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Safety of DP Drilling Operations in the South China Sea

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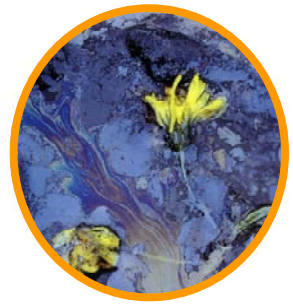
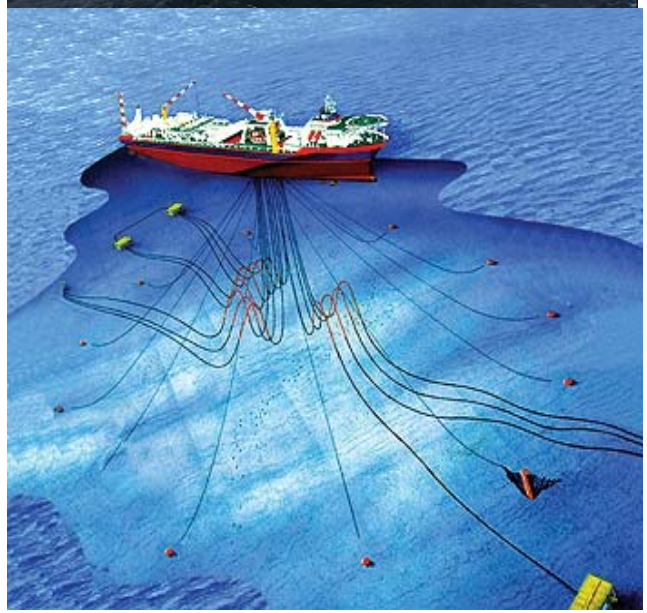


- A world class risk management company
- Established 1971, and 12 offices worldwide in Norway, Sweden, USA, China and UAE
- Primarily focus on the oil & gas, nuclear power, transport and process industries

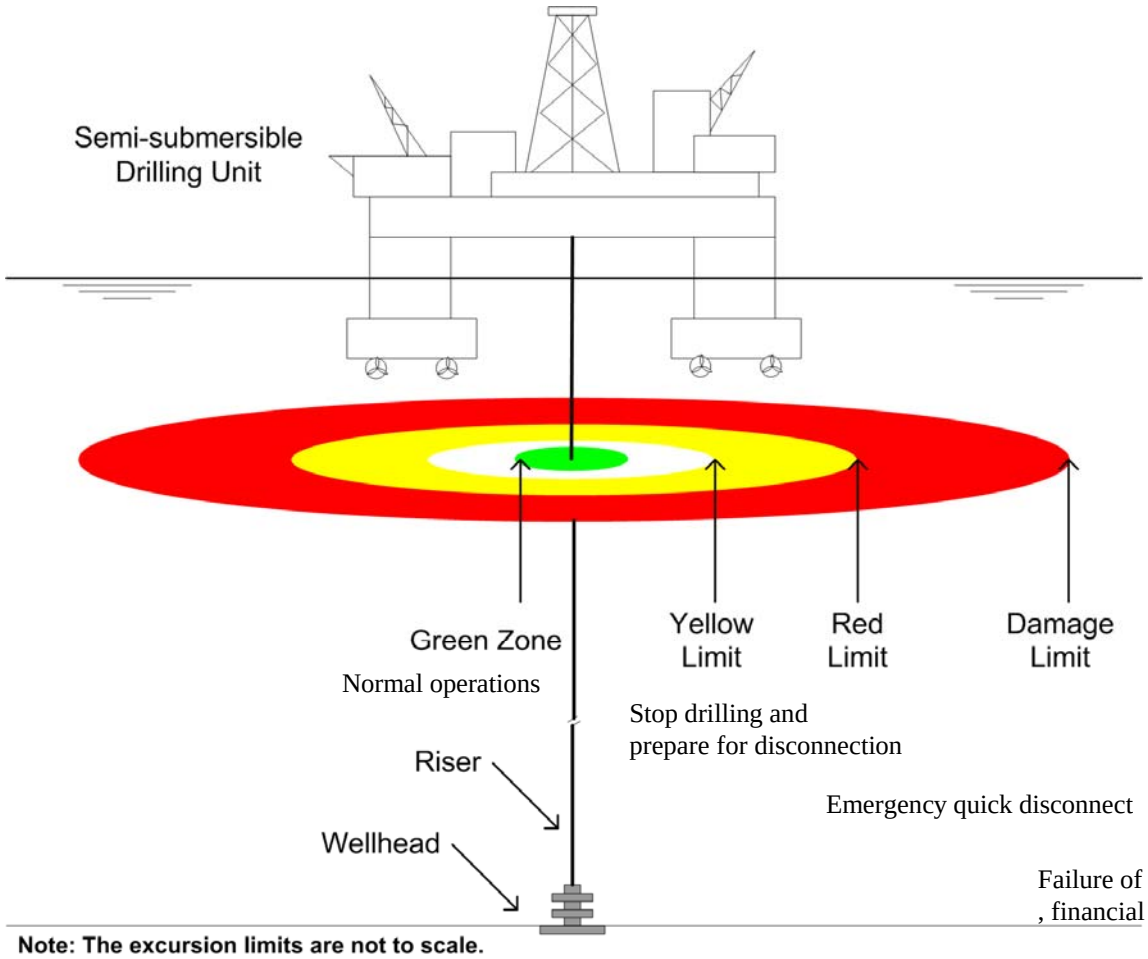
DYNAMIC POSITIONING

- **The dynamic positioning (DP) means to automatically maintain vessel position exclusively by means of the thruster force (IMO 1994)**



less dependency on the water depth, as well as operational efficiency and limited impact on the seabed conditions
More and more being used offshore

MODERN DP DRILLING RIG

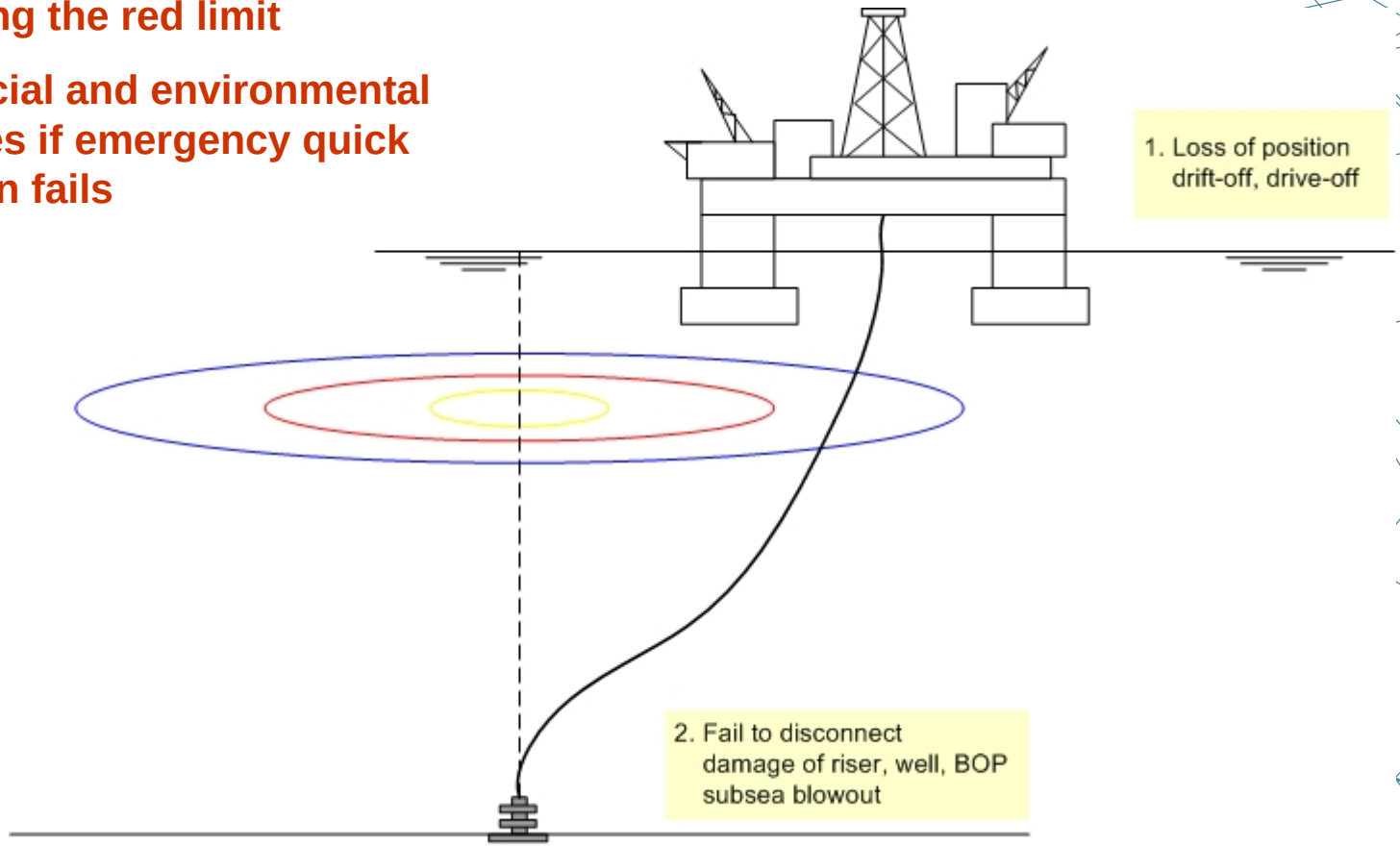


DP DRILLING - HISTORY AND APPLICATION

- **Has been performed within water depth range from about 300 m to ultra deep water, 3000 m or above**
- **Widely used in Brazil, GoM, North Sea since early 1980s.**
- **Deep water drilling in China - 2006 CNOOC & Husky Oil China Inc., Liwan 3-1-1, 1481 m water depth.**

LOSS OF POSITION & CONSEQUENCE

1. **Rig movement becomes uncontrollable**
2. **Rig is crossing the red limit**
3. **Severe financial and environmental consequences if emergency quick disconnection fails**

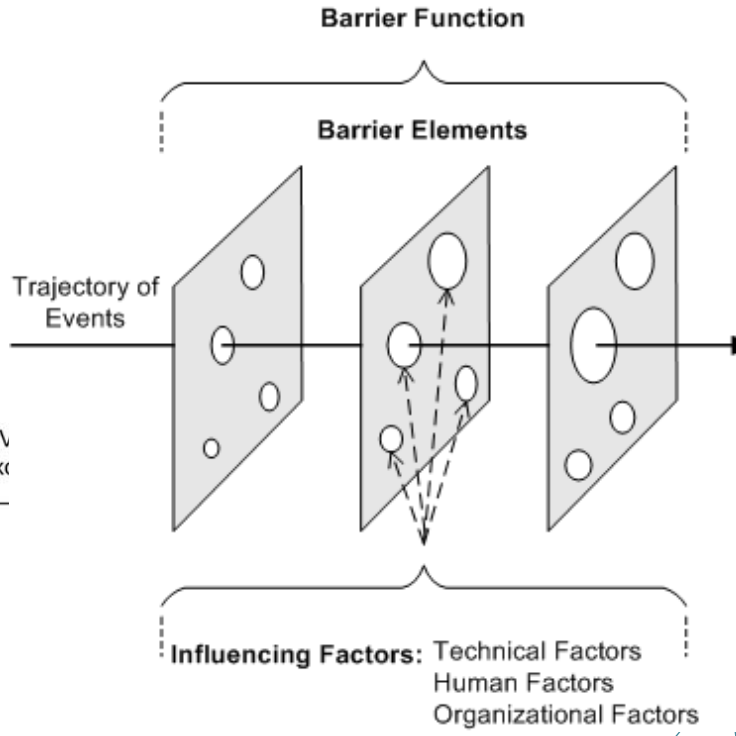


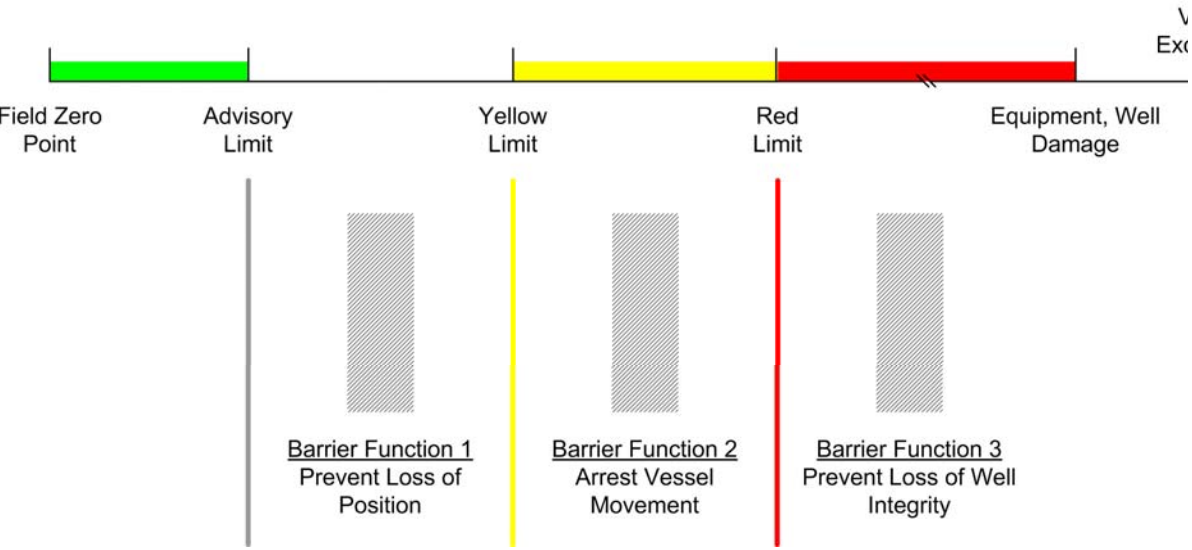
DP DRILLING INCIDENT HEADLINES…

- **Transocean Discover 534 in Liwan 3-1-1, loss of BOP and risers… (2006)**
- **Saipem 10,000 dropped its blow-out preventer (BOP) and riser whilst drilling on block E offshore Equatorial New Guinea. Blowout followed. (2001)**
- **Yatzy in Norwegian waters, drift-off and well damage… (3 months after delivery in 1989)**

A GENERIC SAFETY MODEL: BARRIER METHOD

- **Barrier functions**
- **Barrier elements**
- **Influence factors**



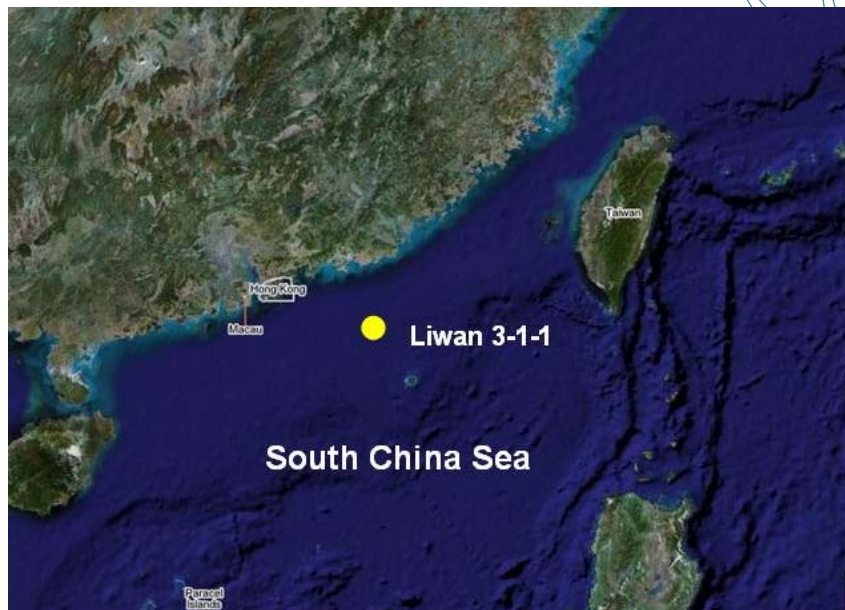


DP Drilling in South China Sea – 3 Challenges and Recommendations

1. **Prevent loss of position**

2. **Arrest vessel movement**

3. **Prevent loss of well integrity**



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LOSS OF POSITION – FAILURE MODE

- **Drive-off**
  - abnormal thruster forces driving vessel away from its target position.

1. Wrong target position in DP-control

2. One or several failed thrusters

- **Drift-off**
  - insufficient thruster forces so that vessel is drifted away from the target position by the environmental forces.

1. Failure onboard, e.g. partial or total black-out, loss of thrusters, etc.

2. Sudden change of environmental conditions

LOSS OF POSITION
Drift-off due to Environmental Conditions

- **Complex Environmental Conditions**
  - South China Sea Monsoon Jet - 1.5 m/s strong current travels from East to West during the winter season and in reverse direction in the summer season.
  - The current may also change its behaviour due to combined effect from monsoonal wind and Kuroshio.
  - Tropic storm and typhoon in the summer season and cold surge from the North in the winter season

- **Experiences**
  - Drift-off due to sudden increase of environmental loads apparently had happened based on the existing yet limited DP drilling experience in the region.

LOSS OF POSITION
Drive-off due to Position Reference Systems

- **Experiences in the South China Sea**
  - Hardly available, and limited

- **Experiences in other parts of the world**
  - 2 DGPS’s + 1 or 2 HPR’s, Deepwater
  - DGPS's generate erroneous position data simultaneously or almost simul-taneously, the erroneous position data are sent to the DP software.
  - DP software uses the erroneous position data for positioning calculations; a drive-off is initiated.

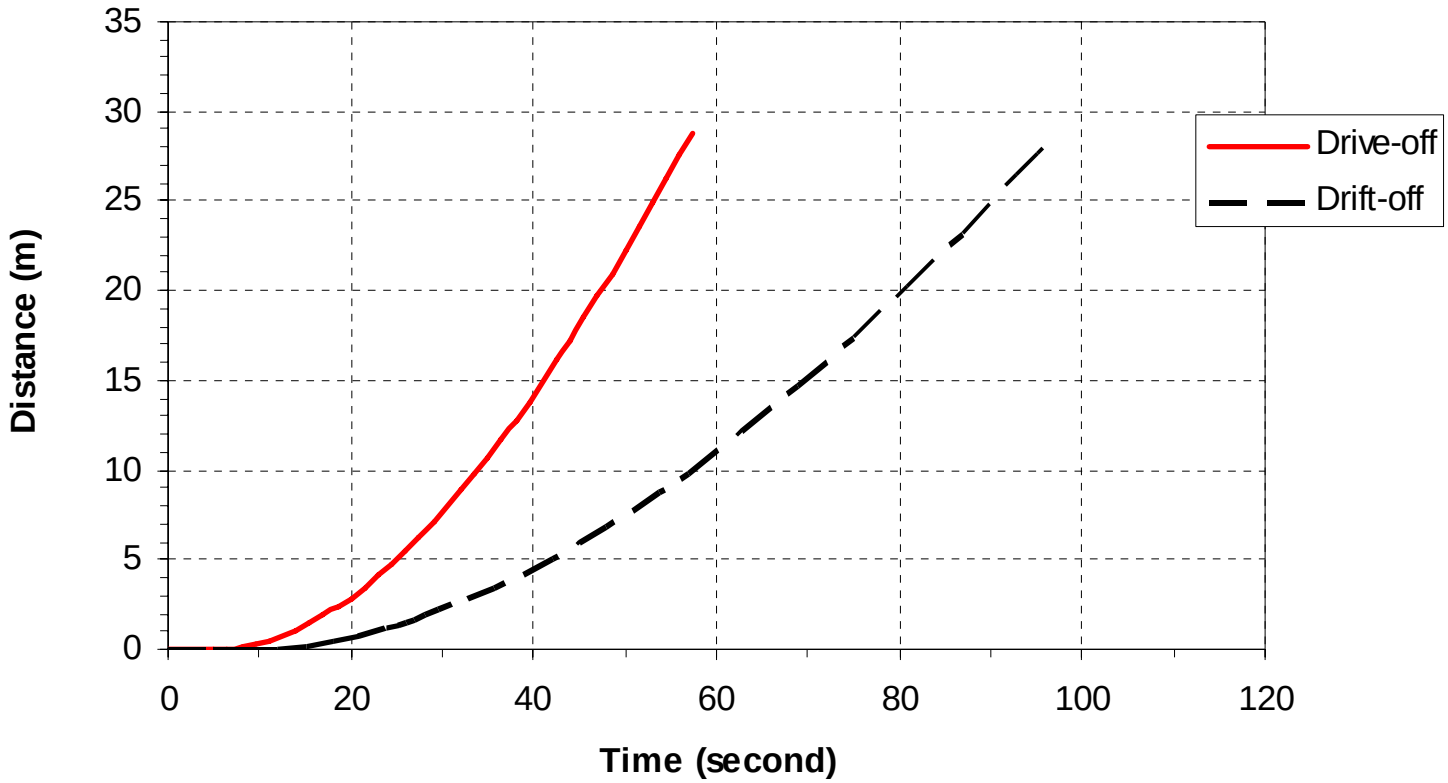
Recommendations to Prevent Loss of Position

- **Prevent Drive-off due to reference systems**
  - Adequate position reference systems
  - Independence between the same type position reference systems

- **Prevent Drift-off due to environmental conditions**
  - Estimate the power consumption in worst case weather conditions during operations preparation, and maintain adequate power online so that the power system could cope with sudden increase of power demands by thrusters due to weather change.
  - Monitor and optimize the vessel heading during the operation.

- **Collect DP incident data in the South China Sea**
  - Collect DP incident data for DP drilling operations in the South China Sea.
  - Such data collection needs joint efforts from oil companies, rig owners and regulatory authorities (COOOSO).

DP rig: Typical Drive-off/Drift-off Behavior



A stressful situation for DP operator since there is very short time available to arrest vessel movement!

Recommendations to Arrest Vessel Movement given Loss of Position

- **Training of DP operators**
  - Follow the industry practices:
    - IMCA M117 “The Training and Experience of Key DP Personnel”
    - IMCA C002 “Competence Assurance & Assessment Scheme”
  - Develop and implement DP simulator training exercises

- **Emergency procedures**
  - Checklist
  - Regular practice of the procedures

PREVENT LOSS OF WELL INTEGRITY

Process of Initiating EQD

1. **Initiate Red Status – by DP Operator**
2. **Push EQD button on receiving Red Status – by Driller**

- **Challenges**
  - The EQD must be activated early enough.
  - A rare event in operation: DP operators drillers may not have much experience of handling such situations.
  - There are potentials that operators may wait too long and activate the red status and EQD too late.

Recommendations to Prevent Loss of Well Integrity

- **Communication system between bridge and drill floor.**
- **Procedure, training, competence and cooperation of DP operator and driller**
- **Simulator training vs. Drills onboard to train manual activation of EQD involving DP operator and driller as a team**

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