Integrated Diagnostics of Sand Producing Wells - Amenam Case Study March, 2010

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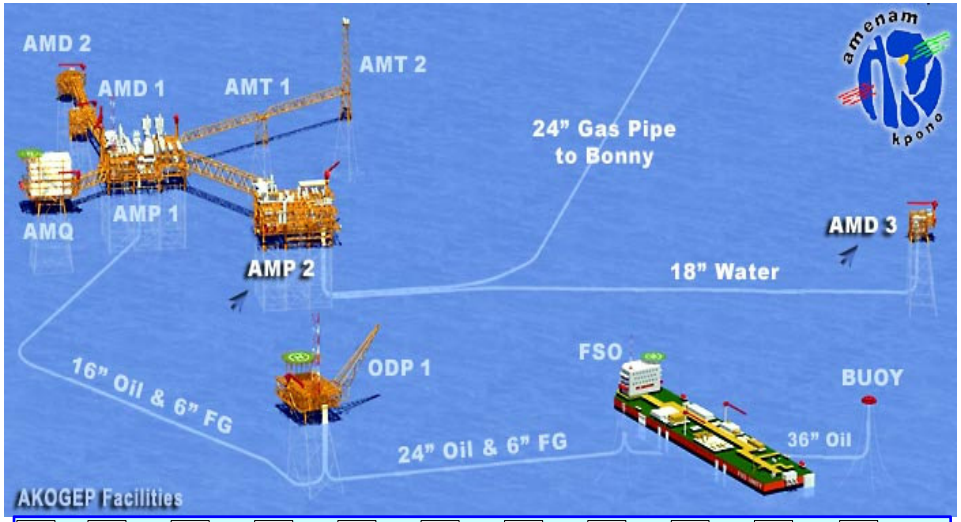
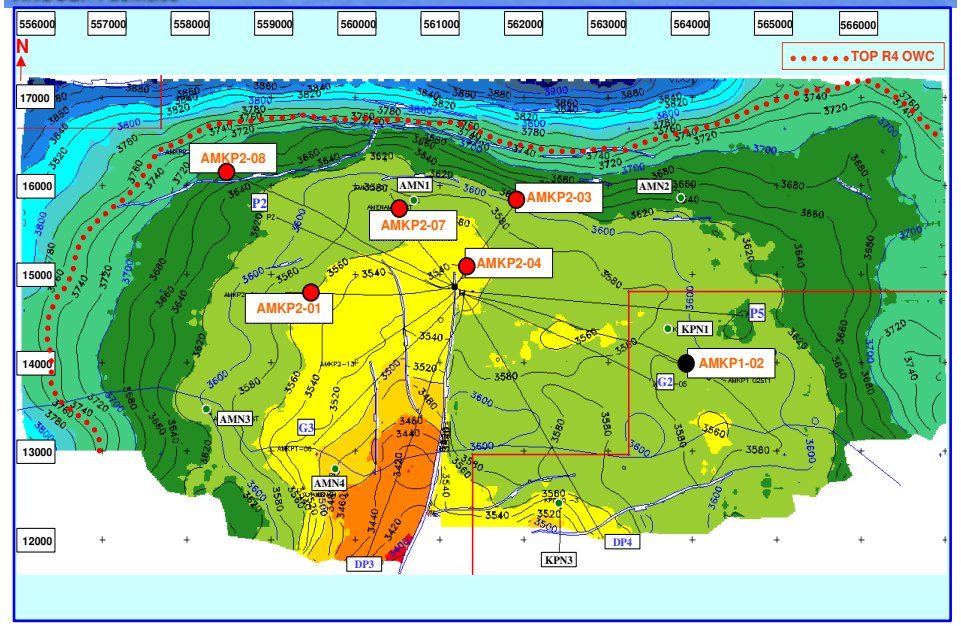
TOTAL

OUTLINE

- Field Overview
- Current Field Status
- Sand Management Strategy
- PSG - Multidisciplinary Approach
- Diagnostics
- Results
- Conclusion

FIELD OVERVIEW



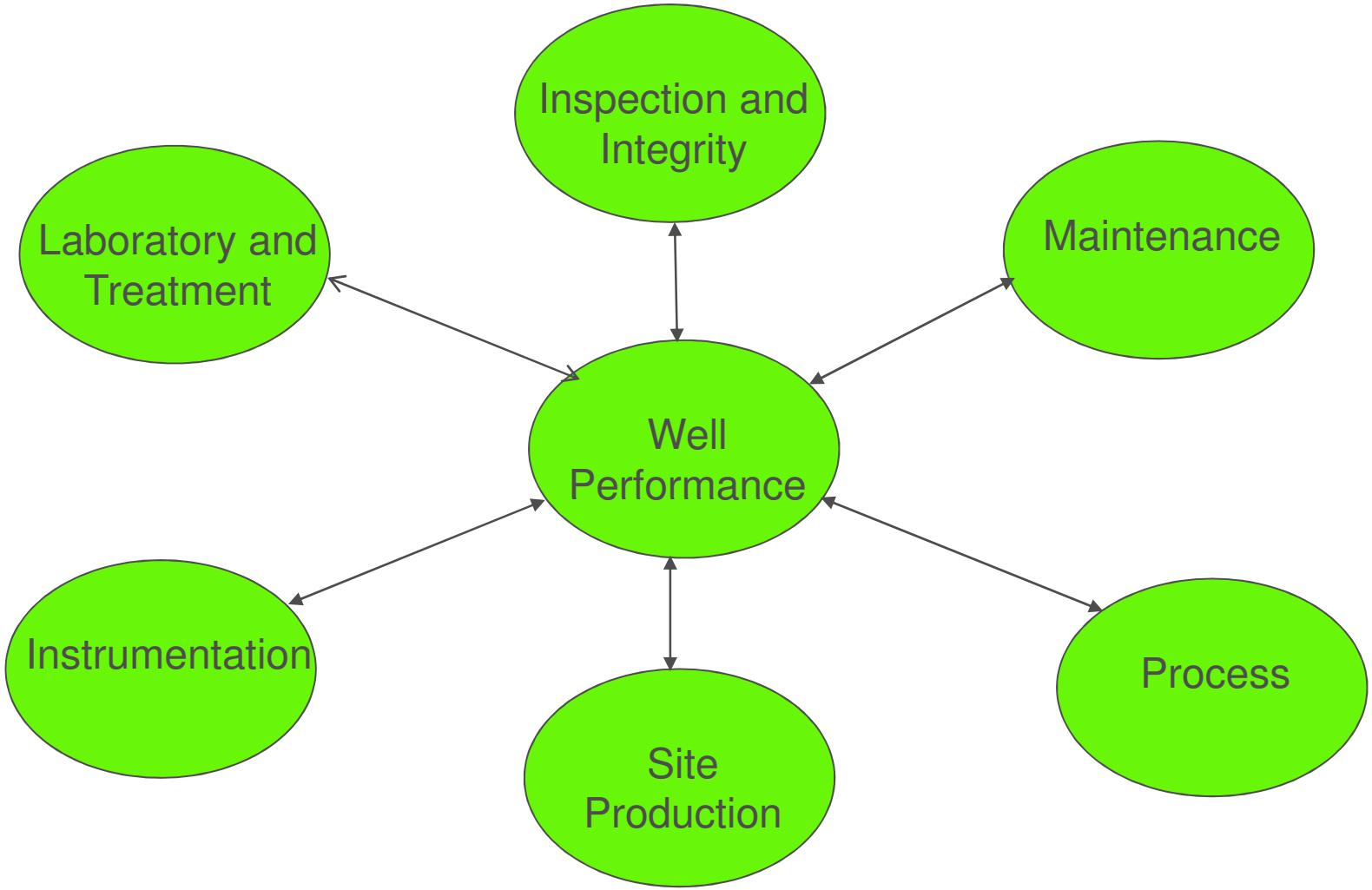


- **Developed on 4 Sandstone reservoirs => 24 Oil producers, 11 Water Injectors, 4 Gas Injectors and 1 abandoned well**
  - R4 (the main reservoir with 67.4% of the reserves) = 15 Oil producers , 4 GI and 7 WI,
  - R9 (1.3% of reserves) => Undeveloped yet
  - R11 (20.4% of reserves) => Initially 5 Oil Producers now 3 and 2 WI
  - R10 (10.9% of reserves) => Initially 4 Oil producers now 6 and 2 WI
- **First oil – July 2003**
- **Initial Completion Strategy =>Selective Perforation of wells along strongest intervals only so as to delay the occurrence of sand production- Thus no Downhole Sand control**
- **Current daily average oil production of 80,000 bopd and 11MMSm3/d of gas**

CURRENT FIELD STATUS

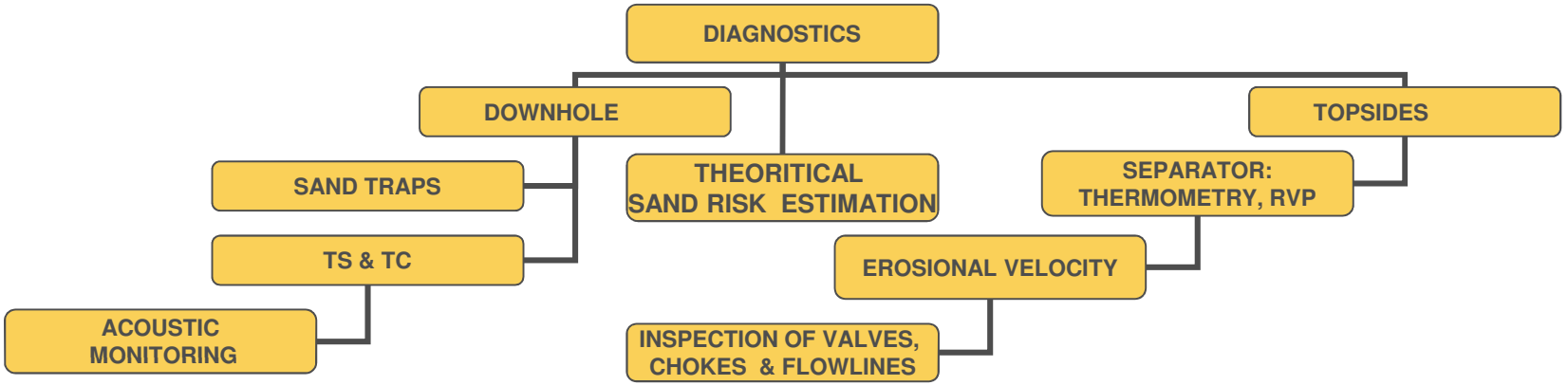
- **Major Water Breakthrough in 2006**
- **Increasing BSW up to 75% and High GOR up to 4500Sm3/m3**
- **Sand Breakthrough - When ??**
  - Passing valves on Test manifold of some HP and MP (Changed out in June, 2009)
  - Sand deposits found in the HP separator
  - Passing choke and Xmas tree valves, (Xmas tree completely changed out in August, 2009)
  - Sand deposits in dead line on manifold of some wells
  - Passing on the Test separator
  - Eroded LDVs and LVs on the HP separator
- **Impact**
  - Shortfalls due to reduction in production rates from suspected wells being choked back
  - Higher operational costs due to increased preventative and corrective maintenance - replaced valves and chokes
  - Separator Cleaning

SAND MANAGEMENT STRATEGY- PSG APPROACH



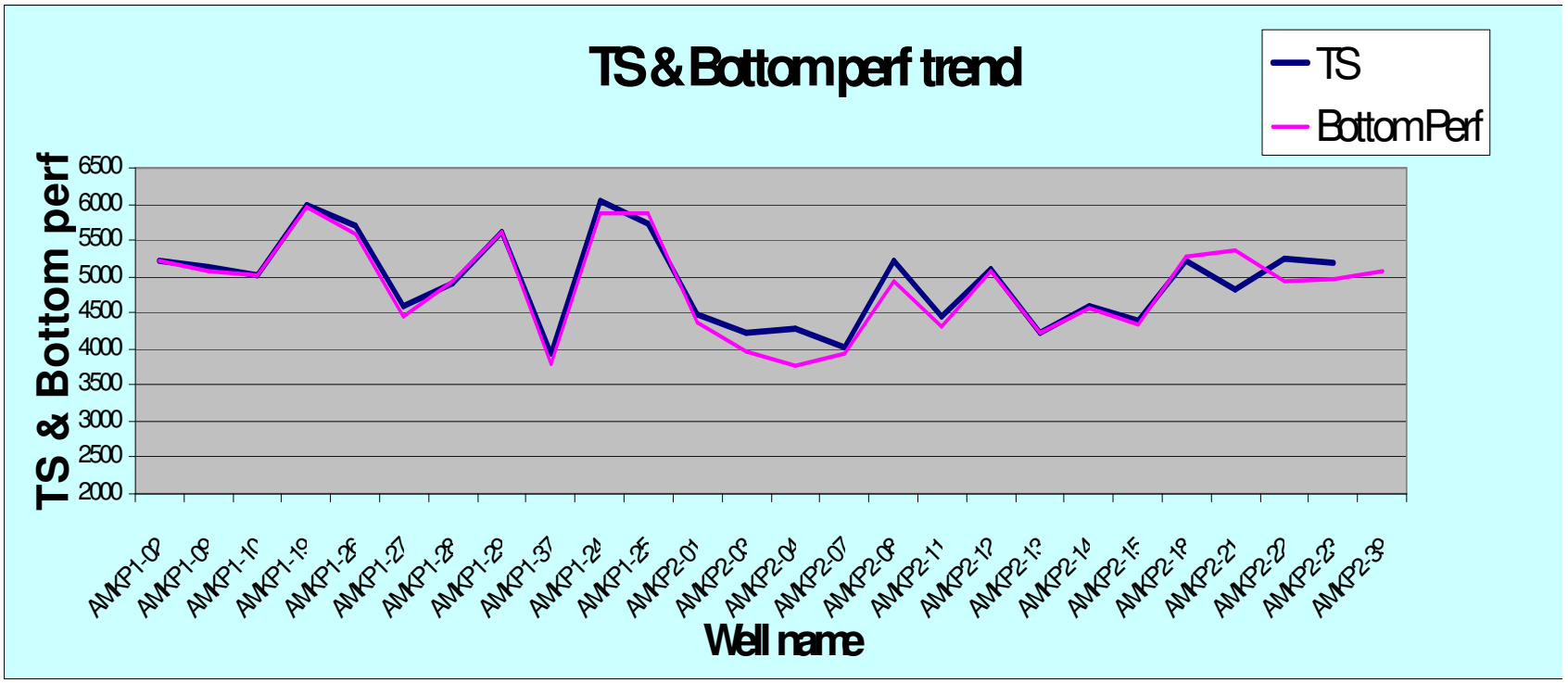
- **TRANSVERSE APPROACH - PSG (Short, Medium and Long term)**
  - Diagnostics, Management / Control from Downhole/ well bore interface to Topside Installations

DIAGNOSTICS



- **General Philosophy : Topside management and control as a start up**
  - Deep wells up to +5,000m
  - High tension experienced with interventions
  - Deviated wells with Inclinations >/= 60 deg
  - Difficult and expensive interventions for through tubing solutions

TS Measurement



- Perforations not really compromised by sediments =>Top sediments < Bottom of perforations
- Sand produced to the surface – Sand in HP and MP separators .

THEORITICAL ESTIMATION

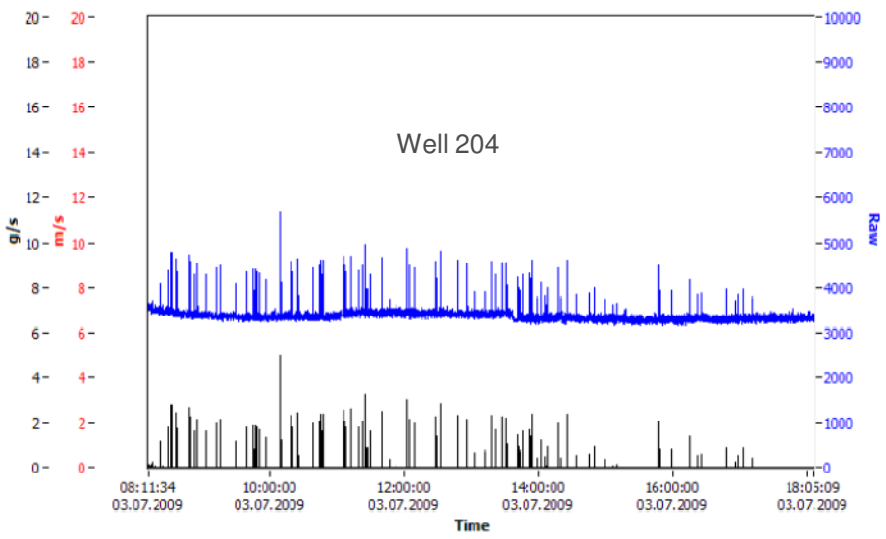
- **Based on Actual BSW**
- **Actual Drawdown**
- **Limit drawdown estimated from Depletion(Initial SP – Current SP) and reservoir bulk density of each well.**
- **Established Criticity, on points ranked on Actual BSW, Actual Drawdown and the Limit drawdown.**
- Wells127, 110, 128, 213, 222 are the most critical wells. Generally, found that risk of sand production was mainly linked to reservoir depletion rather than drawdown, as wells 127, 213 and 222 are seriously depleted.
- **A good and interesting study. Needs to be proven with monitoring and quantification with sand traps**

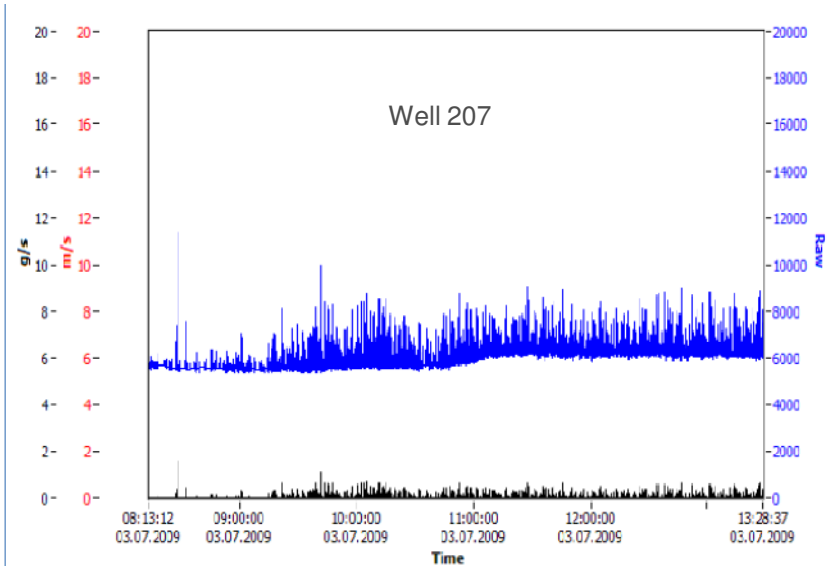
WELL	Criticity
AMKP1-27S	8
AMKP1-10	5
AMKP2-13	4
AMKP1-28	4
AMKP2-22	4
AMKP2-12	3
AMKP1-19	3
AMKP1-09	3
AMKP2-08	3
AMKP2-18	3
AMKP2-15	3
AMKP1-02	2
AMKP2-04	2
AMKP2-01	2
AMKP1-29	2
AMKP2-03	2
AMKP2-14	2
AMKP2-07	1
AMKP1-26	1
AMKP2-23	1
AMKP1-37	1
AMKP2-11	1
AMKP2-39	0
AMKP2-21	0

ACOUSTIC MONITORING- INDICATIVE

- **Spot on monitoring using portable sensors as well as permanent sensors**
- **Very indicative**
- **Not very reliable quantitatively**
- **Corroborates theoretical estimation**
- **Well 204:**
  - Peaks and not continuous sand flows show low sand production
- **Well 207:**
  - Indicates traces of sand throughout the test period of 5hours

WELL	Sand Rate Kg/d
AMKP2-12	23.92
AMKP2-13	8.12
AMKP 1-10	3.37
AMKP2-07	0.69
AMKP2-04	0.52
AMKP1-28	0.38
AMKP1-02	0.26
AMKP1-27	0.03
AMKP2-22	0
AMKP2-39	0



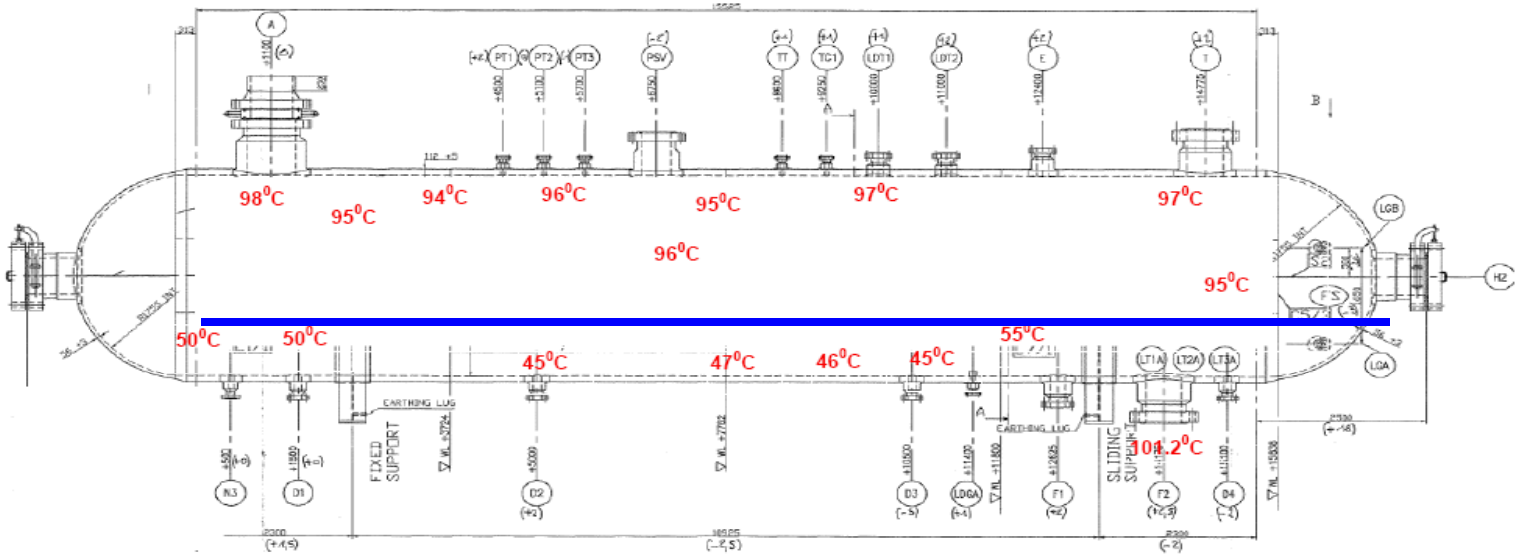


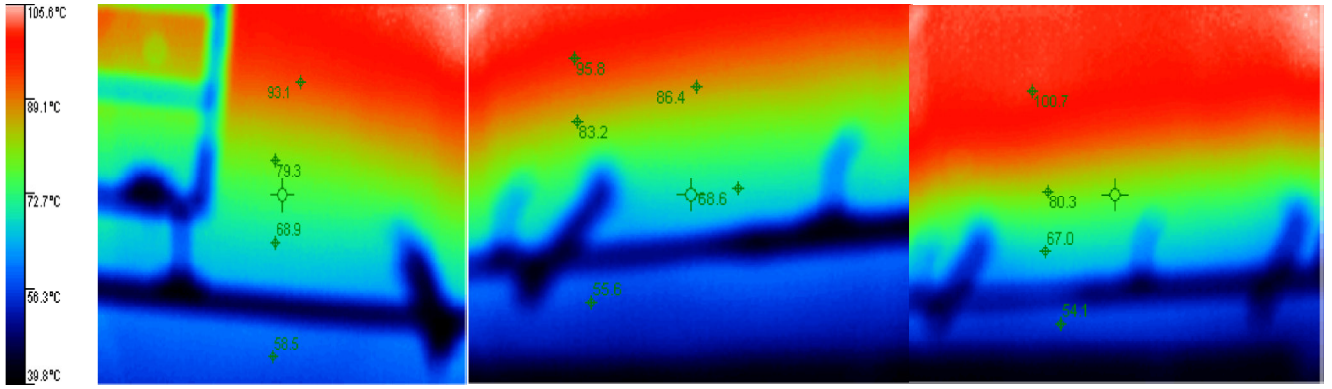
SAND TRAP QUANTIFICATION

- **OBJECTIVE**
  - Identify clearly the sand producing wells,
  - Validation of estimations with physical quantifications / determine the rate of sand production from these wells
  - Establish the maximum allowable sand rates (rates for sand production </= 3kg/1000m3) according to CR with corresponding chokes and WHP.
  - To establish an optimum between sand risk and well productivity

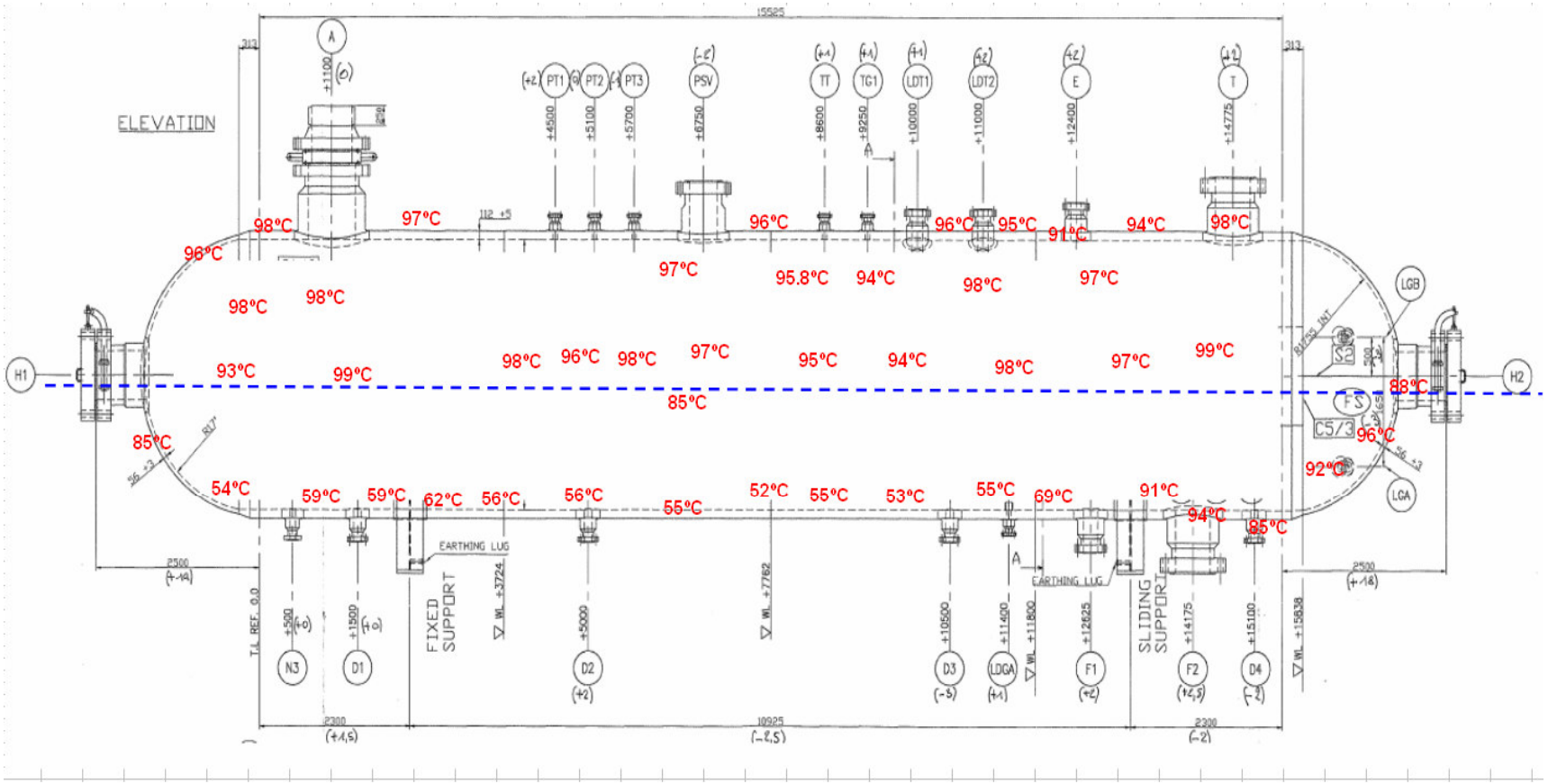
Sand Thermography – Before Desanding

- Thermo graphic Analysis was used to determine the level of sand in the separators
- Very low temperatures indicative of presence of sand .





After Desanding – Sand Thermography



- Temperature increases by about 15 – 20 deg C
- Evacuated Volume during desanding operations = 20.4 tons

INSPECTION AND MAINTENANCE

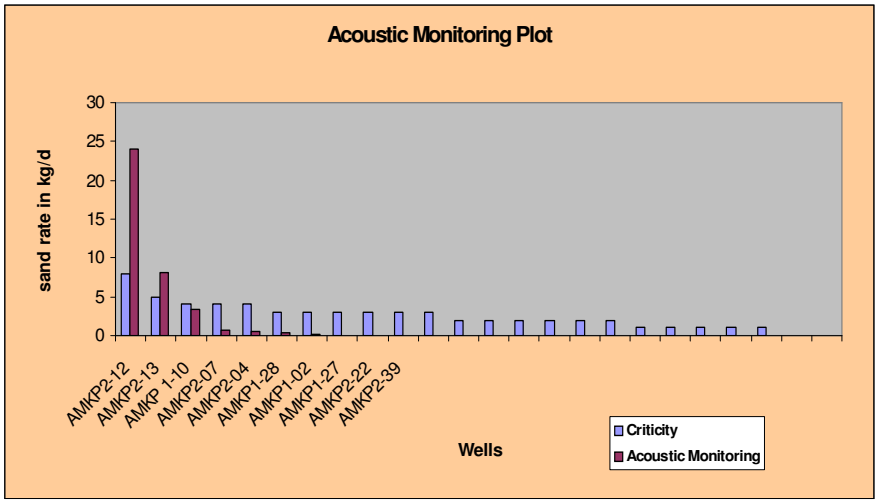
CHOKES AND VALVE CHANGE INVENTORY

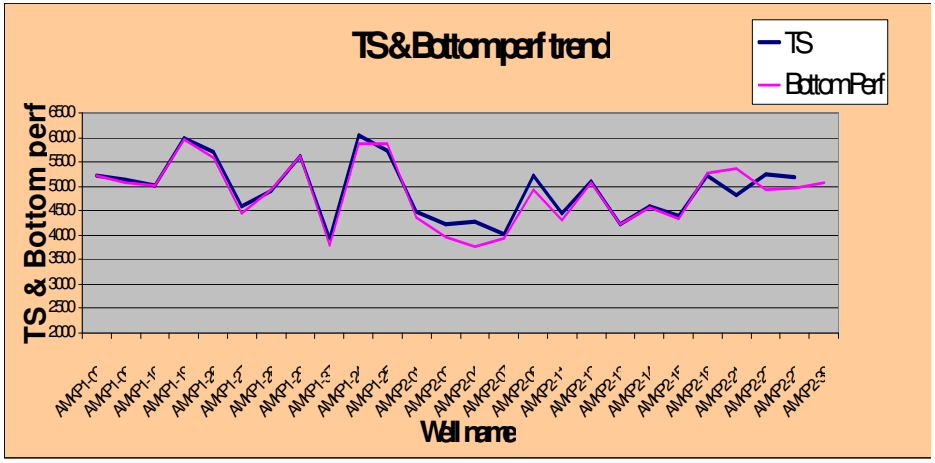
- change out of Xmas tree on Well 1-02, 1-29 and 1-09 –medium/low criticity for sand
- Valve change on test manifold of some HP and MP Wells - AMKP1-02, 1-10, 2-08 and 2-13.

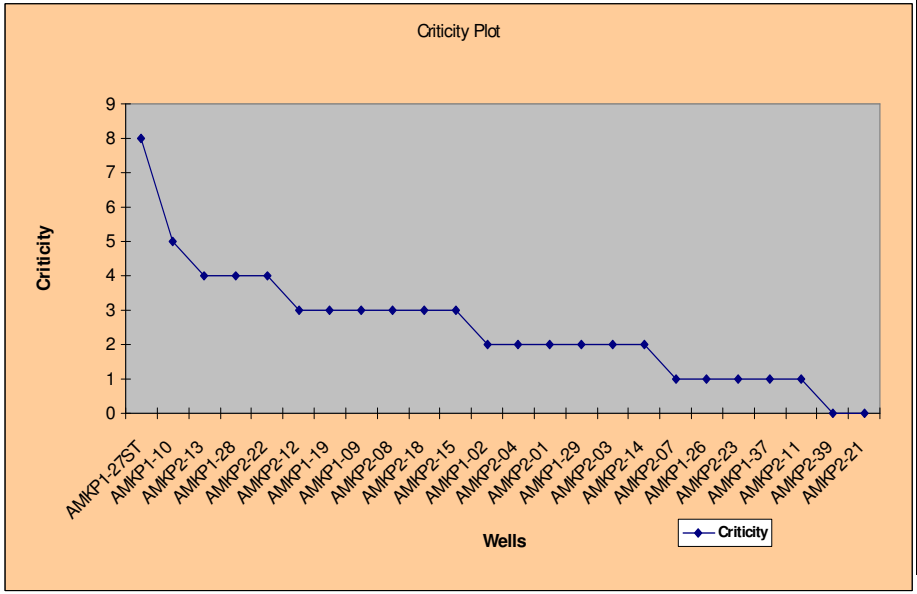
INSPECTION OF FLOWLINES

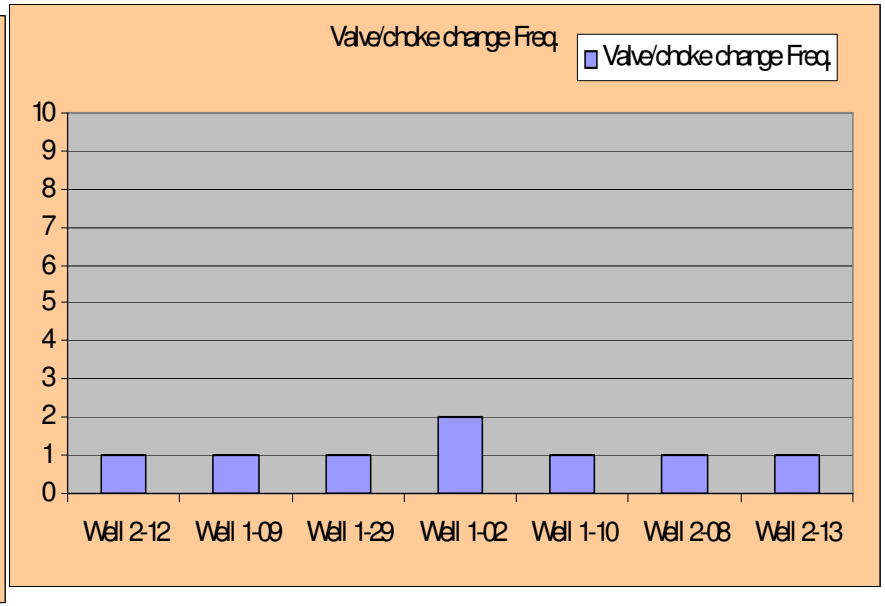
- With ultrasound
- No erosion from well head to manifold
- Flow velocity below erosional velocity of flow lines

RESULTS CORRELATION









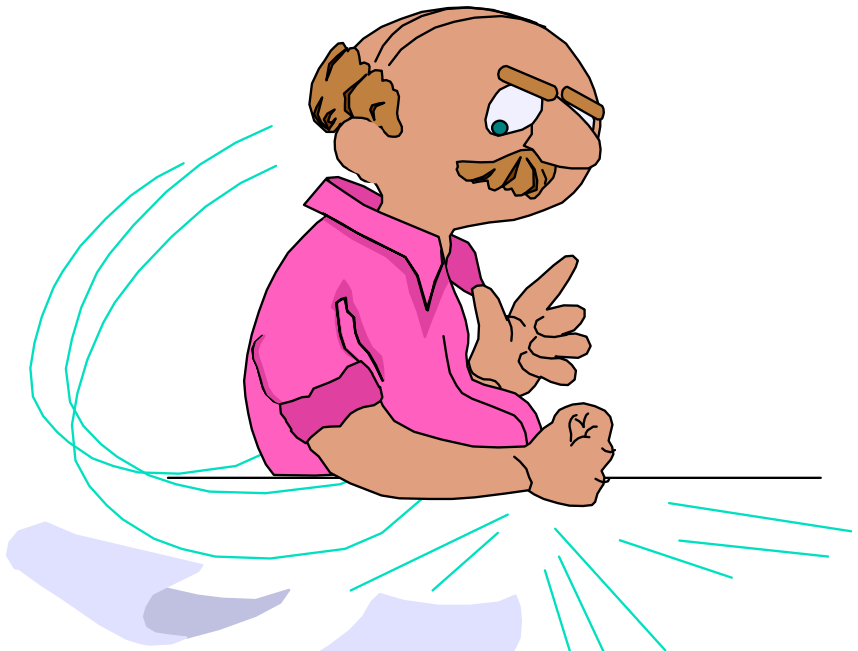
CONCLUSION

RESULTS

- From monitoring high sand rates correspond to high criticity with TS = /> Bottom perforation
- Criticity estimation shows good level of reliability to be validated by sand traps.
- Evidence still corroborated by some valves changed
- All good pedestals / pointer to identification of likely culprit wells to focus on for investigation and quantification

CONCLUSION

- Simplistic diagnostics considering all possible tell-tale sign still a great basis
- Needs traverse and multiple checks to confirm sand
- Physical quantification still the best form of validation



THANKS FOR YOUR ATTENTION