Risk

Sedco Express DGPS Operations
Five Years of Lessons Learned

Lew Weingarth and Stephane Angue

*Transocean, Inc.*

October 17-18, 2006
SEDCO EXPRESS DGPS OPERATIONS
Five years of lessons learned
SEDICO EXPRESS

- DP 5th generation semi submersible / DP class 3 ABS
- 4 azimuth thrusters (7MW each) and 6 generators (4.4MW each)
- ALSTOM 903 DP system
- 2 DGPS position reference systems
- 1 Acoustic position reference system
- ALSTOM ICS (VMS/PMS) system on the bridge (engine control room)
Transocean technical specifications for DGPS suite installation

- 2 separate DGPS suites (hardware/software)
- Dual frequency GPS receivers
- Redundancy in correction links
- Separate UPS for each DGPS suite
- User friendly system
- Compliance with industry standards for reliability, fault tolerance and fail safe behavior
DGPS systems replaced in 2005

Decision was made to replace DGPS suites on board due to:

- Identical software running on both DGPS suite
- Obsolete GPS receivers and computers
- Poor performance during scintillation periods
- No more vendor support
- New sensors and software with better performances available on market.
A motion compensated offset position of the rotary table is required to be output to the DP system and various users.
DPO background and areas of influence

- Marine background
  - Position reference systems
- VMS system
- Reporting
  - Checklists
  - Paperwork
- Electronic
  - Mechanical
  - Background
- Deck
  - Background
  - Operations
- Emergency
duty
- Ballast control

DPO
DPO expectations in Reference position systems performance

• Reliability and accuracy
• Easy man machine interface
• Internal redundancy
• Low variance
• Easy data download and analysis
• Vendor support
Positioning data validation tests performed by the DP system

- Prediction test
- Variance test
- Median check test
- Hardware / system problem test
- Signal latency / age limit
- Freeze test
Position reference and DP system

• Losing one Position reference is not defeating station keeping but the operation status may be affected → Downtime?

• DPO input in DP system is significant regarding position reference performances
  a) set up of the median check limits
  b) set up of the prediction windows limits
  c) set up of position reference weighting
  d) Set up Kalman gain parameter
Former DGPS system - TRINAV

Main positioning antenna
plus three antennas for Roll/Pitch/Yaw determination

Backup position antenna
Reference station data antennas

Receiver 1
Receiver 2
Receiver 3
Receiver 4
Receiver 5
Gyro

Main Computer
Backup Computer

All inputs to the main computer are duplicated to the backup computer

To DP system

To DP system
### TRINAV system

**ADVANTAGES**
- Simple man machine interface
- Good internal redundancy (GPS receiver and differential links)
- 1 GPS receiver + 1 differential link installed on bridge mast
- HF link correction available
- DPO / ET system experience
- Spare parts available on board

**DISADVANTAGES**
- Obsolete (poor Dual frequency performances)
- Poor performance during scintillation period
- No quality control except the DQI parameter
- Same software on both system
- Multiple GPS receiver failures or loss of performances
- RTCM link hardware failures
- Unix O/S
- Software failures and bugs
- No remote control from backup room system
Scintillation was affecting the DGPS prior the event.

• 2216 within 2 seconds acoustic PME, DGPS1 and DGPS2 failed to DP system and DP entered in model control.
• 2217 Yellow Alert activated manually by DPO
• 2217 Acoustic available and selected. In DP
• 2218 DGPS available, 7m drift off due to model control and unstable positioning prior the event
• 2231 position stabilized and Green light on.
DP event 1– Yellow alert – 15/11/2002
Analysis

- Poor performance of DGPS during scintillation. Both DGPS inputs Rejected from DP.
- No specific reason found to explain the acoustic PME rejection (isolated jump / failure)
DP event 2 – Drive off – 29/06/2004

- DGPS 1 and 2 with DQI of 3 but variance was acceptable (<1m).
  01 24 33 Acoustic rejected by DP system on median check. Both DGPS drifted to NW.
  01 24 37 DGPS 1 rejected by DP system
  01 24 38 DGPS 2 rejected by DP system. Entered model control.
    Yellow alert activated manually by operator.
  01 25 14 Acoustic available and selected. Rig in Auto DP
  01 26 05 DGPS 1 selected in DP
  01 30 21 DGPS 2 selected in DP. Rig position stabilized 20m NW of original position.
  01 35 52 Rig back to original position
  01 43 00 Green light on
DP event 2 – Drive off – 29/06/2004

Analysis

- DGPS 1 and 2 were setup differently (different GPS receiver and correction link)
- DQI 3 indicates poor position precision
- PME weighting was in auto.
- Acoustic rejected on median check
- DGPS 1 and 2 rejected on prediction test

DGPS position was affected by poor geometry and low number of satellite was in use.

GPS receiver was unable to use low elevation satellites.
DGPS degraded status – 22/11/2004

- Software failure. Backup solution @ 141km from primary solution. No operator warning.
- Primary solution failing and Trinav switch to backup solution. Rejected by DP (jump of 141km).
- GPS receiver reset to clear the fault.
New DGPS systems installed in 2005

MULTIFIX 4 / WINFROG

SEASTAR DP
## Multifix-Winfrog / Seastar DP

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• 2 separate and independent systems (software and hardware)</td>
<td>• All equipment installed on derrick (except 2 RTCM link antennae)</td>
</tr>
<tr>
<td>• XP correction type quality (orbital and clock)</td>
<td>• No backup GPS receiver on Multifix/Winfrog system</td>
</tr>
<tr>
<td>• Redundancy of RTCM correction type and links</td>
<td>• Poor reliability of the HP solution on Seastar DP system</td>
</tr>
<tr>
<td>• Vendor support</td>
<td>• Some compatibility problem with DP system (latency)</td>
</tr>
<tr>
<td>• Quality control (multifix system)</td>
<td>• Spare parts (expensive / limited on board)</td>
</tr>
<tr>
<td>• Remote control of the backup room system from DP desk.</td>
<td>• Download and replay facilities on the ‘online machine’</td>
</tr>
<tr>
<td>• Good repeatability/variance</td>
<td></td>
</tr>
<tr>
<td>• Possibility to use The GPS without the ‘D’</td>
<td></td>
</tr>
</tbody>
</table>
Multifix-Winfrog / Seastar DP concerns

• Poor reliability of HP solution in Seastar DP (>1200 solution reset in one year)
• Computer failures on reboot process (Seastar DP)
• Software failures (Input/output management software – Seastar DP)
• MRU loss of performance not detected by Multifix software causing position reference rejection in DP
• Software glitch on Multifix 4 (Sunday 0000 GMT bug-negative latency figure)
37 Recorded DP events
From January 2002 to October 2006

DP events recorded

- 2006: 6 events
- 2005: 7 events
- 2004: 6 events
- 2003: 12 events
- 2002: 6 events

Total: 37 events
Recorded DP events by category

- **Electrical**: 43%
- **Thruster**: 22%
- **Operator**: 3%
- **Weather**: 5%
- **Computer**: 8%
- **Other**: 8%

**Reference**: 11%
DGPS related DP events / Yellow-Red alerts

- Around 1500 days of rig operation
- 6 Yellow alert conditions occurred since rig start up. No Red (disconnections) occurred.
- 2 of DGPS system failures leaded to Yellow alert conditions (33% of total yellow alerts)
- No Recorded event related to DGPS since new system installed
Position reference system rejections by DP system since Oct 2002

Position reference system rejections by DP system

- Sonardyne rejection
- DGPS#2 rejection
- DGPS#1 rejection

Installation of new SPRS
New DGPS system time of unavailability since installation

Time of PME unavailability

- Sonardyne
- DGPS2
- DGPS1
Possibility of future improvement on DGPS system design

- A position reference system is only a ‘tool’ for the DPO in order to perform his duty: Keeping the rig on location.

- Position reference system need to be designed to require the minimum operator input and to provide the highest level of reliability (fail safe / internal redundancy).

Areas where improvement might be beneficial:
- Management of the system redundancy
- Operator interface
Management of system redundancy

Hardware
• Backup GPS receiver on every system
• Separate installation area for each GPS receiver
• Use of all available correction type
• Separate data logger for efficient position reference data analysis and monitoring

Software
• Fail safe software (no data output if gyro/MRU input failure)
• No automatic reselection of primary solution after failure.
Possible improvements: Operator interface

- Operator “sound” warning/alarm
- “watch circle” input in DGPS on initial position (available on Winfrog)
- Scatter plot of all available solutions (offset position)
- Confirmation after configuration change
- Easy selection of the primary solution within all available solutions list
- Configuration access through password
Conclusion

• DGPS related DP events have high level of criticality when occurred.
• DP Operator training should be reinforced
• DP Operator and engineer have a different opinion regarding system design and expected performances.
• Technology is moving fast and vendor must consider the DP operator first when designing a new system.
Thank you