- AC Barrier Integrity

William T. Allen

50th General Meeting
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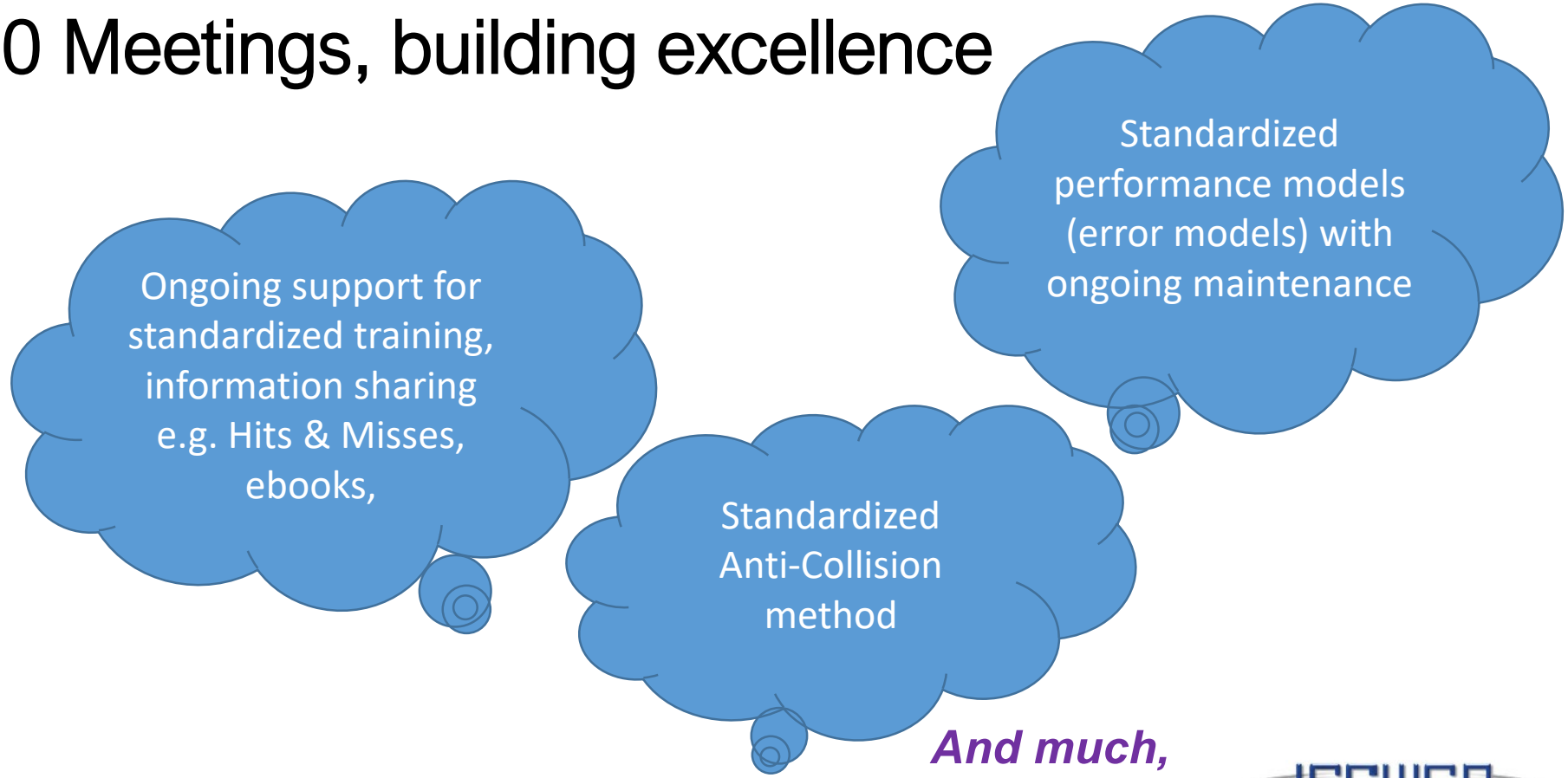
Calgary, Canada

Speaker Bio

- William Allen
  - BP, Global Wells Org., Well Placement Advisor
  - +31 years in energy industry, 13 years at BP
  - UAA / AAS Technology, UoP / BS Business
  - Based in Texas, United States
  - Focus area – Drilling, Well Placement

50 Meetings, building excellence

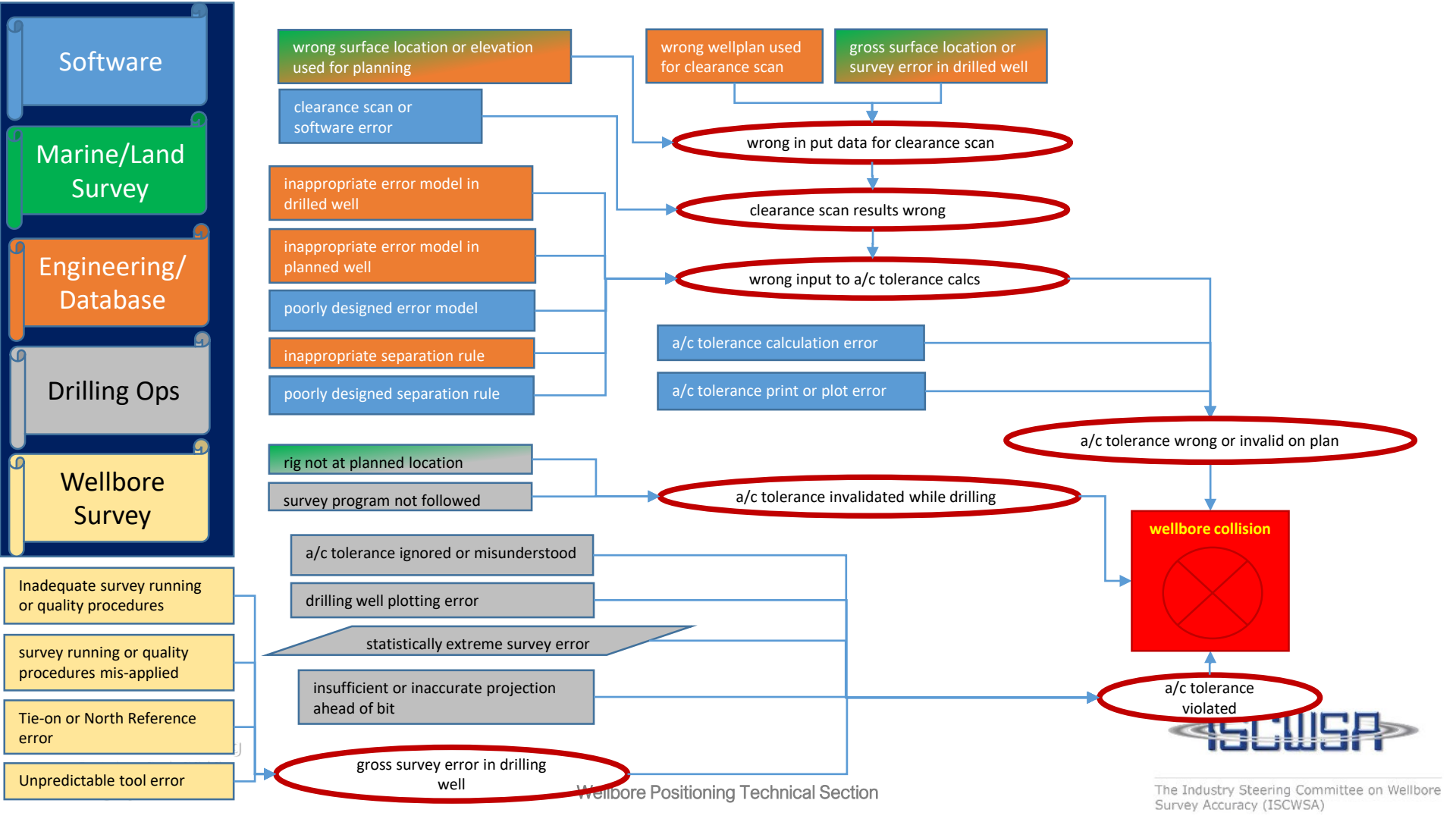


And much, much more

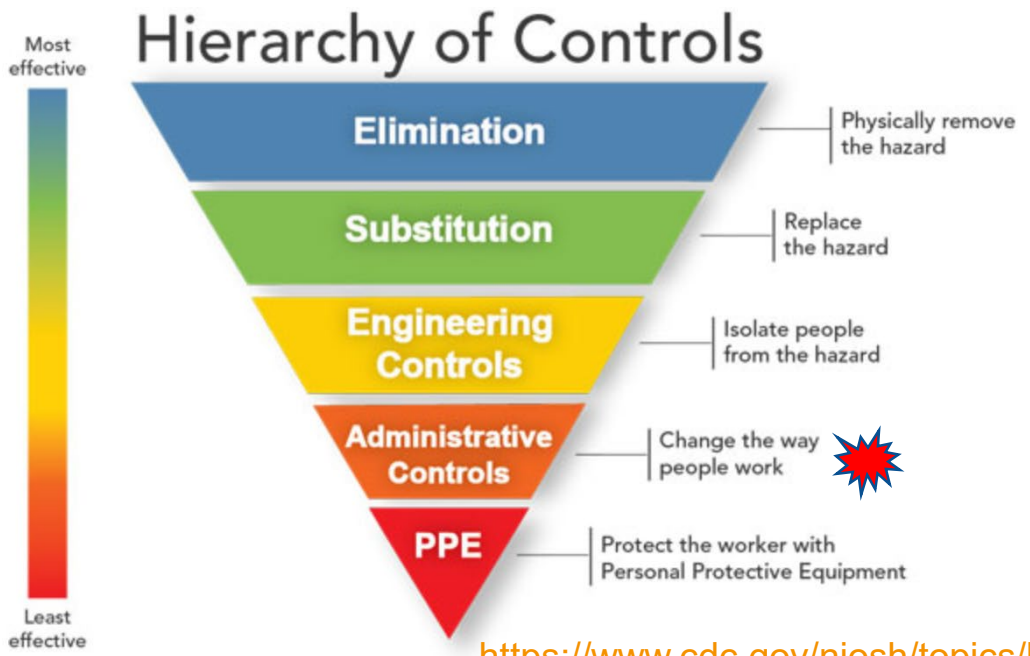
So, are we done?

My Agenda today;

- Review a list of error sources than can lead to a well collision
- Controls and control types, used to prevent those errors
- Common approach to establish & maintain those controls
- Share anonymous well placement performance during a 3 well drilling program
- So, what next?


Software
Marine/Land Survey
Engineering/ Database
Drilling Ops
Wellbore Survey
wrong surface location or elevation used for planning
clearance scan or software error
wrong wellplan used for clearance scan
gross surface location or survey error in drilled well
wrong in put data for clearance scan
inappropriate error model in drilled well
inappropriate error model in planned well
poorly designed error model
inappropriate separation rule
poorly designed separation rule
clearance scan results wrong
wrong input to a/c tolerance calcs
a/c tolerance calculation error
a/c tolerance print or plot error
a/c tolerance wrong or invalid on plan
rig not at planned location
survey program not followed
a/c tolerance invalidated while drilling
wellbore collision
a/c tolerance ignored or misunderstood
drilling well plotting error
statistically extreme survey error
insufficient or inaccurate projection ahead of bit
a/c tolerance violated
Inadequate survey running or quality procedures
survey running or quality procedures mis-applied
Tie-on or North Reference error
Unpredictable tool error
gross survey error in drilling well
Wellbore Positioning Technical Section
ISCWSA
The Industry Steering Committee on Wellbore Survey Accuracy (ISCWSA)

How good are the industry controls?



https://www.cdc.gov/niosh/topics/hierarchy/default.html

The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury has been substantially reduced.

How many organizations enforce Controls

- Set organization “Policy” or “*Requirements*”
  - Approved tools, software, systems, AC method, etc.
- Approve/Agree Procedures needed to deliver the requirements
  - Create “conformant” survey program, “Run” AC scan, “Sign-off” to approve, pre-job session, etc.
- Create competency program

Establish a way of working

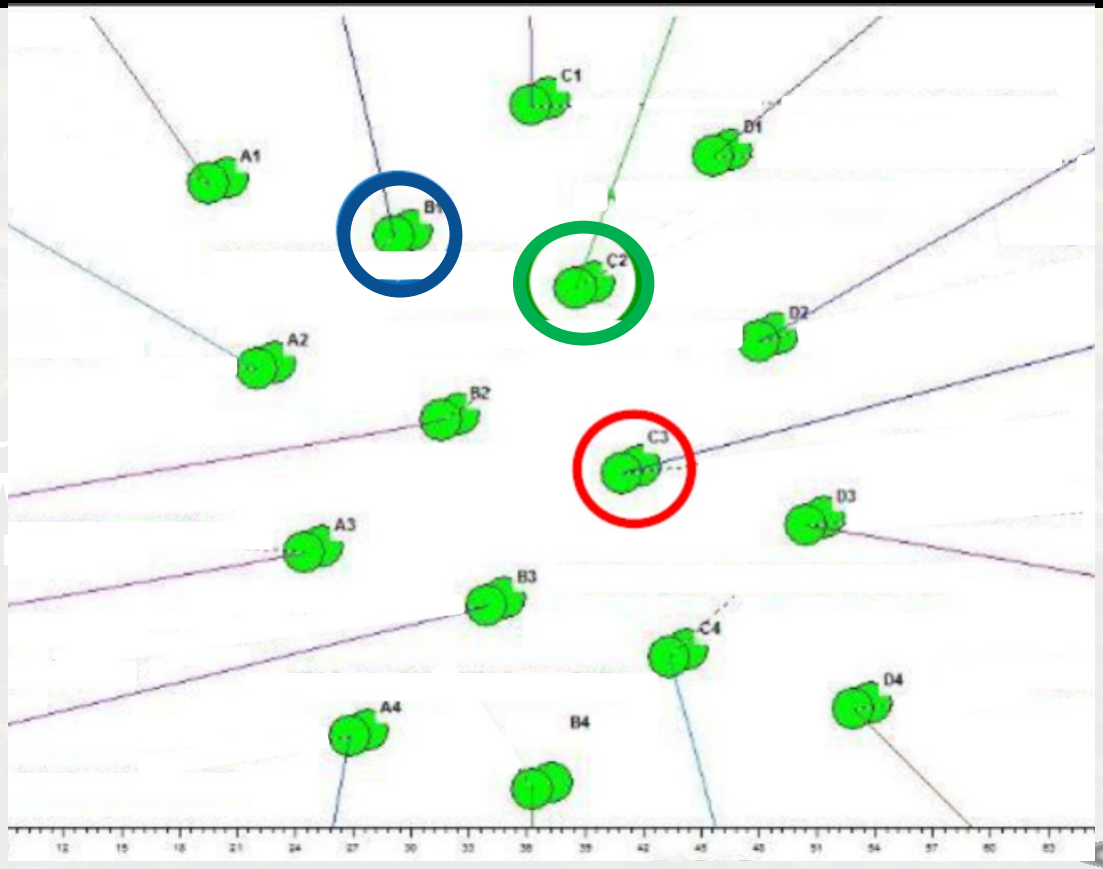
ISCWSA

How things go unexpectedly, 3 well program

In a galaxy far far away… *because well collisions never happen here!*

- The team had a new platform
- The team maintained an area risk tracker, which in this case included the probability of well collision during the drilling program
  - The team listed the collision probability as “never happened in the industry”
- The team was not familiar with congested well drilling
- The team planned for 3 wells
- The team was trained and aware of well placement requirements & procedures

The plan… All plans, no real wells



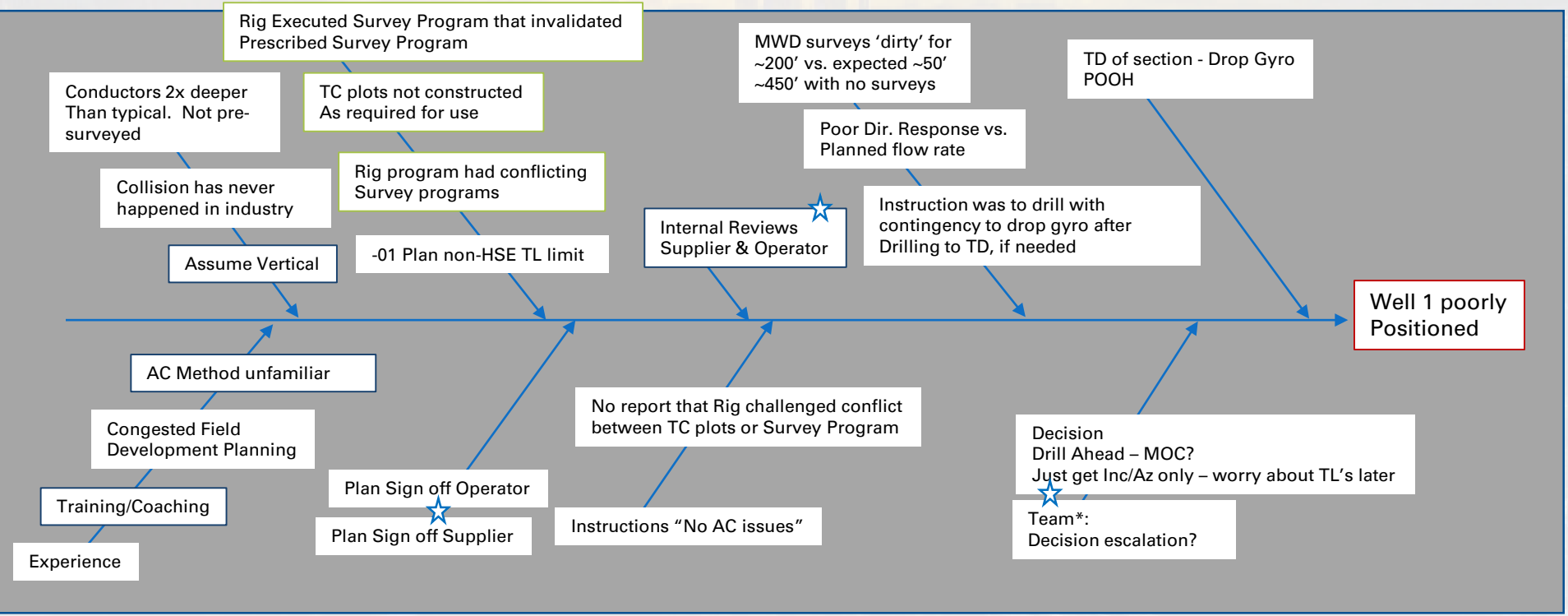
- Conductors driven open ended 200 ft
- 10 ft centers
- 30” Conductors
- Interior Slots chosen first
- Dummy wells inserted in unused slots

Well 2

Well 3

Well 1

Well 1 (initial Spud)



Well 1 (initial Spud)

Rig Executed Survey Program that invalidated Prescribed Survey Program

Conductors 2x deeper Than typical. Not pre-surveyed

TC plots not constructed As required for use

MWD surveys 'dirty' for ~200' vs. expected ~50' ~450' with no surveys

TD of section - Drop Gyro POOH

Poor Dir. Response vs. Planned flow rate

Collision has never happened in industry

Rig program had conflicting Survey programs

Instruction was to drill with

Assume Vertical

AC Method unfamiliar

Congested Field Development Planning

Training/Coaching

Experience

Pla

Plan

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Survey Tool Program **Date** 13/02/2019

From (ft)	To (ft)	Survey (Wellbore)	Tool Nar
147.0	1,400.0	Plan well 1	GWD
1,400.0	12,064.7	Plan well 1	MWD

Proposed Survey Program

Hole Section	Depth in (ft MD)	Depth out (ft MD)	Plan	Survey Tool	Error Model/IPM	Frequency
24"	604	1367	Primary	MWD	MWD+Sag+SC	Per stand
			Backup	Drop Gyro and surface retrieval	Drop Gyro	Per stand, while POOH
17-1/2"	1368	3312	Primary	MWD	MWD+Sag+SC	Per stand
			Backup	Electronic Multi Shot	EMS	As required
12-1/4"	3313	8046	Primary	MWD	MWD+Sag+SC	Per stand
			Backup	Electronic Multi Shot	EMS	As required
8-1/2"	8047	12062	Primary	MWD	MWD+Sag+SC	Per stand
6" Contingency	TBC	TBC	Primary	MWD	MWD+Sag+SC	Per stand

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AC Metho

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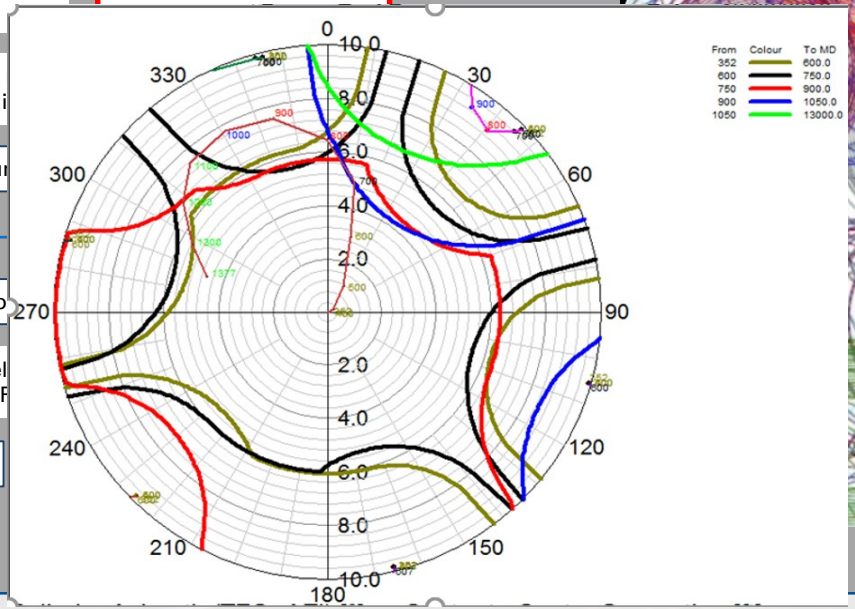

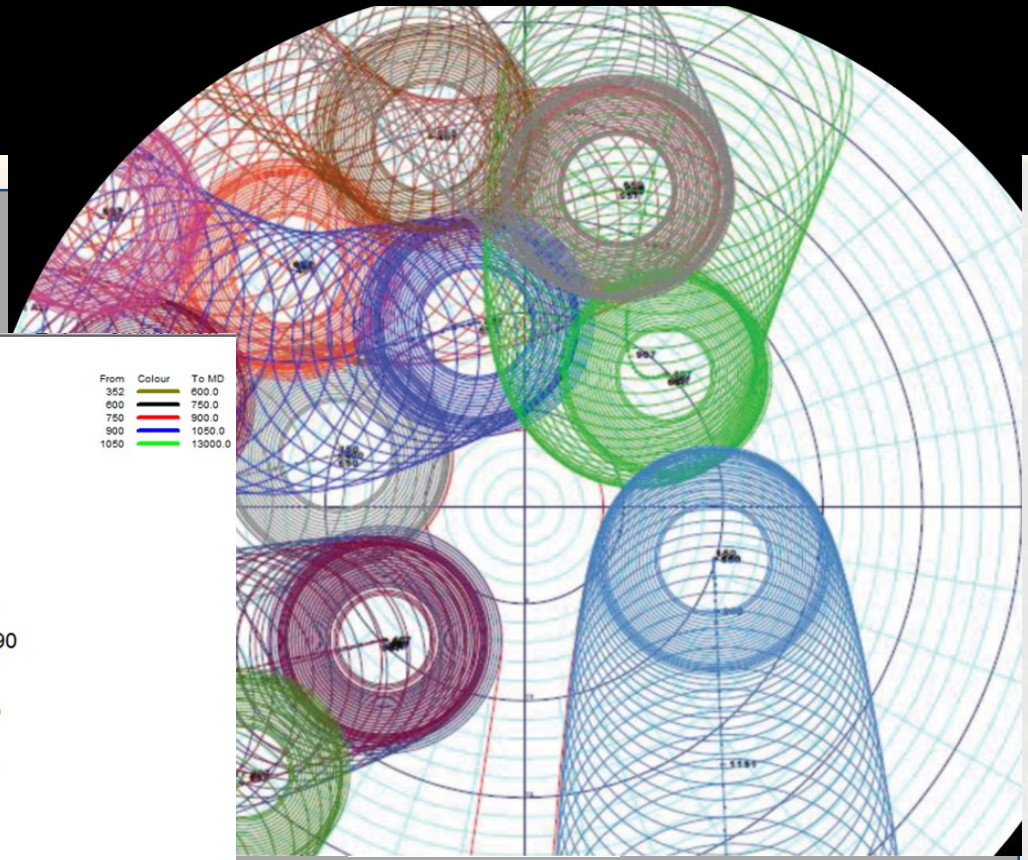

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Assume Vertical

-01 Plan non-HSE TL limit

AC Method unfamiliar

Congested Field Development Planning

Training/Coaching

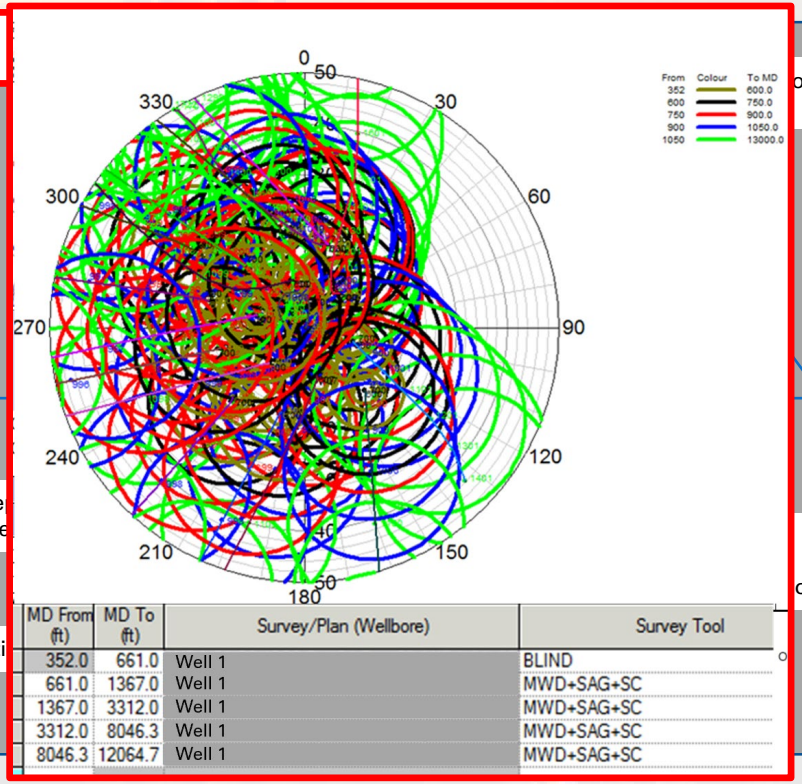
Experience

Plan Sign off Operator

Plan Sign off Supplier

Instructi

No re
betwe

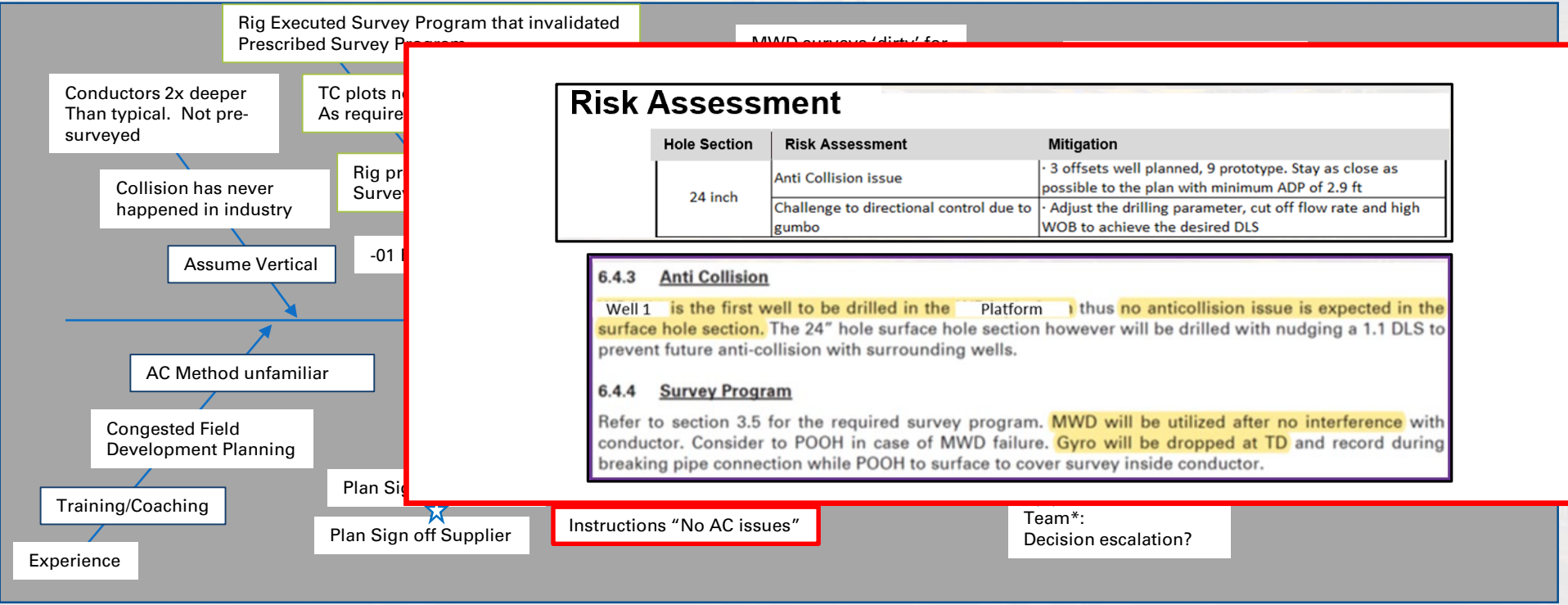


MD From (ft)	MD To (ft)	Survey/Plan (Wellbore)	Survey Tool
352.0	661.0	Well 1	BLIND
661.0	1367.0	Well 1	MWD+SAG+SC
1367.0	3312.0	Well 1	MWD+SAG+SC
3312.0	8046.3	Well 1	MWD+SAG+SC
8046.3	12064.7	Well 1	MWD+SAG+SC

Well 1 poorly Positioned

out TL's later

Well 1 (initial Spud)



Risk Assessment

Hole Section	Risk Assessment	Mitigation
24 inch	Anti Collision issue	· 3 offsets well planned, 9 prototype. Stay as close as possible to the plan with minimum ADP of 2.9 ft
	Challenge to directional control due to gumbo	· Adjust the drilling parameter, cut off flow rate and high WOB to achieve the desired DLS

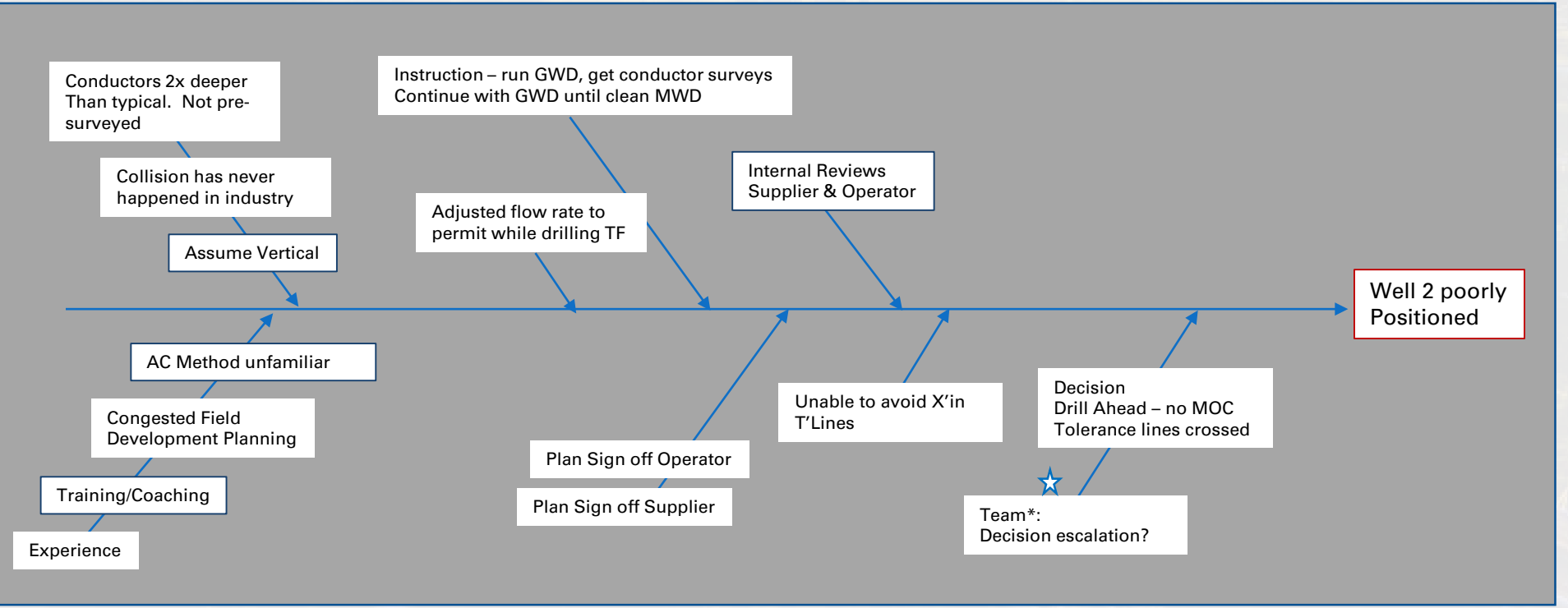
6.4.3 Anti Collision

Well 1 is the first well to be drilled in the Platform thus no anticollision issue is expected in the surface hole section. The 24" hole surface hole section however will be drilled with nudging a 1.1 DLS to prevent future anti-collision with surrounding wells.

6.4.4 Survey Program

Refer to section 3.5 for the required survey program. MWD will be utilized after no interference with conductor. Consider to POOH in case of MWD failure. Gyro will be dropped at TD and record during breaking pipe connection while POOH to surface to cover survey inside conductor.

Well 2


Conductors 2x deeper Than typical. Not pre-surveyed
Collision has never happened in industry
Assume Vertical
AC Method unfamiliar
Congested Field Development Planning
Training/Coaching
Experience
Instruction – run GWD, get conductor surveys Continue with GWD until clean MWD
Adjusted flow rate to permit while drilling TF
Plan Sign off Operator
Plan Sign off Supplier
Internal Reviews Supplier & Operator
Unable to avoid X'in T'Lines
Decision Drill Ahead – no MOC Tolerance lines crossed
Team*: Decision escalation?
Well 2 poorly Positioned

Well 2

Conductors 2x deeper Than typical. Not pre-surveyed

Collision has never happened in industry

Assume Vertical

Instruction – run GWD, get conductor surve
Continue with GWD until clean MWD

Adjusted flow rate to permit while drilling TF

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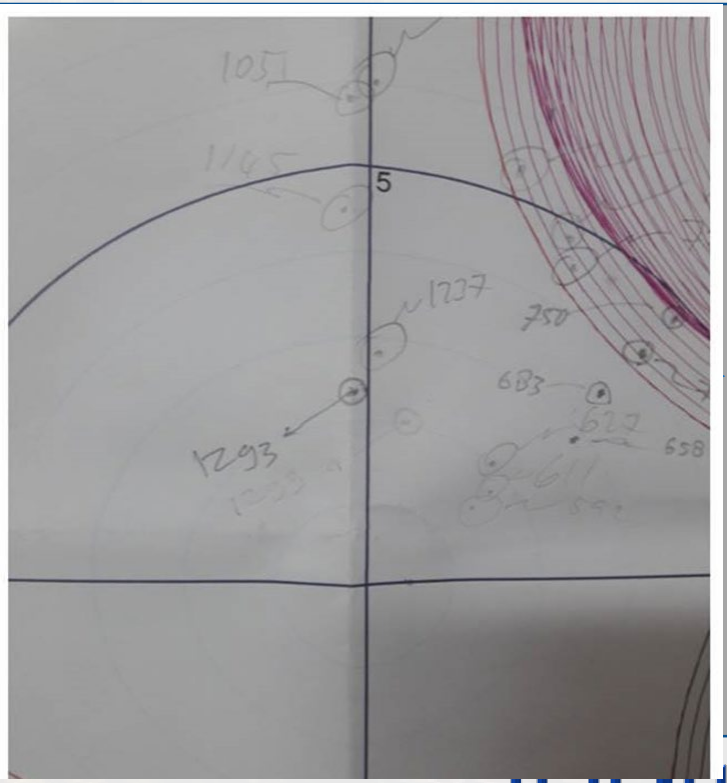
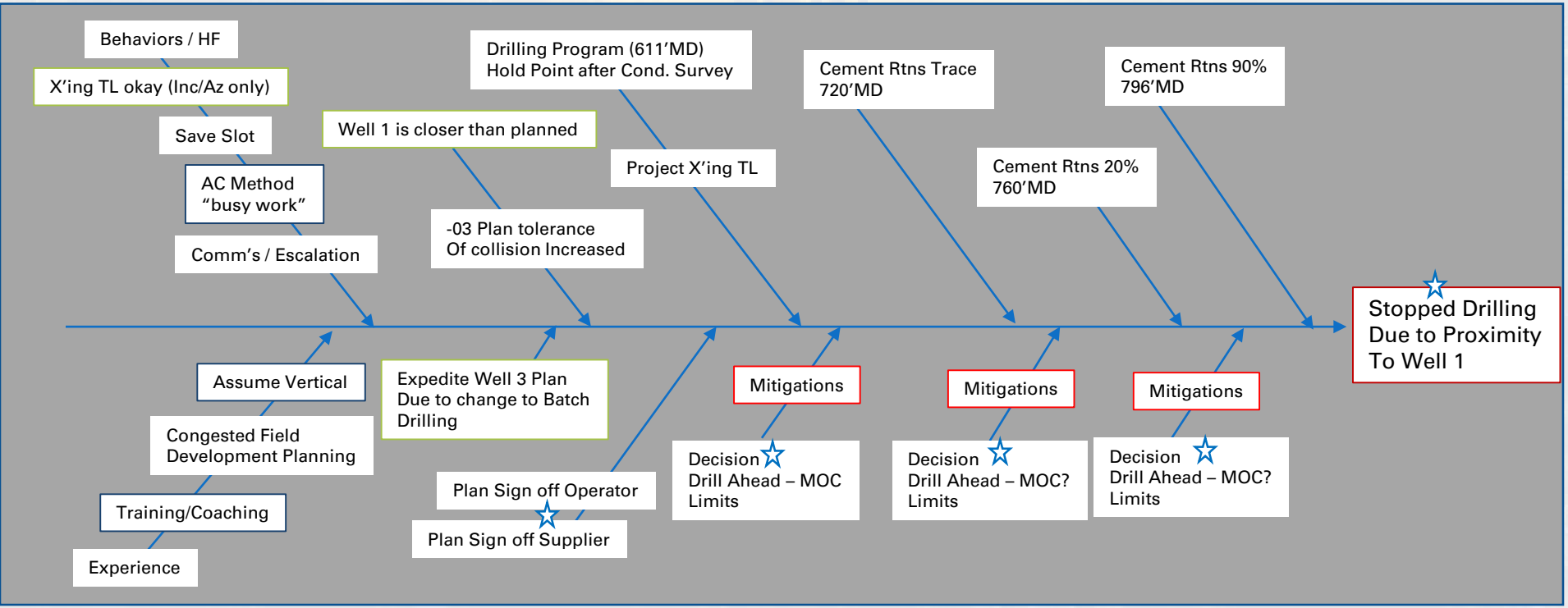
Plan Sign off Operator

Plan Sign off Supplier

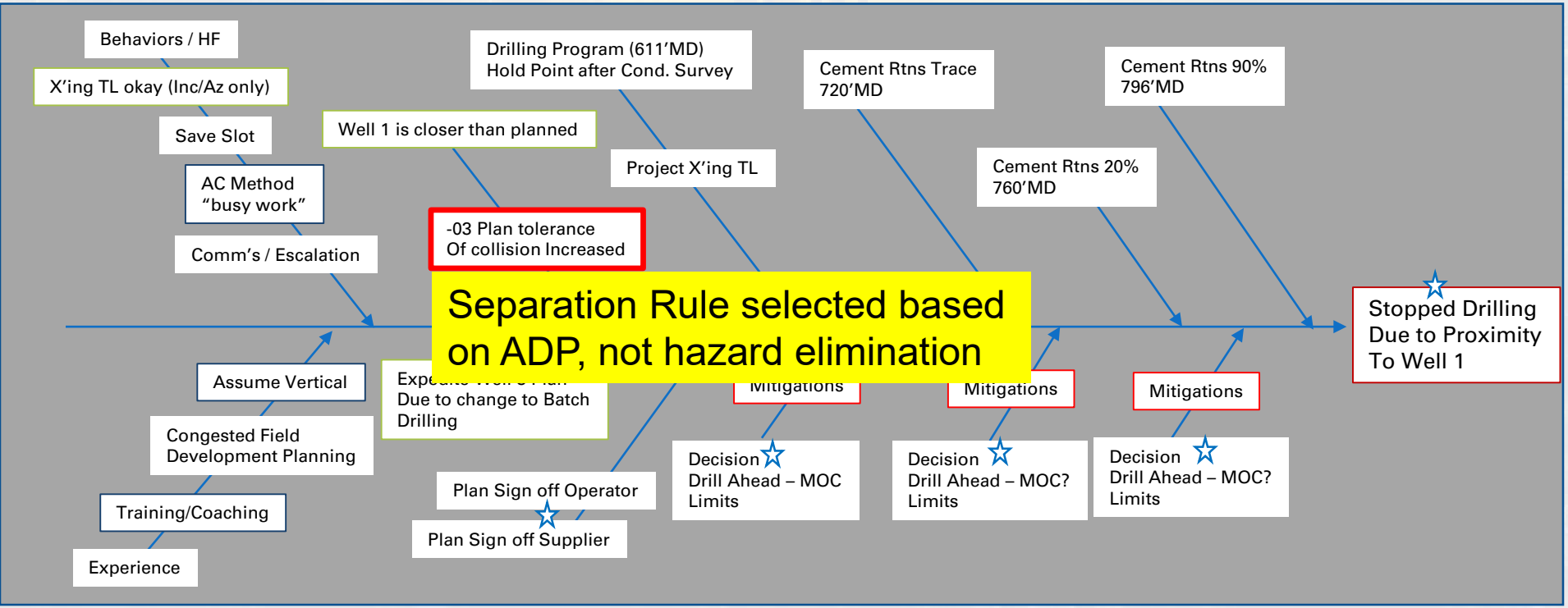


Well 2 poorly Positioned

Well 3


Behaviors / HF
X'ing TL okay (Inc/Az only)
Save Slot
AC Method "busy work"
Comm's / Escalation
Assume Vertical
Congested Field Development Planning
Training/Coaching
Experience
Drilling Program (611'MD) Hold Point after Cond. Survey
Well 1 is closer than planned
Project X'ing TL
-03 Plan tolerance Of collision Increased
Expedite Well 3 Plan Due to change to Batch Drilling
Plan Sign off Operator
Plan Sign off Supplier
Cement Rtns Trace 720'MD
Cement Rtns 20% 760'MD
Cement Rtns 90% 796'MD
Mitigations
Decision Drill Ahead – MOC Limits
Mitigations
Decision Drill Ahead – MOC? Limits
Mitigations
Decision Drill Ahead – MOC? Limits
Stopped Drilling Due to Proximity To Well 1

Well 3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Plan Sign off Operator
Plan Sign off Supplier
Cement Rtns Trace 720'MD
Cement Rtns 20% 760'MD
Cement Rtns 90% 796'MD
Separation Rule selected based on ADP, not hazard elimination
Mitigations
Mitigations
Mitigations
Decision Drill Ahead – MOC Limits
Decision Drill Ahead – MOC? Limits
Decision Drill Ahead – MOC? Limits
Stopped Drilling Due to Proximity To Well 1

Well 3

ISCWSA, November 2011

Recommendation against MASD dispensation for HSE risk wells

SUMMARY

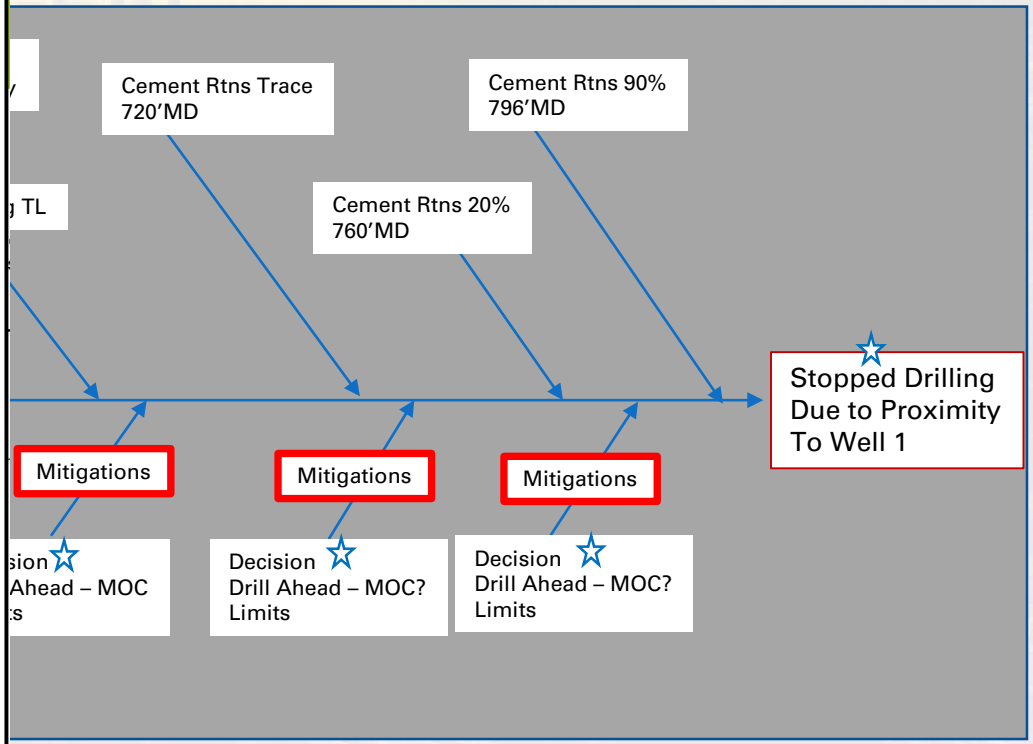
The Collision Avoidance Work Group recommends that HSE risk offset wells should always be subject to a suitably conservative Minimum Allowed Separation Distance (MASD), and that dispensation from such rules should not be allowed. In particular, the probability of the drilling assembly failing to penetrate the offset well in the event of a collision cannot be reliably quantified and therefore does not justify dispensation against a HSE risk MASD.

P2, the probability of penetration once contact is made is not quantified in any formal or objective way. The following are examples of actions/circumstances (sometimes referred to as mitigating actions) that are commonly assumed to reduce the probability of penetration:

- Rotary drilling instead of motor drilling
- Drilling with a mill-tooth bit instead of a PDC bit
- Drilling with a dull or "shirt tail" bit
- Drilling with low ROP
- Monitoring the shakers for cement/steel
- Monitoring offset wellhead vibration
- Monitoring offset casing annular pressure
- Jetting instead of drilling
- Low angle of incidence between wells
- Soft formation
- Multiple casing strings protecting the tubing

The Collision Avoidance Work Group has considered the effectiveness of such actions and circumstances, with the objective of providing guidance to the Industry.

The consensus of the Group is that such actions may be sensible practices in close pass situations, but their effectiveness is not predictable and they cannot reliably ensure that penetration will not occur. Therefore, we do not recommend their use as justification for dispensation against the MASD criterion that would otherwise be applied to a HSE risk offset well. Their use in allowing a reduced MASD should be restricted to offset wells that do not represent a HSE risk.



Summary of Findings

There are many findings, for today, lets discuss the Controls

- Vast Majority are Admin controls
  - Reliance on people, and their imperfections regarding;
    - focus, awareness, training, prioritization, bias, pressure(s)

- Competency can be hard to create, measure, it takes time, unlikely without effective leadership and courage

- Easy to blame team experience, capability and a lack of procedural discipline. However
  - Team was trained and certified in tools and methods & procedures. Surprisingly – few requirement tasks (controls) not performed, but outcome of control failed to initiate expected outcomes e.g. stop job.
  - Once the team transitioned to their own “requirements” the team was still unable to “stop the job” until after a series of undesired results.

- Is the answer to terminate employment with the team? Have them teach others what happened? Or something possibly better – better controls?

In Conclusion yes, we can do more…

- Software that reduces admin controls, or reliance of, with underlying continuous job monitoring
  - Plan that delivers Objectives based on Historical performance & Requirements (plus?)
  - Monitor actual performance vs. expected to achieve objectives/requirements/performance
  - Automatic escalation if failing to deliver or simply outside of limits

- Better integration of requirements into the system to limit, or prevent, poor human choices/performance, such as
  - Poor Survey programs - magnetic surveys planned inside cased hole
  - Poor Survey interval - Flagging survey invalid intervals e.g. MWD survey tied to WRP followed by 200' of conductor
  - Prevent mis-match of reporting/plotting/trajectory (AC report with GWD, TC plot w/o)

- Automated monitoring, data vetting, auto escalation
  - As bit/sensor depth exceeded survey interval – invalidating AC results – escalate
  - As survey QA/QC failed, invalidating AC results - escalate
  - If BHA can not satisfy Survey Program, - notify, escalate
  - Warning, be wary of creating alarms for everything and then ignoring them…

Questions?

Wellbore Surve

Wellbore Positioning

ISCWSA