



An Integrated Approach to Topsides Sand Management

Introduction

- Definitions of Sand & Sand Management
- Why it's good to manage sand – Steps 1-3
 1. Erosion
 2. Deposition
 3. Production Optimisation –See Case Study

Case Study

- BP SGA - Ravenspurn North

Production Optimisation utilising real time Sand Monitoring





Sand & Sand Management Definitions 1

Sand

A detrital grain between 0.0625 mm and 2 mm in diameter. Sand is larger than silt but smaller than a granule according to the Udden-Wentworth scale. Sand is also a term used for quartz grains or for sandstone

Millimeters (mm)	Micrometers (µm)	Phi (φ)	Wentworth size class	Rock type
4096		-12.0	Boulder	Conglomerate/ Breccia
256		-8.0	Cobble	
64		-6.0	Pebble	
4		-2.0	Granule	
2.00		-1.0		
1.00		0.0	Very coarse sand	Sandstone
1/2	500	1.0	Coarse sand	
1/4	250	2.0	Medium sand	
1/8	125	3.0	Fine sand	
1/16	63	4.0	Very fine sand	
1/32	31	5.0	Coarse silt	Siltstone
1/64	15.6	6.0	Medium silt	
1/128	7.8	7.0	Fine silt	
1/256	3.9	8.0	Very fine silt	
0.00006	0.06	14.0	Clay	Mud Claystone

Udden-Wentworth Grain size classification (1922)



Sand & Sand Management Definitions 2

Sand Management

“The process of identifying, evaluating and mitigating against reservoir sand production (and solids – e.g. scale & proppant) and its associated problems”

A.Kinsler - Offshore Magazine June 2009!

Sand Management Segments

1. Prediction
(Rock Mechanics & Modelling)
2. Prevention
(Downhole Control)
3. Monitoring
(Real time Intrusive & Acoustics)
4. Handling
(Online removal from vessels)



Sand Management

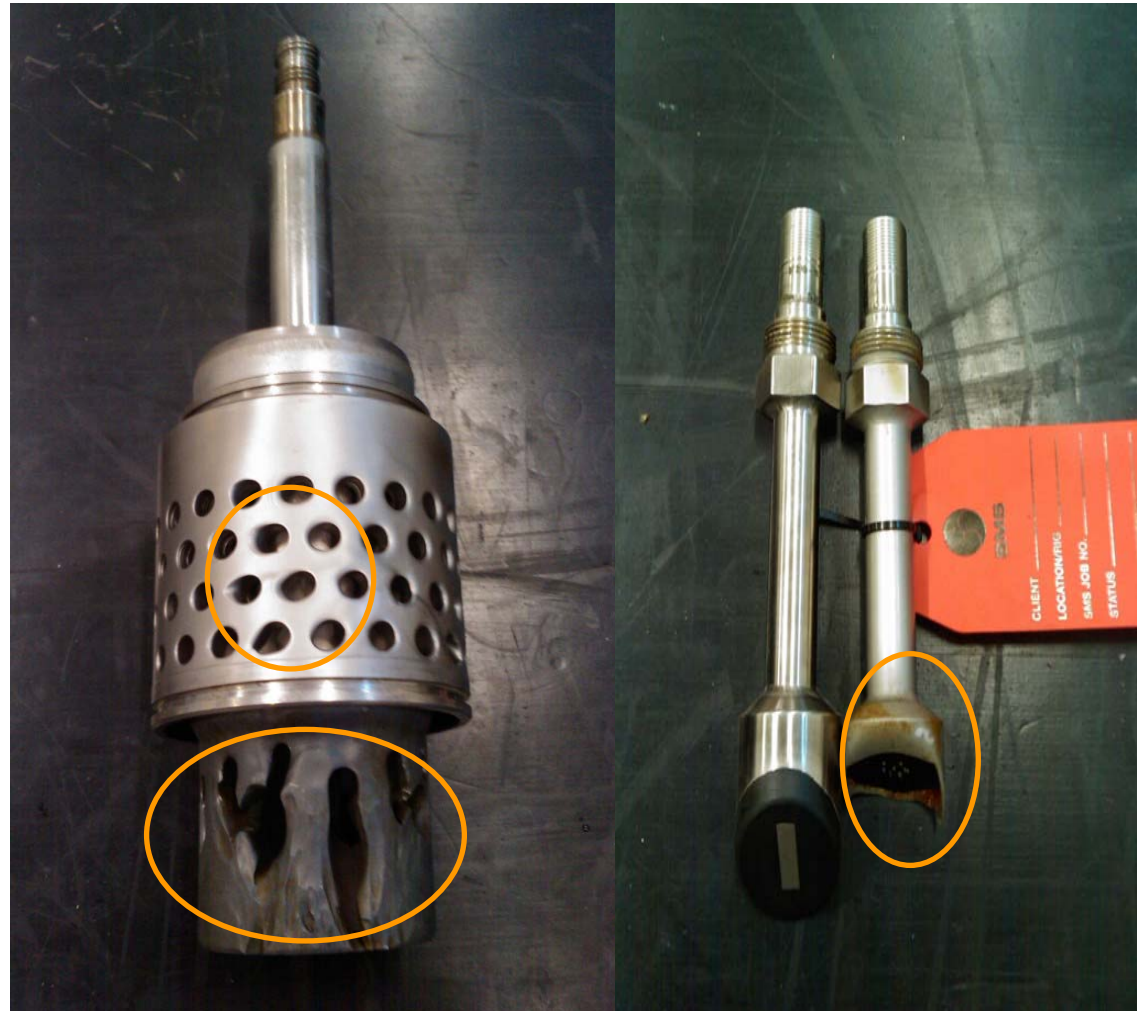
Why it's good to proactively manage sand

Step 1

1. Erosion

HSE's Offshore Division Semi-Permanent Circular SPC/TECH/OSA/19

- Since 1993, at least eighteen dangerous incidents have been directly attributed to produced-sand during oil and gas processing



Cage Choke – extensive Erosion / Probes New & washed out

Sand Management

Why it's good to proactively managed sand

Step 2

1. Deposition

HSE's Offshore Division Semi-Permanent Circular SPC/TECH/OSA/19

- Vessel deposition affecting plant performance, requiring vessel entry to dig out the accumulated sand.
- Furthermore sand deposition can decrease corrosion inhibitor efficiency thereby increasing corrosion / erosion effects





Case Study

BP SGA - Ravenspurn North

Max Sand Free Rate Testing with real time Sand Monitoring

Introduction

- RN Location
- Well Characteristics
 - Historical Issues
- Sand Management GAP Analysis Outputs
 - Hardware Installation
- Production Optimisation Process utilising real time Sand Monitoring

A wide-angle photograph of an offshore oil rig at sea under a cloudy sky. The rig is silhouetted against the horizon. The text "Sand solutions made simple" is overlaid in white at the bottom of the image.

Sand solutions made simple



Ravenspurn North

- Ravenspurn North
- Southern North Sea
- 80 km off East Yorkshire coast
- Developed late 1980s
- First Gas 1990
- BP took ownership 1998
- 42 development wells from ST2, ST3 (NUIs) and RN manned

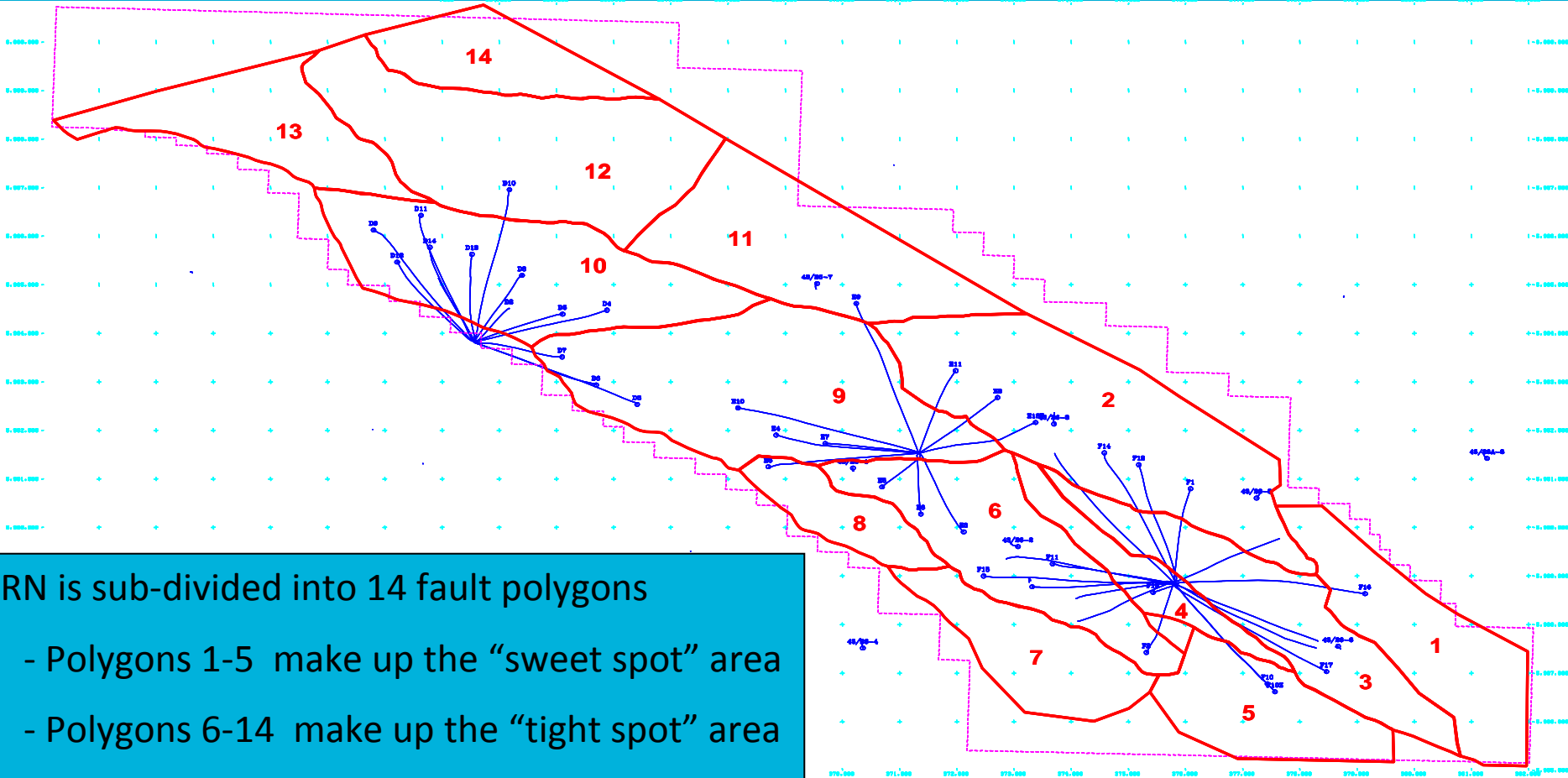


Ravenspur North Well Characteristics

- Sweet spot wells – more permeable part of reservoir
- Tight spot wells – Tight spot wells stimulated by hydraulic propped fracture treatments
- Wells frac'd with non-resin coated Proppant
- Mature field - Reservoir pressure depleted from ~4000 psi to 1000 psi
- Over 1 million lbs of Proppant per frac
- Flowline size: 6" – 10"



Ravenspur North Fault Polygons



- RN is sub-divided into 14 fault polygons
 - Polygons 1-5 make up the “sweet spot” area
 - Polygons 6-14 make up the “tight spot” area
- Material balance models are matched for each producing polygon (9 models in total)



Ravenspurn North Historical Issues

- Significant Sand & Proppant production
- De-sanding units de-commissioned – ceased working
- Sand deposition in the separators and processing facilities

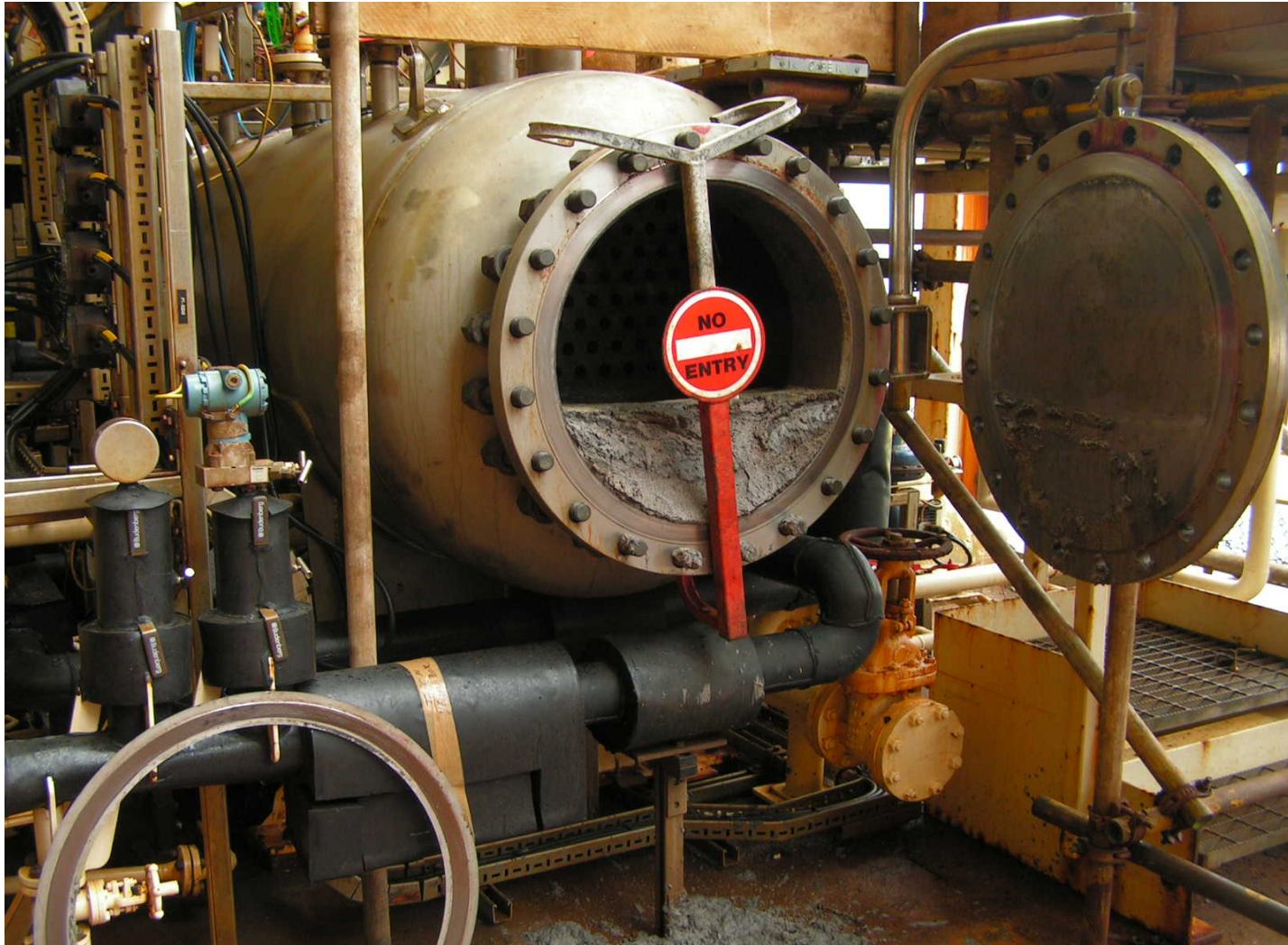


Sand Accumulation Flow Lines





Sand Accumulation Vessels





BP SGA Sand Management GAP Analysis

- Following an integrity review, sand monitoring hardware was procured by SMS for at-risk flowlines
- This was split approx 50/50 Clampon / Roxar
- RN has Clampon DSP sand detectors installed





Hardware Installation 2

- ClampOn DSP acoustic sand detectors installed
- Cabled back to a dedicated sand pc
- Sand pc transfers data into DCS for visibility & alarming
- Dial-in facility to sand pc to allow background noise table
- No real-time flowrate data
- No accurate sand rate calibration possible



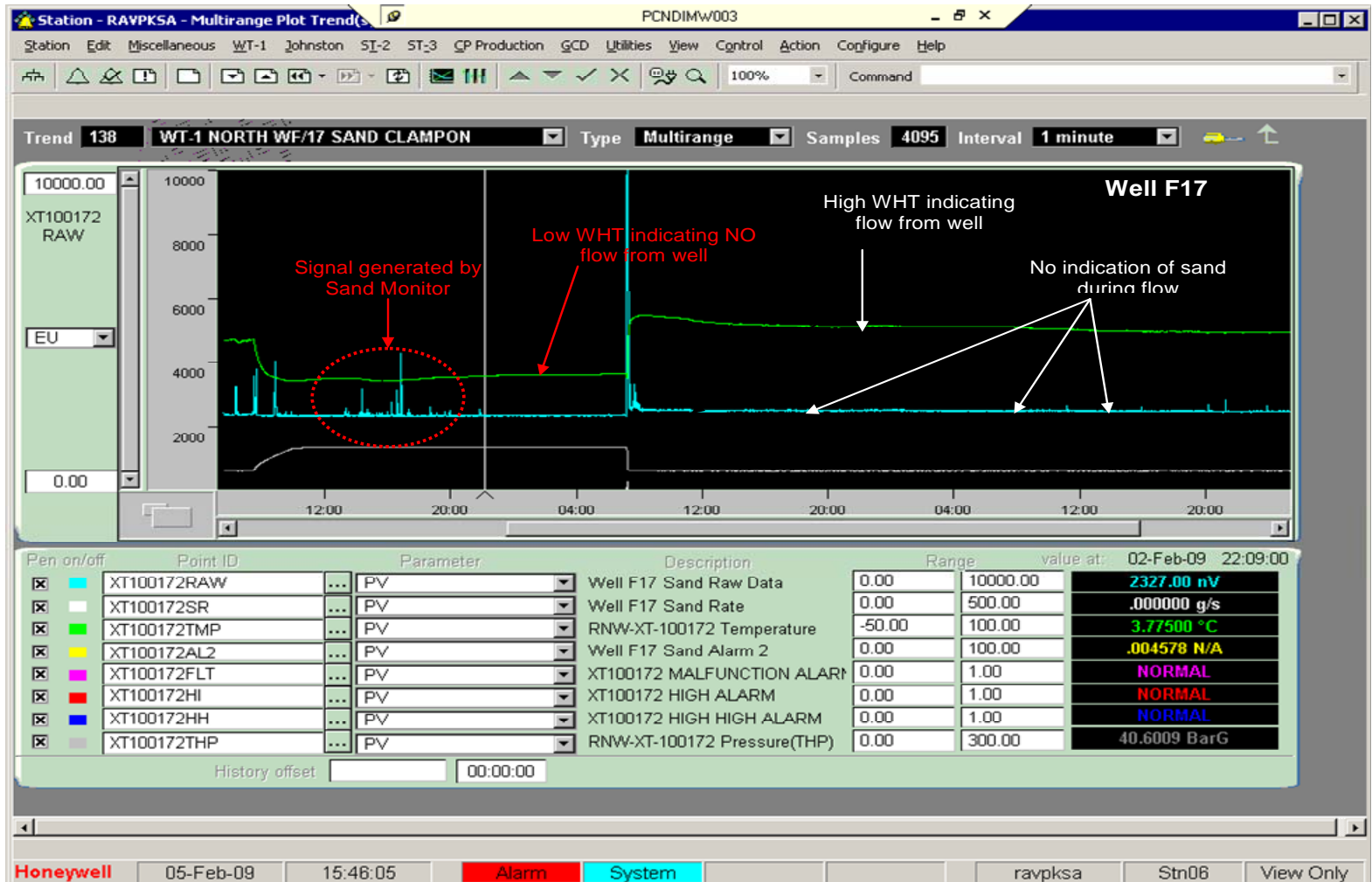
Optimisation Plan Overview / Method

- F17 biggest producer on RN at ~9 mmscf/d
- Well is liquid-loaded
- Well is suspected sand producer
- Sand Risk Assessments Completed for wells
- WHP reduction planned for 2 bar drop



Sand Monitor Test Data

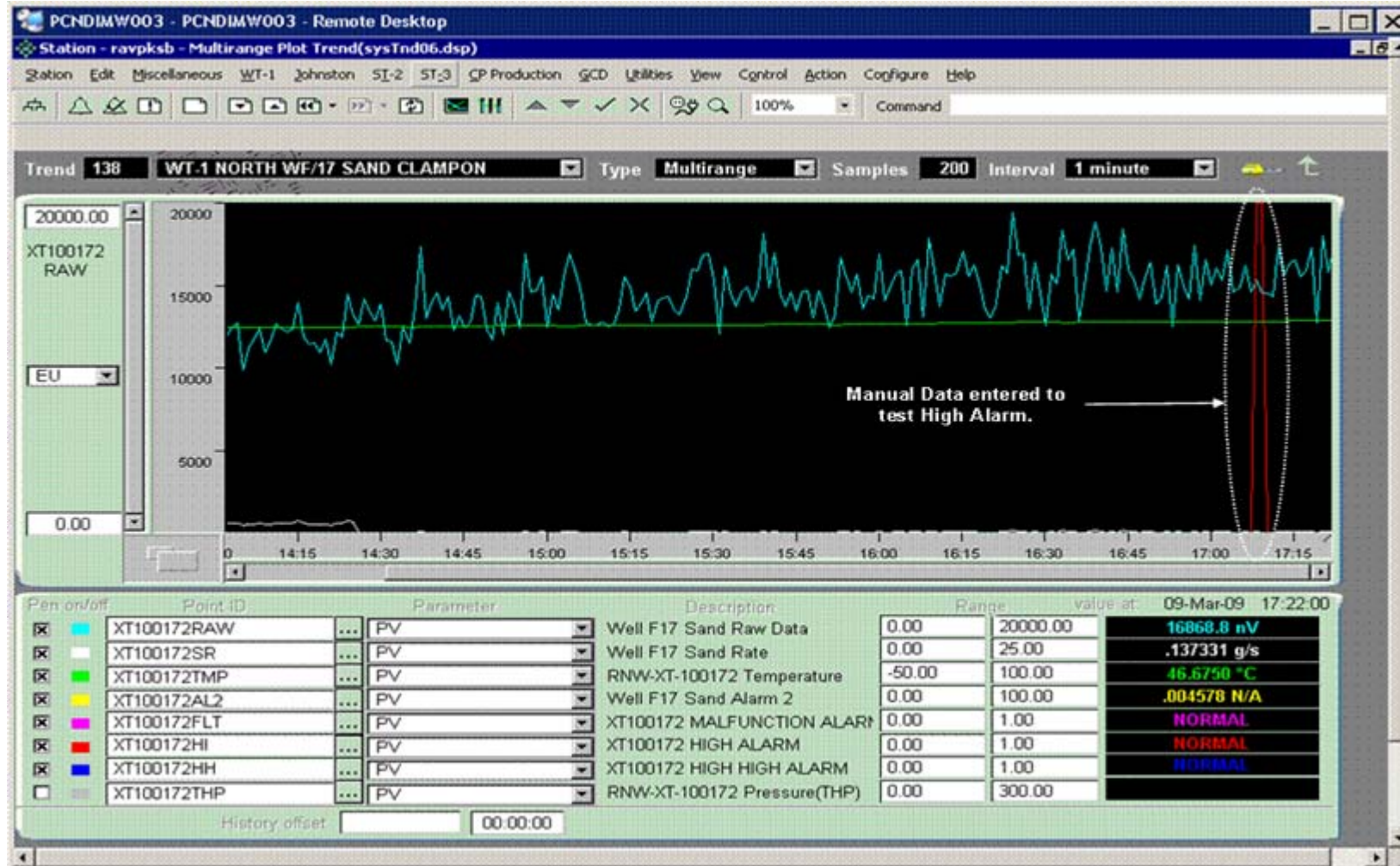
Well F17 at 18 bar Suction Pressure





Sand Monitor Test Data

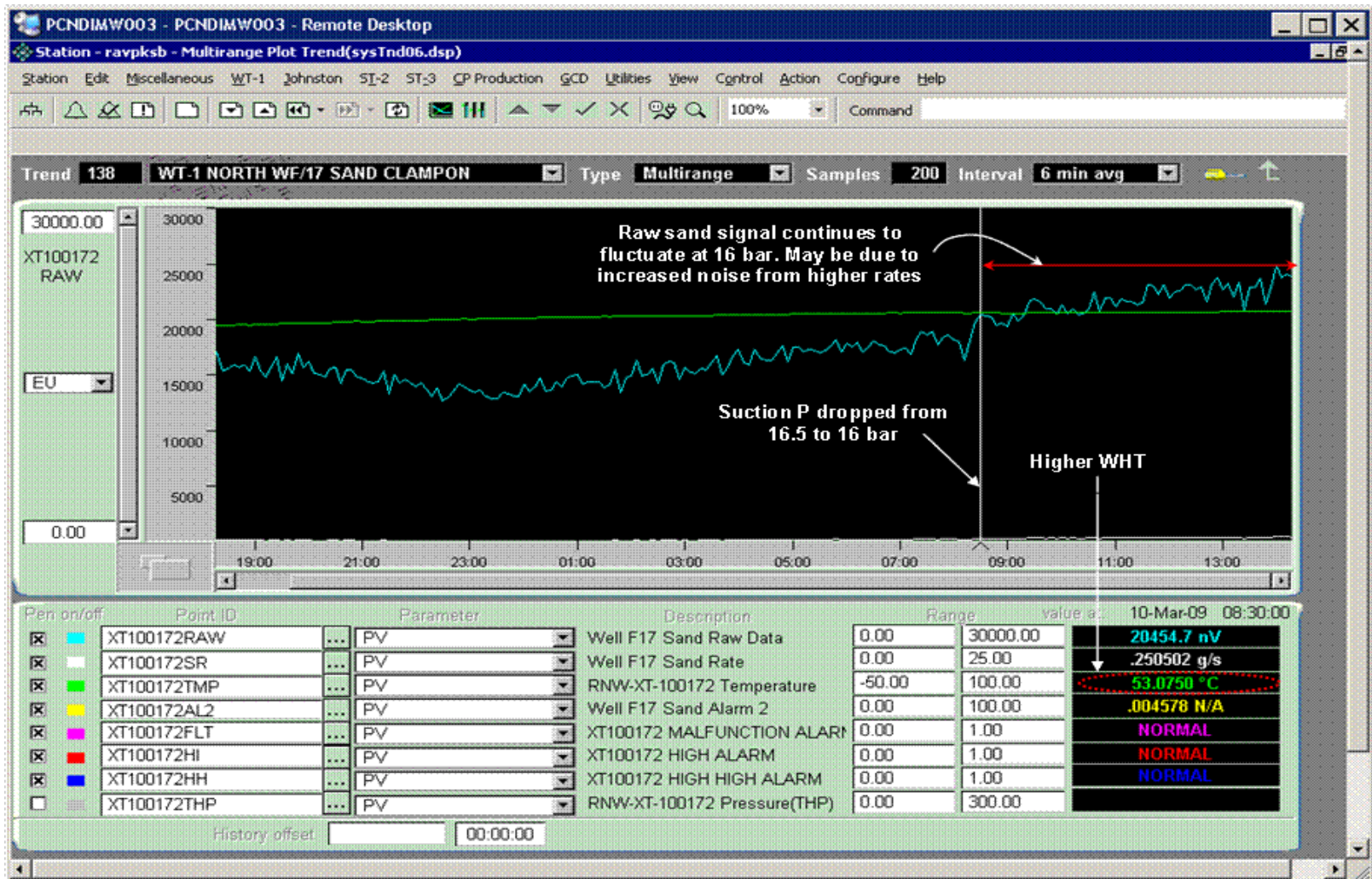
Well F17 at 16.5 bar Suction Pressure





Sand Monitor Test Data

Well F17 at 16.0 bar Suction Pressure

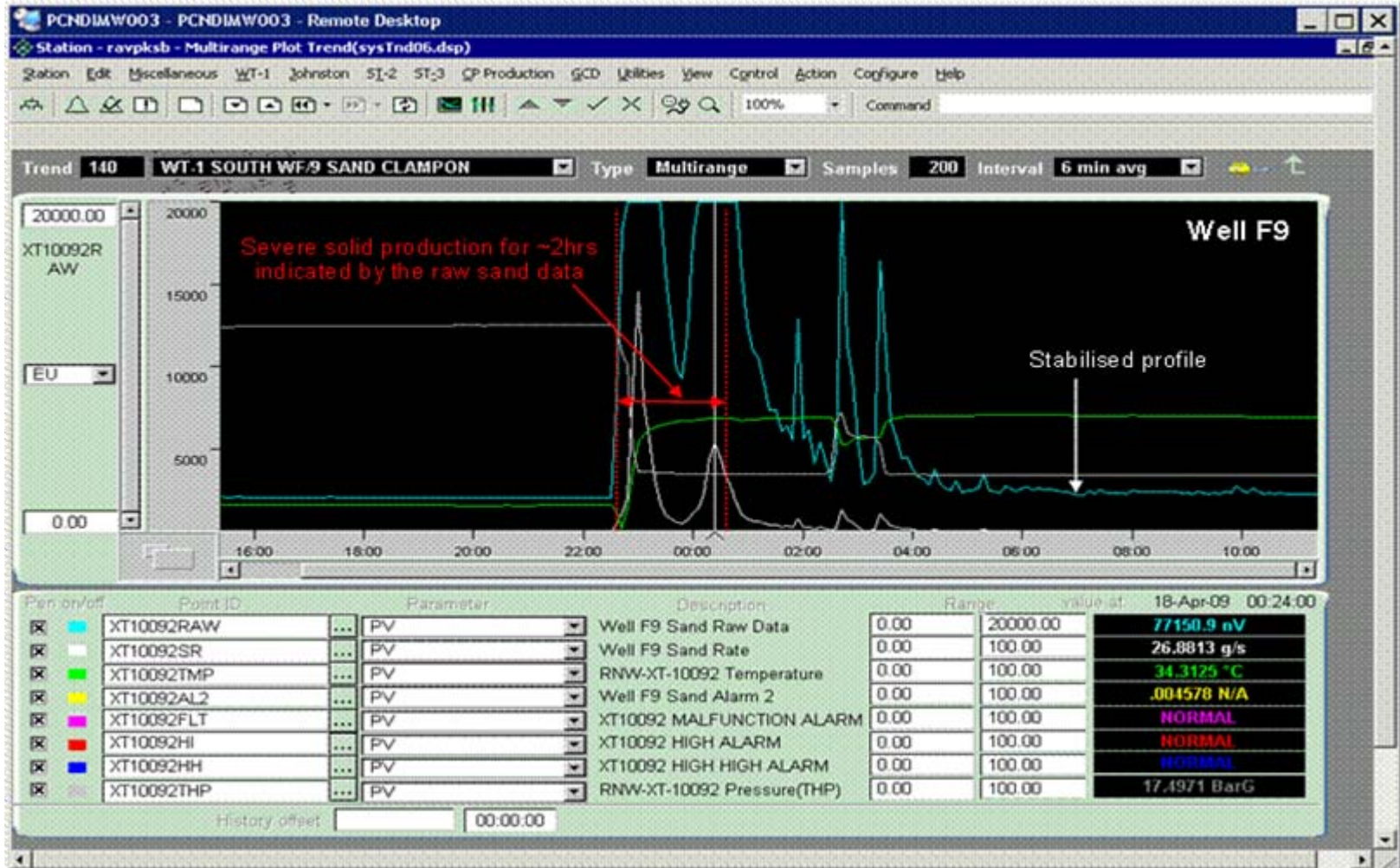




Sand Monitor Test Data

Well F9 at 16.0 bar Suction Pressure.

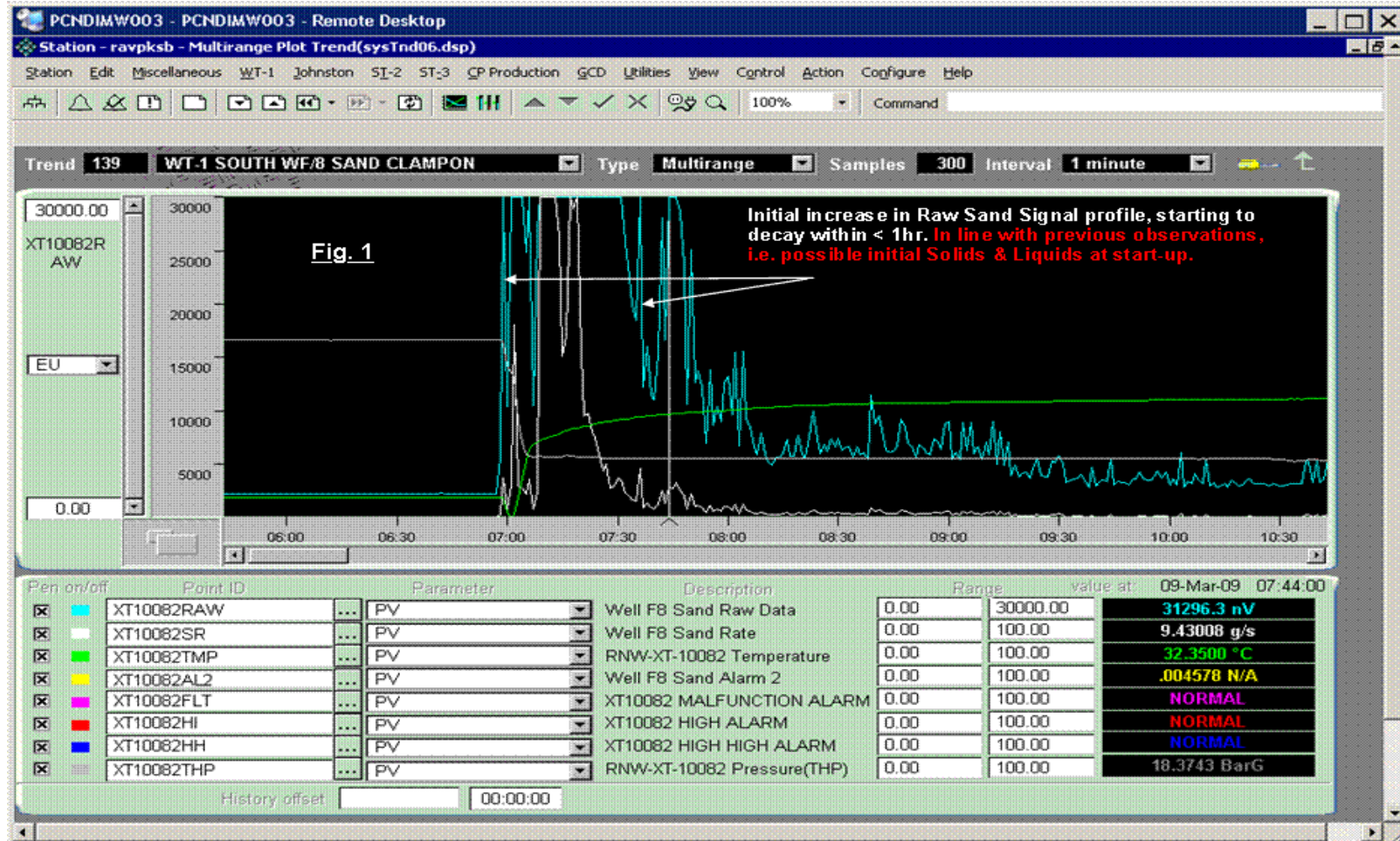
Excessive Transient Solids Production to Sand Free





Sand Monitor Test Data

Well F8 at 16.0 bar Suction Pressure at Well Start-up





Production Optimisation Test Results

- Although no sand-rate calibration possible, still able to complete:
 - Maximum rate sand free tests
 - Bean-up sand tests
- Uplift from well F17 ~3 mmscf/d
- Well effectively unloaded (large liquid slugs produced during test)
- No sign of additional solids in plant facilities

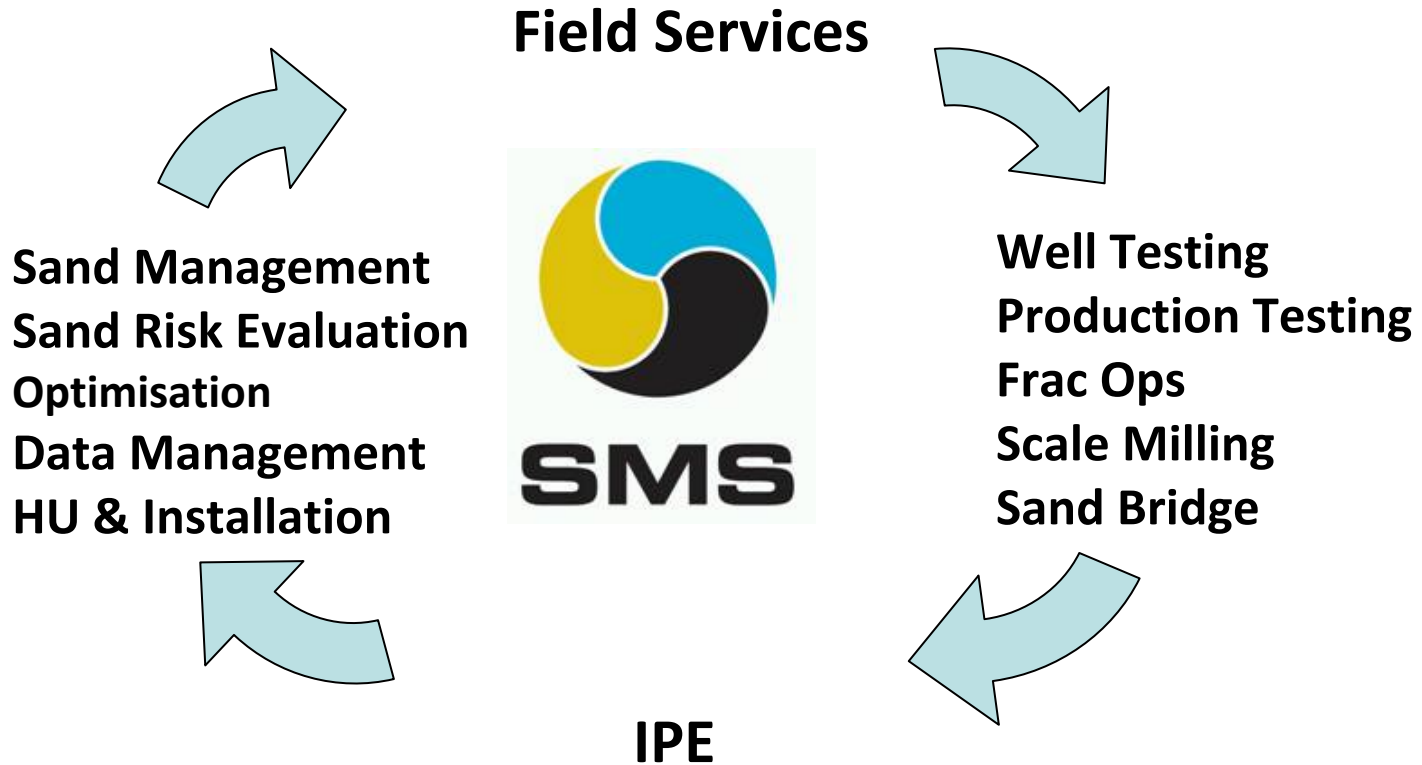


Case Study Conclusions

- Test confirmed that sand testing/monitoring is possible utilising un-calibrated sand detectors
- Training is required to fully interpret & correlate the raw signal from the detectors
- The sand detectors can be used qualitatively to monitor sand-prone wells (where metering a problem)
- Clear positive impact on integrity



Where SMS Add Value Single Source Sand Solution



- Unique Independent Knowledge of Acoustic & Intrusive Systems
- T +44 (0) 1224 853 525 / info@sand-monitoring.co.uk