	Composite Pipe Material	(0,4)

∗ The alphanumeric indicators (e.g., C1, B5) refer to the matrix position (see Table 2 below). The Numbers in parentheses indicate the number of meeting participants who rated each R&D area (Top Priority, High Priority)

Perceived Gaps in R&D Matrix

There were numerous R&D areas that the Workshop participants believed represented significant gaps in the R&D matrix. The areas that were cited in the breakout sessions are listed below. No effort has yet been made to better organize these results. Thoughts expressed in the breakout sessions have been integrated to reduce redundancy.

1. Early Leak Detection and Mitigation Techniques for a Spectrum of Leaks (e.g., Improved leak detection capability for mains and services, to be used in parallel with current surveys)
2. Direct Assessment (inspection techniques for unpiggable pipelines)
3. Prevention of Damage from Directional Drilling
4. Security-Related R&D
5. Broad-Based Real-Time Remote Monitoring (possibly including self-reporting) and Use of Telecommunications Spectrum to Communicate Results (e.g., real-time monitoring of Cathodic Protection systems)
6. Enhanced Repair Techniques (Implemented without Shutdown of Pipeline)
7. R&D Focused on Plastic Pipe used in LDC Distribution Systems
8. Trenchless Pipe Installation Technology (e.g., directional drilling, use of robotics) for pipe placement
9. Development of Improved Three-Dimensional Location Technologies (concern about damage by the companies themselves when working around congested right-of-ways)
10. Rapid repair techniques for plastic pipes
11. Evaluate (and quantify where possible) the strengths, limitations and performance (and the factors that influences these) for current inspection tools. This might include some means for using existing company data to establish the statistical performance of inspection tools currently in use: "Baseline existing Integrity Assessment Tools"
12. Characterizing the impact on integrity management practices of multiple utilities in a common right-of-way (e.g., on Cathodic Protection)
13. Evaluate the potential for current piping to operate at higher stress levels (80% SMYS)
14. Human Factors that influence pipeline integrity (should consider use of technology transfer from other industries)
15. Means to retain in an accessible form the knowledge and experience of people who are leaving through retirement or job-loss resulting from industry consolidation
16. Techniques and reporting requirements to support improved root cause determination for excavation-related incidents
17. Improved coatings for use in field repair
18. Substantiation (and acceptance)of the technical basis for reassessment intervals
19. Development of new polyethylene piping
20. "Armor" for above-ground piping (e.g., in Alaska to prevent line penetration by bullets)
21. Making the results of R&D more available and accessible to companies, public officials and regulatory bodies
22. Techniques for acquisition and archiving company performance data across the industry
23. Standards of acceptability for company performance data (national consensus standards or regulatory standards)

24. Understand the effect of new cyclic pressure loading on gas pipelines (e.g., caused by supplying gas to load-following power plants)
25. Enhanced data gathering and integration practices to support assessment of the potential for third-party-damage risks
26. Communication of information on the impact of pipeline incidents to support local zoning (and set-back) decisions
27. Explore means to reduce the impact of a pipeline rupture and explosion (e.g., additives to gas/liquid or enhanced shutoff capability)
28. Develop a detailed weld database.
29. Technologies transfer on existing repair technologies.
30. Develop a "pigging guide," including: how to make pipe piggable, what tools to use and when, criteria for investigation.
31. Detection of corrosion under disbonded coatings in the absence of coating holidays.
32. Effect of trend toward declining gas quality (increasing moisture) on internal corrosion.
33. Hydrate problems in ultra-deep water.
34. R&D directed toward maintaining pipelines
    - cleaning pigs (standards or guides)
    - better devices for cleaning once corrosion has been detected.
35. Development of a single multi-threat ILI tool – obviate the need for multiple pig runs to identify wall loss, cracking and denting.
36. Expand R&D focus to include long-term needs. Most "priorities" are short term.
37. Development of a set of "Whole Health Indicators" for integrity and effectiveness of controls
38. Need for integrity management tools for distribution companies
39. Greater focus on the next generation of pipelines (materials, fabrication, monitoring, etc.)

Process for Continuation

Objectives

Continuation of the R&D integrated planning process should satisfy the following objectives. The effort and its products should:

1. Facilitate better R&D planning by the organizations that fund pipeline-related R&D
2. Increase the assurance that major industry, regulatory and public concerns are being addressed by ongoing or planned R&D
3. Assemble diverse stakeholder input on R&D needs and priorities
4. Assemble and communicate R&D plans among funding organizations
5. Promote more effective technology transfer

Thoughts on Process

There was general agreement among participants in the breakout sessions on how the effort should proceed. The following approach is a synthesis of the ideas presented in the Workshop. The general consensus was that before organizing another large meeting OPS should put together

a number of small groups to develop a strategic R&D plan. Following completion of such a plan, the larger stakeholder group should be assembled to review and comment upon the structure of the plan and the priorities included in the plan. Development of this plan should include the following elements:

1. Identify a "Steering Group" having limited numbers, but broad stakeholder representation to develop a set of "Guiding Principles" and to guide and oversee the following activities.
2. Define the scope of the R&D-related activities to be included in the planning process (e.g., safety, integrity, environmental protection, operational reliability, deliverability, operational efficiency, security, technology transfer, communication of the state of technology, time frame for R&D). The scope should address whether both basic and applied R&D should be included as well as whether the focus should include the entire pipeline system or just the pipeline.
3. Define the mission, vision and goals of the effort as well as the strategic objectives to be attained by R&D within the scope.
4. Develop a logical structure of the strategic R&D issues that can be used to organize information about ongoing and planned R&D and to assess the completeness of R&D options (e.g., R&D topics could be organized along the line of the major threats to integrity, or in other structures).
5. Consistent with defined scope, develop a detailed implementation plan, including: definition of industry and government roles, means of accurate tracking/reporting (accountability), specific sponsors to focus on individual issues or projects (based on affinity or interest).
6. Organize small working groups of technical specialists to flesh out the R&D projects that represent options for resolving each strategic issue.
7. Organize a small working group to develop options on how to enhance the transfer of developing and completed technology to operators and regulators, and how best to make the results of this integration function available to all interested parties.
8. Consider design of an evaluation process that takes into account all significant decision attributes for use by individual funding organizations
9. Develop the structure and flesh out the content of revised matrices including the essential information about each R&D activity to support communication and priority setting
10. Consider identifying current capable of R&D implementation organizations, and inventory the major competencies of each organization
11. Consider identifying "Centers of Excellence" for each area of technical expertise needed to resolve each strategic issue.
12. Consider assigning responsibility to (and provide funding for) each Center for documenting completed R&D work in its area of expertise and maintaining these compilations of R&D current, including information on ongoing and planned R&D activities in the area.
13. Convene a broader group of stakeholders (with greater representation from public organizations if possible) to review, evaluate and comment upon the work products of the small working groups.

Issues for Future Consideration

1. Need a means of organizing and communicating the results of past R&D and ongoing R&D as it is completed
2. R&D seems to be focused on transmission pipelines to the exclusion of distribution systems
3. Technology transfer from other industries or government sectors is needed to increase the focus and efficiency of pipeline R&D. (e.g., electrical signal analysis to verify the closure of valves, optical systems to monitor the ingress of people near pipelines, human factors)
4. Need new standards for reporting and analysis of performance-related data
5. Regulators (both State and Federal) need to be educated on the availability and use of new technologies
6. There is a very limited number of companies to develop and commercialize new technologies. This may be related to the size of the market for these technologies and the potential for profit derived from R&D investments.
7. Severe limitations on R&D funding
8. Need better mechanisms to encourage R&D with a longer term focus (e.g., co-funding of the vast majority of projects by the government if a long term is expected for a return). Short-term R&D is evolutionary; long-term can be revolutionary.
9. "Apply" vs. "Develop" – in many cases effective technologies already exist, but we need to figure out how better to identify them, then customize them for application to the pipeline industry.
10. Need to move to predictive models. Tie in to Direct Assessment.
11. Olympic excavation of dents found a significant number with gouges that had not been detected in previous pigging
12. DOE has about 30 projects that address issues raised here. Need to get the word out. DOE is requiring its researchers to develop 5-10 page descriptions of the current state of the art in their area (not just their project). All will be available on the web.
13. Need to integrate and update existing codes and standards to reflect what has been learned through R&D
14. Need to consider technologies that compensate for downsizing of companies (loss of technical expertise, loss of knowledge about the specific pipelines being operated)
15. Need to explore how best to assure a commitment to implementing the results of R&D projects (e.g., if full resolution of an issue requires both a technical and a regulatory commitment, then commit at the outset to take the regulatory action consistent with the results of the R&D)

Table 1
Current Pipeline Technology Development Focus Areas
(Listing From R&D Matrix Provided)

A. Improved Materials

1. Develop damage and defect resistant materials
2. Develop higher grade/strength steels
3. Develop materials for higher pressure design
4. Develop enhanced welding and joining techniques
5. Develop composite pipe materials
6. Develop enhanced factory-applied coatings
7. Evaluate the performance of new steels under high usage factors (AOPL)

B. Enhanced Operations, Controls and Monitoring

1. Develop techniques (or materials) to support easy location of the pipeline
2. Characterize causes and preventive techniques for SCC
3. Characterize external corrosion damage and prevent its recurrence
4. Characterize internal corrosion damage and prevent its recurrence (e.g., environmentally benign biocides [AOPL])
5. Enhance techniques for integration and evaluation of risk factor data to define pipe susceptibility to various threats
6. Develop and verify buried coupon evaluation techniques (AOPL)
7. Improve methods for characterizing remaining strength of pipes (AOPL)
8. Understand the protective characteristics of current coatings (AOPL)

C. Damage Prevention and Leak Detection

1. Improve ILI techniques for detecting damage, cracking and defects
2. Develop techniques (or materials) to support easy location of the pipeline (see above)
3. Develop and test real-time sensors for detecting incipient third party damage
4. Develop real-time right-of-way monitoring
5. Develop satellite monitoring for encroachment and ground movement

a. Detection of a spectrum of leaks (i.e., from “weeper” leaks through large line holes)

D. Arctic and Offshore Technologies

1. Develop improved techniques for site evaluation
2. Develop materials and fabrication techniques to enhance low temperature performance
3. Develop alternative inspection and maintenance procedures
4. Develop approaches to detect, verify and respond to leaks

Table 2
R&D Summary Priority Matrix

Number of Votes in Each Priority Category

R&D Problem Area	Top	High	Why?
A. Improved Materials			
1. Damage/Defect Resistant Materials	1	1	
2. Higher Grade/Strength Steel	1	5	
3. Higher Pressure Design	1	2	
4. Enhanced Welding & Joining	1	2	
5. Composite Pipe Materials	0	4	
6. Enhanced Factory Applied Coating	0	2	Interest was expressed in enhanced field-applied coatings
7. Evaluate High Usage Factor Steels	0	3	

Table 2, cont.
R&D Summary Priority Matrix

Number of Votes in Each Priority Category

R&D Problem Area	Top	High	Why?
B. Enhanced Ops, Control & Monitoring			
1. Techniques for Easier Pipe Location (Similar to C2)	4	1	
2. Characterize Stress Corrosion Cracking	2	2	
3. Characterize External Corrosion	6	3	This is the second leading cause of pipe failure
4. Characterize Internal Corrosion	2	2	
5. Enhanced Risk Data Integration	7	9	Data integration key to integrity management
6. Buried Coupon Evaluation Techniques	0	0	
7. Improved Strength Characterization	4	0	Understanding the remaining strength of pipe with defects is necessary to define repair criteria
8. Understand Current Coatings	0	1	

Table 2, cont.
R&D Summary Priority Matrix

Number of Votes in Each Priority Category

R&D Problem Area	Top	High	Why?
C. Damage Prevention & Leak Detection			
1. Improved ILI	20	13	Need techniques to inspect for cracks, unpiggable pipe such as most of LDC piping, new inspection "vehicles", reduce need to excavate when not needed
2. Improve Pipeline Location (See also B1 above)	2	1	Locating piping is critical to preventing third-party damage
3. Real-Time Third Party Damage Detection	13	12	Most significant threat, increasing importance of damage from directional drilling
4. Real-Time Right-of-Way Monitoring	5	12	Same Issue as C3
5. Satellite Monitoring	0	6	Same Issue as C3
A. Detection of Spectrum of Leaks (e.g., "weeper" leaks) – Not in Current Matrix	2	7	Small leaks can cause significant damage

Table 2, cont.
R&D Summary Priority Matrix

Number of Votes in Each Priority Category

R&D Problem Area	Top	High	Why?
D. Arctic & Offshore Technologies			Limited constituency on these issues present at Workshop
1. Improved Site Evaluation	0	0	
2. Materials for Low Temp Performance	0	0	
3. Inspection & Maintenance Procedures	0	0	
4. Leak Detection, Verification, Response	1	0	