ComTrac® – Carbon rod conveyance
Compensator Skid
Weight: 5000 kg
Size: 3.2 x 2.4 x 3.8 m

Drum Skid
Weight: 9000 kg
Size: 4.0 x 2.4 x 3.8 m

Injector Head
Weight: 2300 kg
Size: 1.0 x 1.1 x 2.3 m

Bend Restrictor
12 mm carbon composite Rod
Compensator Skid
Weight: 5000 kg
Size: 3.2 x 2.4 x 3.8 m

Drum Skid
Weight: 9000 kg
Size: 4.0 x 2.4 x 3.8 m

Injector Head
Weight: 2300 kg
Size: 1.0 x 1.1 x 2.3 m

Bend Restrictor
12 mm carbon composite Rod
High power electrical conductor

Composite materials for strength

Centre conductor resistance: 5.2 Ω/Km
Insulation resistance: >1,500 MΩ x Km
Shield conductor resistance: 8.4 Ω/Km
Normal capacitance: 260 pF/m

Max Voltage: 1,500 VDC / 1000 VAC
Max current: 7A

Tensile strength: >15,000 Kg
Compression strength: >700 Kg

Simple pressure control
Low friction coefficient
Carbon fibres reinforce a polymer matrix to give excellent mechanical properties

Strength to weight
  - Twice the strength at one third of the weight (in water)

Less stretch gives better depth accuracy
  - One fifth of the stretch coefficient of regular cables

Slick surface
  - simplified PCE without grease

Sour service
  - Resistant to H₂S and CO₂

Electrical conductor
  - Can accommodate large conductor for high power tools
In a conventional well, the strength of the rod allows larger and heavier toolstrings.

Wireline hold up depth surpassed – access to lateral sections

Push/Pull with a tractor extends reach, rod strength ensures successful retrieval.
Job 1: Offshore Norway
- 28 runs total
  - Logging and mechanical intervention
  - Heavy toolstrings and jarring

Job 2: Onshore continental Europe
- 5 runs
  - Camera
  - PLT

Job 3: Offshore Norway
- 5 runs
  - Fishing
  - Logging
  - Perforating
Third deployment: Offshore North Sea

- 5 runs in hole with maximum deviation over 90 deg

Operations:
- 2 fishing runs with tractor

- 1 Saturation log with tractor
  - Logging interval ~ 1000ft
  - Logging speed <2 ft per minute
  - Time for one pass ~10 hours
  - No stick/slip means fewer passes – over 24 hours operating saved

- 2 Perforating runs with tractor
  - Each string over 52m in length including tractor
  - Conventional wireline would have doubled the runs to 4

- 350 operational hours with no NPT attributable to ComTrac®
Third deployment: Offshore North Sea

- 5 runs in hole with maximum deviation over 90 deg
- Operations:
  - 2 fishing runs with tractor
  - 1 Saturation log with tractor
  - Logging interval ~ 1000 ft
  - Logging speed < 2 ft per minute
  - Time for one pass ~ 10 hours
  - No stick/slip means fewer passes – over 24 hours operating saved
  - 2 Perforating runs with tractor
    - Each string over 52 m in length including tractor
    - Conventional wireline would have doubled the runs to 4
- 350 operational hours with no NPT attributable to ComTrac®
Job 4
Offshore, horizontal producer
Objective: Run and perforate a newly completed well

Total number of guns required: 55 twenty foot guns
Oriented perforation – string contains up to 3 orienting weights
First run perforated underbalanced.

ComTrac – 5 runs

Longest String 140m, 3300kg
Stop press - Job 4

To put it in perspective:
- Standard size football pitch
- Run 1 – 3 guns
- 11 guns
- 15 guns
- Goal achieved
Rod analysis

- 14 samples of rod were cut over the 28 runs

- Remainder of the rod measured

<table>
<thead>
<tr>
<th>Distance from rod end (m)</th>
<th>number of measurement points</th>
<th>Individual reading value range(mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-250</td>
<td>44</td>
<td>11.82-11.99</td>
</tr>
<tr>
<td>250-830*</td>
<td>5</td>
<td>11.53-11.94</td>
</tr>
<tr>
<td>830-3700</td>
<td>4</td>
<td>&gt;11.94</td>
</tr>
</tbody>
</table>

* including section with uneven wear (500-700m)

Average diameter reduction from sample 1 to 14 around 0.2mm

Wear corresponds to section of hole where angle is dropping
Rod wear implications

- Maximum wear measured <0.5mm
- Wear accumulated over 28 runs, with many up and down cycles on each run
- Wear only observable where rod rubs on wall over angle change
- Rod unlikely to cause wear grooves in completion, unlike conventional intervention methods
Rod structural analysis

- Sections tested using both non-destructive and destructive testing for cracks

Ultrasound testing

- The rod section is passed through an array of 8 air-coupled ultrasound transducers designed to detect internal cracks
- A continuous “log” of the interior condition is generated
- Sections with interior cracks can be identified
Physical inspection

The rod is cut into 5cm pieces, polished and inspected with a microscope.

Section from job showing slight crack. The crack does not extend axially. No fracture growth radially.

Section from previous testing. Diametrically opposed cracks (injector). No axial growth.

No loss of tensile strength in either case.
More challenging applications

Consider a long reach well:

- 5,500m section at over 67°.
- 4 separated zones totalling 40 m to perforate.
- Preference to shoot underbalanced.

Concerns for conventional wireline:

- Unlikely to reach TD without a tractor.
- Multiple runs required.
- Underbalance risks toolstring being blown uphole.
## TOOL STRING DIAGRAM

<table>
<thead>
<tr>
<th>Schematic</th>
<th>Tool Model</th>
<th>Description</th>
<th>Length [m]</th>
<th>Weight [kg]</th>
<th>OD [in]</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHD CT</td>
<td>CHD CT</td>
<td>CTD CHD</td>
<td>0.59</td>
<td>3.82</td>
<td>2.68</td>
</tr>
<tr>
<td>M22L</td>
<td>Shooting CTD 2 1/8&quot;</td>
<td></td>
<td>0.60</td>
<td>3.00</td>
<td>2.71</td>
</tr>
<tr>
<td>PSS</td>
<td>Peforating Shoot Sub</td>
<td></td>
<td>0.75</td>
<td>16.00</td>
<td>2.71</td>
</tr>
<tr>
<td>FH</td>
<td>Firing Head</td>
<td></td>
<td>2.25</td>
<td>6.00</td>
<td>2.71</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Tandem</td>
<td>2-7/8&quot;</td>
<td></td>
<td>0.25</td>
<td>13.00</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Tandem</td>
<td>2-7/8&quot;</td>
<td></td>
<td>0.25</td>
<td>13.00</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>Run 2-7/8&quot; 32'</td>
<td></td>
<td></td>
<td>0.83</td>
<td>223.50</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
<tr>
<td>BH</td>
<td>Bullnose</td>
<td>2-7/8&quot;</td>
<td>0.15</td>
<td>5.00</td>
<td>2.88</td>
</tr>
<tr>
<td>Select Fire Switch</td>
<td></td>
<td></td>
<td>0.25</td>
<td>3.40</td>
<td>2.88</td>
</tr>
</tbody>
</table>

The solution:

- A single run, with selective fire
- String weight nearly 1,000kg – length almost 50m
- All zones perforated in a single run in hole
- String weight and rod rigidity counteract effect of underbalance
- No tractor needed

![Surface weight graph](chart.png)

### Notes:
- Total length: 1200 m
- Total Weight: 1250 kg
- Max. OD: 2.88 in
Questions?

Archer