

Oil and Gas Research Program

North Dakota

Industrial Commission

Application

Project Title: Reduction of Flares and capture of
Natural Gas Liquids with Vortex Tools

Applicant: Bakken Frontier, LLC

Principal Investigator: John Simmons

Date of Application: October 17, 2014

Amount of Request: \$390,000

Total Amount of Proposed Project: \$790,000

Duration of Project: 12 Months

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ABSTRACT

Objective:

The project will seek to build upon past successes achieved in Texas with the use of the Vortex tool to capture NGL's and reduce the amount of flaring in The Bakken. The Vortex Tool can aid in the following objectives:

- Increase productivity and efficiency on current oil and gas wells with minimal intervention.
- Increase revenues and provide long term benefit for North Dakota, by increasing productivity and profitability of its oil and gas resources.
- Improve year-round operations by eliminating vapors at high-ambient daytime temperatures in summer and low temperatures (below zero) in winter, proving the viability of this process in the tough ND weather conditions.
- Increase product values that were previously lost to flaring and ensure candidate wells will be in compliance with current and future environmental standards.

Expected Results:

1. Spin oil vapors back into recoverable hydrocarbon products for operators, recovering of vapor values that were previously lost through flash to gas, flaring or tank emissions while remaining in compliance with state and federal environmental regulations.
2. Recover substantially more natural gas liquids (NGL's) than pigging or drip systems alone can accomplish; allow cleaner gas to go to flare or to send the cleaned gas to processing.
3. Increase overall profitability for the oil and gas companies involved, thus maintaining and creating jobs while creating a greener, more energy and economically efficient product.

Duration: 12 months

Total Project Cost: \$790,000

Participants: Bakken Frontier, LLC

PROJECT DESCRIPTION

Vortex Tools use the flow velocities on the surface in flow lines/pipelines, to consolidate vapors to liquids through centrifugal force. The Vortex tools create a spinning, organized flow for solids and liquids in the outer bands and organized flow for gases in a center core.

This allows for more efficient carrying of fluids through pipe, both vertically and horizontally. The centrifugal force created by the spinning of the fluids causes density separation as those fluids travel through the pipe. Gas -- entrained in the oil, condensate or water -- is liberated by the centrifugal force. Additionally, natural gas vapors are consolidated into liquids and blend with the hydrocarbon liquids and can be recovered.

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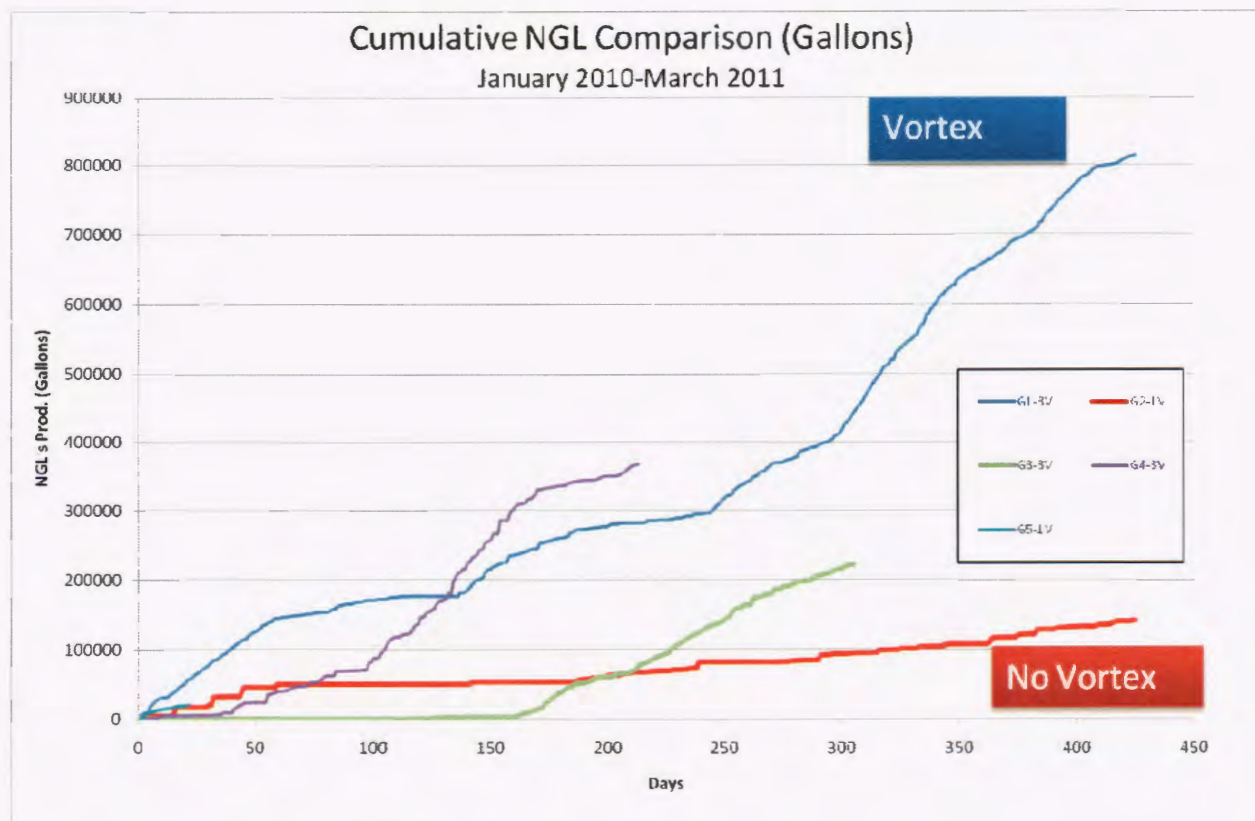
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Vortex has previously conducted a similar test program in a significantly less "rich" gas play in Texas. Based on the data gathered, Vortex believes that this solution can be applied in the Bakken with a substantial positive and economic impact for North Dakota. Previous Texas data notes:

1. Over 1.2 million gallons of additional NGLs were recovered from installing 10 Vortex tools (and associated propane "bullet" tanks) on three gathering lines in a single year, translating to over \$2 million in additional revenues.
2. An average well line with Vortex paid for itself in less than 60 days (including the cost of the Vortex tool and associated tanks and installation).
3. One line with Vortex recovered over eight times the total NGLs when compared to a line with no Vortex installed in the same 15-month time period. Another line recovered 2,700 gallons in six months with no Vortex and over 200,000 gallons in six months with Vortex added.

4. In vapor recovery applications, Vortex eliminates vapors, even at high-ambient daytime temperatures (104-degrees). Conversely, Vortex prevents hydrate formation of vapors at low temperatures and prevented shut-down and lost production in winter.
5. By spinning oil vapors back into the production tanks, increased values were recovered (that were previously lost) and the wells were in compliance with environmental standards.

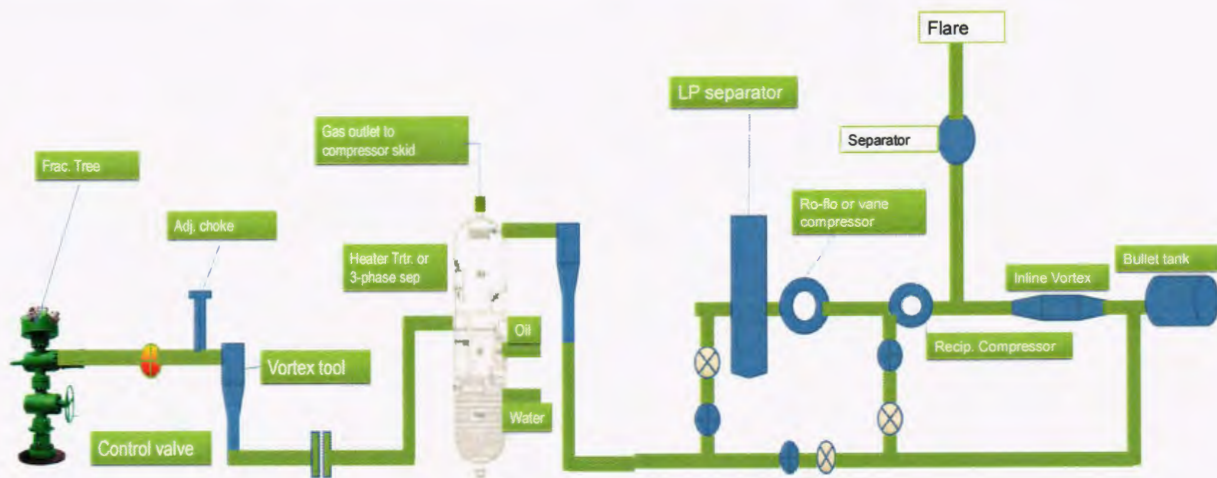
In the Texas study, data was gathered on producing wells with and without the Vortex solution over a 15-month period. The following graph compares three gathering systems with a Vortex tool on each line to a system without any Vortex tools over that same 15-month trial period. The blue line (Vortex) shows the NGLs recovered with the Vortex tools (814,179 gallons) compared to the red line (drips) where only 142,170 gallons of NGLs were recovered. The green line shows the well producing 2,700 gallons of NGLs over six months before Vortex was added and 219,797 gallons of NGLs in the following six months with Vortex added.



Oil and gas production in North Dakota is richer than the Texas fields in which Vortex Tools have already seen success. By way of comparison, the Texas gas ranges from 1150 to 1275 BTU gas, whereas Bakken gas is typically 1400 to 1600 BTU. The higher the BTU, the more liquids that can be recovered in the operators tanks. In addition, many Bakken oil wells produce significant liquid vapors, and there is an expectation of a significant economic benefit in North Dakota, which exceeds the benefit seen in the Texas trials.

Methodology:

The methodology proposed by Vortex is to use existing equipment at the wellhead and tank battery to enhance recovery with minimal additional equipment necessary with a corresponding minimal impact on operations. Vortex envisages tools being deployed in three specific locations:



1. Flowline from the wellhead.

The first point of attack for vapors to liquids is in the flowline directly downstream of the choke on wells with pressure, or directly downstream of the pumping tee on pumping wells. On pressured wells there are additional benefits from the cooling of fluids from pressure drops going through the choke, creating more condensate. In both cases, entrained gases are liberated from the oil, condensate and water to prevent excess flashing at the separator (or separators downstream) and in the production tanks. In high-pressure wells, the spinning of the vapors to liquids helps to prevent the formation of hydrates and, therefore, line freeze-ups.

2. Fluid dump line between the High Pressure (HP) and Low Pressure (LP) Separator or Heater Treater

The second point of attack is immediately downstream of the liquid dump valve on the HP separator. At this point and in the LP separator or Heater Treater, gas is naturally being liberated from the oil, condensate and water by the pressure drop. There are normally very high BTU vapors that can be consolidated and blended into liquids that then go to the production tank. The remaining high BTU "flash" gas from the LP separator or Heater Treater goes to compression and producers get "another bite of the apple" as it cycles through again.

In Texas, Vortex has one operator who has run 46 of these applications to replace Vapor Recovery Units, (VRUs), and their attendant downtime, maintenance and cost. *All tank battery emissions are within "no-permit" tolerances and BS&W in the oil tanks is minimal.* Another Texas operator has increased condensate capture by 2 bpd and 2,000 BTU flash gas capture by 20 MCF/D on 250 BPD of fluid through the separators.

3. Between LP Separator/Heater Treater and Vapor Recovery Tower (VRT)

A vapor recovery tower (VRT) is a separation vessel typically added between the Heater Treater and the LP separator. It operates at or near atmospheric pressure (operating pressure range of 1-5 psi). In a typical set-up, the VRU (compressor operated) is used to capture gas from the VRT. Oil and condensate dumps to the storage tanks from the VRT. The VRT reduces pressure drop substantially and reduces flashing losses, capturing more product to sales.

In an October 2007 report, Anadarko reported that a VRT/VRU captured 170 MCF/D of methane from 20 wells in the Tyler County, TX area and reduced storage tank flash emissions.

In addition to gas liberated by pressure drop from 30 to 60 psi to 1 to 5 psi in the VRT, the Vortex will spin out any additional entrained gas that is then gathered by the VRU. In addition to the value of the gas (in excess of 2,000 BTU), with a Vortex Tool on the pipeline, this additional flash gas will be captured as liquid at the end of the pipeline. The point being, in today's market, it is not just the value of the gas captured (170 MCF/D X 2, 000 BTU X \$2.12), but the value of the hydrocarbon liquid at +/- \$73.00/bbl caught at the end of the pipeline.

Anticipated Results:

Each of the six gathering lines with Vortex is expected to demonstrate increased economic value by:

1. Spinning oil vapors (including casinghead gas vapors) back into recoverable hydrocarbon products for operators, recovering oil vapor values that were previously lost through flaring or tank emissions while remaining in compliance with state and federal environmental regulations (thus avoiding fines and litigation).
2. Recovering substantially more natural gas liquids (NGLs) than pigging or drip systems alone, allowing cleaner gas to go to flare or to send the cleaned gas to processing (with "nuisance liquid" value recovered rather than lost).
3. Increasing overall profitability for the oil and gas companies involved, thus maintaining and creating jobs while creating a greener, more energy- and economically-efficient product.

Facilities:



Vortex Surface tools have been in operation in for many years in other oil fields across the world. The primary technology used for this operation will be the SX Tools – Tangential entry port tool, used in the surface applications to spin gas vapors and associated oil vapors to liquids for recovery in pressurized bullet tanks. These are surface tools that not only separate the NGL's but are also used for Line Sweeping, Line Freeze Mitigation, Paraffin Mitigation, and Pig Through. Another Key Component to the Process is a gathering tank, depending on the production of the well, a 15 to 30 thousand gallon pressurized tank will be onsite to collect the NGL's before transport to market.

Resources:

The critical manpower will be the roustabout crew needed to install the Vortex system. During the project additional manpower needs will be provided by qualified consultants and trucking service companies under the supervision of experienced supervisors.

The work associated with the Vortex installations will be conducted by Bakken Western Services with the main office in Bismarck and a satellite office in Keene North Dakota. Currently the vortex units are manufactured in Wyoming, we are working with a local company in Mandan ND to fabricate the tools.

Techniques to Be Used, Their Availability and Capability:

The Vortex tools are custom manufactured but use commercially available “off the shelf” components. Skill in fabrication is key. We are currently establishing a relationship with a well known North Dakota Company,

Description of the Vortex Tools

Vortex Tools, LLC (Vortex) has developed a patented series of surface and downhole tools to help extend the flowing life, efficiency and productivity of oil and gas wells.

Although Vortex was established in 2001, these breakthrough opportunities in improved natural gas liquid (NGL) recovery and spinning oil vapors into liquid values are recent. These exciting recovery models could shape the future of rich gas fields (like the Bakken), especially as new regulations require oil and gas producers to value natural gas (and its byproducts) instead of flaring it.



The Vortex surface tools (NGL tool pictured left) set up a stable spiraling flow that keeps liquids from dropping out, prevents freezing, reduces pressures and mitigates paraffin build-up. Key applications include increased NGL recovery, replacing pigging/drip systems, paraffin mitigation, replacing vapor recovery units (VRUs) and reducing the time to get oil and gas to sales (instead of flare) on new well flowbacks.

Downhole tools are also available, enabling wells to flow below the critical rate (often down to 75% of critical) as well as lowering the bottom hole pressures and reducing surfactant use by up to 50%. Key applications include wireline retrievable intervention on marginal and declining wells, keeping coal bed methane wells free-flowing, and clearing out liquids from horizontal and vertical installations.

With no moving parts, all Vortex tools are virtually maintenance free.

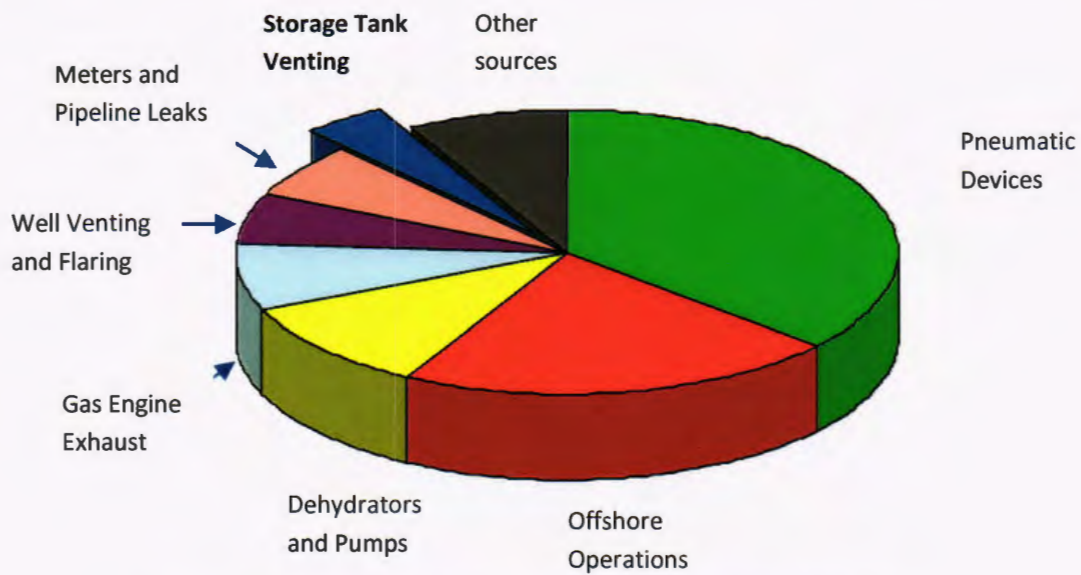
Environmental and Economic Impacts while Project is Underway:

Installation of the Vortex on new builds creates no downtime for operator. Installation of the Vortex Tools comes with minimal downtime on existing wells and is often installed to coincide with standard line maintenance. Vortex can also be installed on a bypass spool to reduce downtime further. With the equipment involved, there is no additional environmental cost, yet with the recovery of NGLs and elimination of vapors, Vortex enables greener, increased value gas.

Since Vortex knocks out NGLs from the rich gas, gas that goes on to treatment is free from “nuisance liquids” and requires far less treatment to reach pipeline quality. Gas that does go on to flare has already had the NGL value recovered by Vortex and burns significantly cleaner.

In vapor recovery applications, Vortex completely eliminates vapors, even at high ambient daytime temperatures (customer experience noted 104-degrees with no detectable vapors). *Since the vapors are pulled into the flow by Vortex, the operator captures richer oil values and remains in compliance with local air laws (avoiding fines and litigation in the process).*

The following chart demonstrates the impact of well venting and flaring (in terms of total methane emissions):



Source: US EPA - Inventory of Greenhouse Gas Emissions and Sinks 1990-2005

Vented emissions from tanks are not readily visible or identifiable without specialized equipment, but do represent significant natural gas losses, reduced operational efficiency, greenhouse gas emissions, and potential safety risks.

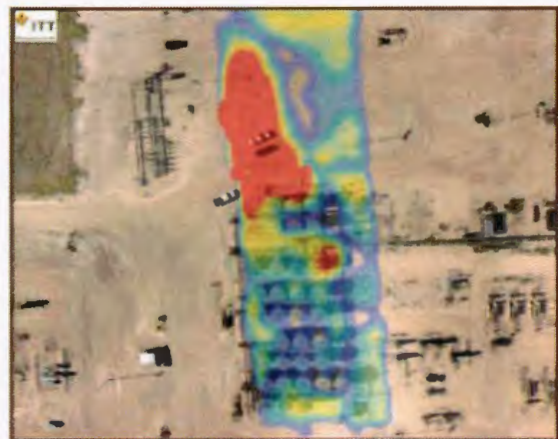


Source: Menaflaringforum.org

Government agencies are using special infra-red cameras to identify emission and the picture above, shows the effect of this technology.



Hand-held camera (Source: Leak surveys)



Aerial image (Source: ANGEL)

The Vortex tool solution will beneficially impact emissions on the individual well and improve air quality and ensure compliance with current and proposed regulations from state and federal agencies.

Ultimate Technological and Economic Impacts:

Vortex's intent is to expand the environmental and economic impacts of the Project throughout the Williston Basin including wells which have marginal production and those where proximity to market makes some wells unviable. The economic advantage offered by the Vortex solution will expand the universe of viable oil and natural gas production..

Why the Project is Needed:

Regulations are forcing the oil and gas industry to value natural gas. In April 2012, the EPA ruled that drillers will be required to capture natural gas starting in 2015. Although drillers can flare the gas for

now, this EPA ruling is forcing the oil and gas industry to put in place the infrastructure to recover natural gas. With the higher costs of building pipelines to bring the gas to market, every producer will be looking for new ways to offset these costs. With Vortex, the operator can recover significant NGL and oil vapor values.

STANDARDS OF SUCCESS

Trying something new is always a challenge and a new idea is always difficult to get funded. However, in this case, the success of this technology solution has already been proven in Texas. The opportunity in North Dakota is substantial and adoption is expected to be significant.

We have a proven product and a plan to execute based on prior operational experience. A key to our success is the establishment of available material and personnel resources. selection of appropriate candidate wells (we have a detailed questionnaire designed to identify targets of opportunity), ensure proximity to market for the recovered liquids (cost effective transportation of recovered product must be established), the process needs to be competitively priced and safe to install and operate with no environmental impact.

After the Project is completed, Vortex will present the North Dakota findings to an industry-wide audience (via trade shows, educational courses, and publications in industry journals), bolstering interest in the North Dakota oil and gas industry.

North Dakota Measures of Success:

Success will be measured comparing Vortex production to comparable wells without Vortex:

- Increased value of oil and gas recovered with the addition of the Vortex solution
- Increased ROI for the North Dakota operator
- Increased value to North Dakota through enhanced recoverable resources
- Reduction in environmental impact of flaring
- Improved recovery of resources previously lost to flaring
- Encourage broad adoption and enhance profitability of North Dakota companies
- Stabilize and create jobs and enhance the economy of North Dakota.

Success will be measured by the recovery of previously lost production (through flaring), comparing Vortex to comparable wells without Vortex.

BACKGROUND/QUALIFICATIONS

John J. Simmons, Chairman, Director

John Simmons graduated Summa Cum Laude from Michigan Technological University with a bachelor's degree in Metallurgical Engineering and is currently Chairman of Carbontec Energy Corporation, Bismarck, ND, the parent company owner of E-Nugget Minnesota, LLC. Mr. Simmons worked in the iron ore industry in Minnesota prior to forming his own engineering company to develop technology that would be the basis for the formation of Carbontec Energy Corporation, Thermo Technologies, LLC, and later E-Nugget LLC, and Bakken Environmental Services, LLC. Mr. Simmons has more than a dozen patents in areas such as energy, coal, chemicals, and oil spill cleanup.

Mr. Simmons is on the Board of Directors of the the University of Mary and a former member of the Board of Directors of the Theodore Roosevelt Medora Foundation. He received the North Dakota Entrepreneur of the Year Award from the University of Mary in 2005.

Alan Miller is President of Vortex Tools, and is one of the patent holders of the Vortex technology. As principal investigator, he will develop detailed operational protocols, test parameters and will work closely with Bakken Western and the fabrication and installation on each of the identified installations.

Richard Haas is Vortex's Regional Sales Director for Texas and the Southern USA. He has over 30 years experience in drilling and well completions and has broad experience in the deployment and operation of Vortex Tools. Richard was the first customer to use Vortex in NGL recovery and vapor elimination applications and will serve as technical consultant on this project to address technical and operational concerns.

MANAGEMENT

The project will be managed hands-on with Bakken Western Services personnel, Toby Sweitzer, Brett Gendreau and a petroleum engineer from KLJ Engineers and its fabrication partner operating directly with the local well operators and owners. Given that 50+ installations have been successfully deployed and almost 1,500 tools have been sold to date, Vortex has developed operational protocols and installation instructions designed to ensure the successful deployment of its technology solution.

The key in this study is to demonstrate economic viability for the Vortex solution and significant resources will be expended in analyzing and selecting candidate wells and partner operators. There is no value in selecting a poor candidate well despite the high expectation of success. Critical analysis of before and after production data, together with the establishment of an effective transportation solution, are other key evaluators of success.

Evaluation Points have been noted under "Standards of Success."

TIMETABLE

ITEM:	MONTH:	STATUS:
Secure funding and establish protocols:	1	Complete
Identify target wells and establish baseline production	1-2	Complete
Establish basis of installation (sale, lease or profit share)	3	Complete
Purchase skid materials, Vortex tools, bullet tanks, separator, generators, compressors and other component materials.	3	In Process
Build skid and assemble components	4	In Process
Complete first installation	5	Pending
Analyze initial data from first installation	6	Pending
Issue interim report on project to NDIC/OGRC	7	Pending
Complete and install second installation package with modifications as needed	8	Pending
Analyze comparative data on different installations	9	Pending
Modify and adjust installations and equipment as needed	10	Pending
Analyze, tabulate and review all data and prepare final report	11	Pending
Finalize program and issue final report to NDIC/OGCR	12	Pending

BUDGET

Project Associated Expense	NDIC's Share	Applicant's Share (Cash)	Applicant's Share (In-Kind)	Other Project Sponsor's Share
Vortex Tools (4")		\$30,000	\$30,000	
Bullet tanks/materials	\$180,000			
Installation	\$ 90,000	\$60,000	\$30,000	
Transportation	\$ 30,000	\$30,000		
Operator	\$ 90,000			
Supervisory		\$30,000		
Principals		\$30,000	\$160,000	
Total	\$390,000 (49.4%)	\$180,000	\$220,000 (50.6%)	

Bakken Western Services, LLC will provide its portion of funding from its own resources.

CONFIDENTIAL INFORMATION

There is no confidential information in this application.

PATENTS/RIGHTS TO TECHNICAL DATA

Nine US patents support the technology that will be used during the course of this project: 6,155,741, 6,659,118, 6,749,374, 7,066,207, 7,082,955, 7,160,024, 7,650,909, 7,663,261 and 8,026,621.

STATUS OF ONGOING PROJECTS (IF ANY)

The applicant has no previous projects or funding from the Commission.

Governor Jack Dalrymple, Chairman
North Dakota Industrial Commission
State Capitol, 14th Floor, Dept. 405
600 East Broadway Avenue
Bismarck, ND 58505-0840

RE: Vortex System to recover natural gas liquids from flare gas/ND industrial Commission

Dear Governor Dalrymple:

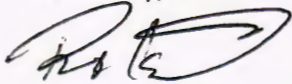
I have reviewed the information that Toby Schweitzer and John Simmons, Chairman of the Bakken Western services LLC, provided that describes the Vortex Tool System, designed to recover natural gas liquids (NGLs) from flare gas without the need for external power or electricity. Mr. Simmons mentioned that there are more than 1400 Vortex Tools successfully being used in the industry, including more than 50 by a single operator and its subsidiary pipeline company to extract NGLs in Texas.

I understand that Bakken Western Services has submitted a proposal to the North Dakota Industrial Commission. Under Bakken Western's proposal, the Commission would provide funds on a 50/50 basis with Bakken Western, to install several Vortex systems to collect the NGLs from flares in the Bakken oil Fields. This program would be designed to determine the effectiveness and viability to profitably extract and recover the NGLs from flare gas, which could substantially reduce flaring and CO2 emissions associated with this burning flare gas. The program would also test the viability of the Vortex Tool in other oil and gas related applications in the Bakken oil Field.

Whiting Petroleum Corporation has always been supportive of new advances in the oil and gas industry and is interested in new technology that could benefit the oil and gas industry.

Subject to the review by our engineering group we would be interested in providing Bakken Western with a site to pilot this Vortex System.

Sincerely,



Rex Korslien
Production Foreman
Whiting Petroleum Corporation
and its wholly owned subsidiary
Whiting Oil and Gas Corporation
701 4th Avenue NW, PO Box 523
Watford City, ND 58854
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