NDIC Funding to Support Research of Petroleum Engineering Program at University of North Dakota

“Contract ID. G-51-02”

Dr. Vamegh Rasouli
Department Chair, Continental Resources Distinguished Professor

December 2019
Agenda

• Introduction

• Report on Current NDIC Funding

• Proposal for New NDIC Funding
Introduction
History of UND Petroleum Engineering

2010-11
- Program Start-Up

2011-12
- First Graduating Class (4 Students)

2012-13
- Dr. Rasouli Joins

2013-14
- ABET Accreditation

2014-15
- Graduate/PhD Program

2015-16
- 2+2 program WSC/SAIT

2016-17
- New Labs

2017-18
- 150 Undergrad 40 Grad/PhD 7 Faculty

2018-19
- 165 Undergrad 60 Grad/PhD 5 Faculty
Objectives of This Proposal

Hands on & Practical Petroleum Engineers to Work in ND Petroleum Industry

Conduct research to address the immediate industry problems and develop future technologies in Bakken

Use PE resources including labs to do regular experiments and field scale simulations addressing specific operational problems

Industry Advisory Council (IAC)

Education

Practical Research

UND PE

Industry Collaboration & Services
Current Teaching, Research & Industry Labs
Geomechanics Labs

Auto Lab 1500 Multi-purpose Test System

Uniaxial Compressive Strength
Hess/Drilling Systems Labs

DrillSIM-5000 ‘conventional’ drilling simulator
Hess Virtual Reality Labs
Hess Innovation Labs

Core Flooding System

Interfacial Tension

Automated Drilling Rig
Hess Innovation Labs

Multiphase Flow Loop Lab

Pipeline Fluid Flow Simulation Lab
Slurry Loop Labs

Cuttings transportation and hole cleaning design
Full-Scale Reservoir Simulated Drilling and Completions Laboratory

Donation by

Sidney Green
President of Enhanced Production, Inc. a Utah corporation, and is Research Professor at the University of Utah
Wellbore Simulator
• 23-inch inside diameter for up to 5-foot rock sample length
• 10,000 psi borehole pressure (20,000 psi simulated depth)
• 12,000 psi confining pressure / 20,000 psi vertical stress
• pressurizing intensifiers
• threaded end closure

Movable Tower on Rails
• 13 feet by 15 feet by 32 feet high structure
• motorized movement to locate at multi-workstations
• variable speed rotary 0 to 450 rpm
• 375,000 pounds axial load capacity
• polished drill shaft seal / rotary slip rings for data recording
**Full-Scale Mud System**
- Continental Emsco FA 1600 / pulse damper
- 1600 hp DC motors / precise variable flow rate control
- 600 volt transformer / Thyristor DC controls
- 420 gpm / 5500 psi fluid ends / 180 gpm / 15,000 psi fluid ends
- 15,000 psi swivel
- 15,000 psi vessel dual-pressure rotary seal

**Mud Mixing / Building System**
- 100 bbl and 60 bbl mud tanks with rotary mixing
- centrifugal circulating pumps and suction pump
- 15,000 psi piping
- Two mechanical chokes and cuttings screen containment
Operation Control and Data Recording

• Fully servo digital operating computer control
• Fully digital data recording--rpm, wt on bit, torque, penetration rate, mud strokes, temperatures, mud pressures, and other
• safety analog visual system

Miscellaneous Accessories

• For drilling, mud testing, borehole testing, and other tests
• Various couplings / specimen fixtures
• Drill pipe breaking tongs, 4.75-inch to 12.25-inch drill bit size
Fluid Ends

Drill Sample

Sand Screen Test
1600 Triplex Mud Pump

Thyrister Controls for Mud Pump
Rotary Table
Mud Tanks

Mud System
Drill Tower

Electrical Controls
Test Rock Samples

Coring Samples
Control Room

Wellbore Simulator & Chock
Pipe Transformers
New Home for the Drilling Rig

- Old Minnkota Power Plant, Grand Forks
- 17,000sqf space & Full Basement
- Rented @ $5,000/month

50 Ton Overhead Crane
What Opportunities the New Labs Offer?

- Accessible to students and others at anytime
- Used for teaching purposes in several courses and demonstration to students
- Equipment can be used as training resources (pumps, compressors etc)
- Can be modified towards any specific research projects
- One of the few lab with capability of 20,000psi pressure application
- Usable for different industry services (sampling, drilling, bit testing etc)
- Enhances the chance for collaboration with other Universities and research institutes
- Strengthen our research proposal submission
- Promotes department’s visibility and ranking worldwide
Status of Current Fund

Contract No. G-045-89

Ending Feb 2020
Background – Current Fund Status

- A total of $600,000 was approved for UND Department of Petroleum Engineering to support its research program. The fund was approved to be spent towards Ph.D. students’ stipends and tuition as well as faculty summer salary. The grant started on Sept 1, 2018 for a period of 18 months.

- At least 9 students to be supported from this grant. In addition the department agreed to support 6 additional students to work on the projects related to this funding.

- At a minimum the following projects agreed to be completed by the students/faculty:
  - Big Data Analytics/UAS/Data Mining
  - CO2-EOR
  - Sulfate Deposition
  - Machine Learning/Refracking
In-kind Contribution Over the Duration of Project

- Itasca Consulting Group: $483,143
- Qbit: $215,000

**TOTAL:** $698,143

- The Cost share includes the software donation from Itasca and the consulting time they spend to help students as co-advisors, in addition to the technical presentations that they delivered on-campus.
Progress Report Status

• The first report was submitted in February 2019.

• The second report is due end of July 2019.

• The final reports will be submitted at the conclusion of each student’s project.
Impacts of the Funding

• Without this funding, the department was unable to recruit this many Ph.D. students, so we greatly appreciate this generous funding support.

• The use of the Ph.D. students as Teaching Assistants for undergrad students has provided a strong support to the delivery of the course.

• Knowing that the results of these projects will be shared by NDIC and reviewed by the industry, has made the students to work hard with the intent to include more practical aspects to their projects.

• Ph.D. students have travelled to many conferences to present their work. This is a great presentation and networking experience for them while inform people about the work that is ongoing at the department.

• In 2019 to date the results of these project have generated publication or submission of over 45 conference and journal papers. This is a significant achievement for UND and reputation of the department worldwide.
Publications (published/submitted)

Publications (published/submitted), Cont’d


Publications (published/submitted), Cont’d

Publications (published/submitted), Cont’d


Publications (published/submitted), Cont’d

61. Lee, H.; Ostadjhassan M., Sep 2019: Molecular weight distribution analysis of kerogen using MALDI-TOF and FTIR. TSOP Meeting, Bloomington IN.
Publications (published/submitted), Cont’d


Ph.D. Students Attending Conferences & Workshops
Conference Attendance

19. Djezzar, S., March 2019: Joint Geological Society of America, Section Meeting South-Central, North-Central, and Rocky Mountain Sections, Manhattan, Kansas. Participated/Poster presentation.
45. Patil, S., May 2018: Oil Chemical Technical Training. Participated
60. Zhou, Z., April 2019, SPE Oklahoma City Oil and Gas Symposium, Oklahoma City, Oklahoma, Oral presentation.
Job Placements

Graduated Ph.D. students

- **Kouqi Liu**: 2018 as 1st Ph.D. graduate, working in Southwest Petroleum Uni as an Assistant Professor
- **Sofiane Djezzar**: 2019, Full time employee at EERC
- **Lingyun Kong**: 2019, Full time employee at EERC
- **Sai Wang**: 2019, Full time employee at EERC
- **Arash Abarghani**: 2019, Full time employee at EERC
- **Seyed Alireza Khatibi**: 2019, EERC and now postdoctoral fellow at Texas at Austin
- **Aldjia Boualam**: 2019, part time employee at EERC
Job Placements

We expect 8 graduates in Spring 2020

Current Ph.D. students Full Time Employee at EERC:

- Agustinus Zandy
- Santosh Patil

Current or past Ph.D. students Part Time Employed at EERC:

- Xincheng Wan
- Ogochukwu Ozzota
- Karthik Balaji
- Ahmed Al-Metwally
Request for New Funding

“Contract ID. G-51-02”
Justification

• The progress review of the current contract demonstrates how effectively the department managed the use of the current funding to support several Ph.D. students, produce several publications and promote the Petroleum Engineering program at UND by attendance of Ph.D. students and faculty in different conferences and workshops.

• DPE has grown significantly in its teaching and research capabilities and has strong lab resources as well as industry contacts, so it is in a position that can grow to its next level to be among top 5 Petroleum Eng programs across the country.
Justification

- Through my personal contact with the oil and gas companies internationally, I have been able, and will continue, to admit high quality individuals with several years of industry experiences to join our Ph.D. program. This is a significant advantage of our program over many others in the country.

- The job placement statistics of our Ph.D. students demonstrates that all of them have been able to join the workforce in North Dakota. The passion and interest of all these international students to remain in the US after completion of their studies and the need of the oil and gas industry to hire them is a significant support to the Bakke development and its future growth.
Justification

- DPE has currently 5 full time faculty members at or above Assistant Professor level. With the available resources within the department to grow teaching and research activities, receiving funding to hire at least one additional contractual faculty would be a great support to the department. It is proposed that his endowed position at Associate Professor level be interviewed and hired jointly with the NDIC with a highlight that the recruited faculty is expected to work on assigned projects by the NDIC and advise at least 5 Ph.D. students funded by the NDIC. The preference is to hire someone with industry background and strong contact with the industry.
New Funding Proposal

- We request funding for 3 years from March 2020, when the current contract will cease. This will cover the period of a Ph.D. duration to make sure we do not fall short in supporting the students.

- The funding is requested to support 15 Ph.D. students, 6 faculty summer salaries and one NDIC Endowed faculty position.

- DPE will commit to support additional 10 students to work on the projects assigned by NDIC, so a total of 25 Ph.D. students will be assigned to work on the projects.

- We continue our research on the previous topics that were proposed by the NDIC.

- Full-Scale Reservoir Simulated Drilling and Completions Labs set up & Operation
1. Tuition and Stipend of Ph.D. Students

Approximate costs of a Ph.D. student per annum

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tuition</td>
<td>$15,000</td>
</tr>
<tr>
<td>Stipend</td>
<td>$15,000</td>
</tr>
<tr>
<td>PC &amp; Office Supply</td>
<td>$1,000</td>
</tr>
<tr>
<td>Travel to Conferences, Workshops</td>
<td>$1,000</td>
</tr>
<tr>
<td>Lab Material, Supply, Maintenance etc for lab based projects</td>
<td>$2,000</td>
</tr>
<tr>
<td><strong>Total per student per year</strong></td>
<td><strong>$34,000</strong></td>
</tr>
<tr>
<td><strong>Total for 20 students per year</strong></td>
<td><strong>$680,000</strong></td>
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</tbody>
</table>
2. Faculty Summer Salary

• Including fringes and benefits varies between $15,000 and $19,000 monthly for Assistant to Full Professor positions. Average of $16,000.

• We request one month of summer salary per annum for 6 faculty members, a total of $96,000.
3. NDIC Endowed Faculty Hiring

• An Associate Professor hiring for a total annual package (salary & benefits) of $140,000.
4. New Lab Set Up

<table>
<thead>
<tr>
<th>Items</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lab Manager Salary including benefits</td>
<td>150,000</td>
<td>150,000</td>
<td>150,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Consulting Fees</td>
<td>50,000</td>
<td>10,000</td>
<td>10,000</td>
<td>70,000</td>
</tr>
<tr>
<td>Equipment Upgrade</td>
<td>300,000</td>
<td>50,000</td>
<td>20,000</td>
<td>370,000</td>
</tr>
<tr>
<td>Lab Supplies</td>
<td>100,000</td>
<td>50,000</td>
<td>50,000</td>
<td>200,000</td>
</tr>
<tr>
<td>Lab Maintenance</td>
<td>50,000</td>
<td>50,000</td>
<td>50,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Initial lab set up</td>
<td>150,000</td>
<td></td>
<td></td>
<td>150,000</td>
</tr>
<tr>
<td>Subcontractors</td>
<td>100,000</td>
<td></td>
<td></td>
<td>100,000</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>900,000</strong></td>
<td><strong>310,000</strong></td>
<td><strong>280,000</strong></td>
<td><strong>1,490,000</strong></td>
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</table>

Harry Feilen
Currently Mgr Operations & Safety – IES
Strong candidate for PE Lab Mgr Position

Alan Black
Former general manager of TerraTek’s Drilling and Completion Laboratory

Sidney Green

Gee Green
## Total Funding Request for 3 Years Period

<table>
<thead>
<tr>
<th>Item</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>15 Ph.D. students tuition &amp; stipend</td>
<td>1,530,000</td>
</tr>
<tr>
<td>6 faculty summer salaries</td>
<td>288,000</td>
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<tr>
<td>One Associate Professor Endowed Position</td>
<td>420,000</td>
</tr>
<tr>
<td>Full-Scale Reservoir Simulated Drilling and Completions Labs</td>
<td>1,490,000</td>
</tr>
<tr>
<td>Total</td>
<td>3,728,000</td>
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</table>
## Cost Share

<table>
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<tr>
<th>Company</th>
<th>Total ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Itasca Consulting Group, software donation &amp; Technical Advice</td>
<td>1,269,150</td>
</tr>
<tr>
<td>SimTech, software donation &amp; Technical Advice</td>
<td>715,000</td>
</tr>
<tr>
<td>Sid Green Four, LLC, technical advice, data sharing and donation of equipment</td>
<td>2,000,000</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>3,984,150</strong></td>
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</table>
## Total Project Costs

<table>
<thead>
<tr>
<th>Item</th>
<th>Total for 3 Years($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NDIC Funding Request</td>
<td>3,728,000</td>
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<tr>
<td>Cost Share</td>
<td>3,984,150</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>7,712,150</strong></td>
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</table>
Questions?