Forebyggende arbeid i letefasen – What do we do to prevent major accidents during exploration drilling?

HSE seminar for small and new operators and licensees
Per Olav Sætre, November 8th 2012
Smooth operator: Swedish junior Lundin has lofty dreams of taking the lead role on the giant Avaldsnes project.

PYTIAS DAUKANTAS
Lundin Norway AS from 2004

- 55 licenses, 28 as operator

**Development Projects**
- Brynhild
- Edvard Grieg
- Bøyla (Partner)

**Production**
- Alvheim (Partner)
- Volund (Partner)
- Gaupe (Partner)

**Offices**
- Offices at Lysaker (Oslo) and Harstad

- 170 employees

Lundin Petroleum AB is an independent Swedish oil and gas exploration and production company (formed in 2001)
Lundin Norway 2nd most operated licences on NCS

Licence count by operator

- Statoil Petroleum AS
- Lundin Norway AS
- Det norske oljeselskap ASA
- Wintershall Norge ASA
- Total E&P Norge AS
- Talisman Energy Norge AS
- Eni Norge AS
- BP Norge AS
- ExxonMobil Exploration & Production...
- ConocoPhillips Skandinavia AS
- E.ON Ruhrgas Norge AS
- BG Norge AS
- DONG E&P Norge AS
- Marathon Oil Norge AS
- GDF SUEZ E&P Norge AS
- VNG Norge AS
- Centrica Resources (Norge) AS
- A/S Norske Shell
- Suncor Energy Norge AS
- OMV (Norge) AS
- Rocksource ASA
- RWE Dea Norge AS
- Maersk Oil Norway AS
- Premier Oil Norge AS
- Norwegian Energy Company ASA
- Dana Petroleum Norway AS
- Faroe Petroleum Norge AS
- Lotos Exploration and Production Norge AS
- Spring Energy Norway AS
- Idemitsu Petroleum Norge AS
- Repsol Exploration Norge AS
- Edison International Norway Branch
- North Energy ASA
- Hess Norge AS
- Chevron Norge AS
- Bayergas Norge AS
- Bridge Energy Norge AS
- PGNiG Norway AS
- Front Exploration AS
- Valiant Petroleum Norge AS

Source: NPD fact pages 27 Feb 2012
Development in rig days per year on NCS

Number of self operated rig days per year

<table>
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<tr>
<th>Year</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
<th>2011</th>
<th>2012 (Estimate)</th>
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<td>Days</td>
<td>100</td>
<td>120</td>
<td>250</td>
<td>300</td>
<td>350</td>
<td>450</td>
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(Chart showing the increase in rig days from 2007 to 2012 with an estimate for 2012.)
New rigs for Lundin:

- Bredford Dolphin
- Songa Dee
- Transocean Winner
- Mærsk Guardian
- Mærsk Giant
- Transocean Arctic
- Island Innovator
- Rowan rig

22 wells in 5 years with 8 different drilling units
**Definition of a major accident:**

“A major accident is defined as an acute incident, such as a major discharge/emission or a fire/explosion, which immediately or subsequently causes several serious injuries and/or loss of human life, serious harm to the environment and/or loss of substantial material assets.”

**Definition by the PSA**

Macondo blow-out in the Gulf of Mexico.
BP / Deepwater Horizon
20st of April 2010
11 people killed and 5 mill. oil barrels spilled

Montara blow-out on the coast of Australia
PTTEPA / West Atlas
21st of August 2009
50 000 to 250 000 oil barrels spilled

Aleksander Kielland disaster
Norwegian continental shelf
27th of March 1980
123 people dead

West Vanguard blow-out on Haltenbanken
Statoil
6th of October 1985
Gas blow-out

Oil spill from Statfjord A
Norwegian continental shelf
12th of December 2007
25 000 oil barrels spilled

Helicopter accident North Sea:
ETAP field (BP) – British sector / 19th of Februar 2009
18 people onboard – all rescued
British sector north east of Scotland / 1st of April 2009
16 people onboard – 8 dead

Ship collision Alvheimfeltet
SPV struck Songa Dee
18th of Februar 2010
½ crew evacuated from rig

Ekofisk bravo blow-out
22nd of April 1977
80 000 – 126 000 oil barrels spilled
We *have to* avoid major accidents!

- **Lundin Norway’s initial strategy has been to avoid:**
  - Deep water wells
  - Wells with High Pressure and High Temperature
    - However, inhouse competence in place
- **Lessons learned**
  - Experienced core team for planning and execution of drilling of wells
  - To learn from previous incidents is an important success factor for LNAS, both own and industry incidents
  - Tools to handle experience transfer – frequently used
- **Major Accident Risk Model**
  - Major Accident Model developed with support from consultancy firm
  - Willingness to participate in research projects
- **Lundin Norway tradition to choose robust well design**
- **Focus on personnel competence and good communication to ensure well control, well integrity and procedures in daily rig operations**
- **In addition to formal verifications, it is essential with in-depth daily follow-up**
External locking of casing hanger to well head (casing above or through reservoir), independent of production test

Increased focus on function test with acoustic control system of shear ram after landing of BOP

Lundin Norway performed verification of rig owners’ own review of BOP status and ”as-built” drawings of BOPs

Separate third-party specialist verification of BOPs

Routines for review of well design in light of Macondo

Lundin participation in DNV initiated ”Joint Industry Project” on well head integrity

Requirements to ”float” equipment when running casing.
  ➔ Avoid use of automatic fill-up equipment when running casing

Requirements to foam cement, especially in hydrocarbon layers
Improved system for closing of BOP functions with ROV

Implemented strict procedures on displacing a well to light fluids/inflow tests (constant bottom hole pressure)
Examples of continuous improvement and robustness

- Robust well designs and plug and abandonment programs
- Risk review of rig’s BOP configuration resulting in update of rig owner’s well control procedures
- Improved rig BOP configuration during last RS
- Participation in ongoing revision of NORSOK D-010 Well integrity in drilling and well operations
- Review of rigs regarding movement of drilling string during emergency power situation. This to ensure that we can get out of difficult situations in a safe manner
- Focus on requirements to barriers when plugging of wells
- Weighted annulus fluids during well testing
- Will secure access to OSR’s capping and containment equipment
Rig intake and drilling preparations

- Maintenance (system, criticality analysis, safety critical equipment)
- Status of barriers and conditions of these (Major Accident Model)
- Vessel traffic surveillance (Statoil Marine)
- Pre-installation and pre-tensioning of anchors (100 years condition)
- Vessel requirements at arrival and work within 500 m zone
- Shallow gas / move-off drill (floaters)
As a newcomer to the NCS, Lundin Norway has had good experience with use of Drilling Management Contractor

- Increased competence and capacity in daily and any emergency situations
- Verification of work – both ways
- The operator is always overall responsible, not the drilling management contractor
Major Accident Risk for exploration drilling

Barriers against Major Accident Risk

Possible indicators identified and evaluated

Involvement of sub-contractor due to
  - limited internal capacity
  - extend use of industry experience
  - model complexity

Workshop with rig contractor

Few indicators (>150 to 76)

Model run since May 2010
The model is based on the bow-tie principle.
The major accident risk tool contains a selection of six major hazard events.
- Well events
- Ship collision
- Hydrocarbon leaks
- Loss of position due to mooring failure
- Stability problems caused by ballast system
- Helicopter accident

The tool has functionalities to:
- Illustrate the main major accident risks during drilling
- Show what factors that affects the risk level
- Present status on the indicators / barriers
- Illustrate the current risk level
- Illustrate risk level trends for Major Accidents
There is currently 76 indicators in the tool
Input are gathered by use of checklists
Collection of indicator information is performed as pre-defined parameters (rig and project specific) or on a frequent basis (weekly or monthly)
Responsibility of Drilling Superintendent, Drilling Supervisor, Drilling Engineer, HSE Coordinator, Operational Geologist
The collected data are entered into the tool and the main results presented to the line management

| Legend | ID | Category | Factor | Indicator | Description | Declaration by | Evaluation criteria | Comments | Responsibilities for data | Data sources | What to report | Frequency
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<td>1</td>
<td>4-C</td>
<td>Revolution</td>
<td>Revolution conditions</td>
<td>Knowledge about reservoir conditions and reservoir features</td>
<td>Developed by</td>
<td>Sufficient knowledge about reservoir conditions, reservoir features and other known factors that may increase risk.</td>
<td></td>
<td>Drilling Superintendent, Drilling Supervisor, Drilling Engineer, HSE Coordinator, Operational Geologist</td>
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<td>2</td>
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<td>Pre-conditions</td>
<td>Maintenance philosophy and system</td>
<td>Efficiency of maintenance system, drilling systems</td>
<td>Developed by</td>
<td>Sufficient knowledge about maintenance philosophy and system</td>
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Collection of data – checklists

Checklist A1 - Input to the Major Accident Risk Model

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<th>Result</th>
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To be reported During rig closure

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Example: Major Accident Risk Findings

Main results:

76 risk indicators
- High category (red): 7
- Medium category (yellow): 20
- Low category (green): 49

High category contributors
1. Deviations during testing of well control systems
2. Reduced BOP reliability caused by component failure
3. Non-shearable tools run through the BOP
4. Number of PTW > 10 per day (high activity level around the rig)
5. High density of commercial vessel traffic in the area
6. Structural resistance against external impact (collision resistance >14MJ not documented)
7. Rough weather conditions (season)

Major risk events in upper green/lower yellow risk region
- Well events (ref. item 1-3)
- Ship Collision (ref. item 5-7)

Main concerns
- Repeated test problems and equipment failures in the BOP/well control equipment
- Repeated equipment related and operational problems with thruster power system on SBV
- Watertight integrity - leak between buoyancy tanks. Water ingress in column through firewater intake system. Corroded pipe supports
- Maintenance management – analysis and plan for maintenance of safety critical equipment
Example: Major Accident Risk Trends

- Loss of stability – water ingress problem + flooded ballast tanks P1 & P2
- Helicopter risk – increased traffic
- Ship collision risk. Challenge with supply vessel technical condition & crew experience + rig & stand-by vessel marine procedures
- Test period completed
- Weather/season
- BOP reliability, well control equipment, non-shearable items through BOP
Experiences after the first years in use:

- The tool is being used!
- There is (as expected..) a challenge to get input from all contributors
  - Requires some administration, particularly in the start-up phase
- Have we selected the right performance indicators?
- Calibration of indicator threshold values (influence level) to reflect their importance for the risk results
  - The tool is not meant to predict accurate results – only risk trends
  - Does the poor performance indicators give the required effect on the risk level?
- Raised awareness and increased involvement – project and offshore
- Areas of main concern becomes a follow-up priority
- Balancing presentation of risk result to the management and board of directors
Lundin Norway has the necessary competence and capacity to operate safely on NCS, and is able to recruit and keep competent employees.

Understanding of condition and robustness of safety barriers at all times is essential. This is also valid for organisational barriers.

Continuous verification and learning processes contributes to safe operations.

See the big in the small things – always work for better practices.

Our success is dependent of solid partners, including a good tripartite collaboration.

We are looking forward to go from a phase as "only" drilling and field development operator, to also be a production operator.
Lundin operated Edvard Grieg platform 2015