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A Guide to Relief Well Trajectory Design using Multidisciplinary Collaborative Well Planning Technology

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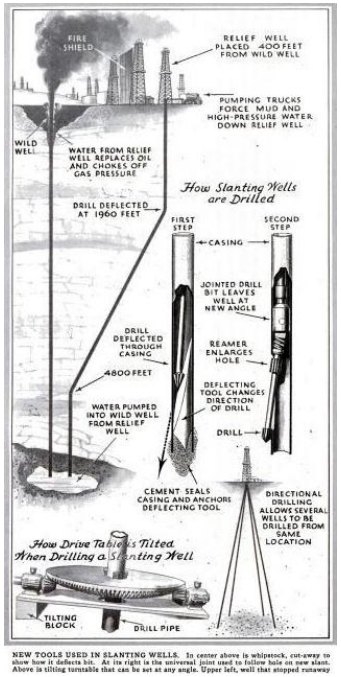
Relief Well

- Purpose: Stop the flow of fluid and get the well under control, back to a state of static conditions.

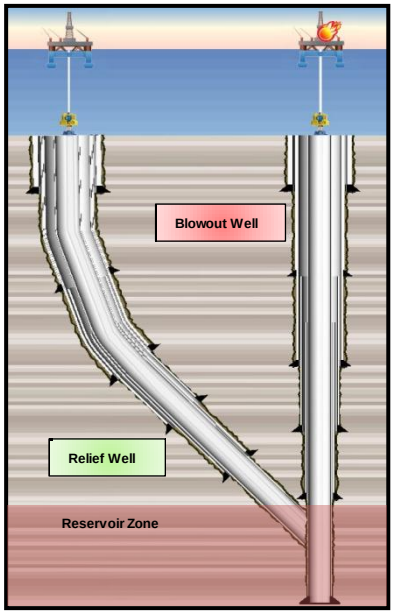
Early Relief Well 1933



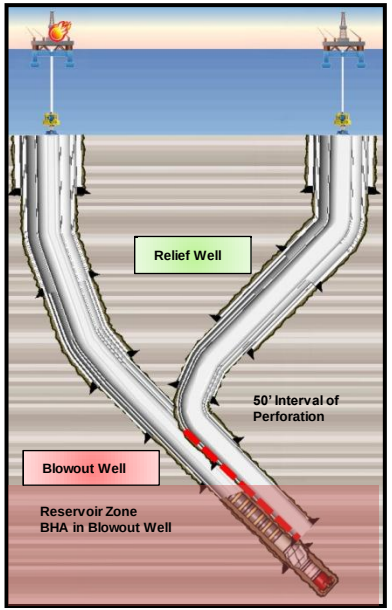
NEW TOOLS USED IN SLANTING WELLS. In center above is whipstock, cut-away to show how it deflects bit. At its right is the universal joint used to follow hole on new slant. Above is tilting turntable that can be set at any angle. Upper left, well that stopped runaway

Popular Science Magazine
May 1934

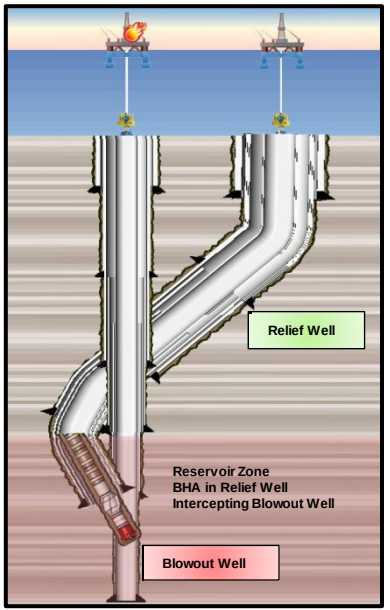
Simple Intercept



Parallel Track

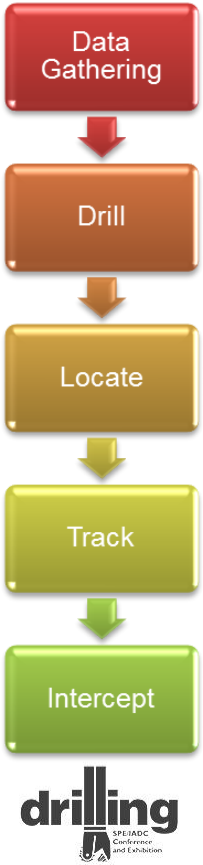


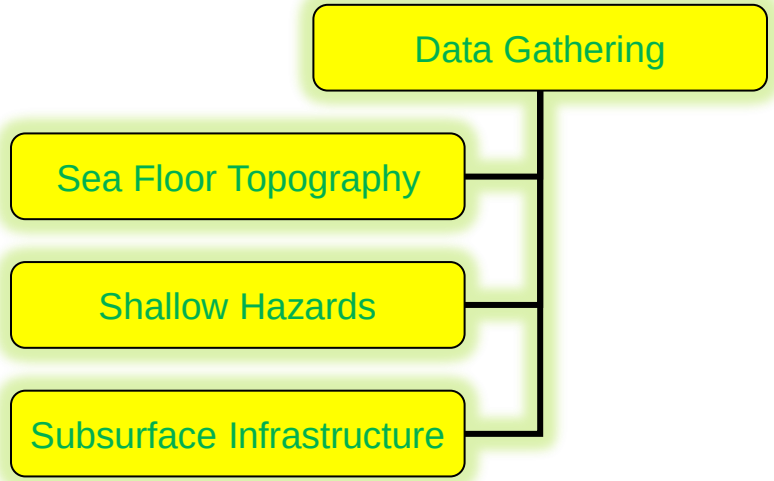
Oriented Intercept

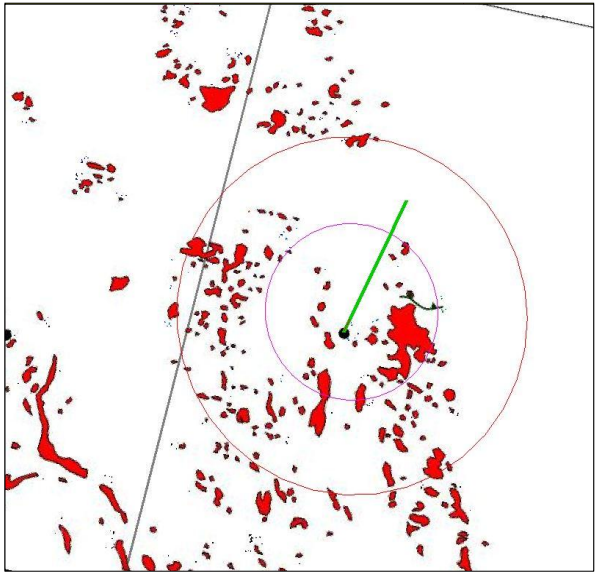


- Cannot over emphasize the need for surveying, redundancy, and processing techniques to reduce the Ellipse of Uncertainty (EOU) of both wells.

Five Major Relief Well Planning Phases





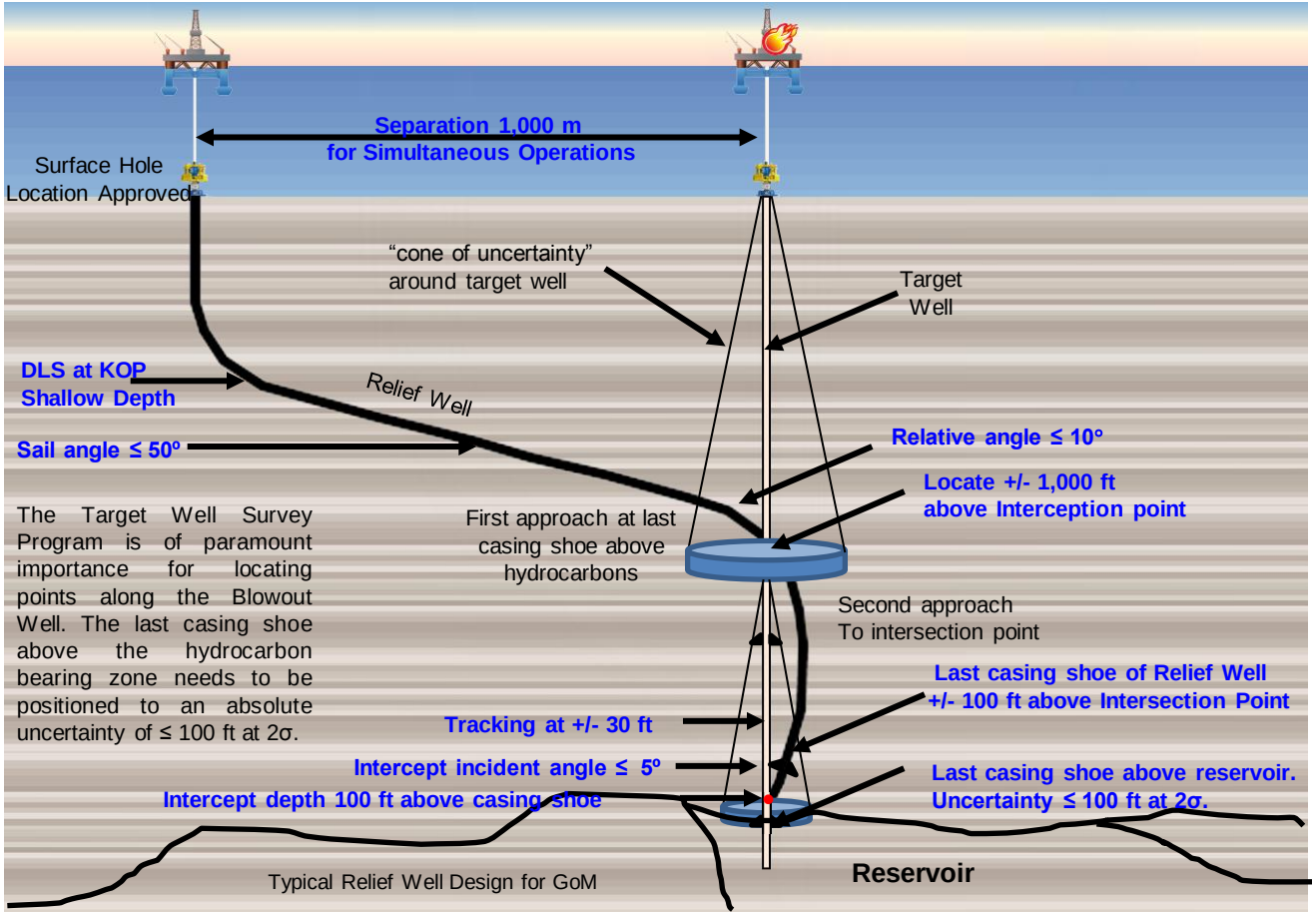


- Steps involve:
  - Acquisition of sub-surface data
  - QC session with the subsurface team
  - Collaborative well planning session
  - Define surface location/s

Five Major Relief Well Planning Phases

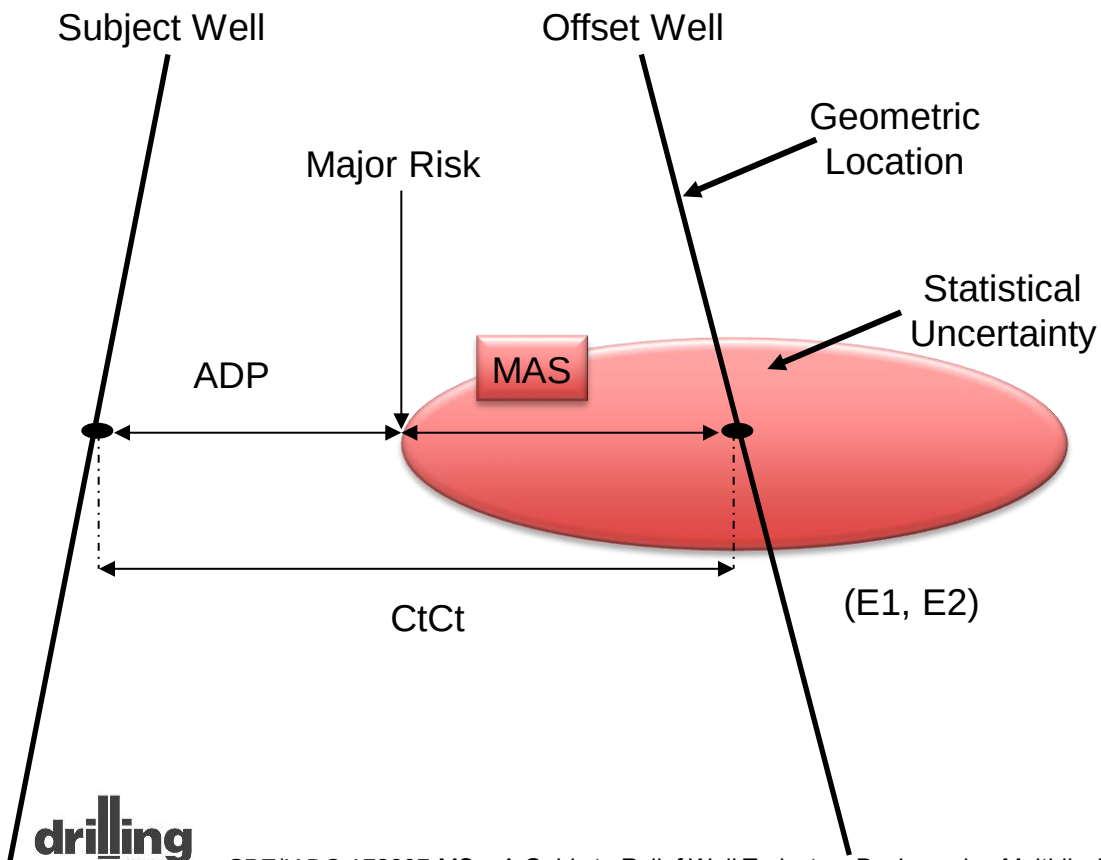
- **Drill**
  - KOP / Sail Angle
  - Torque and Drag
  - Kill Modeling
- **Locate**
  - Incident Angle at Locate
  - Ranging Tools
  - Triangulation
- **Tracking**
  - Track Blowout Well
  - Accidental Intercept
  - Orienting for Interception
- **Intercept**
  - Interception Depth
  - Incident Angle at Intercept
  - Last Casing Shoe of RW

Oriented Intercept Relief Well Design Considerations



DSL – Dog Leg Severity
KOP – Kick Off Point

Relief Well Design

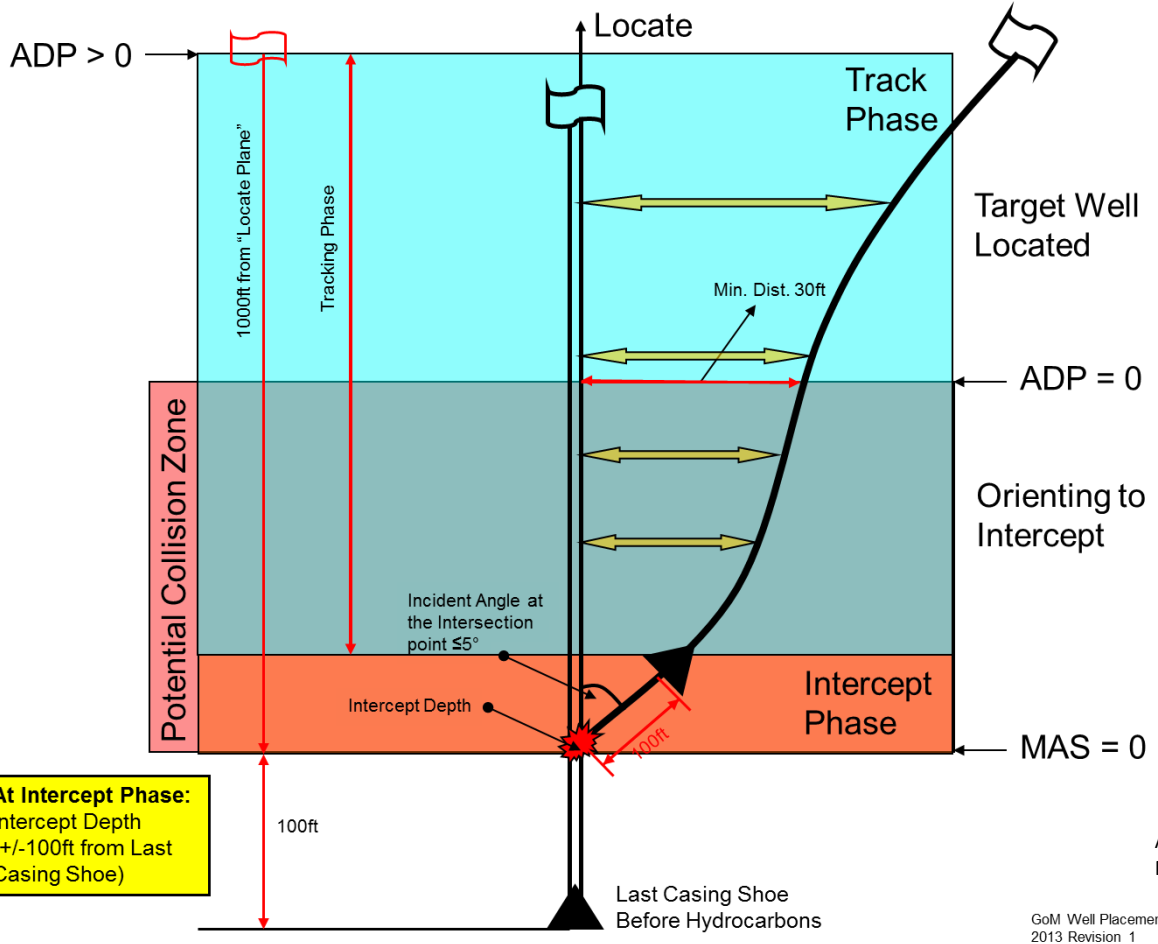


Ratio Factor Rule

- CtCt = ADP+ MAS
- MAS = No Go
- Touch Tolerance Line
  - ADP = 0
  - CtCt = MAS = No Go
- Cross Tolerance Line
  - ADP = Is Negative
- Wells Have Intersected
  - MAS = 0

CtCt = Centre-to-Centre
MAS = Minimum Allowable Separation
ADP = Allowable Deviation From Plan
E1 = Ellipse Of Uncertainty (Subject Well)
E2 = Ellipse Of Uncertainty (Relief Well)

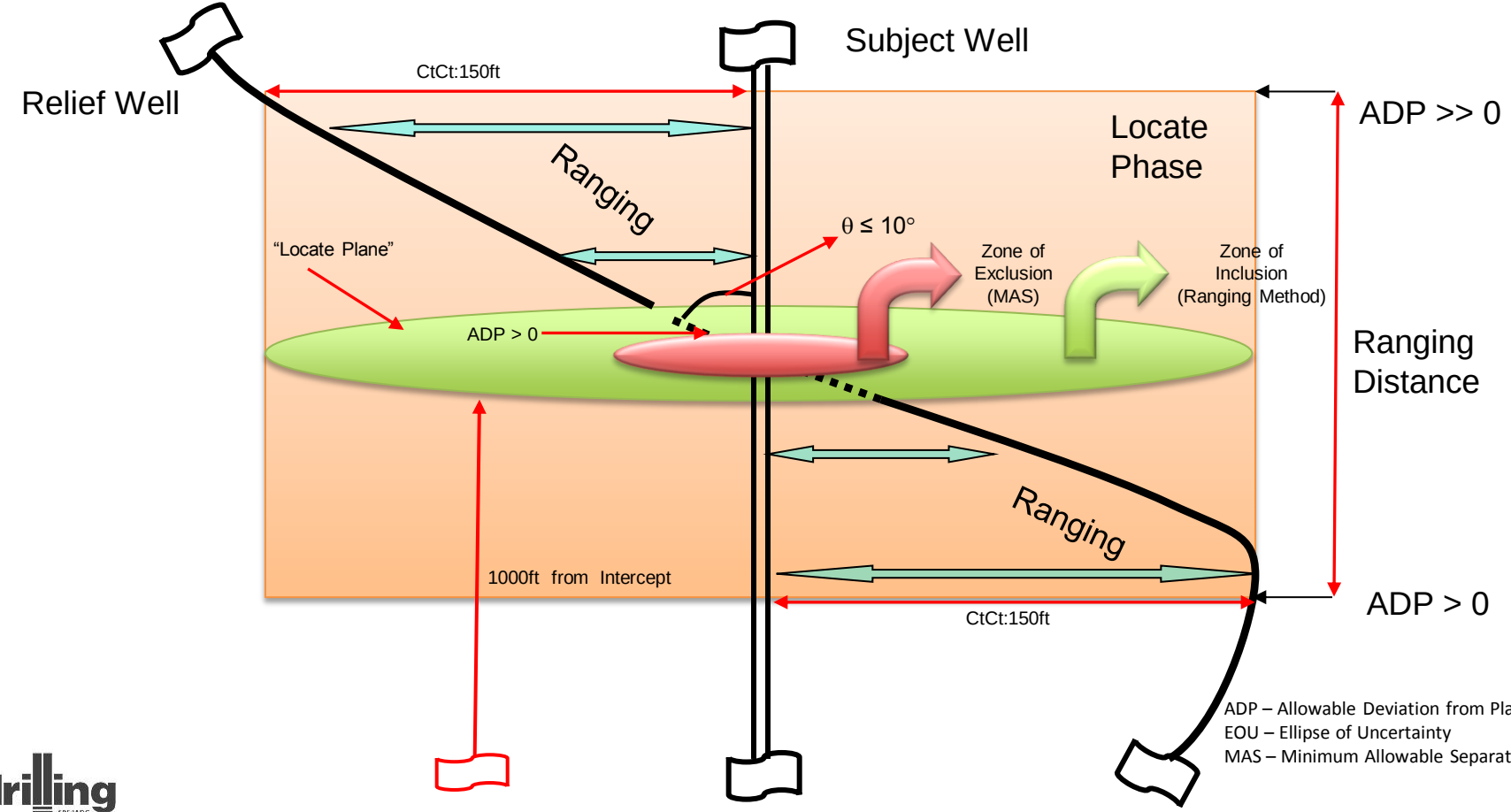
Relief Well Design: Bottom-Up Approach



ADP – Allowable Deviation from Plan
MAS – Minimum Allowable Separation

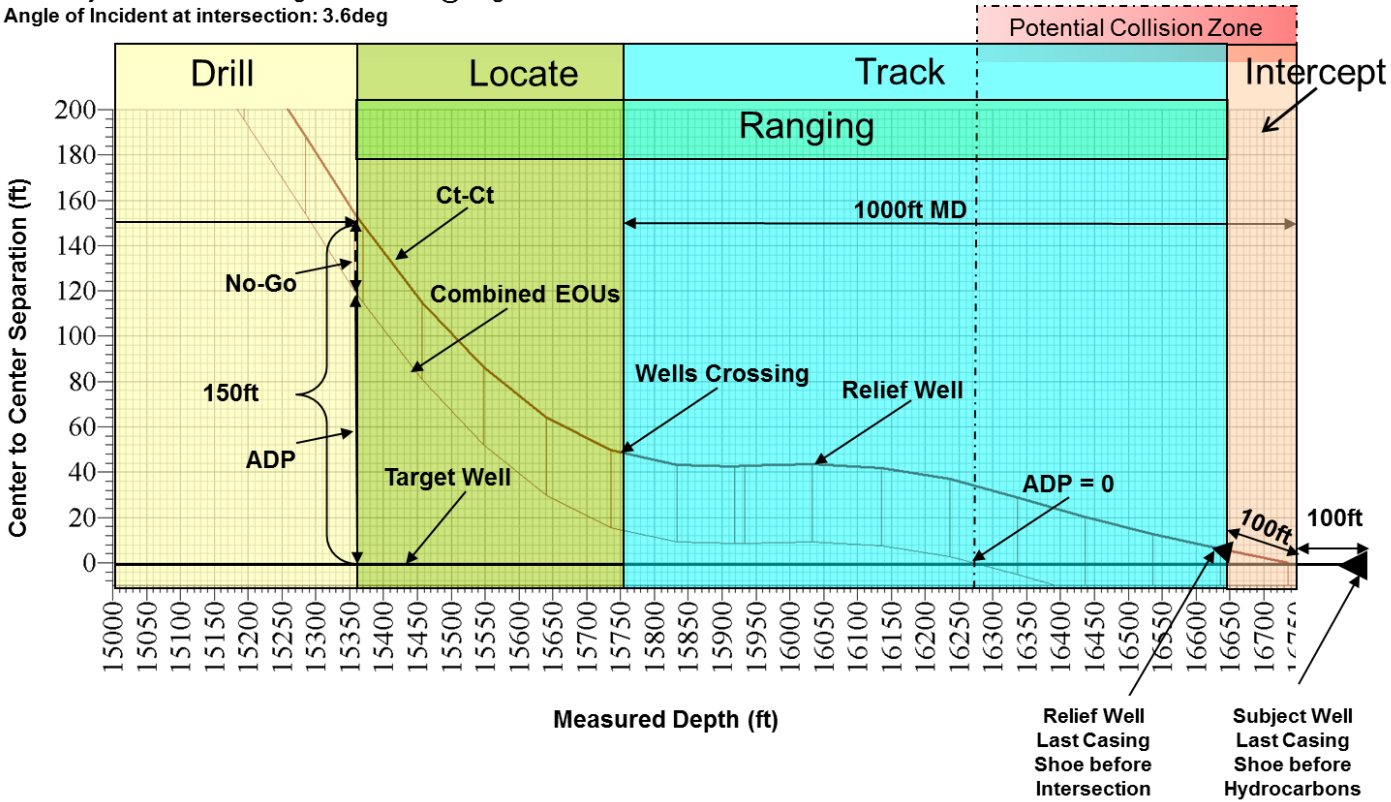
GoM Well Placement Specialist
2013 Revision 1

Relief Well Design: Bottom-Up Approach



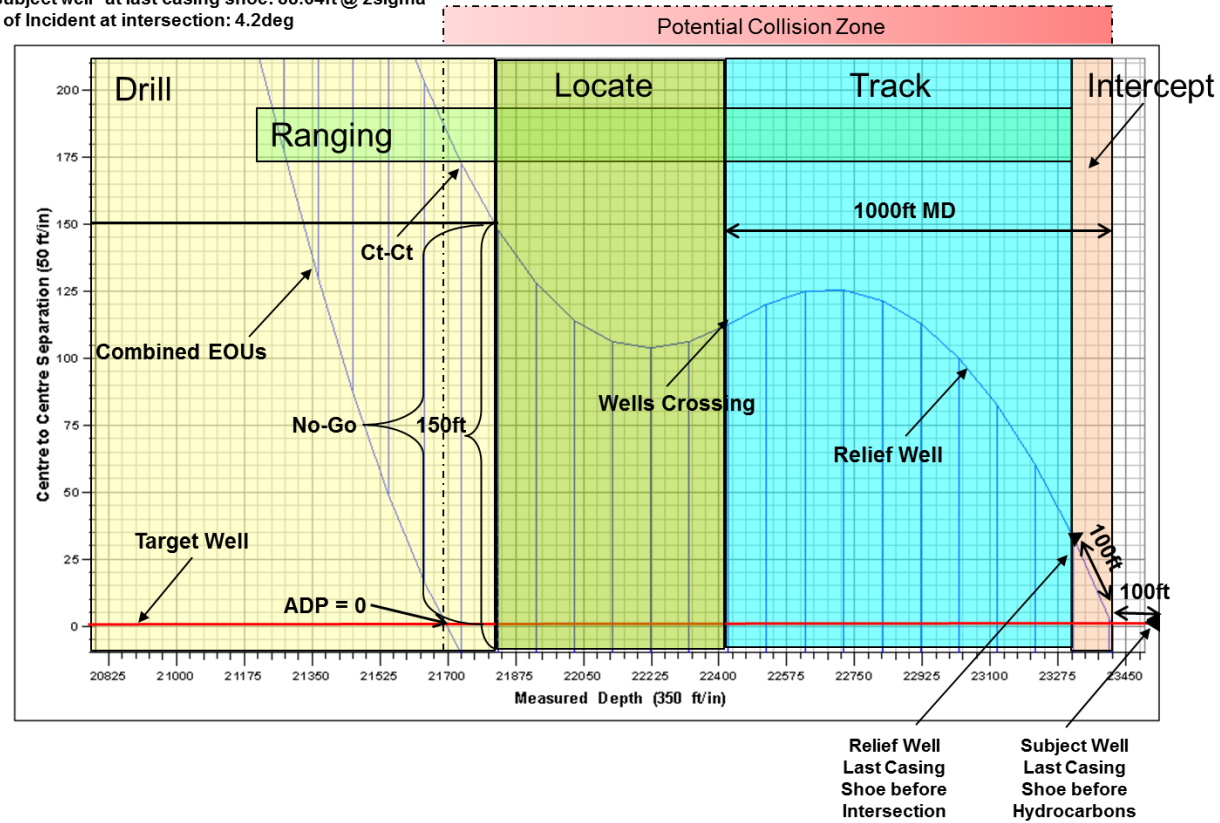
Extrapolated Ladder Plot - Example 1

1. RW1 Surface Location : 2890ft
2. ADP = 0 after the start of the Locate Phase
3. RW1 WP2 Sailing Angle: 25.30deg
4. Angle of incident at the Locate Phase: 7.29deg
5. No Salt
6. EOU subject well at last casing shoe: 72.64ft @ 2sigma
7. Angle of Incident at intersection: 3.6deg

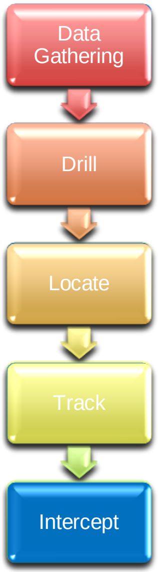


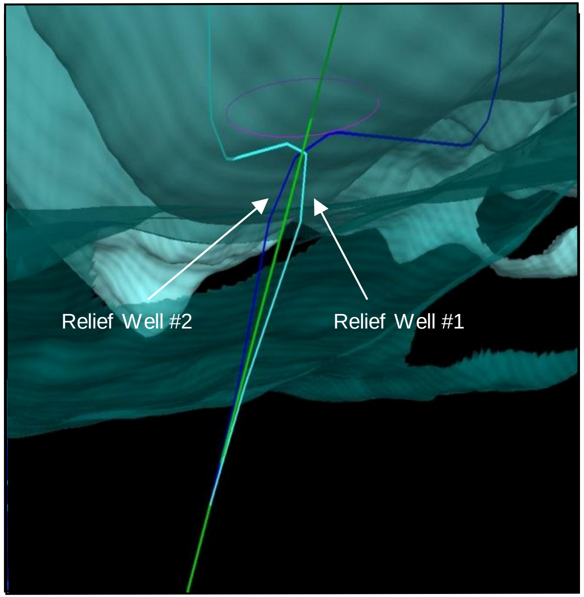
Extrapolated Ladder Plot - Example 2

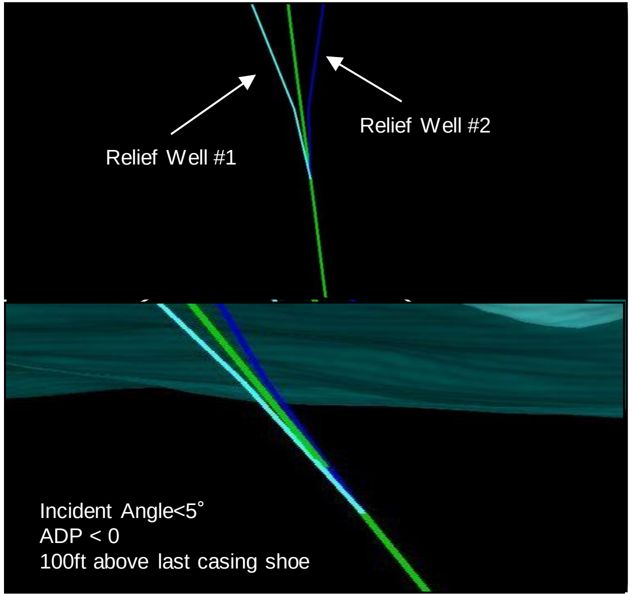
1. RW1 Surface Location : 2490ft
2. ADP = 0 before the start of the Locate Phase
3. RW1 WP3 Sailing Angle: 35.30deg
4. Angle of incident at the Locate Phase: 8.09deg
5. TOS: 15,190ft MD BOS:18,384ft MD
6. EOU subject well at last casing shoe: 88.64ft @ 2sigma
7. Angle of Incident at intersection: 4.2deg



Data Gathering Phase







Surface Location Considerations with slope inclination > 10º (Red)

Conclusions

In order to create a reliable relief well trajectory design, the following must be in place:

- Drilling engineers who are trained on well placement fundamentals and principles.
- A methodical easy to understand systematic approach to relief well design, that defines the rules of engagement based on sound engineering, industry best practices and capability.
- Technologies to facilitate and automate the process to reduce gross errors with the design.
- A multidisciplinary collaborative environment to help with visualization and to optimizing design changes.
- Surveys, redundant surveys, processing techniques and more surveys.

The more precise we can define the position of both wells the greater our confidence will be in locating, tracking and intercepting the blow out well.

Acknowledgements

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Thank You

Questions