Relief Well Intersection Design

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London, England
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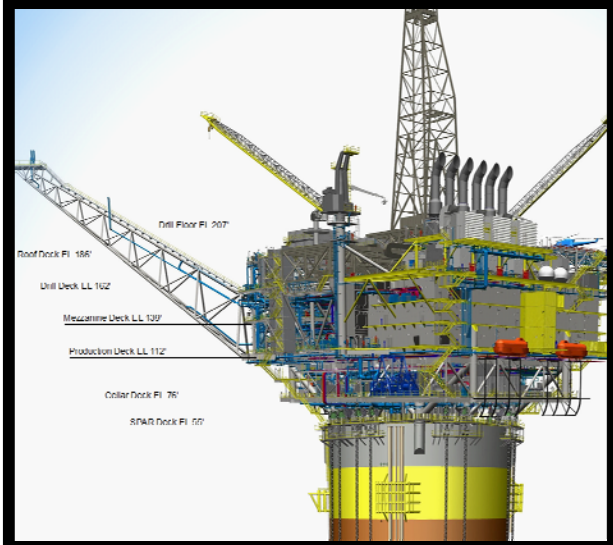
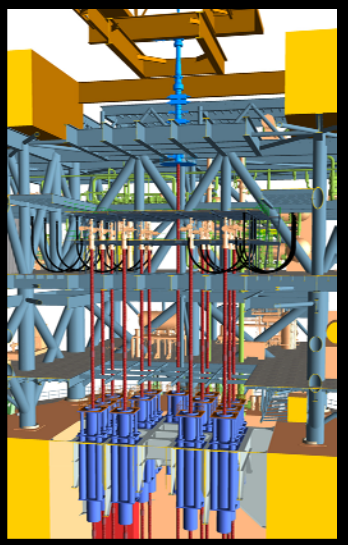
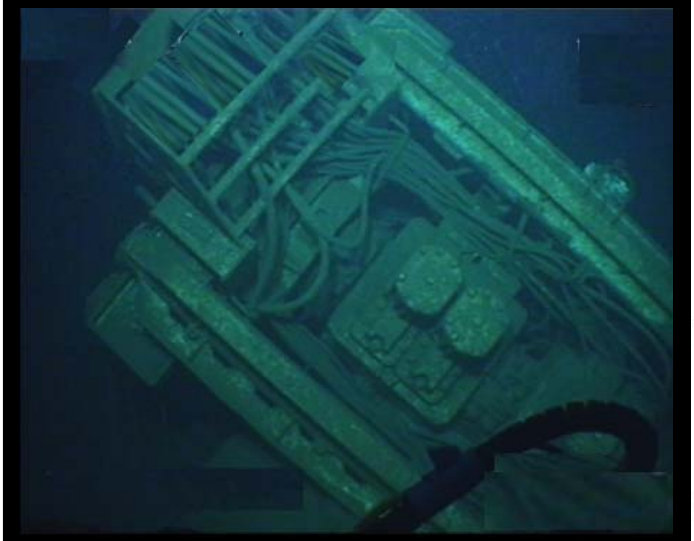
Blowout Broached to Surface

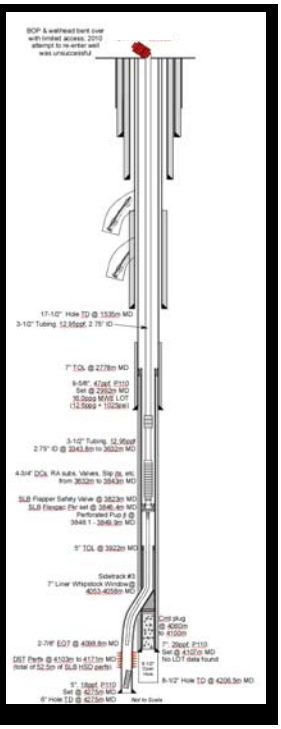
Blowout in a Congested Offshore Wellbay



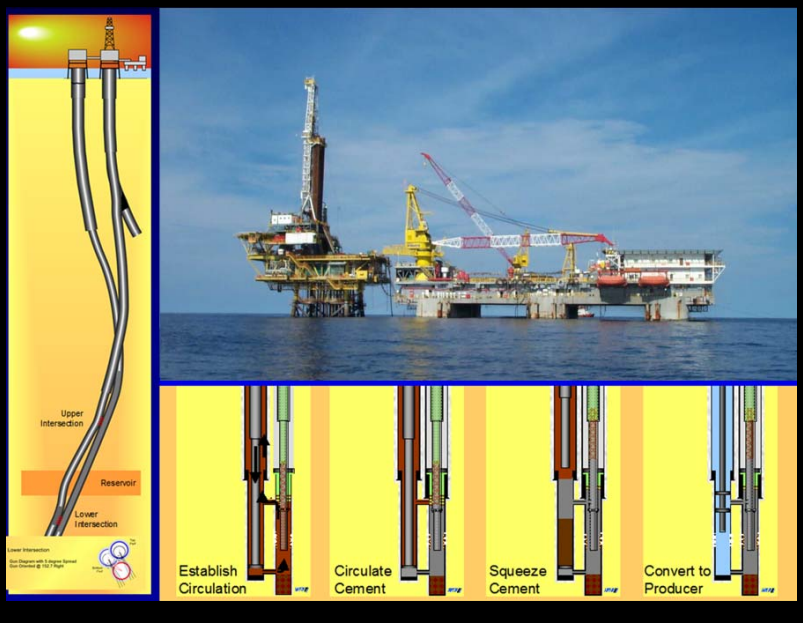


Subsea BOP Bent on Seabed

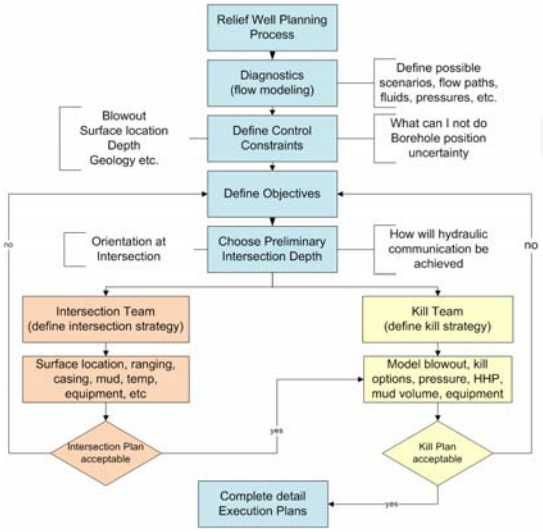




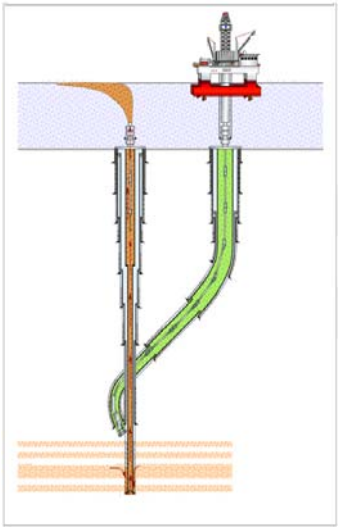
No Surface Access Plug and Abandonment

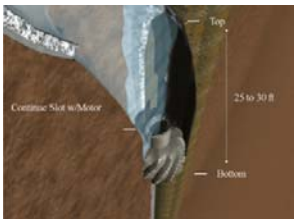


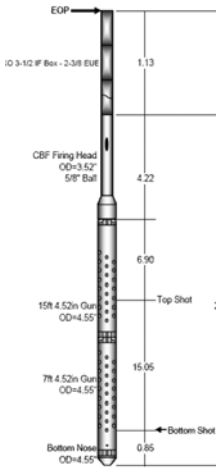
Relief Well Delivery Process



How Important is Well Intercept Design?





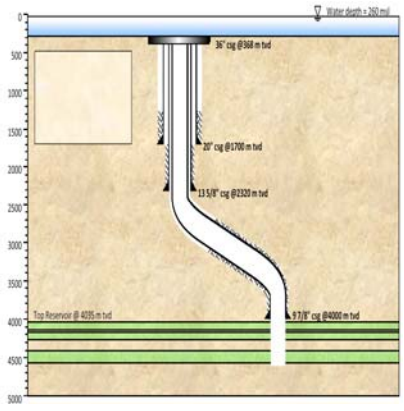


Relief Well Intersection Process

- Intercept depth(s)
- Constraints on relief well surface location(s)
- Target and adjacent well position uncertainties
- Hydraulic communication method(s)
- Target ranging strategy
- Subsurface drilling and well control hazards
- Relief well(s) trajectories
- Casing design
- Drilling program
- Kill program integration

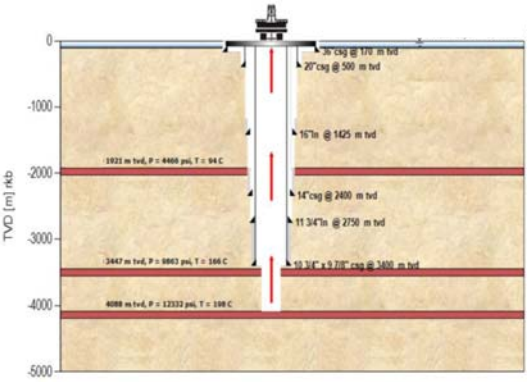
Step 1 - Define the Blowout Scenario

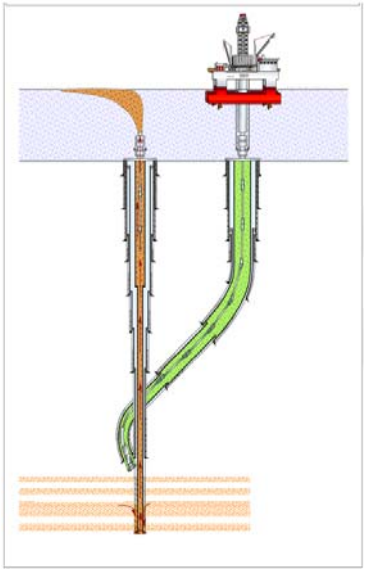
- Well Location South China Sea, January
- Exploration Well (unknown reservoir)
- Blowout to Seabed in 260m MSL
- Flowpath inside open 9-7/8" Casing
- Drilled from moored Semi
- Gyro survey to 20", MWD to TD
- Temperature at top of reservoir 160°C
- Reservoirs: 3x Sandstone – 11,500 psi
- Drilling MW = 2.05 sg (17.1 ppg)
- No adjacent wells < 1000m
- 60 days since spud
- Subsea cap and contain SIMOPS



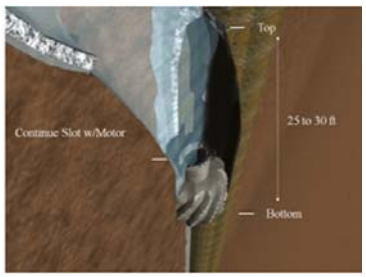
Kill Point Assessment

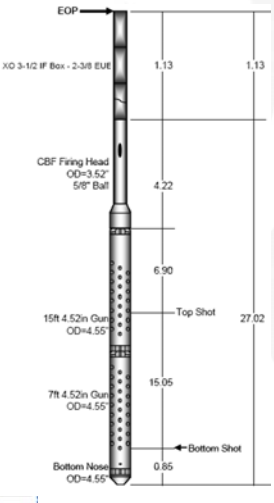
- Objectives
  - Design Intercept in Openhole below 9 7/8" shoe
  - Assess Dynamic Kill for Openhole blowout to Surface





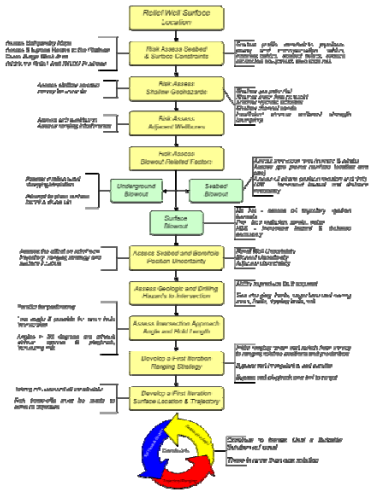
Hydraulic Communication by Open Hole, Milling or Perforating

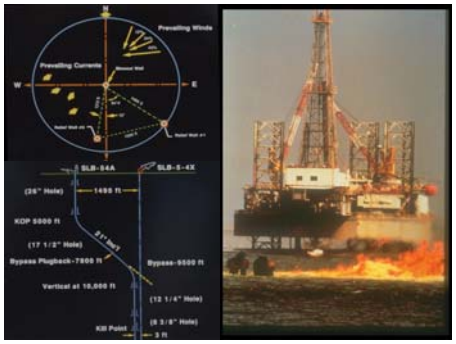




Relief Well Surface Locations

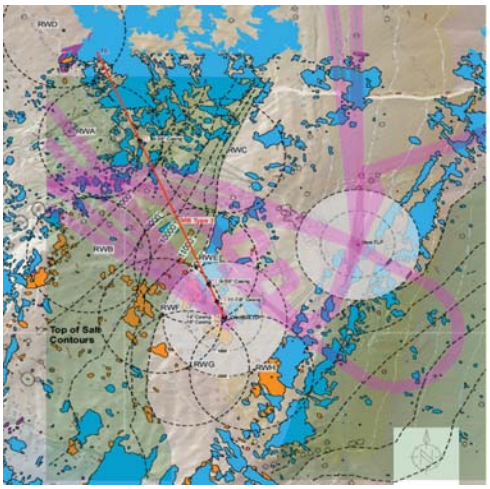
Depends on all Circumstances

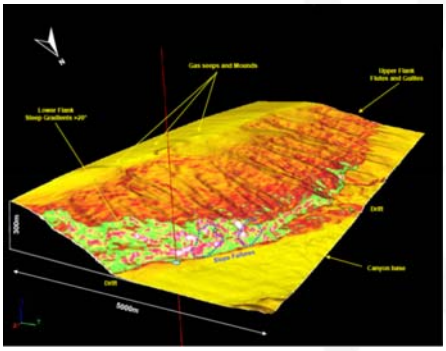




SIMOPS Cap & Contain Constraints

Bathymetry & Geo-Hazard Constraints





Surface Blowout Effluent Constraints

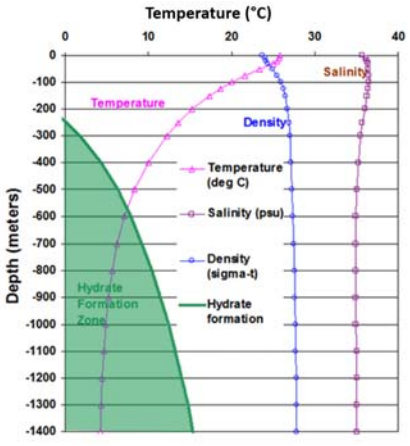
(oil, gas, smoke, volatiles)

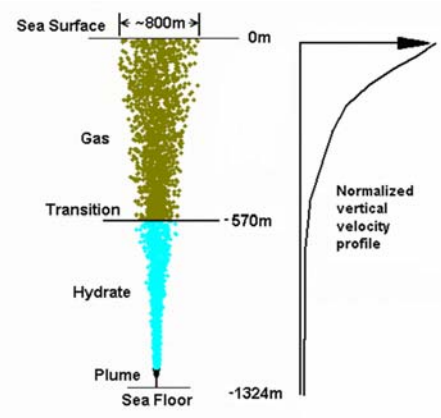
Gas Plumes in the Sea

Typical: 15° to 30° from seabed to surface, bending with sea current

Gas Plumes in the Sea

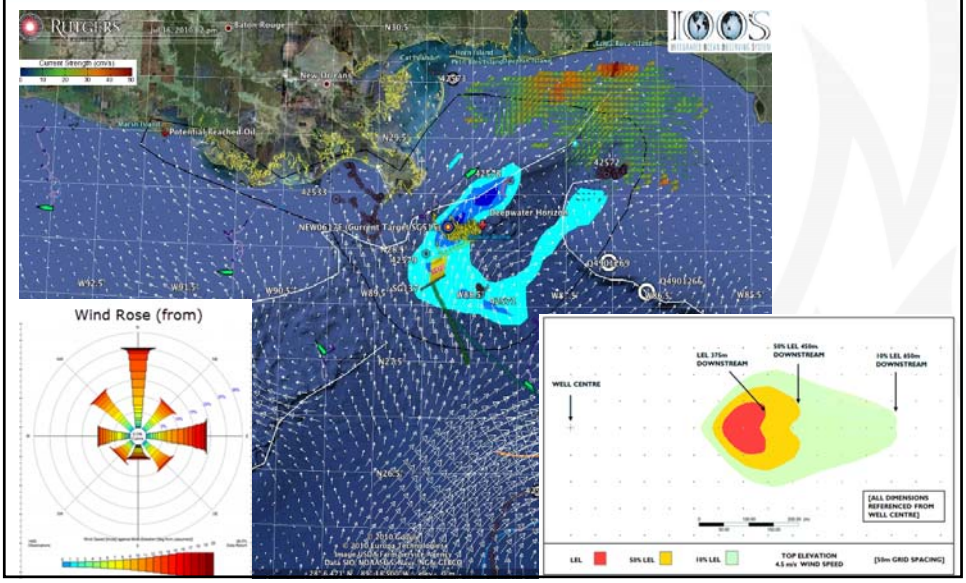
Methane Hydrate formation Curves (Gulf of Mexico)



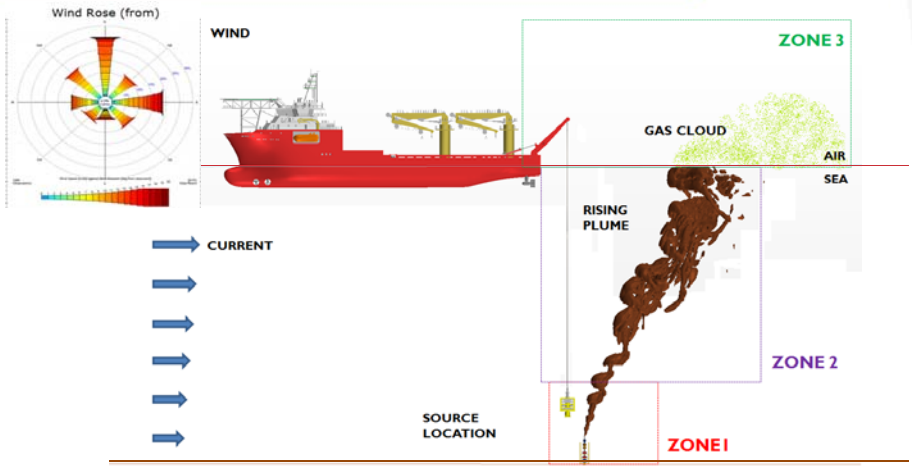


Metocean Data Influence

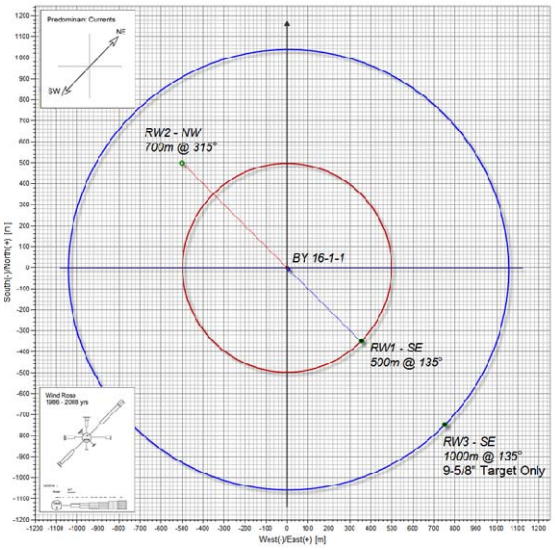
Gas Dispersion, Heat Radiation, Gas Plume & Oil Fate



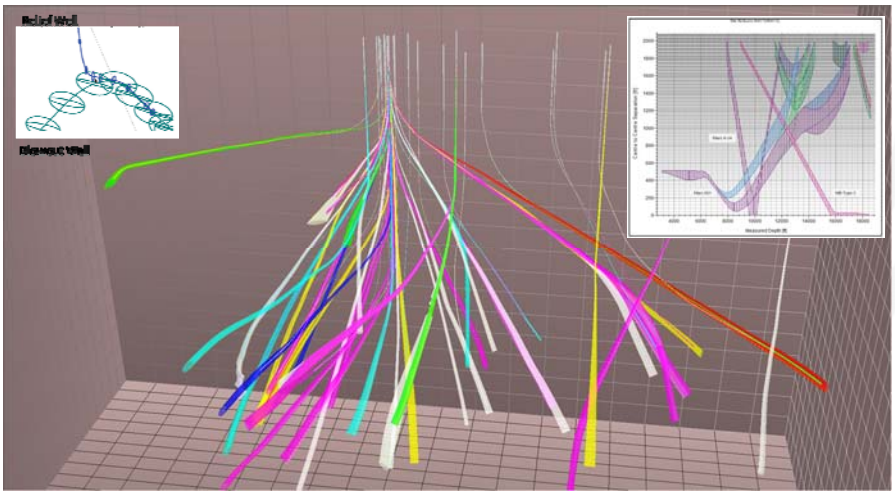
Subsea



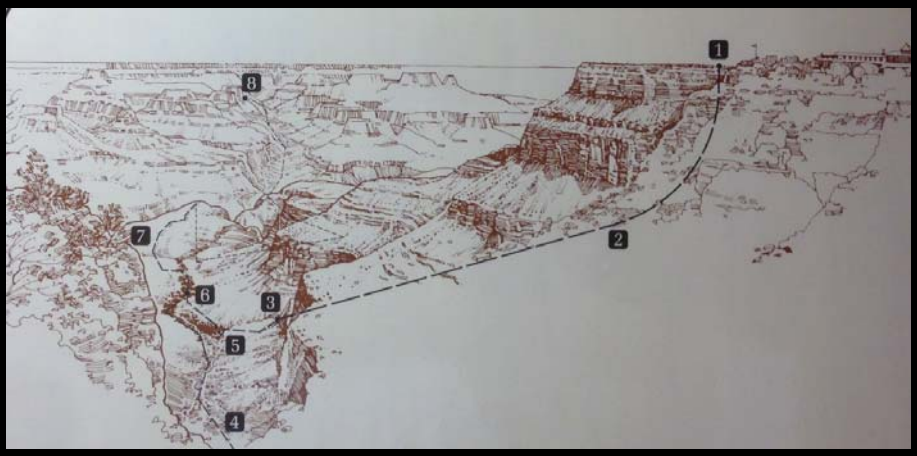
Example Surface Location(s)



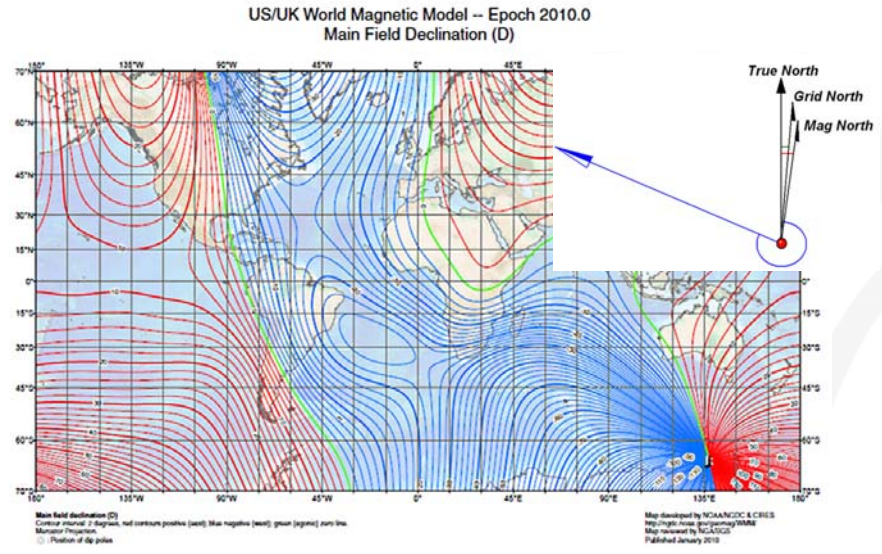
Relief Well and Blowout Position Uncertainty
Adjacent Well Avoidance & Ranging Interference



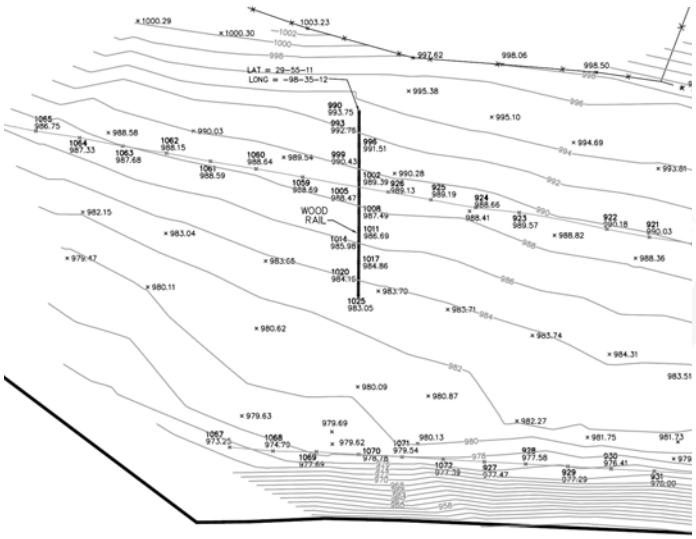
New Water Line for the Grand Canyon



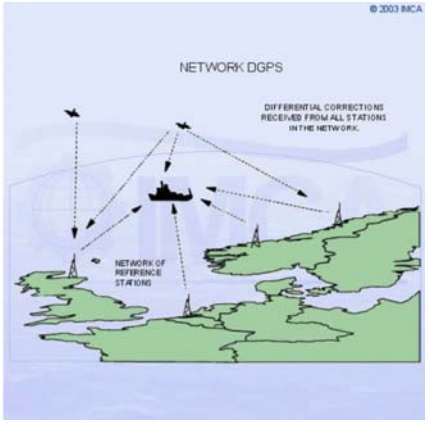
Is Grid Correct and Magnetic Declination Correct, Is Convergence Correct

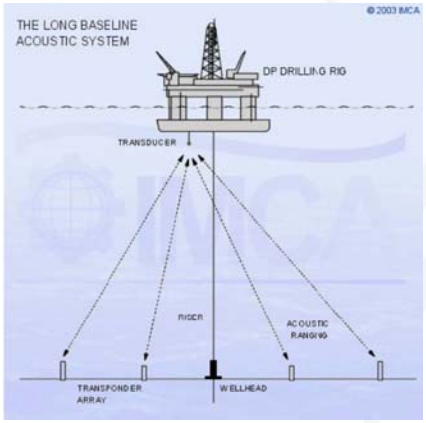


On Land, Surveyor to make Sun Shots and Mark a True North Line



Offshore, DGPS and Subsea Acoustic Positioning Systems





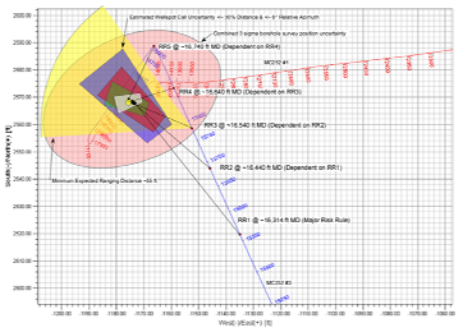
Measuring Magnetic Crustal Anomalies using In-field Referencing

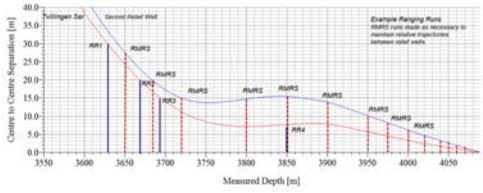
Total Field	**Tf = TfBGGM + TfCrustal Correction**
Declination	**Dec = DecBGGM + DecCrustal Correction**
Dip Angle	**Dip = DipBGGM + DipCrustal Correction**

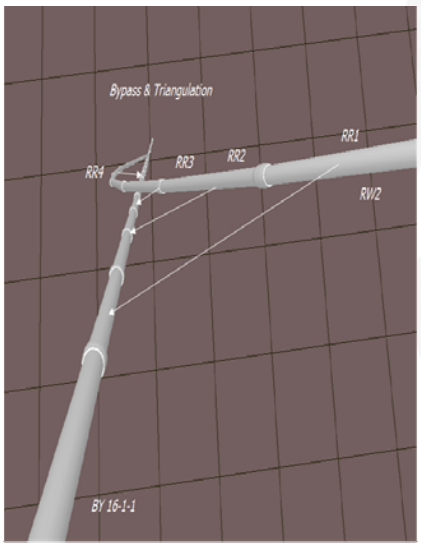
Typical Declination accuracy increase from 0.36° to 0.15° at 1 sigma

High Accuracy North Seeking Wireline Gyros and Gyro While Drilling Tools gMWD

Ranging Strategy and Well Trajectory



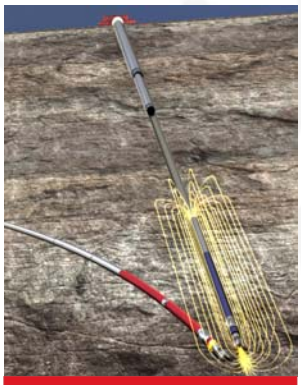




Commercial Ranging Technology

Access Independent Active Magnetic Ranging

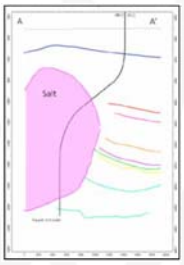
Access Dependent Active Magnetic Ranging



Passive Magnetic Ranging

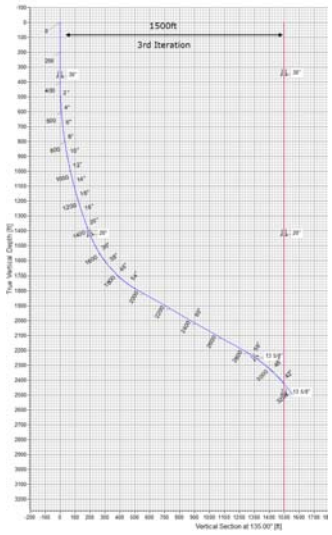
Illustrations Courtesy of Halliburton

Magnetizing Casing with Solenoid for High Angle Intersection and Subsalt Relief Wells



WellCONTAINED

Surface Location and Shallow Intersection Depths & Ranging Strategy



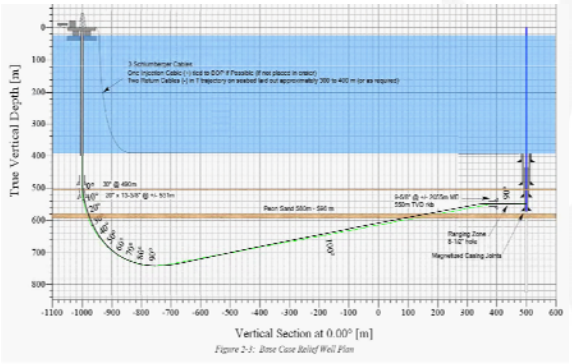


Figure 2-3: Base Case Relief Well Plan

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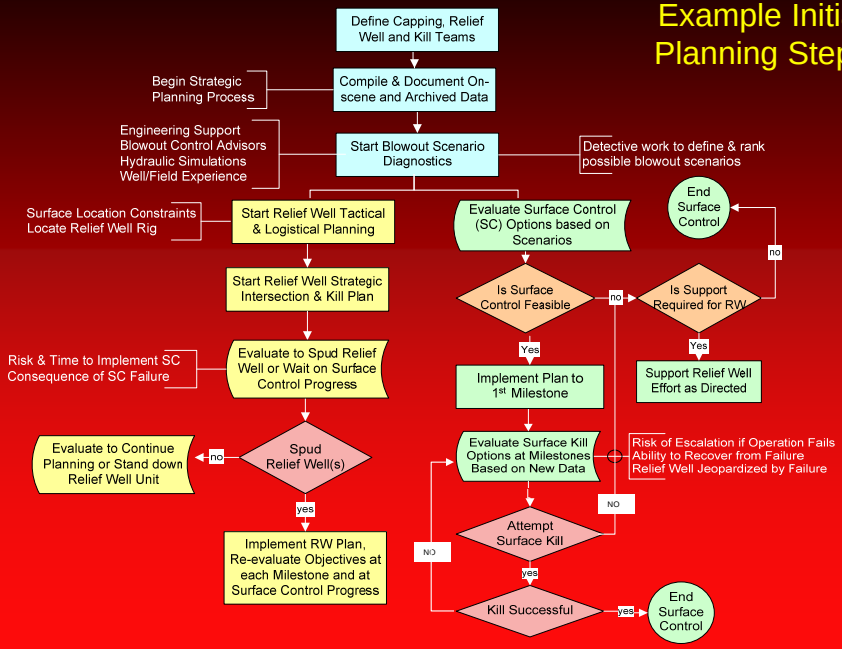
Example Initial Planning Steps



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Thank you.
WILD WELL
CONTROL