Project Description
PARSC 003 - Frost Heave Effects on Pipeline Exposure Rates

Date: March 22, 2013

Purpose
On behalf of the Pipeline Abandonment Research Steering Committee (PARSC), PTAC wishes to retain the services of research organization or consulting firm to provide the services described in this document.

PARSC Program Background
Pipeline abandonment refers to the permanent removal from service of a pipeline. Depending on a number of factors, sections of pipeline may be abandoned in place or removed.

CEPA, the National Energy Board (NEB), the Alberta Energy and Utilities Board (AEUB) and the Canadian Association of Petroleum Producers (CAPP) have collaborated on technical and environmental issues associated with pipeline abandonment, which issues were discussed in the documents referenced below. In 1996, the NEB published a review document titled “Pipeline Abandonment – A Discussion Paper on Technical and Environmental Issues”. In 2007, CEPA published a report titled “Pipeline Abandonment Assumptions” which discussed technical and environmental considerations for development of pipeline abandonment strategies. A comprehensive review was undertaken by the NEB as part of the Land Matters Consultation Initiative (LMCI) which involved four discussion papers on the different topic areas, 45 meetings and workshops in 25 communities across Canada, and written submissions from 13 parties. The final LMCI report, published in 2009 recommended that knowledge gaps on the physical issues of pipeline abandonment be addressed. Thus, Det Norske Veritas (DNV) was commissioned to conduct a literature review regarding the current understanding worldwide with respect to the physical and technical issues associated with onshore pipeline abandonment and use the results of the literature review to critically analyze and identify gaps in current knowledge, and make recommendations as to potential future research projects that could help to fill those gaps. DNV published this Scoping Study in November 2010.

CEPA and PTAC have established the Pipeline Abandonment Research Steering Committee (PARSC) as a framework for collaboration to guide and direct innovation and applied research, technology development, demonstration, and deployment in order to address knowledge gaps summarized in the DNV Scoping Study.
Research findings from the PARSC projects will be shared on a broad scale throughout the pipeline industry, the oil and gas industry, as well as with regulators, government agencies, and other stakeholders.

**Project Description**
Applicants are expected to read relevant sections of the above referenced DNV Scoping Study as the following project description was informed by it and information is not repeated herein.

Pipelines may be segmented during abandonment and left in place as short or long segments. After pipeline abandonment, frost heave has the potential to result in pipeline exposure. Once the warm product is removed, heave of the pipeline could begin to occur especially if it is a short piece of pipe. However, lengthy sections of pipeline may be anchored in place. The rate and importance of this mechanism is thought to depend on soil type, available moisture and wind erosion. No information appears to be available in the literature pertaining to this geohazard and its ability to expose a pipeline once abandoned. The literature on performance of culverts could be used as a proxy. Furthermore, studies could be completed on active pipelines with product near ambient temperatures or inactive pipelines.

**Objective and Scope**
The objective of this project is to understand the mechanism of heaving of abandoned pipelines. The focus will be on agricultural land and roadway/railway crossings and will exclude permafrost. The scope includes three related studies:

- Laboratory testing of soils for frost heave and wind erosion properties;
- Field measurement of heave rates in a single winter and across multiple seasons; and
- Examination of the long term performance of pipelines that are inactive or operating at ambient temperatures.

**Laboratory Testing of Soils**
The laboratory study will examine, under multiple freeze thaw cycles, the interaction of growing ice under the pipeline against resistance forces above the pipeline. The susceptibility of soils to wind erosion will also be considered. This type of work has been conceived many times for cold gas pipelines, but only a limited amount of information is in the public domain, and testing of the abandonment case was not found in the literature.

**Field Measurement**
The laboratory scale work will be compared to results of field studies of pipelines with product at ambient temperatures or for inactive pipelines. Thus, the field scale study would be used to determine the effect of frost on short (50 meters or less) and long segments of pipe, versus
local frost heave effects that could be determined in the laboratory. The study should include installation of markers on the pipeline and a regular program of surveying the markers. Survey stations should be set-up in a number of different terrains and soil moisture conditions. Thermistors should be installed to monitor the development of the frost front at these stations. The extent and impact of wind erosion should be observed.

**Long Term Performance of Pipelines**

An examination of pipelines operating for a long period at ambient temperatures or where operations have been suspended will also be conducted to offer a good perspective on the performance of abandoned pipelines.

**Analysis and Numerical Modeling**

The laboratory results of the research will be to develop a numerical model to determine the effects of different soil types, moisture conditions and wind conditions on the potential for an abandoned pipeline to become jacked out of the ground by frost action.

**Expected Result**

The result of this project would not be definitive, but give general guidance.

The field study of inactive pipelines or ambient temperature product pipelines would provide real scale information related to local frost heave effects on short and long sections of pipe.

**Deliverables**

1. Laboratory testing of soils for frost heave properties
2. Field measurement of heave rates in a single winter and across multiple seasons
3. Examination of the long term performance of pipelines that are inactive or operating at ambient temperatures
4. Numerical model
5. Progress and technical reviews with the Steering Committee
6. Draft report
7. Final report
8. One final presentation to the Project Steering Committee.

**Schedule**

It is expected that the project would be completed as part of a multi-year effort. The applicant will propose a schedule to complete the project.
Confidentiality

The successful applicant will be required to sign a confidentiality agreement related to the project. Disclosure of any project information will be at the discretion of the Steering Committee.