

Contract No. G-046-088

“intelligent Pipeline Integrity Program (iPIPE)”

Submitted by: Statoil Pipelines LLC, Hess Corporation and Oasis Midstream Partners
with the Energy and Environmental Research Center managing the Contract

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PARTICIPANTS

Sponsor	Cost Share
iPIPE Consortium	\$2,114,000
North Dakota Industrial Commission/OGRC Funding	<u>\$1,600,000</u>
Total Project Cost	\$3,714,000

Project Schedule – 57 months	Project Deliverables:
Start Date – April 1, 2018	Quarterly Report: July 31, 2018 ✓
Final Report: December 31, 2022	Quarterly Report: October 31, 2018 ✓
	Quarterly Report: January 31, 2019
	Quarterly Report: April 30, 2019
	Quarterly Report: July 31, 2019
	Quarterly Report: October 31, 2019
	Quarterly Report: January 31, 2020
	Quarterly Report: April 30, 2020
	Quarterly Report: July 31, 2020
	Quarterly Report: October 31, 2020
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	Quarterly Report: October 31, 2021
	Quarterly Report: January 31, 2022
	Quarterly Report: April 30, 2022
	Quarterly Report: July 31, 2022
	Quarterly Report: October 31, 2022
	Final Report: December 31, 2022
Presentations to OGRC/Industrial Commission and Legislative Committees as requested	July 1, 2018 - December 31, 2022

OBJECTIVE/STATEMENT OF WORK:

A core group of pipeline operators proposes an R&D program focused on advancement of emerging technology to prevent and detect pipeline leaks. The proposed work will lead to development and application of new tools that will assist industry's ongoing efforts to continuously improve pipeline integrity, thus reducing leaks and spills.

Multiple field demonstrations of emerging technologies on working pipelines will simultaneously assist technology providers in refining designs, pave a path toward full commercialization in the North Dakota market, prepare pipeline operators for adoption of the new tools, and effectively decrease the number and volume of spills experienced in North Dakota. With demonstrated success, additional consortium members (pipeline operators) will join the effort, thus enabling field testing of more technologies and further proliferating new technology among all pipeline operators.

The goal of this intelligent Pipeline Integrity Program (iPIPE) is to develop and demonstrate cutting-edge technology that can prevent and/or detect gathering pipeline leaks. This goal will be supported by accomplishment of the following objectives:

- Select the most promising emerging (near-commercial) technologies for demonstration
 - Demonstrate multiple technologies on working gathering pipelines
 - Document results of technology demonstrations
 - Facilitate adoption of technologies into North Dakota pipeline operations

Founding members of the industry-led consortium include Hess Corporation, Equinor, Oasis Midstream Partners, Goodnight Midstream, ONEOK, and Andeavor. The consortium has asked the Energy & Environmental Research Center (EERC) to manage the program on its behalf.

STATUS

The Contract has been signed.

The first status report was received on July 25, 2018 for work completed through June 30, 2018. A copy of the report is available on the Oil and Gas Research Program website. The report states, in part, the following:

Many program activities necessarily began before the NDIC had committed cost-matching funds. In an effort to portray the sum total of all program activities leading to successful initial demonstrations, activities occurring before the official start of the NDIC contract have been included below. iPIPE members proceeded with program activities prior to obtaining cost-share commitment from NDIC because they recognized the importance of this work in addressing Governor Burgum's challenge made in May 2017 to apply advanced technologies to eliminate pipeline leaks in North Dakota.

- Program setup
 - An iPIPE program kickoff meeting was held among interested and committed pipeline operators on March 27, 2018. At this meeting, the founding members of the consortium and the EERC laid out the goals, membership requirements, and expected mechanics of the program. Companies interested but not yet committed were then asked to decide on their potential participation by March 30, 2018, to facilitate submittal of a proposal to NDIC's Oil and Gas Research Council (OGRC).
 - A proposal to request state investment via cost match funding was submitted to NDIC OGRC on March 30 by founding members Hess Corporation, Equinor (known as Statoil at that time), and Oasis Midstream Partners. Goodnight Midstream and ONEOK submitted letters of intent to commit along with the proposal package.
 - On May 2, 2018, NDIC OGRC voted to recommend state cost match funding for the program.
 - On May 17, 2018, NDIC approved funding for the program, as recommended by OGRC.
 - A fully executed contract with NDIC was completed on June 20, 2018. The contract was completed with the EERC, which acts as managing partner for the consortium. By the time of contract execution with NDIC, six industry members were also contracted, including Hess Corporation, Equinor, Oasis Midstream Partners, Goodnight Midstream, ONEOK, and Andeavor.
- Technology selection
 - During the week of April 9–13, the EERC sent several requests for proposals to a group of nine technology providers with potential projects that might fit within iPIPE's mission. These technology providers were from a wide array of countries around the world. A deadline of April 23, 2018, was set for receipt of proposals. By April 23, 2018, the EERC had received seven proposals from technology providers, as listed below: t
 - Satelitics – leak detection using artificial intelligence on satellite data

- Insitu – leak detection using drones and advanced analytics
 - eSmart Systems/Microsoft – leak detection using novel sensors, drones, and artificial intelligence
 - Ingu Solutions – inline inspection to detect leaks and measure pipeline health
 - Southwest Research Institute – leak detection using artificial intelligence
 - Omnisens – leak prevention by monitoring land movement in high-risk areas via fiber optic cable
 - Rheidiant – leak detection using an Internet of Things (IoT) approach
- On May 1, 2018, the technology providers listed above presented their proposed development projects to a committee of five representatives of iPIPE membership. The event was styled similarly to a popular CNBC television show called “Shark Tank.” Each technology provider was allotted 30 minutes to present on his/her technology. The five-member committee of industry pipeline experts selected two technology providers for summer 2018 demonstration activities: Satelytics, Inc., of Toledo, Ohio, and Ingu Solutions of Calgary, Alberta. The five-member committee then directed the EERC to immediately begin contracting with the selected companies on behalf of the iPIPE Program.
- Contracting with Satelytics, Inc., was completed on May 29, 2018.
 - Contracting with Ingu Solutions was completed on June 26, 2018.

- Demonstration execution

- Satelytics – On June 1, 2018, Satelytics began its satellite data collection program and subsequent processing with deep learning algorithms. Satelytics is attempting to identify hydrocarbon leaks, equipment encroachment, land movement, vegetation changes, and water quality near gathering pipelines within a target area. Satellite images were captured on June 7, June 14, June 25, and June 30. Results were delivered to iPIPE on June 10, June 18, and June 27 via the user access portal, “Satelytics.io.”
- A “deep dive” meeting was planned for July 11 in Minot to facilitate a daylong, detailed review of all Satelytics results provided to date.

- Demonstration execution – Ingu Solutions

- Following completion of contracting efforts, a specific project time line was negotiated between Ingu Solutions and each of several iPIPE companies that volunteered operating pipelines for demonstration activities. Sets of multiple demonstrations on a variety of pipeline diameters, pipeline materials, and pipeline fluid types are currently scheduled to occur during selected weeks in July, August, September, and October. During each set, the Pipers™ technology will be demonstrated on three to five different pipelines. Each demonstration will likely include Pipers launched inside the pipeline in free-floating mode and in pig-guided mode.

The planned activities for the next quarter are detailed below.

- Demonstration execution – Satelytics

- Weekly satellite data capture and subsequent analysis will continue through mid- September.
- iPIPE members will continue to expand their understanding of utilization of Satelytics.io. With this increased understanding, it is expected that users will provide feedback to Satelytics that will improve the accuracy and usability of its product.
- A “deep dive” meeting, focused fully on understanding the results provided by Satelytics.io and on a group field trip to compare actual field conditions to conditions identified by initial Satelytics.io alerts will occur on July 11.
- Satelytics has requested cooperation from iPIPE members in collecting specific water and soil samples to assist in calibration of new deep learning algorithms being developed specifically for this project. These sampling activities will be completed during the upcoming quarter. The EERC may be asked to assist in some

of this sampling effort.

– iPIPE members will begin formulating refined protocols for responding to and verifying alerts provided by Satelytics.io. During the upcoming quarter, these refined protocols will be executed to ascertain the level of effort required to fully utilize Satelytics.io as a tool to direct field responses to certain key alerts provided by Satelytics.io. This will serve to quantify the economics and accuracy associated with use of the Satelytics product. The EERC will accompany iPIPE members in the field to assist in objective evaluations of these factors.

- Demonstration execution – Ingu Solutions

– An Ingu Solutions team will travel to various pipeline sites volunteered by iPIPE members during scheduled weeklong windows in July, August, and September. During these weeklong demonstrations, Ingu Solutions will work with iPIPE companies to inject the Pipers sensors into operating pipelines and retrieve the sensors for subsequent and immediate data analysis. An EERC representative will be present during these operations to facilitate independent evaluation of the performance of the technology.

– Ingu Solutions will provide results to iPIPE for review and possible improvements.

- Technology selection

– The EERC will continue to research and evaluate potential new and emerging technologies for consideration by iPIPE. The EERC will contact several potential candidates for the next “Shark Tank” event and will solicit proposals from select technology providers.

– The EERC will schedule the next “Shark Tank” event and book a facility at which it will be hosted. Currently, it is envisioned that the next “Shark Tank” event will be held in late October 2018.

The second status report was received on October 29, 2018 for work completed through September 30, 2018. A copy of the report is available on the Oil and Gas Research Program website. The report states, in part, the following:

- Program-level activities

- Program briefings

- ♦ EERC staff presented an introduction to iPIPE at the Bakken Conference & Expo in Watford City, North Dakota, on July 17, 2018.
- ♦ EERC staff presented an update on iPIPE progress at the North Dakota Petroleum Council’s Regulatory Committee meeting in Medora, North Dakota, on August 21, 2018.
- ♦ EERC staff attended the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) Pipeline Safety R&D Forum, held in Baltimore, Maryland, September 11–12, 2018. iPIPE was invited to the forum to exchange information on common interests.

- Member recruitment

- ♦ The program is in discussion with a number of companies regarding new member participation. Some of these companies have approached the EERC regarding membership requirements and benefits, while others have been approached by the EERC and/or existing consortium members. At least two of these companies do not currently have operations in North Dakota. We believe this demonstrates the state of North Dakota’s national leadership in creating a program such as iPIPE.
- ♦ We have verbal commitment from one large North Dakota pipeline operator to join the consortium. This operator will be identified when contracting is completed.

- Program media mentions

- ♦ iPIPE has now been highlighted in nearly 20 public media or related articles. For a list of known media mentions, please refer to Appendix A. (Appendix A is posted on the OGRP website as part of the quarterly report.)
- Technology selection
 - During this reporting period, the EERC continued its worldwide search for companies offering emerging technologies (not yet commercial) to improve gathering pipeline leak detection and gathering pipeline leak prevention. A wide range of technologies was investigated, explored, and considered. These technologies included a vast spectrum of unique approaches such as direct measurement technologies, remote sensing technologies, nanotechnology sensors, self-healing technologies, multisensor fusion technologies, advanced cathodic protection technologies, and miniaturized inline inspection technologies.
 - On August 24, 2018, iPIPE sent requests for proposals (RFPs) to 20 technology providers that the EERC had researched and determined to have promising emerging technologies to improve state-of-the-art leak detection and leak prevention. The RFP can be found in Appendix B of this quarterly progress report. (Appendix B is posted on the OGRP website)
 - During the month of August, the EERC arranged for a Williston, North Dakota, venue to host the October 2018 Shark Tank event, at which the iPIPE Executive Committee will hear 30-minute presentations from each of the ten technology providers that submitted a proposal and will select which of the technologies the program wishes to fund for codevelopment activities during 2019.
 - In August and September, the EERC assisted numerous technology providers in exploring which of their technologies were suited for codevelopment efforts within iPIPE. Technology providers were informed of specific and broad needs of pipeline operators, and the EERC was educated on the state of development of several emerging technologies.
 - By September 21, 2018, the EERC had received ten proposals from the 20 technology providers invited. The companies submitting proposals included the following:
 - ♦ Insitu, Inc.
 - ♦ Satelytics, Inc.
 - ♦ miQroTech, LLC
 - ♦ Southwest Research Institute
 - ♦ eSmart Systems, Inc.
 - ♦ Omnisens
 - ♦ Trinity Bend Solutions, Inc.
 - ♦ Direct-C Monitoring Services, Inc.
 - ♦ Physical Sciences, Inc.
 - ♦ Expert Infrastructure Systems, Inc.
- Demonstration execution – Satelytics
 - A “deep dive” meeting was held on July 11 in Minot. This meeting facilitated a daylong, detailed review of all Satelytics results provided to date and allowed for a deeper interaction between Satelytics representatives and pipeline operators. The meeting resulted in greater engagement between iPIPE members, EERC staff, and Satelytics staff during weekly WebEx-based update meetings. It also resulted in many suggestions to help Satelytics improve its Web-based interface for more efficient use by pipeline operators.
 - Weekly update meetings were held among Satelytics staff and iPIPE members via a WebEx

- conferencing service hosted by the EERC.
- EERC staff accompanied Satelytics staff in the field during the week of August 27, 2018. The EERC–Satelytics team worked with Hess and Oasis Midstream personnel to collect water and soil samples. These samples were then used in efforts to improve brine detection algorithms being refined by the Satelytics team. All samples collected were analyzed by labs contracted by Hess to provide calibration targets for the Satelytics algorithms.
 - During the week of September 17, 2018, EERC staff completed the balance of water and soil sample collections requested by Satelytics.
 - Using data from the completed soil and water sampling, Satelytics has begun refining their brine alert algorithms. Satelytics will report on progress made at the end of the project.
 - During this reporting period, Satelytics continued its satellite data collection program and subsequent processing with deep-learning algorithms. Satelytics is attempting to identify hydrocarbon leaks, equipment encroachment, land movement, vegetation changes, and water quality near gathering pipelines within a target area. Satellite images captured and hydrocarbon alerts were delivered to iPIPE members as shown in Table 1. As of the end of this reporting period, Satelytics had completed 93.75% of its planned image captures and subsequent hydrocarbon alert analyses. Given the exceptionally cloudy nature of much of September 2018 in the designated area of interest, the program extended the contract with Satelytics to the end of November 2018 to enable final satellite image capture and subsequent data delivery.

Table 1. Satellite Image Capture and Hydrocarbon Alert Dates

Image	Analysis	Image Capture	Data Delivered
Tasked Image 1	Analysis 1	6/7/2018	6/10/2018
Tasked Image 2	Analysis 2	6/14/2018	6/18/2018
Tasked Image 3	Analysis 3	6/25/2018; 6/30/2018	6/27/2018; 7/3/2018
Tasked Image 4	Analysis 4	7/4/2018	7/8/2018
Tasked Image 5	Analysis 5	7/7/2018	7/10/2018
Tasked Image 6	Analysis 6	7/12/2018	7/16/2018
Tasked Image 7	Analysis 7	7/17/2018	7/18/2018
Tasked Image 8	Analysis 8	7/23/2018	7/25/2018
Tasked Image 9	Analysis 9	7/30/2018; 8/2/2018	7/31/2018; 8/6/2018
Tasked Image 10	Analysis 10	8/6/2018; 8/7/2018	8/8/2018
Tasked Image 11	Analysis 11	8/12/2018	8/14/2018
Tasked Image 12	Analysis 12	8/21/2018	8/23/2018
Tasked Image 13	Analysis 13	8/30/2018	9/1/2018
Tasked Image 14	Analysis 14	9/5/2018	9/6/2018
Tasked Image 15	Analysis 15	9/18/2018; 9/28/2018	9/19/2018; 9/30/2018
Tasked Image 16	Analysis 16	(pending)	(pending)

- Demonstration execution – Ingu Solutions
 - During this reporting period, six of the planned 15 tests of the Pipers technology were completed on various operating pipelines volunteered by Hess, Equinor, Goodnight Midstream, and Oasis Midstream Partners. Tests were conducted on the following types of pipeline:
 - ◆ 6" DIA composite carrying crude oil (Hess)
 - ◆ 8" DIA steel carrying crude oil (Equinor)
 - ◆ 6" DIA composite carrying produced water (Goodnight Midstream)
 - ◆ 4" DIA steel carrying high pressure gas (Hess)
 - ◆ 8" DIA polyethylene carrying produced water (Equinor)
 - ◆ 6" DIA steel carrying crude oil (Hess)
 - A number of tests planned for completion during this reporting period were delayed until October after encountering challenges in gathering pipeline design information for Ingu Solutions to use in determining appropriate Pipers hardware configurations.
 - Three pipeline segments specified as 2" segments that were initially volunteered by one of the iPIPE members were withdrawn from demonstration plans because none of the iPIPE members had 2" DIA pipelines available to volunteer for these tests.
 - Two pipeline segments (one 3" nonmetallic produced water pipeline and one 4" nonmetallic produced water pipeline) that were initially volunteered by one of the iPIPE members were withdrawn after the pipeline operator sold those assets. As of the time of this report, the program is still seeking replacement for these pipelines to demonstrate Pipers.

The planned activities for the next quarter are detailed below:

- Program-level activities
 - On October 25, 2018, EERC staff will present a high-level summary of iPIPE activities to the Rocky Mountain Environment Health & Safety Peer Group, at the request of RMEHSPG member, Anadarko, in Denver, Colorado.
 - iPIPE representatives will be available to present to NDIC's Oil & Gas Research Council (OGRC) at its choosing, per the declared deliverables included in the contract with the NDIC.
 - iPIPE will continue to solicit additional consortium members, following up on several open discussions.
- Technology selection
 - iPIPE will host its second iPIPE Shark Tank event in Williston on October 30 and 31. At this event, the Executive Committee anticipates engaging with ten different technology providers, then determining which technologies to award codevelopment funding for activities in 2019. Upon selection of technologies for investment, the Executive Committee will ask the EERC to work with each company to refine a detailed scope of work for 2019 codevelopment activities and then contract with the selected companies to complete that scope of work.
 - The EERC will continue to research and evaluate potential new and emerging technologies for consideration by iPIPE. The EERC will contact several potential candidates for the next "Shark Tank" event and will solicit proposals from select technology providers. This is a continuous task that will continue until the 2020 iPIPE Shark Tank event.

- Demonstration execution – Satelytics
 - Weekly satellite data capture and subsequent analysis will continue until the final satellite image is captured and processed. The program strongly prefers that this occur in October, but the image capture is at the mercy of cloud cover in the area of interest.
 - Satelytics will use data obtained from water and soil samples collected in August and September to calibrate and refine its brine detection algorithms.
 - Satelytics will provide iPIPE members with a report detailing Satelytics’ perspective on overall performance of its technology throughout the summer/fall 2018 demonstration period.
 - The EERC will begin writing a final report for NDIC on the overall progress of the program, a summary of Satelytics performance, and a summary of Ingu Solutions performance. This report is due by the end of January 2019.
 - The EERC will also begin writing a separate detailed report on the EERC’s independent assessment of Satelytics’ performance during 2018 demonstration activities. This report will include an assessment of performance, estimation of challenges remaining before commercialization (if any), and an EERC forecast of commercial deployability.

- Demonstration execution – Ingu Solutions
 - Ingu Solutions will work with program members and the EERC to accomplish the remaining field tests on operating pipelines. Tests are currently scheduled for two weeks in October on Oasis Midstream Partners pipelines, Hess Corporation pipelines, and Equinor pipelines.
 - An Ingu Solutions team will travel to various pipeline sites volunteered by iPIPE members during scheduled weeklong windows in July, August, and September. During these weeklong demonstrations, Ingu Solutions will work with iPIPE companies to inject the Pipers sensors into operating pipelines and retrieve the sensors for subsequent and immediate data analysis. An EERC representative will be present during these operations to facilitate independent evaluation of the performance of the technology.
 - The EERC will begin writing a final report for NDIC on the overall progress of the program, a summary of Satelytics performance, and a summary of Ingu Solutions performance. This report is due by the end of January 2019.
 - The EERC will also begin writing a separate detailed report on the EERC’s independent assessment of Ingu Solutions’ performance during 2018 demonstration activities. This report will include an assessment of performance, estimation of challenges remaining before commercialization (if any), and an EERC forecast of commercial deployability.