ALASKAN ARCTIC PIPELINE WORKSHOP

Captain Cook Hotel -- Anchorage, Alaska

November 8-9, 1999

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Executive Summary

On November 8 & 9, 1999, a workshop on Alaska Arctic Pipelines was held at the Hotel Captain Cook in Anchorage, Alaska. The workshop was initiated and sponsored by the Minerals Management Services (MMS) through the Technology Assessment and Research (TAR) program. C-CORE of St. John's, Newfoundland in collaboration with AGRA Earth & Environmental, Colt Engineering and Tri Ocean of Calgary, Alberta led the workshop on behalf of MMS.

The objective of the workshop was to bring together members of the public and a group of experts with skills related to offshore pipeline design, operation maintenance and inspection to examine the current state of practice for pipeline alternatives under consideration for Alaska offshore oil & gas reserves. A key aspect of the workshop was that it was open to the public and the speakers were urged to make their presentations in a format that would avoid highly technical discussions, formal lectures and commercial overtones. Rather, speakers were urged to provide a candid presentation that would focus on their particular area of expertise in such a way that it could be seen how Arctic pipeline development is undertaken to address the concerns and interest of the public sector, the regulators, the designers and the operators. The excellent response of all speakers towards meeting these objectives was a key reason why the conference was judged to be an outstanding success by the people that attended.

When this workshop was being planned, it was expected that about 60-70 people would attend. Indeed it was hoped that at least this number of people would be there to enable the type of dialogue that was desired. The fact that 155 people registered for the workshop is a clear indication of the level of interest and commitment to building safe and reliable pipelines with minimum environmental impact of all the participants representing the public, regulators, design consultants, operators and research agencies.

The program opened with an overview of the Alaskan offshore arctic activities and the current MMS initiatives including objectives for this workshop. This was presented by Mr. Jeff Walker, Minerals Management Service, DOI, and Anchorage, Alaska. Mr. Walker described the status of the current North Star project and the Liberty project in particular. He also gave detailed descriptions of a number of other initiatives that were being pursued by MMS. These initiatives include technology reviews such as pipe-in-pipe technology, ongoing assessment of alternative pipeline technologies and environmental impacts as related to the Liberty project, evaluation of conceptual engineering documentation and the assessment of oilspill probabilities. Mr. Walker's presentation set the framework for the workshop and underlined the importance of the regulatory aspects related to the design, construction and operations of arctic offshore pipelines.

The first presentation after the opening session was that of Mr. Larry Bright, Fish and Wildlife Service, Department of the Interior. The subject of his presentation was Arctic Resources at Risk. Mr. Bright's presentation provided the focus for the workshop. The minimization of environmental risk is the first objective of all stakeholders involved with the development of arctic pipelines. Yet not everyone is aware of the implications of a potential loss of product into the environment. The presentation by Mr. Bright focused on the living resource of the Arctic offshore and their vulnerability to oil spills and other major disturbances. The presentation underlined the importance of the arctic eco-systems to fish, water birds and marine mammals as

well as the dependency of the Inupiat people upon biological resources of the north for both physical and cultural sustenance. A number of specific examples of vulnerable wild life and potential impact for the unique habits were described. The presentation clearly implanted in the minds of all participants the importance of working together to ensure that oil spills under any circumstances do not occur.

Challenges for arctic offshore pipeline developments were presented by Andrew Palmer of Cambridge University. He described the environmental loads, the construction challenges, inspection and leak detection technologies and possible repair. In reviewing these potential problem areas he assessed the degree of confidence that can be assigned to their solution. This was a very good indication to the participants of the level of conservatism that should be considered in the design of arctic pipelines. Dr. Palmer also gave a history of the construction and brief performance of the Pan-Arctic Drake F76 flow line systems that was constructed in 1978.

The opening session ended with a brief description of the TAR sponsored project entitled "An Engineering Assessment Of Double Wall Versus Single Wall Designs For Offshore Pipelines In An Arctic Environment", which is being carried out by C-CORE. The presentation was given by Dr. Jack Clark, who gave a report on the status of the study and outlined the scope of work that would be completed in January 2000.

The second section focused on pipeline design, construction and operations. It opened with a detailed comparison of API and CSA offshore pipeline stress and strain design criteria by Dr. Ray Smith, formerly of the National Energy Board of Canada but now a consultant. Dr. Smith gave a comparison of the stress limits defined by the API recommended practice and those of the CSA standard. The presentation highlighted the difference between API and CSA that deal with strain considerations and strain limits as they apply to the design, installation, and operation of offshore pipelines. This generic presentation was followed by a presentation of three specific projects. Mr. Glenn Lannan described how the North Star and Liberty pipeline design permitting, construction and operations planning had been carried out. A detailed explanation of the design philosophy was given as well as a description of the criteria developed to ensure that a safe and efficient offshore pipeline system would be built. Mr. Keith Myer, Michael Baker Jr. Inc. described the horizontally directional drilled Colville River crossing which is a key component of the Alpine Pipeline project. Several alternatives studied were described. This presentation was of particular interest to the workshop in that it represents the only known use of pipe-in-pipe design configuration for containment in the case of leak or rupture of the carrier pipeline.

The session ended with a presentation by Wes Tonkin of Alyeska Pipeline Company. Mr. Tonkin discussed the operational and monitoring of the Trans-Alaska Pipeline. He presented details on the state of the art work that is being done to measure settlement and corrosion of the pipeline and how it is analyzed to ensure that operating pressure requirements are maintained.

The third session of the first day opened with an overview of pipeline configuration alternatives by Mr. Ray McBeth of Tri Ocean Ltd. He focused primarily on the offshore and gave a detailed overview of pipeline configurations that have been used in the oil industry. Dr. Carl Langner followed this presentation with a description of pipe-in-pipe flowline installations in the Gulf of Mexico. Concentric pipes in pipe configurations in the Gulf region are primarily used to achieve high thermal insulation for flow assurance. By keeping the internal fluid warm the formation of hydrate plugs are prevented and paraffin deposits which constrain the potential flow are reduced. He noted that a pipe-in-pipe with the annulus filled with low density foam provides a better insulation than a comparable single wall pipe with external coating even when the latter is buried in the seafloor. It is because of the dense pressure resistant foam required for the external coating. He described several installations and illustrated techniques for applying insulation assembly and installing the flow lines offshore.

Cobie Loper of Wellstream discussed the use of flexible pipe for offshore and onshore arctic applications. He noted that flexible pipelines had been used for over twenty years in more temperate climates in the offshore and during the past several years development activities were completed to ensure the ability of the product to function in arctic applications. Mr. Loper provided a summary of the structure of the flexible pipeline, materials and qualifications testing that had been established specific to arctic applications and the state of the art technology.

The presentation by Norman Sanderson of BP Amoco that followed gave a detailed description of the installation of the Troika flowline in the Gulf of Mexico. It consisted of two 10-inch thermally insulated flow lines over a distance of 14 miles. The tow out of over 400 miles across the seabed to the Troika field in the Gulf of Mexico was described and illustrated.

For the final paper in the Pipeline Technology Session, John Greenslade of Colt Engineering described pipe-in-pipe applications in the petrochemical industry. He noted that this configuration is used for secondary containment, mechanical protection, enhanced constructability and heat transfer control. Examples of each application were reviewed and typical designs were presented along with the key issues for design of such systems.

The final session of the first day included four presentations on pipeline operational monitoring technology. Peter Jax of Siemens AG opened this session with a description of LEOS which is a sensitive detection system for buried pipelines. He noted that it had been used in temperate regions for over 20 years. It detects molecules moving from a potential leak to the environment by a sensor tube laid along the pipeline. The presentation was particularly appropriate in that this system will be the first leak detection installation used for an offshore arctic environment when it is installed in the year 2000 on the North Star pipeline project. The basic systems, the performance history and the capabilities related to leak detection and identification were described. Mr. Ed Farmer of EFA Technology Inc. followed with an overview of sensor based leak detection technology. He noted that leak detection is a component of the overall safety program and described the strengths and weaknesses of a number of methodologies. He noted that the strong emphasis placed on leak detection is a manifestation of the corporate culture focused on safety and security.

The GEOPIG technology that is used for out of straightness assessment was presented by David Hektner of BJ Pipelines Inspection Services. This instrument is an intelligent tool that is used for measuring pipeline position to a much higher degree of accuracy than traditional ROV techniques. Mr. Hektner pointed out that cost savings can be realized due to minimal maintenance requirements and other remedial work. The Pipeline Inertial Geometry surveying instrument (GEOPIG) can also measure displacement in the horizontal plane which is of particular interest to offshore areas subjected to ice scour. In the next presentation on pipeline inspection, recently completed projects were described by Mr. Johannes Rosenmöller of Rosen. He gave a spirited presentation on monitoring for flaws detection with smart pigging. Although he did not provide an abstract for his presentation, he gave several examples of monitoring with state of the art pigging equipment. An important observation by Johannes Rosenmöller was that pigging could very accurately detect leaks or flaws in a single wall pipe. The assessment of integrity of the outer wall of a pipe-in-pipe system is beyond current technology.

The second day of the workshop opened with a session on pipeline risk analysis. This was of particular interest to all of the participants as it focused on a detailed and somewhat controversial aspect of pipeline design. The opening presentation was by Mr. Mark Stevens of C-FER Technologies who described PIRAMID which is a quantitative risk based approach to integrity, maintenance planning and design optimization for pipelines. Developed under a joint industry program, the software is very flexible and can be used to rank and compare existing or hypothetical pipelines based on the estimated level of operating risks. New results of analyses are then used for optimal integrity maintenance strategies but also preferred design alternatives for new pipelines.

Mr. Justin Bucknell of MSL Services Corporation followed with an appraisal of the development of pipeline defect assessment methodologies. Mr. Bucknell noted that structural integrity may be threatened by defects introduced into a pipeline system either during construction or operation and observed that not all defects are harmful to the integrity. He emphasized the importance of the ability to distinguish between those defects that can be tolerated from those that cannot be tolerated. A database of screened test results for different defect forms was generated as a basis to assess available defect methodologies.

A presentation by Kent Muhlbauer (WKM) drew upon his background of experience to present lessons learned in pipeline risk management. It was pointed out that there are several risk assessments approaches that can be used to develop a formal risk management system in the pipeline industry but there is a possibility for inefficiencies if not total misunderstanding and misconceptions. Mr. Muhlbauer described the most popular pipeline risk assessment management techniques and presented some practical issues that should be considered when risk assessment is moved into risk management.

Dr. Bob Bea of the University of California at Berkley described a general engineering approach for risk assessment and management, which is identified as RAM PIPE REQUAL. The approach that he proposes is based on the use of qualitative, quantitative and a mix of the two analytical methods. Details of the approach were presented with particular emphasis on pipeline corrosion.

John Greenslade of Colt Engineering presented a risk assessment method for evaluating perceived environmental risk and the life cycle costs of a project. It is called the Influence and Tornado Diagrams. The method is particularly useful in that it is interactive amongst the public, regulators and the project proponents. Perceived environmental and permitting risks are first identified and influence diagrams are developed to link those risks with their impacts on the project. The method introduces potential risk mitigation measures to optimize the project development with respect to environment and permitting risk. It offers an open and analytical approach to identify public concerns and evaluate the cost and schedule impacts from mitigating and perceived risks. The various stages of the project to which it should be applied were described.

The final session of the formal presentations consisted of a Regulations Panel Discussion. This session was of great interest to the participants in that it is believed to be the first time that various regulators had been able to respond as a panel in a workshop format dedicated to arctic gas pipelines. Presentations were made by Mr. Jon Strawn of the US Department of Transport, Mr. Ted Moore of the Alaskan Department of Environmental Conservation, Mr. Greg Swank of the State Pipeline Coordinator's Office, Mr. Alex Alverado of the Minerals Management Service. Dr. Ibrahim Konuk of the Canadian Geological Survey also participated and spoke on the development of a regulatory approach and some lessons from the Canadian experience. Each of the participants made a presentation to the workshop and then willingly accepted all questions from the floor. In the last presentation by Dr. Konuk, some lessons that may be useful for both regulators and industry that could lead to a collaborative approach for the development of a regulatory system to serve both public and industry were presented.

During the course of the workshop participants were invited to write out questions on flip charts that they would like to have dealt with in discussion. The three breakout sessions to deal with questions and facilitate further discussion were: (1) Design; (2) Construction and (3) Operation and Maintenance. These sessions proved to be particularly valuable as there was extensive involvement of the participants in each of the sessions. Some 50 questions were identified and responses were provided by both the presenters at the workshop and other participants in the discussions sessions. All of the questions that were presented and the responses that were captured by scribes of each the sessions are included in Appendix D.

Each of the discussion leaders (Clark, Langner, Bea) presented summaries of the breakout discussion sessions which they chaired. This was followed by open questions and answers and discussion. Bill Fowler and Martin Thurlow of ARCO gave a very clear and thorough explanation of the reasoning behind the design of the Colville River crossing in a step by step scenario based way. The workshop participants very well received this presentation, as it was the first public discussion of the engineering design aspects of the project in a workshop setting. There was also an insightful analysis by Bob Bea on the observed offshore oil mishaps, which he and his colleagues had studied in detail. His studies have shown that double hull tankers are experiencing extensive corrosion of the interior and exterior keels. This highlights the importance of corrosion prevention measures when considering pipe in pipe construction for offshore pipelines.

The final wrap up plenary session also provided a forum for a lively and informative discussion session. Andrew Palmer gave a summary of presentations setting out his perception of what was achieved by the workshop. He noted that the workshop served as an example to Europe and elsewhere on how to create an informed community. He also observed that there are some 25 pipe-in-pipe systems in the Gulf of Mexico and the North Sea, some of which had been operated for more than 15 years. None had been used for containment but their satisfactory performance provides some degree of confidence and they indicate an acceptable level of safety.

Although no consensus was reached on the optimum system for Arctic offshore pipelines (that was not a workshop objective), virtually all the considerations were discussed openly and candidly by the participants. There is no doubt that some people left the workshop thinking that a robust single wall pipeline is preferable to a double wall pipe. Others thought the case had been made for double wall pipes where the additional cost of being able to contain product is warranted. For many, the jury is still out. Irrespective of the lack of convergence in thinking, the workshop has been a major benefit in advancing the studies of the Arctic pipeline alternatives.

Finally, it was observed that the regulatory process like all human activities isn't perfect but sessions such as provided by this workshop were very important in improving the process and expanding the knowledge and involvement of the whole community. The TAR program of the MMS was commended by numerous participants for having initiated the workshop as well as Dr. Ryan Phillips of C-CORE for his coordination.

INTRODUCTION

The Alaskan Arctic Pipeline Workshop was held on November 8 and 9, 1999 at the Captain Cook Hotel., Anchorage, Alaska. An executive summary of this workshop is presented above. The announcement and agenda for the workshop are printed in Attachment A.

This workshop, sponsored by the Minerals Management Service (MMS), facilitated the exchange of technical information on Alaskan Arctic offshore pipelines between the public, engineering community and regulatory agencies. The objective of the workshop was to bring together a group of experts with skills related to offshore pipeline design, operation, maintenance, and inspection, and to examine the current state of practice for Arctic pipeline alternatives under consideration for Alaska's offshore oil and gas reserves.

Over 155 people participated in the workshop, including 25 from the mainland USA, 15 Canadians and 5 Europeans. The list of participants is printed in Attachment B. There were 27 invited presentations in 6 sessions. Dr Andrew Palmer described the 'Challenges Arctic Offshore Pipeline Developments'. Sessions followed on Pipeline Design, Construction & Operation; Pipeline Technology; Pipeline Operational Monitoring Technology and Pipeline Risk Analysis. The presentations concluded with a Panel Discussion of Regulators from U.S. Department of Transportation, Alaska Dept. of Environmental Conservation, Alaska State Pipeline Coordinator's Office, Minerals Management Service and NRC, Canada.

The abstracts of most presentations are printed in Attachment C. The visual aids used in most of the presentations are listed in Attachment E. The presenters' affiliations are shown in Attachments A and B.

Discussion sessions on the 3 topics of Design; Construction and Operations & Maintenance were led by Dr. Jack Clark of C-CORE; Dr. Carl Langner and Dr. Bob Bea of University of California at Berkley respectively. Andrew Palmer oversaw these discussion sessions and provided his thoughts on the workshop at the closing session. The summary of these discussions and closing remarks are printed in Attachment D.

The workshop liaison was Mr. Robert W. Smith of the MMS. The workshop was coordinated by Dr Ryan Phillips on behalf of C-CORE with the assistance of AGRA Earth & Environmental, Colt Engineering and Tri Ocean Engineering.

Attachment A:
Final Announcement of Alaskan Arctic Pipeline Workshop

BACKGROUND INFORMATION

MMS participated in the EIS process for the Northstar Project, which included an analysis of double-walled pipeline technology. The Northstar Project is a joint State/Federal development project located offshore, approximately 21 miles northwest of Prudhoe Bay. The EIS concluded that the practicability, applicability, and current technology limitations or constraints associated with the use of a multi-mile double-walled pipeline in a subsea Arctic environment are currently unknown.

MMS is reviewing the proposed Liberty DPP for a facility on the Beaufort Sea OCS, which includes a pipeline to shore. BP Exploration (Alaska) Inc. submitted the plan and the associated Oil Spill Contingency Plan (OSCP) to MMS in February 1998. The Liberty development project is located in the Beaufort Sea approximately 20 miles east of Prudhoe Bay. The DPP and associated OSCP are presently under regulatory and environmental review.

In an effort to further develop an understanding of Arctic offshore pipeline technology and issues, MMS awarded a research effort entitled “An Engineering Assessment of Double Wall Versus Single Wall Designs for Offshore Pipelines in an Arctic Environment” to independently review pipeline technology and to hold an Arctic pipeline workshop.

This workshop was initiated to facilitate the exchange of information between the public, engineering community and regulatory agencies. These efforts are led by C-CORE, St. John's, Newfoundland, Canada in collaboration with Agra Earth & Environmental, Colt Engineering and Tri Ocean.

Announcement of ALASKAN ARCTIC PIPELINE WORKSHOP
Anchorage, Alaska November 8-9, 1999

This public workshop, sponsored by the Minerals Management Service (MMS), will facilitate the exchange of technical information on Alaskan Arctic offshore pipelines. The objective of the workshop is to bring together a group of experts with skills related to offshore pipeline design, operation, maintenance, and inspection, and to examine the current state of practice for Arctic pipeline alternatives under consideration for Alaska’s offshore oil and gas reserves. Participants are expected from both North America and Europe to discuss these issues.

VENUE:
The workshop will be held on November 8 and 9, 1999, from 8:30 a.m. to 5:00 p.m., each day. The workshop venue will be the Aft Deck room of:

The Hotel Captain Cook
939 West Fifth Avenue, Anchorage, Alaska 99501
Phone: 907-276-6000
Reservations: 1-800-843-1950 (inside USA)
Email: info@captaincook.com

FOR FURTHER INFORMATION CONTACT:

Mr. Robert W. Smith
MMS, Engineering and Research Branch
381 Elden St., Mail Stop 4021, Herndon, Virginia 20170
Phone: (703) 787-1580
Fax: (703) 787-1549
Email: robert.w.smith@mms.gov

REGISTRATION:
The workshop will not have a registration fee. However, to assess the probable number of attendees, MMS requests attendees to register by contacting:

Dr. Ryan Phillips
Workshop Coordinator
C-CORE, St. John's, Newfoundland, Canada, A1B 3X5
Phone: (709) 737-8354
Fax: (709) 737-4706
Email: ryanp@morgan.ucs.mun.ca

Agenda - Alaskan Arctic Pipeline Workshop

Session Monday November 8th	***Presenters***
8:00-8:30 ***Registration***	
8:30-10:00 ***Opening Session*** 8:30-8:40 ***Introduction*** Overview of Arctic offshore activities and current MMS initiatives and objectives of workshop 8:40-8:50 ***Arctic Resources at Risk*** 8:50-9:35 ***Challenges for Arctic Offshore Pipeline Developments*** 9:35-10:00 ***Arctic Offshore Pipelines Comparative Assessment Project***	Chair: J. Greenslade, Colt Eng. J. Walker, DOI/MMS L. Bright, DOI/FWS A. C. Palmer, Cambridge University J. I. Clark, C-CORE
10:00-10:30 ***Break***	
10:30-12:00 ***Pipeline Design, Construction and Operation*** - Comparison of API and CSA Offshore Pipeline Stress and Strain Design Criteria - BPXA Northstar and Liberty Pipelines - Horizontally Directional Drilled (HHD) Colville River Crossing - Operation and Monitoring of the Trans-Alaska Pipeline	Chair: R. McBeth, Tri Ocean R. Smith, Consultant G. Lanan, Intec K. J. Meyer, Michael Baker W. Tonkins, Alyeska Pipeline
12:00-13:00 ***Lunch*** *(on your own)*	
13:00-14:30 ***Pipeline Technology*** - An overview of pipeline configuration alternatives - Pipe-in-Pipe Flowline Installations in the Gulf of Mexico - Flexible pipe for onshore and offshore Arctic applications - Troika Flowline installation by the bottom tow technique - Pipe-in-Pipe Applications in the Petrochemical Industry	Chair: D. Begley, Agra R. A. McBeth, Tri Ocean C. G. Langner, Consultant C. Loper, Wellstream N. Sanderson, BP Amoco J. Greenslade, Colt Eng.
14:30-15:00 ***Break***	
15:00-16:30 ***Pipeline Operational Monitoring Technology*** - LEOS - Sensitive Leak Detection System - Measurement-based Leak Detection Technology - Out-of-Straightness Assessment using Pipeline Inertial Geometry Survey (GEOPIG) Technology - Monitoring & leak detection with smart pigging	Chair: R. Phillips, C-CORE P. Jax, Siemens AG E. Farmer, EFA D. Hektner, BJ Pipeline Inspection Services J. Rosenmoller, ROSEN

Session Tuesday November 9th	***Presenters***
8:00-8:30 ***Registration***	
8:30-10:30 ***Pipeline Risk Analysis*** - PIRAMID - A Quantitative Risk-based Approach to Integrity Maintenance Planning and Design Optimization for Pipelines - Appraisal and Development of Pipeline Defect Assessment Methodologies - Lessons Learned in Pipeline Risk Management - RAM PIPE REQUAL: A Risk Assessment and Management Based Process for the Requalification of Marine Pipelines - Influence and Tornado Diagrams: A Risk Assessment Method for Evaluating Perceived Environmental Risks and the Life Cycle Costs of a Project	Chair: D. Begley, AGRA M. Stephens, C-FER J. Bucknell, MSL W. K. Muhlbauer, WKM R. Bea, UC Berkley J. Greenslade, Colt Eng.
10:30-11:00 ***Break***	
11:00-12:30 ***Regulations Panel Discussions*** Regulatory agencies, responsible for reviewing and monitoring pipeline related functions, will present information on their regulatory requirements. - U.S. Department of Transportation - Alaska Dept. of Environmental Conservation - Alaska State Pipeline Coordinator's Office Organization, Operation, and Authorities - Minerals Management Service - Development of a Regulatory Approach for Arctic Pipelines; Some Lessons from the Canadian Experience	Chair: J. Clark, C-CORE J. Strawn, DOT/OPS T. Moore, ADEC B. Britt, SPCO A. Alvarado, MMS/GOM I. Konuk, NRC/Canada
12:30-13:30 ***Lunch*** *(on your own)*	
13:30-15:30 ***Breakout sessions*** * Discussion of technologies & techniques for Design, Construction, and Operations & Maintenance of Arctic offshore pipelines.	*Discussion leaders* R. Bea, UC Berkley J. Clark, C-CORE C. Langner, Consultant A. Palmer, Cambridge U.
15:30-16:00 ***Break***	
16:00-17:00 ***Summary & Concluding Remarks*** Including discussion leader summaries.	Chair: J. Clark, C-CORE A. Palmer, Cambridge U.

* Attendees will have the opportunity to propose issues for discussion and to participate in the breakout sessions from 13:30 to 15:30 on November 9th.

Attachment B:
Alaskan Arctic Pipeline Workshop Participants

18-Nov-99 **Alaskan Arctic Pipelines Workshop Participants**

Surname	First name		Affiliation	Role
Abdelnour	Razek		Fleet Technology Ltd.	
Alvarado	Alex		MMS Pipeline Unit	Speaker
Anderson	Carl		MMS	
App	Jennifer	B.	Trustees for Alaska	
Arey	Ned		North Slope Borough	
Ballard	Kirsten		Alaska Department of Environmental Conservation	
Barbas	Serghios	T	Exxon Production Research	
Barrett	John		ARCO Alaska Pipelines	
Barrow	Albert		US Dept. of Interior	
Bea	Robert		UC Berkeley	Speaker & Discussion Leader
Begley	Dan		Agra Earth & Environmental Ltd	Project Member
Belloni	L		Offshore Kazakhstan International Operating Co	
Bendersky	Mark		Alaskan Science & Technology Foundation	
Bennett	Mike		State Pipeline Coordinator's Office	
Berg	Catherine		U.S. Fish and Wildlife Service	
Bieri	Tim		CC Technologies	
Bohl	Christy		MMS Alaska Region Office	
Bonar	Frank	K.	Rocksaw Technology, Inc.	
Bridges	John	W.	Marine Mammals Management Office	
Bright	Larry		U.S. Fish and Wildlife Service	Speaker
Britt	William	G	State Pipeline Coordinators Office	Speaker
Brown	Bryce	W.	ROSEN USA	
Bryce	Peter		Intec	
Bucceri	Tom		State of Alaska	
Bucknell	Justin		MSL Services Corp.	Speaker
Burwell	Mike		MMS	
Casey	Phyllis		MMS Alaska Region Office	
Cederstrom	Elaine		Alaska Department of Environmental Conservation	
Chang	Michael	K.	BP Pipeline (Alaska) Inc	
Choromans	Doug		MMS Alaska Region Office	
Clark	Jack	I	C-CORE	Speaker & Discussion Leader
Colberg	Sigurd		Alaska Dept. of Environmental Conservation	
Cologgi	John		ARCO Alaska, Inc	
Colonell	Joseph	M	URS Greiner Woodward Clyde	
Cowling	Edgar		Phillips Petroleum Company	
Cronk	John		Unocal	
Dash	Chris		ARCO Alaska, Inc	
Davis	Jerry		Department of Transportation	
DeGange	Tony		U.S. Fish and Wildlife Service	
Dennis	Lew		Unocal	
Donnelly	Jim		Precision Tube Technology	
Donnelly	Martin		TransCanada	
Duchin	Melanie			
Eck	Daniel	J	Arco Alaska Inc	
Egger	Pat		Houston Contracting Co.	
Eschenback	Ted			
Fanter	Lloyd		U.S. Army Corps of Engineers	
Farley	Katie		State Pipeline Coordinator's Office	

Surname	First name		Affiliation	Role
Farmer	Ed		EFA	Speaker

Flanders	Bill		Aleyska Pipeline Company	
Fowler	Bill	M	ARCO Alaska, Inc.	
Goldmann	Ed		ARCO Alaska, Inc	
Goll	John		MMS	
Gray	Glenn		Alaska Division of Govt Coordination	
Greenslade	John		Colt Engineering Limited	Speaker & Project member
Guarino	Robert		Saipem, Inc.	
Hackney	David	A	Alyeska Pipeline Company	
Hanson	Jeanne		National Marine Fisheries Service	
Hektner	Dave		Nowsco	Speaker
Hinnah	Dennis		MMS Alaska Region Office	
Hobbie	David		US Corps of Engineers, Alaska	
Hutmacher	Bill		US Coastguard	
Jarrett	Pat		State Pipeline Coordinator's Office	
Jax	Peter		Siemens AG	Speaker
Johnson	Elden	R	Alyeska Pipeline Company	
Johnson	Lee		Johnson & Associates	
Johnson	Gilbert	L	NANA/Colt	
Kachler	Dennis		BP Amoco	
Kalman	Mark		Halliburton	
Killins	Joe	D	ARCO Alaska Pipelines	
King	Corey		US Coastguard	
King	Fred		MMS Alaska Region Office	
Klatt	Terry	J	Alaska North Slope LNG Project	
Klimowski	Edward			
Konuk	Ibrahim		Geological Survey of Canada	Speaker
Kozisek	Louis	C	NANA/Colt	
Kuentzel	Marvin			
Lanan	Glenn		Intec Engineering Inc.	Speaker
Langner	Carl		Engineering Consultant	Speaker & Discussion Leader
Lew	Moon		BP Amoco	
Lfefher	Ed		BP Amoco	
Livers	Chuck		Arctic Geo International	
Loper	Cobie		Wellstream	Speaker
Lowry	Paul	L	MMS Alaska Region Office	
Lynch	Leon		Alaska Department of Natural Resources	
Martin	Paul		MMS	
Masterson	Dan	M	Sandwell Engineering Inc.	
Maunder	Tom		Alaska Oil and Gas Conservation Commission	
McBeth	Ray		Tri Ocean	Speaker & Project member
McHale	Jim		Alaskan Clean Sea	
Miller	Dwayne		Dwayne Miller & Associates	
Miller	Pamela	A.	Arctic Connections	
Milles	Chris		Alaska Department of Natural Resources	
Misener	Barbara		University of Alaska, Fairbanks	
Monkelien	Kyle		MMS Alaska Region Office	
Moore	Ted		Alaska Department of Environmental Conservation	Speaker
Muhlbauer	Kent		WKM	Speaker
Munger	Mike		Alaska Department of Environmental Conservation	
Murrell	Julie		State Pipeline Coordinator's Office	
Surname	**First name**		**Affiliation**	**Role**
Mutter	Doug		US Dept. of Interior	
Myer	Keith		Michael Baker Jr Inc	
Nelson	Kristen		Petroleum News Alaska	

Newbury	Thomas		Minerals Management Service	
Novotney	Tom	F		
O'Connor	Kristina		Dept of Natural Resources	
O'Grady	Thomas	J	VECO Alaska, Inc.	
Oerth	Herb		US Coastguard	
Okakok	Rex		North Slope Borough	
Owen	Les		BP Amoco	
Pace	Christopher		Alaska Department of Environmental Conservation	
Palmer	Andrew		Cambridge University	Speaker & Discussion Leader
Papia	Gene		Clearwater Environmental	
Pekich	Lisa		ARCO Alaska, Inc	
Persson	Brad		Regulatory Commission of Alaska	
Phillips	Ryan		C-CORE	Secretary
Repp	Steven		BP Amoco	
Rice	Dan		State Pipeline Coordinator's Office	
Roby	David		MMS Alaska Region Office	
Rockwell	Ted		U.S. Environmental Protection Agency	
Rogowski	Kenneth	G.	Alaska Department of Environmental Conservation	
Rosenmoller	Johannes		ROSEN	Speaker
Saengsudham	Sam		Department of Transportation	
Sanderson	Norman		BP-Amoco	Speaker
Sautner	Joe		Alaska Department of Environmental Conservation	
Schliebe	Scott		U.S. Fish and Wildlife Service	
Schmitz	Steven		Alaska Dept. of Natural Resources	
Schultz	Gary		Alaska Department of Natural Resources	
Simmons	Gary		Simmons & Associates	
Smith	Charles		MMS /TAR	Sponsor
Smith	Robert		MMS	Technical Liaison
Smith	Ray		Consultant	Speaker
Snow	Al		TransCanada PipeLines Limited	
Sondergard	Murray		TransCanada Transmission	
Stang	Paul		MMS Alaska Regional Supervisor	
Stephens	Mark		CFER Technologies Inc	Speaker
Strawn	Jon		US DOT/OPS	Speaker
Susich	Mark		Marathon Oil	
Swank	Greg		State Pipeline Coordinator's Office	
Swanson	John		Michael Baker Jr Inc	
Tame	Jonathan		European Marine Contractors	
Tart	Bucky		Golder Associates	
Taylor	Eric	J	U.S. Fish and Wildlife Service	
Teeter	Steve		ARCO Alaska, Inc	
Thornton	Win		Winmar Consulting Services, Inc.	
Thurlow	Martin		Arco	
Tonkins	Wesley	G	Alyeska Pipeline Company	Speaker
Townsend	Darryl		NANA/Colt	
Trimm	Bryan		URS Greiner	
Visser	R	C	Belmar engineering & management services co.	
Walker	Jeff		MMS	Speaker
Surname	**First name**		**Affiliation**	**Role**
Wall	Rance		MMS Alaska Region Office	
Wiesman	James		WIMAR	
Wuestenfeld	Karen		BP Amoco	
Zelych	Grant		Tri Ocean	

Attachment C:

Abstracts of Presentations at Alaskan Arctic Pipeline Workshop

Abstracts of Presentations at
ALASKAN ARCTIC PIPELINE WORKSHOP
Anchorage, Alaska November 8-9, 1999

Overview of Arctic Offshore Activities and Current MMS Initiatives and Objectives of Workshop

Jeff Walker, Minerals Management Service, DOI

BP Amoco's (BP) Northstar development project will be constructed this winter in the central Beaufort Sea. The project will include the first subsea pipeline constructed in the Beaufort Sea and to my knowledge, the first subsea oil pipeline in the Arctic. The pipeline is a single walled steel pipeline and includes other design factors and operating measures directed at assuring safe operations under Arctic conditions. In October 1999, the State Pipeline Coordinators Office issues a final Right of Way approving the Northstar pipeline.

In February 1999, the US Army Corps of Engineers issued a Final Environmental Impact Statement (FEIS) for the Beaufort Sea Oil and Gas Development/Northstar Project. The FEIS concluded that in conceptual design and in limited field applications (testing, but not operations) pipe-in-pipe (double wall pipe) designs could increase pipeline integrity, provide oil spill containment and enhance leak detection. The FEIS further concluded that the actual benefits versus costs and risks associated with single and double walled pipeline alternatives require a project specific analysis based on the most current available information.

This workshop is one of several initiatives which have been undertaken to assess alternative pipeline technologies for the Arctic in general and BP's proposed Liberty development project in particular. Other initiatives include the following:

- MMS contract to review historic application of pipe-in-pipe technology and implications for Arctic conditions.
- Ongoing review and assessment of pipeline technologies and environmental benefits by BP for the proposed Liberty development project. BP will advance conceptual engineering for promising design alternatives.
- MMS managed third party contractor to review BP conceptual engineering documentation to assess reasonableness of assumptions and equity in design approach.
- MMS managed third party contractor to provide assessment of oil spill probabilities for the different pipeline design alternatives developed by BP.

Inherent in these initiatives and this workshop, is the objective to understand both the environmental benefits these pipeline design alternatives could provide and the technical aspects of construction, inspection, leak detection, maintenance and repair.

Arctic Resources at Risk

Larry Bright, Fish & Wildlife Service, DOI

Some of the most knowledgeable engineers in the pipeline industry are gathering in Anchorage this November to discuss the state-of-the-art in pipeline technology and how it may apply to the Alaskan Arctic. The immediate objective of the workshop is information transfer, but the underlying purpose of the workshop and related analyses is the protection of a fragile arctic ecosystem. This talk will focus on the living resources of the Arctic and why they are particularly vulnerable to oil spills and other major disturbances. Arctic ecosystems do not have the stabilizing benefits of high biological diversity, yet from May through August they harbor hundreds of thousands of fish, waterbirds, and marine mammals. In addition, the Alaskan arctic is home to the Inupiat people who depend on the biological resources of the north for physical and cultural sustenance. Molting waterfowl (particularly oldsquaw) and brood-rearing black brant that occur in nearshore lagoons are particularly susceptible to injury and mortality because molt prohibits birds from easily leaving an area contaminated with oil. Nearshore and offshore habitats in the Beaufort Sea provide foraging, rearing and migrating areas for anadromous fish including arctic cod, least cisco, and broad whitefish. An offshore oil spill could drive marine mammals out of the reach of subsistence hunters, impact internationally managed species such as polar bears and waterfowl, and impact unique habitats such as the arctic kelp - invertebrate community known as the Boulder Patch. Complicating the analysis of these risks is the difficulty of recovering oil spills in the Arctic. Extensive sea ice, fog, shallow nearshore waters, and extreme temperatures will likely inhibit our ability to recover oil released into the Beaufort Sea. Consequently, pipeline designs that provide the greatest assurance of product containment will likely provide the greatest level of environmental protection. It is our collective charge to apply the best of current pipeline technology to the task of insuring the protection of these unique and irreplaceable resources.

Challenges for Arctic Offshore Pipeline Developments

Andrew Palmer, Cambridge University

Marine pipelines in the Arctic pose several additional challenges, among them ice forces, strudel scour, ice rideup, construction, inspection, leak detection and possible repair. This paper reviews each of the potential problem areas, and attempts to assess the degree of confidence that can be assigned to their solution. It also briefly examines the lessons learned from the construction and subsequent history of the Panarctic Drake F76 flowline system constructed in 1978.

Arctic Offshore Pipelines Comparative Assessment Project

Jack Clark, C-CORE

This project will provide an engineering assessment of double wall versus single wall designs for offshore pipelines in an Arctic environment. The project will offer an extensive, non-bias engineering and environmental assessment, considering both pros and cons, of single versus double walled designs for offshore pipelines in an Arctic environment. The study is assessing if a double walled design provides the same or a greater degree of engineering integrity and environmental robustness as compared to a thicker walled single pipe design for an Arctic offshore application. The study is appraising the economics of one selection over the other, relative to the potential risks (real and/or perceived) associated with either application.

Pipeline Design, Construction and Operation

Comparison of API and CSA Offshore Pipeline Stress and Strain Design Criteria, Ray Smith, Consultant

This presentation will provide a brief overview and comparison of the API and CSA offshore pipeline stress and strain design criteria. It will compare and highlight differences in procedures and provisions used to establish the various 'stress limits' defined in the API Recommended Practice with those defined in the CSA Standard. The presentation will also highlight those provisions contained in both API and CSA that deal with strain considerations and 'strain limits' as they apply to the design, installation and operation of offshore pipelines.

BPXA Northstar and Liberty Pipelines *Glenn Lanan, Intec Engineering Inc.*

BPXA has been working on the present design, permitting, construction and operations planning for the Northstar pipelines since 1995 and on the Liberty pipelines since 1997. Survey and preliminary design work have been ongoing for decades. This presentation will briefly summarize the results of many peoples efforts to design safe and efficient offshore pipeline systems. Key design/construction/operational features will be highlighted as a basis for understanding the pipeline's expected performance in this unique environment.

Horizontally Directional Drilled (HHD) Colville River Crossing *Keith Meyer, Michael Baker Jnr. Inc.*

The Colville River Crossing was a design and construction feature that figured prominently in all planning and development phases of the Alpine pipeline, which transports crude from the westernmost North Slope oil field back to the Kuparuk River facilities. A number of alternative moding and pipeline routings were identified and evaluated, and are discussed in this presentation. A brief overview of the design features and detailed analytic evaluation of the chosen Horizontally Directional Drilled crossing mode are introduced, followed by a summary of the critical milestones of the construction and identification of the remaining completion items.

Operation and Monitoring of the Trans-Alaska Pipeline *Wes Tonkins, Alyeska Pipeline*

Alyeska Pipeline Service Company maintains the pressure capability of the Trans-Alaska Pipeline to meet the requirements for all flow rates up to 2.1 MMBPD. Settlement and corrosion of the pipeline is actively monitored, inspected and analyzed to ensure that the operating pressure requirements are maintained.

Pipeline Technology

An overview of pipeline configuration alternatives *Ray McBeth, Tri Ocean Engineering Ltd.*

This presentation provides an overview of pipeline configurations that have been used in the oil and gas industry with the emphasis on offshore applications. Basic configurations and definitions of the associated pipeline components are presented. Available installation techniques are summarized. Statistical distributions of pipe-in-pipe and single wall pipeline installations are shown to summarize the geographical location, configuration, intended use, and pipe characteristics of the currently available data base.

Pipe-in-Pipe Flowline Installations in the Gulf of Mexico *Carl Langner, Consultant*

In the U.S. Gulf of Mexico, flowlines are constructed in concentric pipe-in-pipe configurations primarily to achieve high thermal insulation for flow assurance purposes. Keeping the internal fluids warm helps prevent formation of hydrate plugs and reduces paraffin deposition which can constrain the flow. A pipe-in-pipe in which the annulus is filled with low density foam, provides better insulation than a comparable single pipe externally coated with a more dense, pressure-resistant foam, even when the latter is buried in the seafloor to reduce heat losses. This presentation describes several recent pipe-in-pipe flowline installations, illustrates the various techniques for applying the insulation, assembling the pipe joints, and installing the flowlines offshore.

Flexible pipe for onshore and offshore arctic applications *Cobie Loper, Wellstream*

Flexible pipe has been used extensively for offshore subsea applications in moderate climates for over 20 years. In 1996, product development activities were completed to verify the ability of the product to function in onshore and offshore Arctic applications. Qualification activities included low temperature material and full scale testing. The development activities culminated in the deployment of numerous jumpers on various drill sites on the North Slope. This presentation will provide a brief summary on the product structure, materials and qualification testing specific to Arctic applications, state of the art technology and subsea operating experience including installation and operation loads.

Troika Flowline installation by the bottom tow technique *Norman Sanderson, BP Amoco*

An overview of the Troika flowline installation in 1997 using the bottom tow method. The Troika field is tied back over a distance of 14 miles to the Bullwinkle platform in the Gulf of Mexico by two 10-inch thermally insulated flowlines. Each flowline was fabricated in two sections on the beach at Matagorda Peninsula then towed 400 miles across the seabed to the Troika field in Green Canyon, Gulf of Mexico. The talk will give a brief overview of the bottom tow technique illustrated by a description of the Troika flowlines.

Pipe-in-Pipe Applications in the Petrochemical Industry — *John Greenslade & Nick Lenstra, Colt Engineering*

Double walled piping has been used in the petrochemical industry for secondary containment, mechanical protection, enhanced constructability and heat transfer control. This paper reviews the use of double walled piping in each of those applications. Examples of typical designs are provided. Key design issues for double walled pipelines are discussed.

Pipeline Operational Monitoring Technology

LEOS - Sensitive Leak Detection System — *Peter Jax, Siemens AG*

LEOS is a sensitive leak detection system for buried pipelines for over 20 years. It sniffs the molecules moving from a potential leak to the environment by a sensor tube to be laid along the pipeline and a central measuring system. The paper gives an overview on the basics of the system, its track record from references and capabilities with respect to sensitivity, pinpointing the leak, identifying the leak material, etc. In year 2000 LEOS will be implemented at the 6 mile offshore pipeline of the Northstar project. This will be the first installation under an Arctic environment. The special measures to ensure a safe installation of the system and a reliable operation will be described.

Measurement-based Leak Detection Technology — *Ed Farmer, EFA Technologies Inc.*

Pipeline leak detection is a component of an overall safety program – a tool that enhances operator performance in pipeline management. Various methodologies exist, each with strengths and weaknesses and each requiring specific support by the owner - operator to ensure performance. Leak detection is one manifestation of a corporate culture focused on safety and security.

Out-of-Straightness Assessment using Pipeline Inertial Geometry Survey (GEOPIG) Technology

Stuart Clouston, Gordon Blair, and David Hektner, BJ Pipeline Inspection Services

With an increase in the development of high temperature, high-pressure offshore oil and gas fields, smaller diameter subsea flowlines are being installed in deeper water and more environmentally sensitive areas. Due to the potential for increased flowline upheaval a general tightening of the design specifications for out-of-straightness (OOS) during pipelaying operations is becoming more important.

In such critical production applications Pipeline Inertial Geometry (GEOPIG) surveying using intelligent tools has become a preferred approach for measuring pipeline positioning to a much higher degree of accuracy than with traditional ROV techniques. As a result, cost savings can be realized due to minimal rock dumping and other remedial work, and for the first time pipeline displacement in the horizontal plane can be assessed. Furthermore, the Inertial Survey can be performed after backfill as well as open trench and can be re-run following production start-up for shape verification. None of the techniques previously used for out-of-straightness measurement can provide 'through life' monitoring of pipeline stability.

In conclusion, Pipeline Inertial Geometry surveys for determination of pipeline out-of-straightness can, through higher accuracy, improve both the pipeline constructor's and operator's confidence in the stability, integrity and safety of a pipeline system.

This paper explores the theory used for out-of-straightness measurement using a Pipeline Inertial Geometry (GEOPIG) tool, the potential benefits to the operator and gives an overview of recently completed North Sea projects.

Monitoring & leak detection with smart pigging — *Johannes Rosenmöller, ROSEN*

Pipeline Risk Analysis

PIRAMID - A Quantitative Risk-based Approach to Integrity Maintenance Planning and Design Optimization for Pipelines

Mark Stephens, C-FER Technologies Inc.

This presentation describes a multi-year joint industry program that has produced a comprehensive risk-based approach to integrity maintenance planning for existing onshore and offshore pipeline systems that can also be used to evaluate new design alternatives. The associated software, known by the acronym PIRAMID, consists of a suite of failure frequency and consequence estimation models that have been implemented within a decision analysis framework to facilitate the risk management process. The software can be used to rank and compare existing or hypothetical pipelines based on the estimated level of operating risk and to aid in the determination of optimal integrity maintenance strategies for existing lines or the preferred design alternative for new lines.

Appraisal and Development of Pipeline Defect Assessment Methodologies — *Justin Bucknell, MSL Services Corp.*

This presentation will discuss the background, scope of work and status of an ongoing project designed to evaluate available assessment methods for offshore pipeline defects. A prerequisite to pipeline safe operation is assurance of structural integrity to a sufficient level of reliability. Such integrity may be threatened by defects introduced into a pipeline system during its construction or operation. Since it is impractical, if not impossible, to prevent all defects from occurring and because not all defects are harmful to integrity, it is important to be able to distinguish defects that can be tolerated from those that cannot. A large number of empirical and/or analytical tools are available for the assessment of pipeline defects. The subject project includes an extensive review of related literature, including international codes, standards, published reports, papers and articles and a critical appraisal of current industry practice and code provisions. A database of screened test results for different defect forms has been generated against which available defect assessment methodologies will be assessed.

Lessons Learned in Pipeline Risk Management *Kent Muhlbauer, WKM*

Pipeline risk management continues to grow in popularity among pipeline operating companies. It offers opportunities to understand the risks of pipeline operations, and then provides a framework by which to make cost-effective decisions for managing those risks. With several risk assessment approaches available and with the relative newness of formal risk management in the pipeline industry, there is the possibility for process inefficiencies, if not outright misunderstanding and misconceptions. This presentation highlights the most popular pipeline risk assessment/management techniques and discusses some practical issues that should be considered in embarking on risk assessment and then moving into risk management.

RAM PIPE REQUAL: A Risk Assessment and Management Based Process for the Requalification of Marine Pipelines
Bob Bea, University of California at Berkeley

This paper proposes a general engineering approach for Risk Assessment and Management (RAM) of marine pipelines. The system is identified as RAM PIPE REQUAL. The approach is based on use of qualitative, quantitative, and mixed qualitative-quantitative analytical methods. The paper outlines the approach, its attributes and strategies, and further details the qualitative-quantitative approach for design and reassessment of pipelines subjected to corrosion.

Influence and Tornado Diagrams: A Risk Assessment Method for Evaluating Perceived Environmental Risks and the Life Cycle Costs of a Project
John Greenslade, Colt Engineering &
Ian Henderson, CSC Project Management Services

A method is presented to identify and analyze the environmental risks associated with a development project. The proposed method is interactive amongst the public, regulators and the project proponents. The first step in this method is the development of a comprehensive list of the perceived environmental and permitting risks associated with the project. Influence diagrams are developed to link those risks with their impacts on the project. A risk analysis is then performed to produce a tornado diagram to rank and graphically present the relationship amongst the perceived risks and the life cycle cost of the project. By introducing potential risk mitigation measures and reiterating the risk analysis, the project development plan can be optimized with respect to environmental and permitting risks. This approach offers an open and analytical approach to identifying public concerns and evaluating the cost and schedule impacts on the project from mitigating the perceived risks.

Risk analysis is an integral part of probabilistic design methods and project risk management. This method offers an adaptation of those methods to analyzing and managing the environmental and permitting risks associated with a regulated project. By beginning with perceived risks, value judgements are replaced by analytical analysis and public confidence in the permitting process can be enhanced.

It is suggested that the process be applied at several stages in the planning of a project: early in the presentation of the project to the regulatory community, as part of the EA or EIS development and along with the agency permit applications.

Regulations Panel Discussions

- U.S. Department of Transportation *Jon Strawn*
- Alaska Dept. of Environmental Conservation *Ted Moore*
- Alaska State Pipeline Coordinator's Office Organization, Operation, and Authorities *William Britt, Jnr.*
- Minerals Management Service *Alex Alvarado*

Development of a Regulatory Approach for Arctic Pipelines; Some Lessons from the Canadian Experience
Ibrahim Konuk, NRC

The presentation will summarize the development of a new regulatory system especially for the industries that use new technologies or technologies that do not have extensive experience base such as the offshore arctic pipelines. It will discuss alternative approaches including advantages and disadvantages.

Significant portion of the presentation will describe the experiences gained in Canada that dealt with projects such as Drake Point, Benthorn and various Arctic drilling programs.

In the last portion of the presentation, the author will present some lessons that may be useful for both the regulators and the industry towards a collaborative approach for the development of a regulatory system, which would serve both the public and the industry.

Attachment D:
Summary of Discussion Sessions and Closing Remarks

DISCUSSION SESSIONS

Three separate and consecutive discussion sessions were held at the workshop. The topics of these discussions were focussed on Design, Construction and Operations & Maintenance. The questions and issues considered in these sessions are outlined below. Comments from the audience are noted under each bullet. These comments do not necessarily reflect the opinions of the workshop participants, presenters, sponsors or organizers.

The discussions were summarized by each discussion leader to all participants in the closing session of the workshop. Andrew Palmer concluded the technical portion of the workshop. His observations are noted at the end of this section.

1. Design — Leader Jack Clark

1) The discussions about design reported various strain limits somewhat arbitrarily selected. More pertinent for offshore pipelines is the limit KD^2/t=ε D/2t.1 which expresses a lower bound on bending strain, above which the pipe may buckle, and the ovality exceeds 2%. These results were established in the 1970s. K=1/rho is the curvature in the pipe centerline.

   For Northstar the absolute lowest strain limit was 2.3%. Even at 5% strain, there was no buckling or increased ovality. Their thick wall pipe did not buckle. This is documented in technical notes.

   A large amount of work was also done on TAPS pipeline that has a large D/t ratio and is not like the Northstar pipe.

   The DnV code (1966) is actually less conservative in its buckling formulation.

   Strain limits should not limit the use of a pipeline subject to large deformations if the integrity and operational serviceability still exists.

2) What were the critical engineering design criteria that led to casing the Colville River crossing?

   Ans. The risk based management decision was controlled by design, constructability, environmental and economic factors.

   A major concern was what would happen if there were a leak – in a normal pipe the leak would never be found due to dispersion into geological strata.

   Decision based on circumstances at that time.

   Each case should be based on the particular aspects of that period of time – economics and technical innovations may result in different solutions today or in the future.

3) Can you repair the leak if one should happen on Colville River Crossing?

   Ans. Leak detection is installed. Control fluids. Corrosion allowance. De-oxygenation – Chemical controls. Outside pipe is a coated heavy walled pipe.

   Anticipate no leak.

   If leak, pull out the carrier pipe is probably the way to go.

   If that doesn’t work, completely new installation may be required.

4) How do you keep the annulus dry?

   Ans. It is sealed, keeping it dry could involve a vacuum drying system.

5) I question the relevance of lower 48 pipeline failure data for purpose built Arctic applications

   Ans. Data is not particularly relevant – brought up for establishing the legitimacy of the concern.

   Always on to create a problem when using historical data

Northstar already represents a pipe-in-pipe application, as it is 3 times thicker than it had to be.

Accident statistics – it should not be taken as representing something that should? Not recorded?

More than having the data or statistics on failure it is the lessons that can be gathered from these failures.

Option may be to put more steel in the design.

6) There seems to be an underling belief that pipe-in-pipe systems are safer than single pipe systems. If there is one lesson the industry has taught us it is that the more complex the design the more likely it is to fail.

Ans. More complex systems have more failure mechanisms but must go through these to see if they occur at the same time.

7) Can you get a comparative risk of the two options: pipe-in-pipe vs. single line pipe?

Ans. Difficult to establish reliable statistical numbers for the risk assessment – therefore difficult to do numerically.

8) Problems to be addressed by pipe-in-pipe are not necessarily eliminated or are they?

Ans. No, each application must be evaluated on its own particular merits.

Weldable Query – ans. The question should be what are the risks involved? What are the benefits?

Pushing for a quantitative analysis and should have the potential benefit of containment.

What are the best options?

Rhetorical question **-** What is the objective of having a double pipe in pipe? Requirements must or should address the particular application.

Cannot compare railway or road crossing failures of pipe-in-pipe with this application – no sealing assurances are specifically designed in.

Functional analysis of double wall pipe in pipe – performance parameters and characteristics, costs etc may result in the determination of a single all (very much) thickened pipe.

For the Northstar application, which was the first offshore arctic pipeline, simpler was better.

9) Would appreciate information about comparative spill risks of pipelines and barges, The reason is that the Liberty proposal involves transport of diesel fuel to the island by barges during summer and trucks during winter in contrast, the Northstar project involves 2 pipelines and transfer of fuel (gas) to the island through a pipeline.

Ans. Not that difference is inferred.

Gas is the normal fuel. Diesel is for emergencies.

10) *Was not the key difference between Alpine, Northstar and Liberty* **-** *Arco was willing to overrule engineering in order to get timely permits whereas BPX was looking for an excuse to delay.*

Arco management, seeking timely permits, made the decision to go to a cased river crossing to mitigate the effects of a leak situation. PERIOD.

Secondary containment- also structural integrity.

Primary for secondary containment, not structural integrity.

No comment by Arco representative on the accusation of management overriding an engineering decision.

No comment made on the BP situation – which implies that BP is just looking for an excuse to delay.

Arco – when we could not answer how to clean up a spill or leak under the river – then decision was made to a cased pipeline.

11) *What is the MMS perception of the advantages of pipe-in-pipe?*

MMS is not going to dictate the design but going to evaluate the merits of the design.

12) *Why isn't Intec's report on the 4 different Liberty pipeline designs available for discussion on this session?*

Report was not the focus of this workshop. It was not the objective of this workshop to look at Intec's report.

13) *What lessons of double walled pipeline design for Alpine are relevant for Northstar or Liberty situations (presentation did not relate the Colville crossing top potential offshore applications; including problems with loss of drilling muds in the HDD drilling)*

Horizontal drilling instead of the case of a trench. Drilling muds used at Colville for horizontal drilling are not relevant to Northstar or Liberty.

Question really involves a comparison of apples and oranges.

Liberty was designed on the bases of its specific design needs.

The case of horizontal drilling is determined primarily by the 'sece'tability of the soils.

14) *Relative to double walled pipelines are the potential applications of containment & leak detection system w/in the annulus outweighed by potential increase risks due to corrosion, construction complexity & lack of pigging or the outside casing*

Experience dictates that general cannot directly be reached or one outweighs the other – must take all design parameters and requirements into consideration.

Is containment the primary concern? If it is then must address other problems that may arise due to the containment being implemented.

Have not found any applications in crude oil transmission where pipe in pipe has been used.

Did not look at river crossings!

No subsea use yet of pipe in pipe offshore pipelines.

Pipe in pipe limits the inspection of the casing or outer pipe. Also you give up some level of corrosion protection and you buy containment.

15) *How are companies in the GoM currently dealing with corrosion of outside pipes in double walled designs.*

Cathodic protection, coatings.

16) *Consider repair difficulty in evaluating pipeline design – pipe-in-pipe will be impossible/expensive to repair. What about difficulties of any pipelines*

Will be expensive.

Single walled pipe can be repaired – logistical support /equipment may dictate when you can do it.

Same integrity – can get it real close – mechanical connectors.

You can get a welded repair.

Repair of outer pipe – hyperbaric welding may be possible.

17) *Any experiences with repair of bundle or pipe in pipe?*

None was known.

18) *Is 8 years of ice data enough to develop a 100 year event*

Can see very old scours – relict type and in fill.

Northstar – gouges are not that long-lived.

Abundant amount of ice scour data available that allows for very predictive analyses.

19) *Alpine – applicability of Alpine double walled design?*

This has already been addressed.

20) *Can we design a subsea pipeline to eliminate the risk of ice contact (gouge below level of pipeline)?*

Three zones are considered. The top one interacts by the ice. The second lower zone is disturbed by ice presence, and may be where pipe is placed.

21) *Secondary containment with plastic pipe – how would it respond to modest ice gouging*

Return period for 7-foot burial is several million years.

Plastic pipe is too flexible – will not provide secondary containment – it does not have as much pressure containment at the point of leakage,

Problem of cathodic protection.

Would not recommend a plastic pipe as the secondary containment.

21) *Drake Point F76*

Never any intent to pay for costs through production.

Demonstration project to show capability to produce gas from the arctic.

2. Construction — Leader Carl Langner

1) Discussion emphasized the particulars of the Northstar and Liberty pipeline projects. Other Arctic pipeline issues discussed to some extent.

2) *Would like more information on situations in which long directional wells (essentially underground pipelines) have been drilled in ice bonded permafrost, Tom Newbury MMS*
   - Option of directional drilling to access reservoir from onshore an/or directionally drilling to access an offshore production facility.
   - Permafrost substrate application? Difficult to drill
   - Mud selection a critical factor? Oil based mud may not be permitted.
   - Distance may be limited to about 10km. May require intermediate traction devices not yet developed.

3) Options to armor the trench as a protection of the pipeline from external trauma. Options include some type of concrete cover, or freeze pipes arrayed above and to each side of pipelines, which form a freeze ball around the pipe.

4) There has not been nearly enough said about material selection, or about pipe and weld inspection, which are at least as important as corrosion and leak monitoring

- material selection and weld inspection
- Material selection needs to have a good connection with project designers.
- Emphasise putting as much quality into pipe selection, welding and inspection technology; as in monitoring corrosion and leaks
- All rods from a single batch
- A viable means to enhance pipeline integrity
- No repairs during construction offshore
- X-ray and UT will be used on Northstar

5) If the line is installed by pull or conventional lower-in method pipe in pipe assembly could be constructed on ice

6) Cathodic protection complex in pipe in pipe applications. May require coating all steel surfaces and leaving annulus filled with dry nitrogen gas.

7) Definition of carrier pipe
- retire term. Use inner pipe for flow line etc. Use outer pipe for casing etc.

8) What method of NDT inspection can be used on casing pipe welds?
- inner pipe of pipe in pipe, or single pipe, can always be inspected by x-ray or UT or both. Outer pipe can always be UT'd but can only be X-rayed if inner and outer pipes are welded separately and then slid together.
- Northstar welds will be inspected by both x-ray and UT
- Northstar project will not allow weld repairs. Defective welds will be cut out and re-welded.
- Inspection should extend beyond welding to coating and CP systems

9) What are the obstacles to directionally drill the 6 mile 10" pipelines? Can R&D overcome these obstacles?
- Weld technology limits directional drill feasibility.
- Recommend funding R&D into HDD technology for Arctic

10) Focus seems to have been on small diameter oil pipelines with their associated risk etc. What are the issues surrounding the potential construction of large diameter Gas pipelines in the offshore regions of Alaska/Canada? Footnote: Natural gas pipeline between US & Canada will never happen off coast of Arctic National Wildlife Refuge.
- lets walk before we run

11) What problems, if any, were encountered in the installation of double walled pipeline for the Alpine under the river. What solutions if any were found for these problems. What is the current state of the outer pipeline?
- lesson of drilling through permafrost and insulation

12) Pipeline insulation options in permafrost. How to include active cooling as well as insulation

13) Trenching a ditch allows you to see /know what you are running through

14) How far cans directional drilling in the Arctic is done technically/economically? What are the limits in the Arctic that we don't see elsewhere?
- this question is answered above

3. Operations & Maintenance Leader Bob Bea

1) What type of rules or guidelines will be followed for decommissioning of pipelines in Alaska's OCR and State waters? Will pipelines be similar to those for the GoM and North Sea?

2) How will this effect design and installation?

1 & 2) Aleskya has decommissioned sections of TAPS by cleaning out product and capping pipe ends, then leaving pipe buried. Onshore examples of decommissioned pipes were discussed, e.g. the Whitepass Skagway pipeline from BC to US has not been removed due to concern over environmental damage caused by removal. Permittors are leaving option open by granting suspension rather than abandonment permits. In valuable right of ways, there may be a future requirement to remove pipes to allow redevelopment. In GoM, a lot of pipes are decommissioned and left in place.

3) How can the casing pipe be inspected since external corrosion fails for more pipelines than internal?

Corrosion can be detected by magnetic flux leakage (MFL) or ultrasonic techniques. The MFL method is unable to magnetize the outer wall of PiP due to air gap. Ultrasonics would only work if the air gap was very small. The consensus was that there is currently no effective means of monitoring corrosion of outer pipe.

4) Shouldn't we consider pipeline REPAIR technology during the design process for new pipelines? How do we repair pipe-in-pipe in a subsea / Arctic setting? How do you repair any of the pipeline systems in this situation?

- In double-hulled ships repairs are very difficult. Subsea pipeline repairs are very difficult offshore and extremely difficult in Arctic.
- Cased crossings have repair technique possibility – pull out inner pipe, repair and replace.
- Well analogy – routinely pull tubing eg 4" from 24,000' well
- Challenge length, accessibility (cant get to both ends) inner pipe, what about outer pipe damage
- PiP conceived to have spacers
- Casing leaks – packers to squeeze off, sleeves, internal liners (straddle pack) wells designed to do that

5) How do combined risks of natural gas explosion and crude oil pipelines affect operations and design?

- Gas is a human safety issue, oil is environmental issue, different consequences. What is value of human life, what is value of environmental damage? If access is only 6 to 8 months, if spill is irretrievable. Informed consent - on North Slope no one there, for Valdez there is risk to town and innocent bystanders. Assessing the risk is not the same as communicating risk.
- Consequences, consider spill x spread x receptor x product volatility (e.g. benign)

6) LEOS: to what extent is this an Arctic 'pilot' test and has it been used in arctic temperatures, salt water, subsea?

- 20 years of operation. Max length 8 km in operation, improve to 10km, only for buried or cased pipelines, in Rhine in deeper water, will be modified for intended environment. First application offshore. 1 day /measurement. 6 hours to take each measurement.

7) Do we need to pig the outer casing of a double walled line to monitor it?

- For large outer diameter – crawl through. Also could pull inner pipe and then inspect outer.

8) Is the B31G code good?

- Good but very conservative. But if remove factor of safety then may feel uncomfortable. RAM program includes 151 tests, found no correlation for corrosion allowance to area parameter. Metal loss corrosion is different between machined and natural defects. Residual stresses in pipe from machined defects, so etch defects in test pieces.

9) Does Alaska have the best maintained pipelines in the world

- Alaskan pipelines are not at end of bathtub curve, with increase failure rates, except perhaps Cook Inlet pipelines from 1968 on. Cathodic protection may be challenge in weird soils. Operations show very good conditions all things considered, remember these pipes are over designed.
- 1 x 10-3 failures /year – failure rate riser to riser – is similar for both MMS and Norwegian Petroleum Directorate data – even to recent increase due to decrease in inspection with time. Main causes – corrosion and anchors & spuds.
- Pipeline leak before pipe rupture – different design concern to other pipes.
- Risk controlled by maintenance
- Consciousness / alertness of operating companies makes big difference
- A State position – cutbacks concern in companies – people, prevention, spill response
- Cook Inlet pipes are at 4 x times design life.
- TAPS – one section worn out 5 yrs ago. Use of liners – conduit (done already over 6ml length)
- Alyeska monitoring – monitor change in wall thickness – repairs before failure.
- As pipeline life increases, throughput decreases, so costs allocated for maintenance are less, but this is time important to monitor, check ups, on bath tub curve end.
- Inline inspection – need sensor improvement, defect smaller than sensor footprint, concern.
- RAM program results is accessible through MMS. Unocal will do POP test in Spring. James Wiseman provided overview of POP program, MMS is a sponsor.

10) What constitutes failure of a pipe-in-pipe (double wall pipeline)

- Any component failure in PiP is failure
- This was considered a very demanding criteria- might cause polarization of opinion.
- State has not defined failure. Need leak detection system.
- Zero defects is goal – maybe achievable in 20 years time – no accidents – reduce safety/reliability – cycle
- What is purpose of 2nd wall? Impact resistance or double containment. There will be a significant time before performance function can be verified.
- Offshore oil PiP application now in place NOT for containment, but thermal and carrier (bundle) considerations.

11) Cathodic protection and corrosion protection of a double wall pipeline
- care: good idea – undesirable consequences. Study of new technology is good, but remember question – does it give safer pipe?
- In long term, what is direction of Beaufort developments?
- CP is nightmare in PiP

12) Design & regulatory criteria for Northstar, but question if gone through North Sea operations, but didn't hear this mentioned in workshop so far.
- talk to each other at workshops like this,

13) Valves – do they increase or decrease risk to pipeline operations?
- Probability of failure may increase or decrease. More things to go wrong, but also more information. "Killed by your own

4. Concluding Observations — Andrew Palmer

The workshop topic has been well addressed. This workshop serves as an example to Europe and elsewhere on how to create an informed community.

1) A statement was made "If you do not have a number, you do not have a fact, you have an opinion". This is dangerous. What is the source of the number? There is pressure to obtain a number for example for risk analyses. However, is it just mathematics, or does it involve data, judgement or extrapolation? Be careful, you could have " a number pretending to be

2) Bob Bea presented an analysis of observed offshore oil mishaps. This data was considered insightful.

3) Bill Fowler and Martin Thurlow of Arco clearly explained the reasoning behind the Colville River crossing in a step by step, scenario based way.

4) There are more than 5 pipe in pipe systems in the Gulf of Mexico and over 20 in the North Sea; some have been in use for more than 15 years. Some have quite simple configurations, some have quite complex configurations, and for example the Gannett bundle has 14 internal lines. None of these have been used for containment. Their apparently satisfactory performance to date provides some degree of confidence, and may indicate an acceptable level of safety. There will be a need to look closely at the scenarios for the application for containment. ' If x happens, what action can be taken?' In medical testing, there is an awareness of false positive and false negative test implications. We need to consider the same. There are scenarios in which PiP may have given enhanced safety against containment, such as the oil release from a single walled pipe under the Mersey estuary.

5) The regulatory process is an imperfect process, like all human activities. This process is improved through informed discussion, an expansion of knowledge and involvement of the whole community. The workshop was very valuable in these respects.

Attachment E:
Presentation and Information Files

Session	***Presenters***	***Paper***	***Presentation***
Introduction Overview of Arctic offshore activities and current MMS initiatives and objectives of workshop ***Arctic Resources at Risk*** ***Challenges for Arctic Offshore Pipeline Developments*** ***Arctic Offshore Pipelines Comparative Assessment Project***	J. Walker L. Bright A.C. Palmer J.I. Clark		Walker.pdf Bright.pdf Palmer.pdf Clark.pdf
Pipeline Design, Construction and Operation - Comparison of API and CSA Offshore Pipeline Stress and Strain Design Criteria - BPXA Northstar and Liberty Pipelines - Horizontally Directional Drilled (HHD) Colville River Crossing - Operation and Monitoring of the Trans-Alaska Pipeline	R. Smith G. Lanan K.J. Meyer W. Tonkins	Smith Paper.pdf	Smith Overheads.pdf Not Available Meyer.pdf Tonkins.pdf
Pipeline Technology - An overview of pipeline configuration alternatives - Pipe-in-Pipe Flowline Installations in the Gulf of Mexico - Flexible pipe for onshore and offshore Arctic applications - Troika Flowline installation by the bottom tow technique - Pipe-in-Pipe Applications in the Petrochemical Industry	R.A. McBeth C.G. Langner C. Loper N. Sanderson J. Greenslade		McBeth.pdf Langner.pdf Loper.pdf Sanderson.pdf Greenslade PinP.pdf
Pipeline Operational Monitoring Technology - LEOS - Sensitive Leak Detection System - Measurement-based Leak Detection Technology - Out-of-Straightness Assessment using Pipeline Inertial Geometry Survey (GEOPIG) Technology - Monitoring & leak detection with smart pigging	P. Jax, E. Farmer D. Hektner J.Rosenmoller		Jax LEOS1.pdf Jax LEOS2.pdf Farmer.pdf Hektner.pdf Rosenmoller.pdf
Pipeline Risk Analysis - PIRAMID - A Quantitative Risk-based Approach to Integrity Maintenance Planning and Design Optimization for Pipelines - Appraisal and Development of Pipeline Defect Assessment Methodologies - Lessons Learned in Pipeline Risk Management - RAM PIPE REQUAL: A Risk Assessment and Management Based Process for the Requalification of Marine Pipelines - Influence and Tornado Diagrams: A Risk Assessment Method for Evaluating Perceived Environmental Risks and the Life Cycle Costs of a Project	M. Stephens J. Bucknell, WMuhlbauer R. Bea J. Greenslade	 Bea Paper.pdf	Stephens.pdf Bucknell.pdf Muhlbauer.pdf Bea.pdf Greenslade Risk.pdf
Regulations Panel Discussions - U.S. Department of Transportation - Alaska Dept. of Environmental Conservation - Alaska State Pipeline Coordinator's Office Organization, Operation, and Authorities - Minerals Management Service - Development of a Regulatory Approach for Arctic Pipelines; Some Lessons from Canadian Experience	J. Strawn T. Moore G. Swank A. Alvarado I. Konuk		Not Available Not Available Swank.pdf Alvarado.pdf Konuk.pdf
Breakout sessions Discussion of technologies & techniques for Arctic offshore pipelines 1. Design, 2. Construction, and Operations 3. Maintenance	*Discussion leaders* J. Clark C. Langner R. Bea		 Discussion.pdf Discussion.pdf Discussion.pdf
Summary & Concluding Remarks Including discussion leader summaries.	A. Palmer		Discussion.pdf