**From:** Liao, Tony T
**Sent:** Mon Jul 12 22:51:27 2010
**To:** Mason, Mike C
**Subject:** Overview of Macondo Well Modeling 12July2010.ppt - updated...
**Importance:** Normal
**Attachments:** Overview of Macondo Well Modeling 12July2010.ppt
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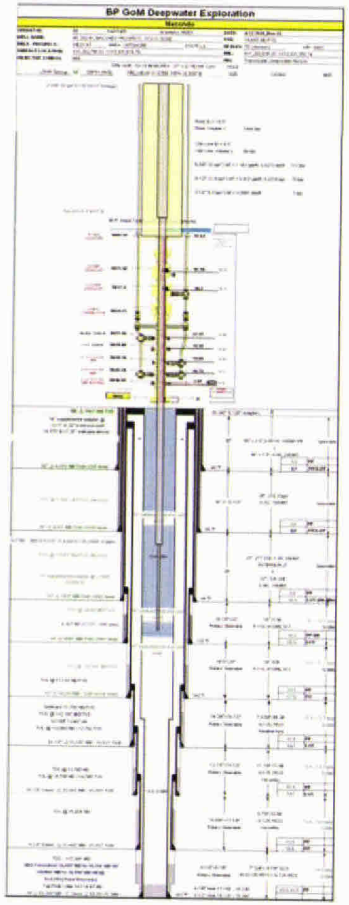
Hi Mike,

Please refer to the updated version of the slides I prepared. Please note this version included feedback from Chris. Bob saw the earlier version.

See you tomorrow.

Best regards,
Tony Liao

# APPROACHES TO CHALLENGES IN MACONDO WELL MODELING



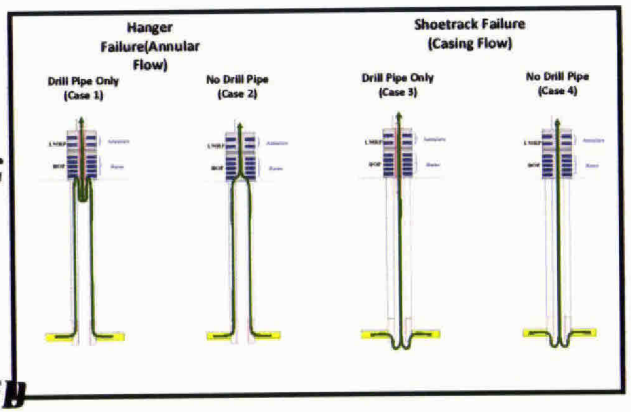

PRESENTED ON JULY 14TH, 2010

PRESENTED BY EPT BASE MANAGEMENT TEAM

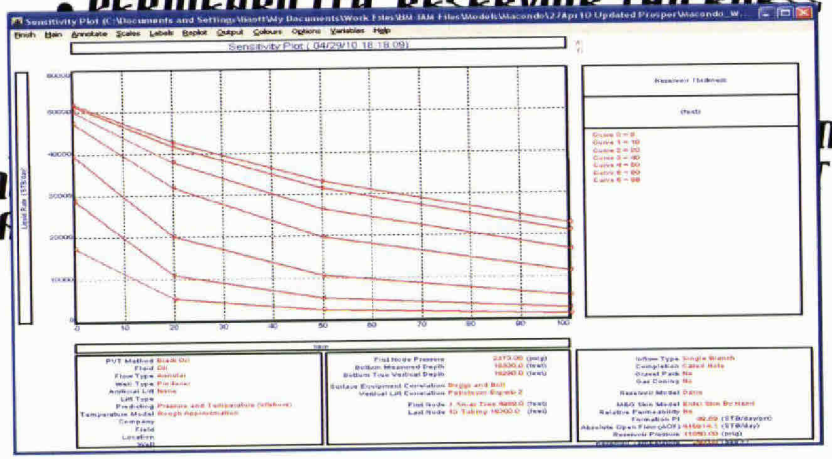
# APPROACHES TO CHALLENGES

- COMPLICATED FLUID BEHAVIOR: WORKED WITH PVT VENDORS TO CONFIRM LAB MEASUREMENTS, USED THE MOST UP-TO -DATE EQUATION OF STATE MODEL IN ALL ENGINEERING CALCULATIONS

- FLUID FLOW PATHS: INVESTIGATED ALL POSSIBILITIES THE FLOW PATHS
  - INSIDE CASING, BEHIND CASING IN THE ANNULUS, . . .FOCUSED ON 4->




- UNCERTAINTIES ON OIL PRODUCTION RATE: ESTIMATED RANGES OF OIL RATES BASED ON POSSIBLE RANGE OF RESERVOIR PARAMETERS
  - PERMEABILITY, RESERVOIR THICKNESS OPEN TO



- M… …NAGE… …THE
- DA…

**Scenario:**
- 88' reservoir
- 300 mD
- 3800 to 2270 psi

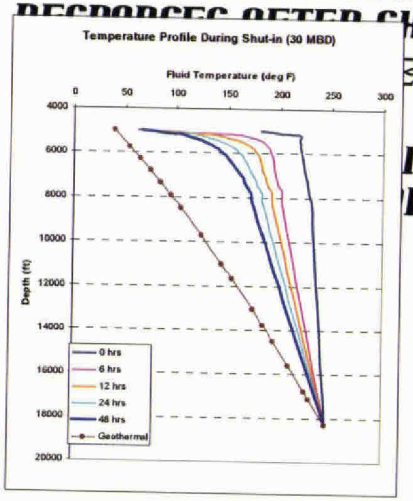
| | Hanger Failure (Annulus Flow) | | Shoetrck Failure (Casing Flow) | |
|---|---|---|---|---|
| | Drill Pipe Olny | No Drill Pipe | Drill Pipe Olny | No Drill Pipe |
| Skin 0 | 1.13 | 1.16 | 1.13 | 1.16 |
| Skin 10 | 1.14 | 1.19 | 1.14 | 1.18 |
| Skin 25 | 1.15 | 1.2 | 1.15 | 1.23 |

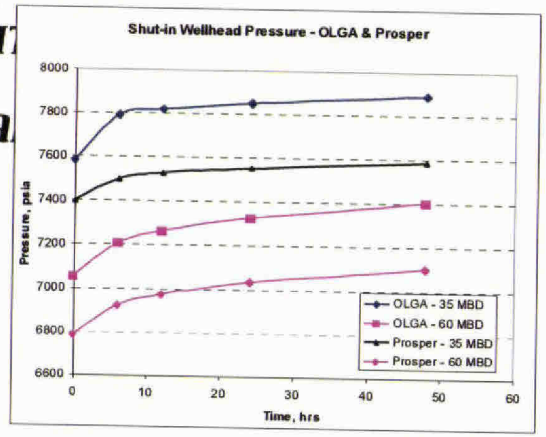
**Scenario:**
- 44' reservoir
- 170 mD
- 3800 to 2270 psi

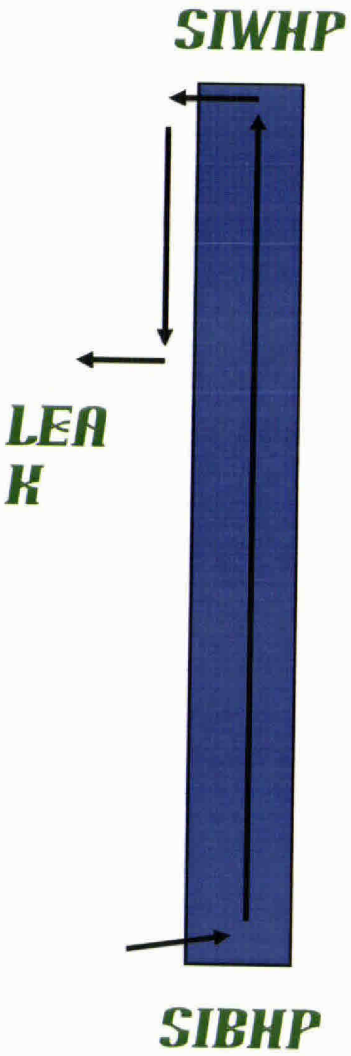
| | Hanger Failure (Annulus Flow) | | Shoetrck Failure (Casing Flow) | |
|---|---|---|---|---|
| | Drill Pipe Olny | No Drill Pipe | Drill Pipe Olny | No Drill Pipe |
| Skin 0 | 1.15 | 1.19 | 1.15 | 1.22 |
| Skin 10 | 1.18 | 1.25 | 1.18 | 1.26 |
| Skin 25 | 1.22 | 1.28 | 1.21 | 1.31 |

# APPROACHES TO CHALLENGES

- TOP KILL OPERATIONS: INVESTIGATED WELL BEHAVIORS USING ADDITIONAL DATA COLLECTED DURING TOP KILL OPERATIONS
  - ADDED BP PROPRIETARY DRILLING MUD MODEL IN GAP VIA OPENSERVER
- SHUT-IN WELLHEAD PRESSURE: CONSTRUCTED A NETWORK MODEL FOR THE SURFACE SYSTEM CONSIDERING
  - RESERVOIR DEPLETION USING VIP SIMULATIONS
  - POSSIBLE FLOW PATHS AND CROSS FLOW
  - DIFFERENT OIL FLOW RATES PRIOR TO SHUTIN
  - TRANSIENT PRESSURE AND TEMPERATURE



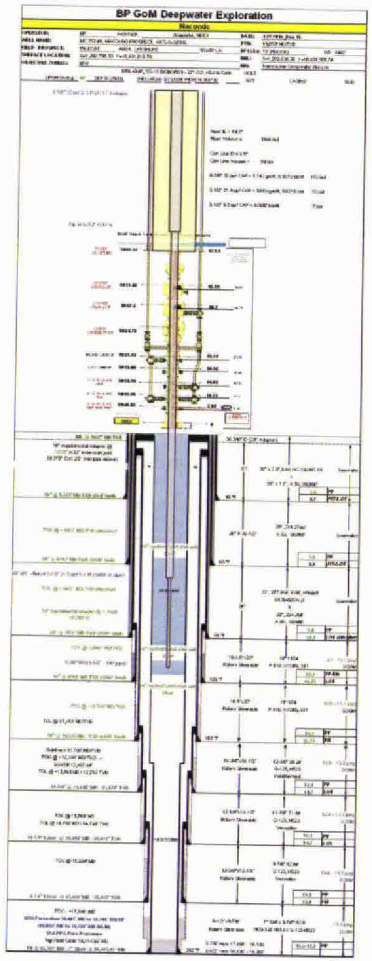



# OTHER AREAS OF INVESTIGATION...

- HYDRATE POTENTIAL IN THE 6" RISER FROM WELLHEAD TO THE ENTERPRISE
- TRANSIENT THERMODYNAMICS INVESTIGATION (DETAILED ENTHALPY MODEL)
- BROACH TO THE FORMATION NEAR THE 18" CASING SHOE
- STATUS OF AND POSSIBLE FLUID FLOW RATES THROUGH THE RUPTURE DISKS ON THE 16" CASING
- POTENTIAL FRACTURE OF THE SHALE NEAR THE 9 7/8" CASING NEAR THE BOTTOM OF THE WELL
- RESERVOIR DEPLETION CALCULATIONS FOR RELIEF WELL PLANNING
- INJECTIVITY ASSESSMENT FOR ALTERNATIVE DISPOSAL ROUTES
- ROLE WITH NATIONAL LABS
  - DATA EXCHANGE AND EXPLANATIONS
  - SOFTWARE AND METHODOLOGY EXPLANATIONS
  - COLLABORATION ON ASSUMPTIONS AND ANALYSES IN JOINT WORK SESSIONS
- MANAGEMENT PRESENTATIONS (INGLIS, SALAZAR, DUPREE, AND CHU)

# Approaches to Challenges in Macondo Well Modeling

Presented on July 14th, 2010




Presented by EPT Base Management Team

# Approaches to Challenges

➢Complicated Fluid Behavior: worked with PVT vendors to confirm lab measurements, used the most up-to – date Equation of State model in all engineering calculations

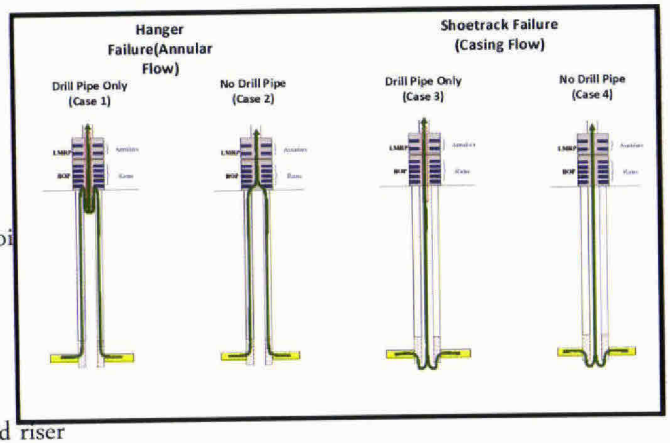
➢Fluid Flow Paths: investigated all possibilities of the flow paths

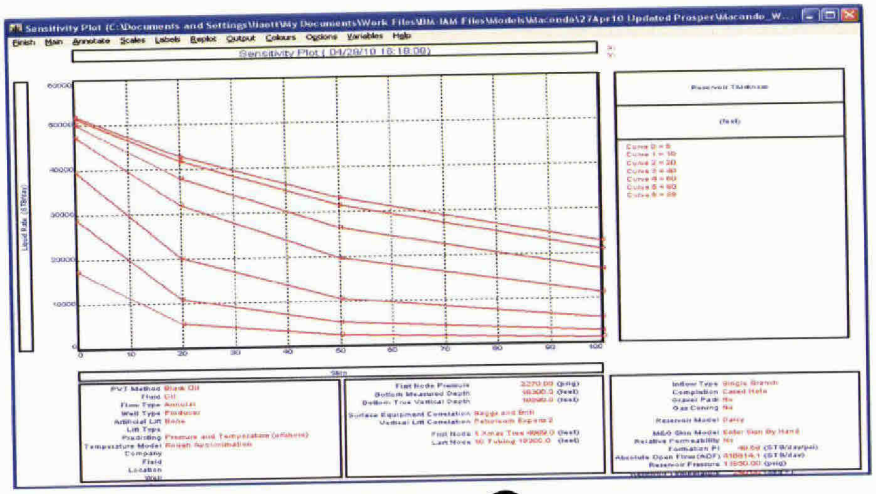
- Inside casing, behind casing in the annulus, ...focused on 4->

➢Uncertainties on Oil Production Rate: estimated ranges of oil rates based on possible range of reservoi parameters

- Permeability, reservoir thickness open to flow, skin,...

➢ Rate changes with removal of the damaged riser: model the well rates with and without the damaged riser



| Scenario: 88' reservoir, 300 mD, 3800 to 2270 psi | Hanger Failure (Annulus Flow) | | Shoetrck Failure (Casing Flow) | |
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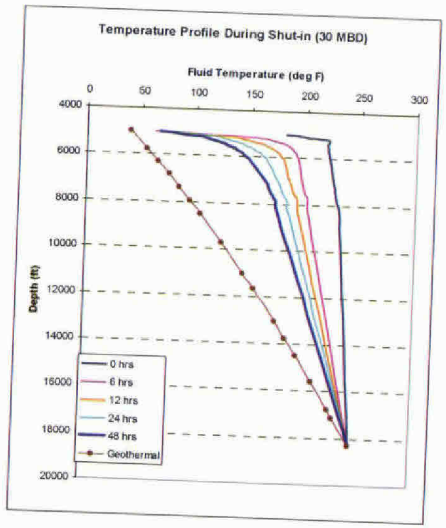
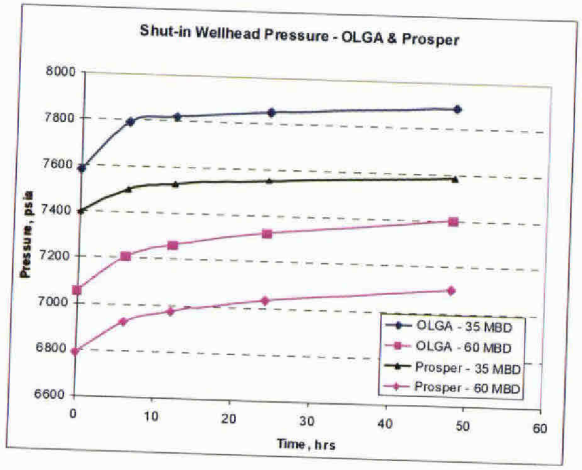
# Approaches to Challenges



- Top Kill Operations: investigated well behaviors using additional data collected during top kill operations
  - Added bp proprietary drilling mud model in GAP via OpenServer
- Shut-in Wellhead Pressure: constructed a network model for the surface system considering
  - Reservoir depletion using VIP simulations
  - Possible flow paths and cross flow
  - Different oil flow rates prior to shutin
  - Transient pressure and temperature responses after shutin
  - Subsurface system with integrity (no disk failure)
  - Rupture disks failed and fluid leak into different reservoir




# Other Areas of Investigation...

- Hydrate potential in the 6" riser from wellhead to the Enterprise
- Transient thermodynamics investigation (detailed enthalpy model)
- Broach to the formation near the 18" casing shoe
- Status of and possible fluid flow rates through the rupture disks on the 16" casing
- Potential fracture of the shale near the 9 7/8" casing near the bottom of the well
- Reservoir depletion calculations for relief well planning
- Injectivity assessment for alternative disposal routes
- Role with National Labs
  - Data exchange and explanations
  - Software and methodology explanations
  - Collaboration on assumptions and analyses in joint work sessions
- Management presentations (Inglis, Salazar, Dupree, and Chu)