Leak Detection in Pressurized Pipelines Using SmartBall Technology

Mogan Padayachee  
Rand Water Services  
Johannesburg, South Africa

Mike Wrigglesworth  
Pure Technologies Ltd.  
Benghazi, Libya
Topics

• Importance of Asset Management Program
• Leak Detection as Condition Assessment Indicator
• SmartBall Technology Overview
  – Case Study
• Prestressed Concrete Pipelines in South Africa
• Questions
Why is Asset Management So Important?

- Regulatory requirements
- Aging infrastructure and renewal requirements
- Procurement challenges
- Backlogs in terms of service delivery
- Water Quality Disasters
- Non-Revenue Water (NRW) – unacceptably high
- Need for real-time management of water services and water assets
An Integrated Dynamic Approach

- Destructive
- Non-destructive
- Non-interruptive
- Real-time / remote monitoring of water assets.
- GIS / MIS
- Cost / risk / benefit models
- Failure risk predictability models: Rehabilitation vs replacement models
Leak Detection for Condition Assessment?

• A leak detection survey is a great ‘First Step’ for a large diameter pipeline condition assessment program
• Not just NRW concern
• Water from leaks can promote corrosion of:
  – Cylinder
  – Joints
  – Prestressed Wires
• Settlement/joint displacement
• Erosion concerns
• Leak detection in large diameter pipe has been challenging for conventional technologies
• SmartBall - internal leak detection technology
• Commercially available since 2007
• Surveyed more than 1000km of pipe
• Water and wastewater applications

SmartBall
SmartBall Insertion/Extraction

- Minimum 100mm (4”) top outlet with valve (6-inch for new taps)
- 8 bolt flange pattern
- Adequate headroom
SmartBall Capture
While Traversing the Pipeline

- SmartBall travels near the flow velocity
- Emits acoustic ping every 3 seconds
- Tracking equipment used to follow SmartBall
- Records data up to 12 hrs (longer times possible)
SmartBall Case Study in Jo’Burg

- B1 pipeline is a 1370mm steel pipeline with lead caulked joints laid in 1964
- Over time and as a result of excessive internal water pressure taking up by stress inside the pipeline, the movement of the pipes has given rise to displacements of the keeper rings and lead on the joints resulting in leaks.
- 7.5km of the B1 pipeline was inspected in two phases using SmartBall
# Phase I Leak Locations

<table>
<thead>
<tr>
<th>Leak number</th>
<th>Distance from insertion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>617</td>
<td>Small</td>
</tr>
<tr>
<td>2</td>
<td>637</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>738</td>
<td>In the chamber</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>2405</td>
<td>Large</td>
</tr>
</tbody>
</table>
## Phase II Leak Locations

<table>
<thead>
<tr>
<th>Leak number</th>
<th>Distance from insertion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>643</td>
<td>Medium</td>
</tr>
<tr>
<td>2</td>
<td>804</td>
<td>Medium</td>
</tr>
<tr>
<td>3</td>
<td>922</td>
<td>Medium</td>
</tr>
<tr>
<td>4</td>
<td>947</td>
<td>Medium</td>
</tr>
<tr>
<td>5</td>
<td>990</td>
<td>Medium</td>
</tr>
<tr>
<td>6</td>
<td>1514</td>
<td>Medium</td>
</tr>
<tr>
<td>7</td>
<td>1776</td>
<td>Medium</td>
</tr>
<tr>
<td>8</td>
<td>1819</td>
<td>Medium</td>
</tr>
<tr>
<td>9</td>
<td>2495</td>
<td>Small</td>
</tr>
<tr>
<td>10</td>
<td>2782</td>
<td>Medium</td>
</tr>
</tbody>
</table>
# Phase II Leak Locations (con’t)

<table>
<thead>
<tr>
<th>Leak number</th>
<th>Distance from insertion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>2959</td>
<td>Large</td>
</tr>
<tr>
<td>12</td>
<td>3352</td>
<td>Medium</td>
</tr>
<tr>
<td>13</td>
<td>3788</td>
<td>Medium</td>
</tr>
<tr>
<td>14</td>
<td>3832</td>
<td>Medium</td>
</tr>
<tr>
<td>15</td>
<td>4177</td>
<td>Large</td>
</tr>
<tr>
<td>16</td>
<td>4308</td>
<td>Medium</td>
</tr>
<tr>
<td>17</td>
<td>4567</td>
<td>Medium</td>
</tr>
<tr>
<td>18</td>
<td>4700</td>
<td>In the Chamber (Medium)</td>
</tr>
</tbody>
</table>
Excavation Results

- To date, seven leaks have been excavated
- None visible at surface
- Locations confirmed
- Repaired
Excavation Results
Conclusions

• Large diameter pipes leak too!
• SmartBall accurately identifies and locates leaks
• 7/18 leaks repaired to date
• SmartBall to be used to inspect remaining 45km of B1 pipeline
Prestressed Concrete Pipe in South Africa

- Widely utilized in the water industry for bulk water conveyance and transmission since the 1940’s.
- PCP are nominally reinforced with pre-stressed wire around the outer section of the pipe for strengthening.
- Currently in operation at many water utilities and municipalities in South Africa.
- Has been documented evidence of deterioration over a period of time.
- Can result in catastrophic blast when wires are broken.
  - Environmental risk
  - Human risk
Prestressed Concrete Pipe
South Africa PCP Network

- DWAF = 200km
- Rand Water = 196km
- Umgeni Water = 80km
- Bloem Water = 110km
- City of Cape Town = 100km
- Durban Metro = 50km
- Nelson Mandela Bay Metro = 140km
- Eskom = 100km
Assessment Methods for PCP

Pipes that can be dewatered

• Electromagnetic Inspection
• Visual Inspection

Pipes that must remain in service

• Acoustic Monitoring
• Leak Detection
Do PCP Leak Before They Fail?

- A leak detection survey is a good first step in condition assessment program
- Joint leaks can lead to further problems with wires
- Early indications are that PCP may leak before catastrophic failure
- Further research required and ongoing
Cape Town PCP

- Voëlvlei Pipeline
  - Constructed 1968 to 1970 by Interpace
  - 77 km 1525 mm diameter
  - Lockjoint SP-31 (non-cylinder type)
  - Circumferential & longitudinal stressing
Cape Town April 2004 Leak

- Standing water in farmers field indicated leak
- Exact position was unknown
  - Could not be determined with traditional instruments
Voëlvlei Pipeline Leak - April 2004

Photos courtesy of Cape Town Water
Cape Town April 2004 Leak

- Condition of wires indicated that the leak was not new
- Not typical – bursts usually catastrophic with no early indication
- Early identification probably prevented catastrophic failure
Photos courtesy of Cape Town Water
Conclusions

• Water loss is more than a NRW issue
• Leak detection is a good first step for the condition assessment of large diameter pipe
• SmartBall is ideal for the inspection of large diameter pressure pipe, including PCP