Polyurethane foam pig with a pipe bore measurement system integrally moulded into the tool.
South Pars Gas Field
South Pars Gas Field

Iran – South Pars phases 6-7-8
Sea Line 1
Sea Line 1

Scale Thickness - Run 2

Scale Volume Per Block (m³)
Scale Thickness Per Block

Distance (m)
Sea Line 1

Cumulative Scale Volume - Run 2

Distance (m)
Volume (m³)

Cumulative Scale Volume

Sea Line 1

Cumulative Scale Volume - Run 2

Distance (m)
Volume (m³)

Cumulative Scale Volume
Sea Line 2 - 2005

- 32” Gas and Condensate Line
- Known to have hard scale deposits
- The line had not been gauged
Sea Line 2
32” Multi-Channel Caliper
With 50% Bore Passing Capability
32” Multi-Channel Caliper
With 50% Bore Passing Capability
Bore Proving Tool

- Assess the restrictions in the pipeline prior to putting in a hard bodied pig
- First pass measure of the thickness & distribution of deposits to help plan cleaning campaign
Scale & Wax Measurement Tool

- Measure during cleaning
- Final measurement to ensure pipe clean enough for ILI tool
Scale & Wax Measurement Tool
Scale & Wax Measurement Tool
Pathfinder Development
2009

Bore Proving Tool Requirements

• Soft Bodied – Flexible
• No External Mechanical Parts
• Measures & Records the Pipe Bore
• Useable by the Client
• Reasonably Priced
Pathfinder Development

- 2009 – Concepts & Feasibility
- 2010 – Working Prototypes
- 2011 – Operational Prototypes
- 2012 – First Job
The Pathfinder

Features

- Foam Pig – Medium to High density PU
The Pathfinder
Features

• Removeable caliper cartridge containing sensors, logger and batteries
The Pathfinder

Features

- Caliper Cartridge – Connect run plug to power up
- Simple to Load
The Pathfinder

Features

• Electromagnetic Transmitter Can be added as an option
The Pathfinder
Features

- Multi-channel system - 8 Caliper sensors
- Clock Position (Roll) & Tilt measurement included
The Pathfinder
Features

- Girth weld detection
The Pathfinder
Features

- Disposable foam body with re-useable caliper cartridge
Line K1, Naples
ExxonMobil
Line K1, Naples

Internal Anodes On Similar Pipeline
Line K1, Naples

Gauging Pig Cut Out
Line K1, Naples
Line K1, Naples

Test Loop Anode Response

Pipeline Anode Response
Line K1, Naples

Sample Of Data From Pipeline Showing 2 Bends and 6 Anodes
12” x 12km Crude Oil Pipeline
Offshore Sicily

Minor wax deposits found
12” x 29km Crude Oil Pipeline
Offshore Sicily

Looking For Wax Deposits

Minor wax deposits found
16” x 11km Diesel Pipeline
Onshore Sicily

Bi-di pig stuck and reversed out both ways
14” x 23km Natural Gas Pipeline
East Coast Italy

Cleaning prior to MFL inspection

Pressure Spikes observed 3.5hr into run

Pathfinder identified 2 restrictions 3hr 20min into run
12” x 2km Crude Oil Pipeline
Offshore Sicily

Cleaning prior to MFL inspection
Pathfinder looking for hard scale or wax deposits
Data analysis showed large anomaly 12 min into run
12” x 2km Crude Oil Pipeline
Offshore Sicily
### 12” x 2km Crude Oil Pipeline
Offshore Sicily

<table>
<thead>
<tr>
<th></th>
<th>Max Dent Depth</th>
<th>Max Bore Restriction</th>
<th>Est Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run 1</td>
<td>74mm</td>
<td>100mm</td>
<td>15.2m</td>
</tr>
<tr>
<td>Run 2</td>
<td>63mm</td>
<td>86mm</td>
<td>13.4m</td>
</tr>
<tr>
<td>Run 3</td>
<td>66mm</td>
<td>94mm</td>
<td>12.8m</td>
</tr>
</tbody>
</table>
12" x 2km Crude Oil Pipeline
Offshore Sicily
Pathfinder Development
2009

Bore Proving Tool
Requirements

• Soft Bodied – Flexible
• No External Mechanical Parts
• Measures & Records the Pipe Bore
• Useable by the Client
• Reasonably Priced
### The Pathfinder
#### Technical Data

<table>
<thead>
<tr>
<th>Pig Sizes</th>
<th>To suit nominal pipe bores 4” to 16”</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foam Pig Body</td>
<td>Medium density polyurethane</td>
</tr>
<tr>
<td>Operating Pressure</td>
<td>20bar standard – 200bar option</td>
</tr>
<tr>
<td>Caliper Sensors</td>
<td>8 independent caliper sensors</td>
</tr>
<tr>
<td>Orientation Sensors</td>
<td>Roll and Tilt</td>
</tr>
<tr>
<td>Data Download</td>
<td>USB interface to laptop or PC</td>
</tr>
</tbody>
</table>