Improved Directional Drilling Technology for the Bakken Formation – Phase 2

Laserlith Corporation (Lead)

Ideal Aerosmith

University of North Dakota

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Application Date:	**May 27, 2011**
Requested Amount:	**$500,000 for Phase 2**

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1. Executive Summary/Abstract

It is imperative to bring reliable, domestic hydrocarbon reserves on-stream to help the United States reduce dependency upon foreign oil. Hence, the Bakken Formation, with estimated reserves at 200-400 billion barrels of oil, is a critical national asset, which needs to be developed to its maximum capacity. At present, only 1%-3% of Bakken reserves are anticipated to be recovered due in part to limitations with existing oilfield technology, including limitations in the accuracy of existing directional drilling technologies.

The intent of this project is to increase the efficiencies of horizontal drilling through a redesign of drilling tools by including the use of miniature gyroscopes in the drilling assemblage. The result of the project will be a prototype miniature MEMS gyroscope assemblage for testing. Miniature MEMS gyroscopes enable the directional sensor to be positioned next to the drill bit. The benefit is more accurate navigation and significant savings in drilling time and drilling cost. MEMS gyroscopes currently available cannot withstand the harsh down-hole conditions. However, Laserlith has demonstrated that its MEMS gyroscope technologies at 200°C – more than adequate for the Bakken Formation as well as other formations that may come online such as the Three Forks. Schlumberger, Chevron and other companies have confirmed the need for improved directional drilling technologies. The current technology, magnetometers, cannot be significantly improved since the errors are introduced by external sources.

The proposed project, the 2nd phase of the high temperature directional guidance sensor program, is to be completed in 1 year. As discussed, the 1st phase already developed a MEMS gyroscope prototype. Laserlith President Cassindy Chao will serve as the Principle Investigator in collaboration with Ideal Aerosmith and the University of North Dakota.

Total Project Cost: Phase II to be $ 1,039,346 (including $ $539,346 of matching).

2. Project Description and Our Solution

The proposed project will develop a MEMS gyroscope that can be installed directly behind the drill bit. Schlumberger, Baker-Hughes, Chevron and Halliburton/Sperry have confirmed strong interest for a sensor that can directly sense the rotation of the earth. Unlike existing magnetic sensors that are affected by proximity to ferrous metals (such as the drill bit), MEMS gyroscopes have no such limitation. Currently, the limited number of gyro-based tools available use mechanical gyros, which are too large for many tool designs, have questionable reliability and excessive power consumption. This project will build upon the high temperature MEMS gyroscope prototype developed during the 1st phase of this program based on gyroscope technology developed under prior DoD work (Figure 1).

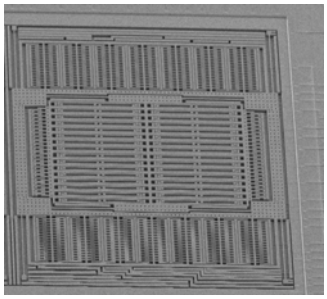


Figure 1. MEMS gyroscope for defense use that meets the performance requirements for oil drilling

2.1 MEMS-Electronics Integration Technology

In Phase I of the project, we solved the temperature compatibility problem by using our proprietary MEMS-electronics integration technology to 'divide and conquer' the problem (Figure 2). Our MEMS-electronics integration technology allows the separate optimization of the electronics circuit from the micromechanical sensing element. With this approach, the MEMS sensing structure is produced in one process while the electronic circuits are procured from proven specialized foundries. The ability to use state-of-the-art foundry processes is important: a transistor's thermal electronic noise is proportional to the square root of its channel length.[1] Figure 3 shows one of the world's most sensitive vacuum leak sensors fabricated in this approach.

[1] — Lee, Thomas, "Design of CMOS Radio Frequency Integrated Circuits, Cambridge University Press, UK, 1998.

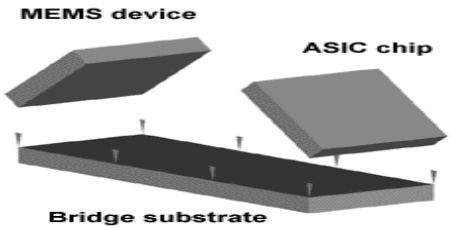


Figure 2. Our process enables a 'divide and conquer' approach to the high temperature gyroscope.

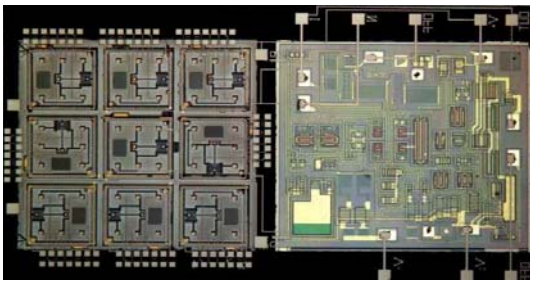


Figure 3. MEMS-electronics integration technology with no signal-loss penalty.

Competing integration techniques, such as traditional wirebonding, impose a heavy performance penalty on the device. Wirebonding typically incurs a 99% signal loss due to high parasitic capacitance. The ability to separate the processing is critical. Other competing approaches, such as co-fabricating the MEMS and the electronics on the same chip, have numerous constraints during manufacturing. With our proprietary process, the chip designer can focus on developing a mechanical sensor that is thermally robust while still using high-performance electronics. For example, the sensor structure can be as thick as possible to provide high sensitivity, without concern for high-temperature processes to deposit the thick layers (eg. 600°C and hotter) that will melt the circuits. The electronic application-specific ASIC chip can be produced in specialized processes that guarantee operation at 225°C for 5 years. Due to funding constraints, the Phase I portion of the project fabricated a standard room-temperature for testing purposes only. The Phase II work will develop the electronic circuitry.

2.2 Meeting Requirements

Our team, having two key enablers, is in a unique position to rapidly and successfully execute this program:

1. Sensor design with the required performance to be demonstrated in the proposed Phase II project.
2. The proprietary technology that enables the low-parasitic integration of micromechanical sensors with specialized electronic circuits. This was demonstrated in Phase I.

Over the last 10 years, the team has already developed over 10 different devices with the same proprietary technology, including devices that meet stringent high-g shock and temperature cycling requirements for military applications.

2.3 Facilities/Equipment

The proposed project leverages ongoing development contracts from the Department of Defense that are supporting the establishment of a state-of-the-art MEMS foundry in Grand Forks. This project was funded for $2.4 million in the FY09 defense budget and also $2.4 million in the FY10 defense budget.

Design tools include L-edit and ANSYS multiphysics finite element simulation software.

Process equipment includes proprietary bonding equipment and pre-bond cleaning tools that enables the MEMS-electronics integration. Other equipment includes sputtering and electroplating systems.

Ideal Aerosmith has an impressive array of inertial test equipment for the development and integration process. This will enable the system to be evaluated at both the component and system level.

Ideal Aerosmith and Laserlith both have facilities conveniently located next to the UND campus. This will allow UND, Laserlith, and Ideal Aerosmith a convenient site to collaborate on the project.

Our facilities meet all applicable environmental laws and regulations of federal, state, and local Governments for, but not limited to emissions, effluents, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

2.4 Environmental Impact

No environmental impacts are anticipated during the project. If deployed, improved guidance technology will help prevent accidents and environmental mishaps.

3. Project Plan, Time Table and Standards of Success

The proposed project has been divided into 2 phases. The 1st phase has been completed. We plan to demonstrate the complete 2nd phase high-temperature gyroscope within 1 year. Laserlith Corporation, the lead organization, will manage the overall program. Quarterly progress reports will be submitted.

3.1 Phase 2 Work

Phase 2 will build upon the MEMS gyroscope prototype developed in Phase 1, and optimize the micromechanical structure, fabricate and integrate the high temperature circuit, and build/integrate the entire module.

The goal of Phase 2 is to prepare the complete sensor for down-hole testing. This also includes incorporation of support electronics and algorithms such as Kalman filters.

Mechanical sensor design, fabrication and integration will be performed by Laserlith and Purdue. Module integration and testing will be performed by Ideal Aerosmith and the University of North Dakota. Electronics design and testing will be performed by Purdue. Electronics circuit will be produced by a semiconductor foundry.

3.2 Standards of Success and Importance to North Dakota - CONFIDENTIAL

By the end of the program, the developed MEMS gyroscope, along with support electronics, will be integrated into the down-hole package to be tested by Schlumberger personnel.

The successful development of the proposed sensor will result in production of MEMS gyroscopes and the entire sensor module (except high temperature electronics) in Grand Forks. Benefits to North Dakota include the creation of 20-30 jobs.

Improved oil drilling technologies can dramatically lower the cost of oil drilling. For example, a MEMS gyro can significantly reduce drilling time for casing window cutting applications, intermediate radius re-entry applications and steering applications.

For the Casing Window Cutting application, Baker Hughes has estimated that adding a gyroscopes to the current MWD tool can save approximately $35,000 per well based on avoidance of the cost to plug back and re-drill (Figure 4). For the Intermediate Radius Re-entry application, Baker Hughes has estimated that $115,000 per well can be saved based on net rig time savings and avoiding the need to plug back and re-drill the sidetrack (Figure 4).

For steering applications, a direct cost savings cannot be estimated from eliminating the need to plug back and re-drill. However, improved accuracy will lead to a reduction in drilling time. In particular, directional measurement errors will accumulate from magnetometers whereas gyroscopes do not.

Table 1 — Wireline Gyro Replacement Example

Casing Window Cutting	Wireline	MWD Gyro
Drilling Rig Daily Rental Rate	$60,000	$60,000
Directional Drilling Daily Rental Rate	$10,000	$10,000
Gyro Orienting (during 2 days)	13 hours	1 hour
Cost to Cut Window (during 2 days)	$140,000	$105,000
Rig Time Saved		12 hours
Window Cutting Savings		$35,000
Total Savings/well		**$35,000**

Table 2 — Wireline Gyro Replacement Example

Intermediate Radius Re-Entry Kickoff	MWD Alone	Steering Gyro *	MWD Gyro
Drilling Rig Daily Rate	$60,000	$60,000	$60,000
Directional Drilling Daily Rental Rate	$10,000	$10,000	$10,000
Window Cost	$75,000	$75,000	$75,000
Drilling Time	1 day	1-1/2 days	1 day
Plug-Back Cost	$80,000		
Cost to Build Curve	$225,000	$180,000	$145,000
Window Cutting Savings (from Table 1)			-$35,000
Cost to Cut Window & Kickoff the Curve	$365,000	$320,000	$250,000
Total Savings/Well		**$45,000**	**$115,000**

* Assuming a wireline gyro steering tool is available

Figure 4. Baker Hughes' cost savings estimate with the availability of a MEMS gyroscope

In the last two years, instability in the price of oil had significant impact on drilling in North Dakota. When the price was low, it become uneconomical to drill in many areas in the Bakken Formation. By making available a technology that reduces the cost of drilling, the proposed project helps 'immunize' the state's economy from these wild fluctuations in the price of oil. For example, improved hydraulic fracturing techniques have dropped the breakeven cost in Mountrail county from $60 to the $14-$20 range. Figure 5 illustrates the effect that a 20% improvement in drilling cost may have on the companies and different counties in the Bakken play. In Figure 5, the dotted red line at $66 illustrates a 20% reduction in drilling cost from an average 'breakeven' cost at $80.

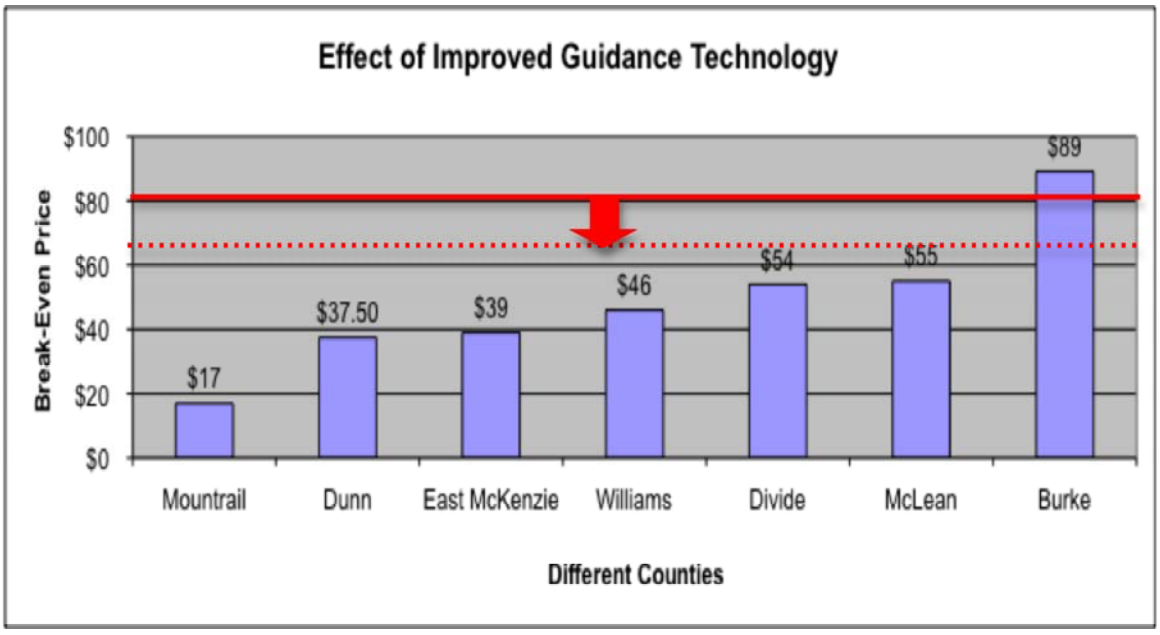


Figure 5. Breakeven and profitability: The proposed technology is particularly relevant for oil production areas that have marginal production relative to the cost of drilling.

Along with oil drilling jobs, there are substantial multiplier effects. This affects hotels, restaurants, home building, road building and other infrastructure.

The project involves students from North Dakota State School of Science and the University of North Dakota. As a result, students will benefit from exposure to the MEMS industry and the oil drilling business.

We believe this technology can make a contribution in addressing our nation's energy problems, reducing the cost of oil drilling in North Dakota, and adding to the long term economic prosperity of North Dakota. In the long term, the technology can be applied world-wide for off-shore deep-water applications, and North Dakota companies can realize the growth of supporting this market while developing further enhancements. The importance of the proposed technology to North Dakota and the country is further demonstrated by matching funding from RPSEA – the award letter is attached in the appendix.

3.3 Economic Impact

Economic impact during the project includes hiring of 5 engineers/technicians in Grand Forks. Collaboration with the University of North Dakota will result in additional education benefits.

Economic impact after the project is successfully completed is substantial:

1. Laserlith and Ideal Aerosmith will produce the entire sensor module in Grand Forks, including the MEMS gyroscope chip. This will translate into the creation of 20-30 jobs.
2. Improved oil drilling technology can increase the amount of oil that can be extracted economically. A 1% increase in what can be extracted from the Bakken Formation may result in billions of dollars of taxable revenues.
3. With the recent dramatic volatility in the price of oil, reduced drilling cost is even more important to North Dakota's economy. As discussed, support businesses such as hotels, restaurants, home building and infrastructure will benefit from the resulting multiplier effects.

4. Management and Facilities

4.1 Personnel

Management members have extensive experience in the semiconductor manufacturing, advanced sensors, and oil drilling equipment. Key personnel include:

Cassindy Chao, Laserlith President and Project PI/POC, has spent the last 11 years establishing and reorganizing companies in the technology, consumer products, and recycling sectors. She ran the US operations for an overseas consumer products manufacturer raising domestic sales to $200 million per annum. Earlier, she was an Executive Director at Goldman Sachs, responsible for research coverage of media, satellite, and internet companies. She received her B.A. from Wellesley College in 1990.

Jim Richtsmeier, Sr. VP- Business Growth & Technology for Ideal Aerosmith has 19 years experience in technology and test solutions. Much of Jim's experience is in test development for inertial sensors such as gyroscopes and magnetometers. Jim has led many of Ideal's product development efforts while continuing to look for new markets. Jim holds a BS degree from University of North Dakota.

Will Semke, Professor at the University of North Dakota, is involved in developing precision motion control, smart structures and aerospace payloads. He is experience in navigation control hardware and algorithms for UAS and other remotely controlled devices. Professor Semke will provide design and testing of Kalman Filter algorithms for the MEMS gyroscope. He received his PhD from University of Wisconsin Madison.

5. Timetable

5.1 Time Table and Evaluation Points

Figure 6 shows the project time table. As discussed, quarterly reports will be submitted. Key milestones/Evaluation Points for Phase 2 are the electronic circuit, the complete MEMS gyroscope, and integrated sensor module.

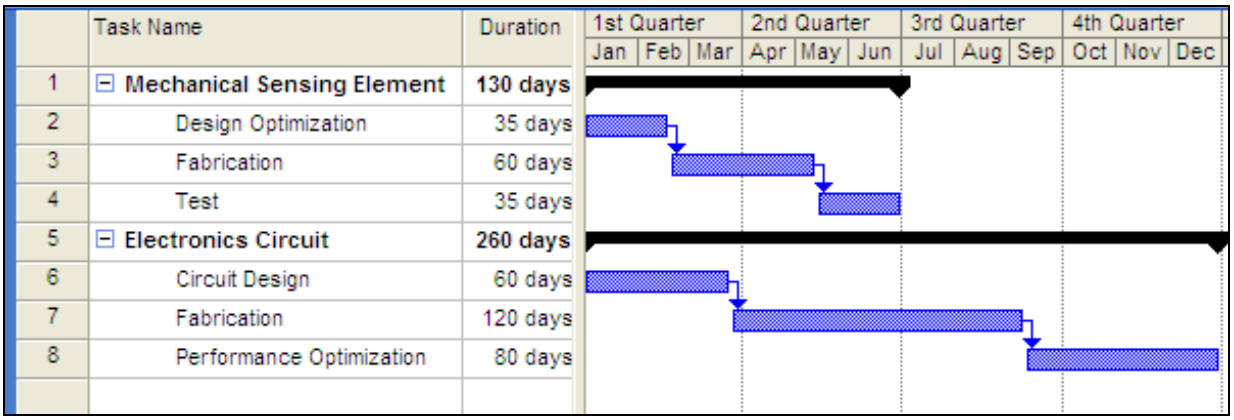


Figure 6. 1-year Project time table.

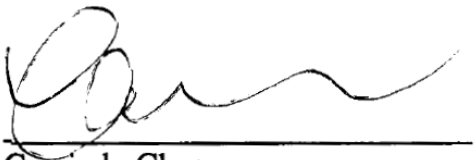
6. Budget

The budget for the Phase 2 project is $1,039,346. Requested funding from the Oil and Gas Research Council is $500,000. Matching funds of $489,346 from RPSEA contract and $50,000 from Laserlith Corporation's indirect cost. Beyond these matching funds, the project also leverages ongoing MEMS development contracts from the Department of Defense that are funding the establishment of a state-of-the-art MEMS foundry in Grand Forks, North Dakota. For this project, $2.4 million was budgeted in the FY09 defense budget for this project, and $2.4 million was also budgeted in the FY10 defense budget.

Funding Sources		Phase II
Oil and Gas Fund		500,000
Matching Funds		539,346
Subtotal		**1,039,346**
Project Breakdown		
Salaries		200,000
Labor Overhead		282,160
Materials		100,000
Technical Subcontracts		110,000
Fabrication Run		250,000
Other Direct Costs		97,186
Subtotal		**1,039,346**

7. Tax Liability: Affidavit

I, Cassindy Chao, certify that Laserlith Corporation does not have any outstanding tax liability owed to the State of North Dakota or any of its political subdivisions.



Cassindy Chao
Title: President
Laserlith Coporation

5/25/11
Date

8. Patents and Rights to Technical Data

The team wishes to reserve all patents and rights relating to the MEMS gyroscope design, fabrication process, packaging process, and circuit design.

9. Appendices

Our appendices are as follows:

9.1 - Letter of Interest from the Army Research Laboratory

9.2 - Letter of Interest from Army Armament Research Development and Engineering Center

9.3 - RPSEA award letter

9.4 - Weatherford/Tech21 Letter of Intent

9.5 - Grand Forks Region Economic Development Corporation Support Letter

9.1 Letter of Interest from the Army Research Laboratory

DEPARTMENT OF THE ARMY
US ARMY RESEARCH, DEVELOPMENT AND ENGINEERING COMMAND
ARMY RESEARCH LABORATORY
2800 POWDER MILL ROAD
ADELPHI MD 20783-1197

October 1, 2008

To:
Ms. Cassindy Chao-Bierhaus
Laserlith Corporation
University of North Dakota Center for Innovation
4200 James Ray Drive
Grand Forks, North Dakota 58203

From:
Dr. Madan Dubey
Research Physical Scientist
US Army Research Laboratory
Sensors and Electron Devices Directorate
AMSRD-ARL-SE-RL
2800 Powder Mill Road
Adelphi, MD 20783
V: 301-394-1186
F: 301-394-4562
E:mdubey@arl.army.mil
SIPR:mdubey@arl.army.smil.mil

Dear Cassindy
The Laserlith team possesses unique capabilities to deliver a MEMS-based gyroscope sensor. Your MEMS-IC integration technology enables integration of MEMS and IC process with minimal signal losses. The Army Research Laboratory is interested in evaluating your sensor technologies for UAV, missile and munition applications.
The Laserlith team has also met many milestones in MEMS technologies including demonstrating MEMS switches that operate beyond 300 billion switching cycles, accelerometers that operate under more than 100,000g conditions, and MEMS mirrors that operate under high energy laser illumination for missile defense applications.
Kind Regards,

Madan Dubey
Dr. Madan Dubey

9.2 Letter of Interest from Army Armament Research Development and Engineering Center

DEPARTMENT OF THE ARMY
UNITED STATES ARMY
ARMAMENT RESEARCH DEVELOPMENT AND ENGINEERING CENTER
PICATINNY ARSENAL, NEW JERSEY 07806-5000

October 14, 2008

Ms. Cassindy Chao
Laserlith Corporation
4200 James Ray Drive Suite 201-A
Grand Forks, North Dakota 58203

Dear Cassindy:

I am writing to express ARDEC's continued interest and strong support in Laserlith's MEMS gyroscope technologies. ARDEC is an ardent supporter of entrepreneurial small businesses and we are pleased with your track record in developing state-of-the-art MEMS sensors and safe & arm devices over the last 5 years.

Beyond the oil drilling application, low-cost advanced MEMS gyros are critical for providing inertial guidance in smart munitions. Your technology can reduce the cost and improve the accuracy of many of our smart munitions. The improved accuracy and low drift rates possible with your technology also offers important advantages for guiding UAV and UGV systems.

In particular, we are impressed with your MEMS-CMOS integration technology, which can improve the signal-to-noise ratio of capacitive sensors by up to 99%. Furthermore, your batch hermetic sealing capability will be critical for reducing the cost of gyro sensors by eliminating the need for expensive one-at-a-time vacuum packaging.

Respectfully,

Mark J. Mezger
Business Development Manager
US Army Armaments RDEC

9.3 RPSEA Award Letter

Research Partnership to Secure Energy for America

SUBCONTRACT AGREEMENT
Cost Reimbursable Cost Share Contract

SUBCONTRACTOR:	SUBCONTRACT #: 9121-3500-10
Laserlith Corporation	TYPE: Cost Reimbursable – Cost Share – No fee
ADDRESS:	
4775 Technology Circle, Ste 3 Grand Forks, ND 58203	Total Estimated Costs: $619,346.00 Subcontractor Cost Share: (21 %) $130,000.00 RPSEA Maximum Share: $489,346.00

INTRODUCTION

This Subcontract Agreement sets forth the Agreement between Laserlith (herein after known as "SUBCONTRACTOR,") and Research Partnership to Secure Energy for America, a Texas corporation with principal offices in Sugar Land, Texas (herein after known as RPSEA, CONTRACTOR) relating to a Defined Effort to provide {Project Title}. It is the desire of RPSEA and SUBCONTRACTOR to gain further knowledge concerning the subject matter of the Defined Effort. The effort to be performed by SUBCONTRACTOR under this Subcontract will be part of RPSEA's Prime Contract DE-AC26-07NT42677 that has been issued by the Department of Energy. The work, defined in Appendix 1 (Statement of Work) will be performed on a Cost Reimbursable – Cost Share basis, in accordance with Schedule A (Specific Terms and Conditions), and any referenced documents in **18.0 Order of Precedence** section of this agreement.

SCHEDULE A
SPECIFIC TERMS AND CONDITIONS

1.0 PERIOD OF PERFORMANCE

The term for this Subcontract is 24 months, beginning on the date signed by the RPSEA representative in clause 19, unless amended in writing by mutual agreement of the parties. SUBCONTRACTOR is not obligated to continue work or provide services and RPSEA is not obligated to compensate SUBCONTRACTOR for expenses incurred or commitments made before or after these dates.

1.1 ESTIMATED COST

The estimated cost, for the work to be performed under this Subcontract is:

Estimated Total Cost: **$619,346.00**
Laserlith Cost Share: **$130,000.00**
RPSEA Maximum Share: **$489,346.00**

1.2 FUNDING

This subcontract is funded on a cost reimbursable basis in the amount of $489,346.00. The Energy Policy Act of 2005 requires the expenditure of 2.5% of the total estimated

9.4 Grand Forks Region Economic Development Corporation Support Letter

September 1, 2011

Mr. Brent Brannan, Director
Oil and Gas Research Program
North Dakota Industrial Commission
600 East Boulevard Ave Dept 405
Bismarck, ND 58505-0840

Re: Laserlith Corporation – Phase II Improved Directional Drilling Technology for the Bakken Formation

Dear Mr. Brannan,

The Grand Forks Region Economic Development Corporation is pleased to provide this letter of support for Laserlith Corporation's Phase II Improved Directional Drilling Technology for the Bakken Formation proposal to the North Dakota Oil and Gas Research Council.

Laserlith Corporation's research is focused on delivering reliable and high performance communications equipment and advanced sensors for military and energy applications. The referenced proposal is designed to create micro-electro-mechanical systems (MEMS) gyroscope capable of providing accurate and precise inertial guidance information under adverse conditions. This technology will improve target acquisition, resulting in more accurate oil exploration in western North Dakota's oil play.

If successful, the Improved Directional Drilling Technology for the Bakken Formation initiative has the ability to positively impact economic development on a state-wide basis. This technology is designed to lower drilling costs in the western North Dakota, rendering otherwise non-economical wells explorable. If successful, the program will result in the development and manufacturing of the MEMS gyroscopes in eastern North Dakota, thus creating new jobs and wealth in both western and eastern North Dakota.

The Grand Forks Region Economic Development Corporation board of directors encourages the North Dakota Oil and Gas Research Council's favorable consideration of Laserlith Corporation's Phase II Improved Directional Drilling Technology for the Bakken Formation proposal.

Sincerely,

Steve Burian
Chairman

CC: Karlene Fine, North Dakota Industrial Commission

600 DeMers Avenue, Suite 501, Grand Forks, ND 58201 • Phone (701) 746-2720 Fax (701) 746-2725 • www.grandforks.org

9.5 Weatherford/Tech21 Letter of Intent

TECH21 ENGINEERING SOLUTIONS LTD
Etive House, Beechwood Business Park, Inverness, IV2 3BW
Tel: +44 (0)1463 710008 Fax: +44 (0)1463 729768 Email: enquiries@tech21.co.uk
www.tech21.co.uk

Laserlith Corporation
c/o: Cassindy Chao
4201 James Ray Drive,
Suite 1450
Grand Forks,
ND,
USA 58202

8th November 2010

Dear Mrs. Chao,

This is a letter of intent to confirm that Tech21 Engineering Solutions are willing to provide advisory services to support the development of your MEMS gyroscope for directional drilling applications. This would include providing guidance on equipment use and specifications based on our experience in the directional drilling field.

We believe that if MEMS gyroscopes can provide the performance necessary for unconventional drilling applications then they could provide significant benefits to the oil industry. A high temperature, highly accurate MEMS gyroscope could save on wireline deployment time, provide the directional control required for drilling and minimize tortuosity. It could also make significant contributions to minimising well collision risks.

We look forward to working with your team.

Regards,

Dr. Andrew McGregor
General Manager
Tech21 Engineering Solutions Ltd.