Composite Drilling Riser Investment Program
PANGAEA DRILLING TECHNOLOGY LLC

4265 San Felipe Street, Suite 1100
Houston, TX . 77027
Phone: 713 960-6617, 916 567-9797  Fax: 916 567-9898
email: shillassociates@aol.com, BEcarbon@aol.com
Vision, Mission and Strategy
Technology Proponents
Market Opportunity
Technology – Competitive Advantages & Track Record
Barriers to Market Acceptance & The Competition
Technology Valuation
Intellectual Property
Investment Proposal
Vision, Mission & Strategy

**Mission**
To become a recognized world leading company for design and manufacture of composite drilling risers.

**Vision**
Create a new company for technology commercialization with founders and Shell Tech Ventures as shareholders.

**Project Objectives**
To have our technology trialed by one of the top ten Oil and Gas E&P companies on a drillship within 24 months.
To have our technology used as a complete drilling riser in deep water within 5 years.

**Technology Objectives**
To design and fabricate a 90’ section of drilling risers within 24 months.
To consolidate and formally protect our current IP
To select a manufacturing partner within 24 months

**Strategy**
To lever prior R&D efforts in Composite Risers
To lever 30+ years of Composite design and manufacturing experience into Riser IP
To lever knowledge and network within the O&G industry into project and investment opportunities.
Founders

Steven Hill

With over 30 year's professional experience in the oil and gas offshore and onshore industries, mostly in South America, Pacific Rim and West Africa, Steve has worked for numerous esteemed companies and provided Business Development and Project Management services to various other energy related and power development companies. Steve serves companies as an ADVISOR or MENTOR in the area of placing large complex projects back on plan profitability, improving the client relationship and using his vast networks of professional friends and past clients, that admire his skills and abilities, to secure new business for his current clients.

Dr. Brian Spencer

Over the past 40 years, Brian has become one of the industry leading experts in the design and development of composite components and manufacturing processes. His industry contributions have been recognized by his peers through his unanimous election to ‘Fellow’ status in the SAMPE by its Board of Directors. Brian also received the Judd Hall Composites Manufacturing Excellence Award. His client list is long, varied and distinguished, including DARPA, NASA, Boeing, US Navy, BF Goodrich, United Technologies, Chevron, Conoco-Philips, Textron, and Statoil. Spencer Composites is the only licensed manufacturing facility certified for the production of Composite Risers.

Darrell Hawkins

Darrell has spent the last 10 years working on a variety of natural gas technologies and projects in numerous countries with many varied stakeholders. Having experience with Upstream producers, midstream transporters, downstream consumers, consultants, regulators, technology start-ups, investment bankers, Venture Capital and Angel Investor firms, Darrell has unique knowledge on how the primary stakeholders view risk and particularly, technology risk in O&G projects. He has successfully raised capital for two different start-up companies with gas technology focus. Previously, he was a naval officer and a naval architect with 20 years experience in a diverse range of international projects throughout development, execution and acceptance phases.
## Market Opportunity – Steel Drilling Risers

### Vendors:
- CIW
- NOV
- DrillQuip
- Russian vendors
- Chinese vendors

### Sales price $380,000 per 90’ joint
- with three 15,000 psi choke kill lines
- 42 Mil per rig
- (10,000 feet of HP riser with 3 CK lines)

### $4B/year market in 2014
- (158 quotations in 2013, 22 orders per year)

### Typical Cost breakdown (NOV)
- Steel riser 90’ with NOV connectors
- Specification: 925 psi, FAT 6200 psi, 30” ID, 90 feet long

<table>
<thead>
<tr>
<th>Steel tubular products</th>
<th>42,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Choke and kill lines</td>
<td>81,000</td>
</tr>
<tr>
<td>Machine time</td>
<td>12,300</td>
</tr>
<tr>
<td>Connectors</td>
<td>63,000</td>
</tr>
<tr>
<td>Manufacturing &amp; engineering</td>
<td>29,700</td>
</tr>
<tr>
<td>Margin (40%)</td>
<td>152,000</td>
</tr>
<tr>
<td><strong>Total per joint ($)</strong></td>
<td><strong>380,000</strong></td>
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Composite Advantages

1. Safety
   - No Corrosion
   - Strength improves with cold temperature
   - Better fatigue performance
   - Lower risk during handling

2. Reduced Weight
   - Lower Ship OPEX
   - Increased Drilling Depth by 60% – Lightweight means a 3rd Gen Drill vessel can secure 5th Gen Drilling day rates

3. HSE
   - Embedded Instrumentation mean 24/7 data on integrity
   - Lower risk of fatigue failure

4. IP
   - Performance advantage can be maintained by IP control
SCC Composite Oilfield Tubular Experience

1. Heidrun High Pressure Drilling Riser
   • Operating Pressure 925 psi, FAT 6,200 psi
   • 22 inch ID, 50 feet long

2. Magnolia High Pressure Production Riser
   • Operating Pressure 9,950 psi, FAT 11,250 psi
   • 9.7 inch ID, 64 feet long

3. Petrobras Drilling Riser
   • Operating Pressure 500 psi, FAT 5,000 psi
   • 20 inch ID, 50 feet long

4. Choke and Kill Line
   • Operating Pressure 15,000 psi

5. Completion Tubing
   • Burst Pressure 8,800 psi
   • 5.43 inch ID, 30 feet long
Break Through These Roadblocks

• Harsh Environment Application
• Increased COST
• Standardized steel connectors required
• Present the advantage of reduced weight
Barriers to Market Entry

Oil companies and fabrication companies are listening even with the usual roadblocks in place.

<table>
<thead>
<tr>
<th></th>
<th>Barriers</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>History of Metal Use</td>
<td>Very conservative industry with minimal composite experience</td>
</tr>
<tr>
<td>2</td>
<td>Standards</td>
<td>Lack of API Specifications and Standardization</td>
</tr>
<tr>
<td>3</td>
<td>Costs</td>
<td>Higher CAPEX but longer service life and increased drilling depth by 60% without changing the vessel equipment</td>
</tr>
<tr>
<td>4</td>
<td>Integrity Monitoring</td>
<td>In-Service Inspection Requirements</td>
</tr>
<tr>
<td>5</td>
<td>Connectivity</td>
<td>Industry standardized steel connectors required</td>
</tr>
<tr>
<td>6</td>
<td>Logistics</td>
<td>Increased distance from existing infrastructure</td>
</tr>
</tbody>
</table>
Competing Composite Technology For Risers

1. REPSEA Project
   - Joint Industry Project For Composite Drilling Riser
   - Thick wall metal liner reduces performance efficiency

2. Heidrun Composite Drilling Riser
   - In Service in North Sea
   - Thin wall titanium liner – Reduced cost benefit
   - Hybrid carbon fiber/fiberglass composite

3. Petrobras Composite Drilling Riser
   - Carbon steel liner, issues with liner buckling
   - Carbon fiber composite

Proposed Project Will Address the Cost and Performance Issues From Previous Projects
IP Will Be Developed To Enhance Performance and Reduce Production and Operating Costs
Metal lined composite risers in offshore applications
WO 2004044372 A1

**ABSTRACT**

The present invention provides a metal lined composite riser section (200) for use in offshore applications featuring a traplock (240) metal-to-composite interface to secure a plurality of structural composite over wrap layers about a metal liner assembly. Each trap lock is formed with at least one annular groove (250) or channel which has been made in the exterior surface of the metal liner assembly. The annular trap grooves may be of various geometries and may be arranged adjacent to each other to form a trap lock having 2 to 8 or any number of grooves required to ensure proper adhesion between the composite over wrap layers and the metal liner assembly. A number of structural composite over wrap layers (350) are secured about the assembly by building up alternating combinations of helical and hoop fiber windings to form a composite material. The present invention also provides a method of making such composite riser sections.

Multiple seal design for composite risers and tubing for offshore applications
WO 2003050380 A1

**ABSTRACT**

The present invention discloses multiple sealing systems for composite risers and methods of preventing interior fluid leakage to the outside of composite risers. Single or multiple elastomeric seals are formed between an elastomer applied in single or multiple grooves provided circumferentially along the outer surface of a metal to composite interface (MCI) of a liner assembly of the composite riser and an elastomeric shear ply provided on the outside of the liner assembly. The elastomeric seals and a seal between the MCI and the liner of the liner assembly provide a multiple sealing system for the composite riser to prevent leakage of interior fluids. In the event that the integrity of the seal between the MCI and liner fails or the integrity of the liner is compromised, the elastomeric seals would prevent leakage of the fluid to the outside of the composite riser.
Method of manufacturing composite riser
US 7662251 B2

ABSTRACT
A method of manufacturing a composite riser section with a liner assembly comprises holding the liner assembly in a horizontal position, bowing the liner assembly upward, and winding resin impregnated fibers about the liner assembly to form a structural composite overwrap. Another method of manufacturing a composite riser with a liner assembly comprises holding the liner assembly in a horizontal position between two supports, and winding resin impregnated fibers about the liner assembly to form a structural composite overwrap. A system for manufacturing a composite riser section with a liner assembly having a longitudinal axis comprises a first support and a second support that hold the liner assembly in a horizontal position therebetween, and a plurality of rollers that rotate the liner assembly about the longitudinal axis.
Calibration of FEA Models

Optimum tolerances; angles, thicknesses & cylinder

Embedding Sensors

Customized tooling

MCIs unique for each application

New manufacturing methods

Trade Secrets

PANFAEA has unique knowledge on successful, complex composite design manufacturing
Variable Viscosity Solventless Prepolymer Formulation

ABSTRACT
This invention relates to a prepolymer formulation comprising dicyclopentadiene that is at least 92% pure wherein the prepolymer formulation is flowable at ambient temperatures by virtue of the addition of a reactive ethylene monomer to the formulation.

Publication number: US20130144022 A1
Publication type: Application
Application number: US 13/311,290
Publication date: Jun 6, 2013
Filing date: Dec 5, 2011
Priority date: Dec 5, 2011
Also published as: WO2013085846A1
Inventors: Brian E. Spencer, Zachary B. SPENCER
Original Assignee: Brian E. Spencer, Zachary B. SPENCER
Classifications (7), Legal Events (1)
External Links: USPTO, USPTO Assignment, Espacenet

1. Provisional Patent application serial number 61/536,719
2. Filed September 2011
3. Describes the SCC method of improving the Autofrettage process.
4. This is significant in extending cycle life for thin metal lined pressure vessels, such as risers.
Improved Metal – to – Composite Interface (MCI)

- Patent application serial number 61/857,478
- Filed July 2013
- Describes a method of significantly increasing the axial load that can be carried across an MCI.
- This has particular relevance to the axial load capacity of a riser.
## Technology Valuation

<table>
<thead>
<tr>
<th>Client</th>
<th>Scope</th>
<th>Expenditure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heidrun Project</td>
<td>Design, Fabricate, Test, Certify, Install and Monitor</td>
<td>~ $10 MM</td>
</tr>
<tr>
<td>REPSEA Project</td>
<td>Design, Fabricate, Test, Certify, Install and Monitor</td>
<td>~ $10 MM</td>
</tr>
<tr>
<td>Petrobras Project</td>
<td>Design, Fabricate, Test</td>
<td>~ $3 MM</td>
</tr>
<tr>
<td>Magnolia Project</td>
<td>Design, Fabricate, Test, Certify, Install and Monitor</td>
<td>~ $10 MM</td>
</tr>
<tr>
<td>Det Norske Veritas</td>
<td>Preparing Operating Standards and Testing Riser Components</td>
<td>~ $1 MM</td>
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</table>

SCC has conducted at least $35m worth of R&D effort to gain the knowledge and IP underpinning PANGAEA valuation.
To discuss this investment opportunity further please contact

Steven Hill
Email: shillassociates@aol.com
Cell: 713-417-0390