OFFSHORE SURVEY IN THE OIL & GAS INDUSTRY...WHAT’S THAT ALL ABOUT?

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Why Position Matters
The Exploration & Production Lifecycle
Seismic
Rig Moves
Seabed & Geohazard Surveys
Construction Support
Subsidence Monitoring
Emergency Response
Conclusions
WHY POSITION MATTERS

- Around 80% of the data used by Oil & Gas companies are spatially referenced.
- Errors in positioning, or a poor understanding of spatial relationships, can be extremely costly and have hugely significant safety and commercial implications.
- With just some of the implications:
  - Major HSSE incidents, legal costs, drilling targets missed, incorrect interpretation and understanding of reservoir characteristics, loss of asset value, loss of revenue, higher lifting costs, delays to schedules, loss of reputation.
IS YOUR SURVEY REFERENCED CORRECTLY?

- **Coordinate Systems & Datum**
  - 18 Offshore systems
  - 15 Onshore systems
  - 8 Datums (3 x ED50)
- **Vertical reference**
  - Units (metres/feet)
  - Drill Floor Elevation, Kelly bushing?
  - Datum, Mean Sea Level (MSL), Lowest Astronomic Tide (LAT)?
- **North References**
  - True, Grid or Magnetic North?
# The Upstream Oil & Gas Industry Lifecycle

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- Coordinate Reference Systems & Geodetic Parameters
- Geo-Info & data management
- GIS & Mapping
- Remote Sensing
- Emergency Response
- Seismic, Well and Asset Coordinates
- Positioning & Navigation
OFFSHORE SURVEY IN THE INDUSTRY LIFECYCLE

Explore
- Scouting
- Seismic
- Environmental Baseline
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Stratigraphic Coring
- Geotechnical Borehole

Appraise
- Seismic
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Geotechnical Borehole

Develop
- As Built Survey
- Seismic
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Pipeline Routing
- Shallow Geotechnical Construction Support

Produce
- Seismic
- Environmental Monitoring
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Pipeline Inspection
- Shallow Geotechnical Construction Support

Decommission
- As Left Survey
- Environmental Monitoring
- Seabed Survey
- Geohazard Assessment
- Rig Positioning
- Pipeline Inspection
- Construction Support
SEISMIC

- 2D Seismic
- 3D Seismic
- 4D Seismic
- Broadseis
- Wide Azimuth (WAZ)
- Multi Azimuth (MAZ)
- Undershoot
- Transition Zone (TZ)
- On Bottom Cable (OBC)
- Node Surveys
- Electro Magnetic (EM)
Hydrophones

Seismic Source (airgun)

Survey Ship

Path of reflected sound
10+ steerable streamers
6 – 8 kms long
100 – 150 m lateral separation
2400 hydrophones to be positioned every 11.5 seconds
For a 1000 sq km 3D survey = 135 million coordinated hydrophone positions

Vessel Navigation
Gun timing control
Streamer steering
Streamer positioning
Real time navigation data processing
Post Processing
SEISMIC – PERMANENT RESERVOIR MONITORING

- Seismic array covers an area of 40 sq. km
- >120 kms of 4D seismic cable
- 300m between cables
- Designed around seabed infrastructure
- Available hub connectors allow for adding more cables in the future.
- Cable trenched into seabed
- Umbilical connection to platform based seismic recording system

Cables trenched to an average depth of 1.1 metres
79 locations were rock dumped

Seabed Array Termination Canister
THE LIFECYCLE

Explore | Appraise | Develop | Produce | Decommission

RIG POSITIONING

- Jack Up Rig
- Semi-Submersible Rig
- Dynamically Positioned (DP) Rig
- Drill Ship

- Exploration & Appraisal
- Development
- Workover
- Abandonment
FRONT END FEASIBILITY STUDIES

Using GIS analysis to assess ease of access to Drilling Permits

Underlying Data

- Protected Habitats (Oyster Ground)
- Migratory Birds
- Fish & Mammals

and also

- Shipping Activity
- Explosive Remnants of War
- Military Areas
Seabed surveys – Design, Acquisition and Reporting:

Shallow Geohazards?

How hard is the seabed?

Seabed Flat?

Obstacles & Debris
ANCHOR PLANNING & MOORING ANALYSIS

All executed in GIS ......
POSITIONING RIG & ANCHORS IN THE CORRECT PLACE

- Ensure rig & anchors are positioned within tolerance
- Design Anchor Plan or jack up location
- Compile Well Set Procedures
- Manage positioning Contractor
- Confirm location
- Antenna Offsets & Winch Offsets
- Gyro Checks & Known Errors
- Subsea Structures
Seabed Survey

- Seabed Survey,
- Bathy Survey
- Geohazard Survey
- High Resolution 2D (HR2D) Seismic Survey,
- Shallow and Deep Geotechnical
- Environmental
UNDERWATER VEHICLES FOR SEABED SURVEYS

Autonomous Underwater Vehicle (AUV)

- Designed to run multiple survey sensors simultaneously
- Sharp clean data possible
- More coverage in less time
- Accurate positioning is a challenge over extreme topography

Remotely Operated Vehicle (ROV)

- Not designed to run full survey sensor spread simultaneously
- Very high resolution data possible
- More time for less coverage: expensive for large areas
- Greater control on subsea positioning
- Greater flexibility for close inspection or changing survey plan
EXAMPLE OF SEABED SURVEY

30 to 60 metre peaks
Drilling Hazards
- Shallow gas
- Faults
- Boulders
- Loose sands
- Reactive clays

Other Geohazards and Hazards
- Buried channels
- Geotechnical/shallow soils
- Seabed topography
- Obstructions
- Habitats
- Archaeological
- Explosive Remnants of War
SAFETY CRITICAL ACTIVITIES
SAFETY CRITICAL ACTIVITIES
OFFSHORE CONSTRUCTION

- Explore
- Appraise
- Develop
- Produce
- Decommission

Construction Support

- Pipelay
- Pipeline Bundle Tow & Installation
- J-Lay, S-Lay
- Manifold / Template Installation
- Heavy Lift Barge
- Ploughing, Trenching & Jetting
- Out Of Straightness Survey
- Seabed Intervention
- Metrology
- Spool Piece, Jumper, Riser
- As-Built Survey
- Decommissioning
What is decommissioning?

Decommissioning is the process by which options for the physical removal and disposal of structures at the end of their working life are assessed; a plan of action is formulated by the operator, approved by government and then implemented.

The overall timescale for this is several years, as it needs to take into account many diverse factors and involves many organisations.
Tilt & Settlement Surveys
Continuous GPS Monitoring
Air Gap Survey
Scour monitoring
Seabed Geodesy
Time lapse (4D) Gravity
SEABED GEODESY

- Method to ascertain reservoir compaction
- 175 AMTs on seabed to measure subsidence and deflection
- Pilot project of 10 stations deployed in 2007
- Full network in operation since 2010
- Sample every 2 hours
- 22.5 million measured ranges observed and analysed since start of the full network
- 2 x Data download operations per year
SEABED GEODESY
Emergency Response

- Incident Preparedness
- Oil Spill Response
- Search and Rescue
- Incident Investigation
DATA INTEGRATION TO PROVIDE SITUATIONAL AWARENESS

Available anywhere in the world where Shell operates (upstream, downstream, shipping)
Q & A