Simultaneous Operations and Anti-Collision:

Surface and Subsurface Protection of Health, Safety and Environment in Ohio's Oil and Gas Fields

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Division of Oil and Gas Resources Management

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BACKGROUND

- Commercial oil and gas production in Ohio dates to 1860. Nearly a century later, a drilling boom in the early 1960's lead to regulatory oversight of Ohio's oil and gas industry.
- Throughout the booms and busts of the 20th century, Ohio witnessed continued exploration and development of conventional reservoirs.
- In the late 1970's, directional drilling was first utilized in Ohio to develop previously inaccessible reserves under lakes and urban centers.
- Likewise, regulatory oversight grew in response to fulfill the Divisions Mission Statement of protecting public health, safety, and the environment.

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- As operations shifted from developing a single well into reservoir rock from multiple locations to multiple wells into a source rock from single locations, the advent of centralized 'pad drilling' of unconventional horizontal wells in a production line fashion created new challenges to both the engineers tasked with efficiently maximizing recovery from leaseholds and regulatory agencies in protecting public health, safety and the environment.
- The early days of Ohio's unconventional development left many pads incomplete due to several issues.
- This situation leads to the focus of this presentation, considering the risks involved with return to pad operations functioning safely around existing production capable wells.

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Drilling

- During rig up activities the crane operator failed to properly plan and execute lifting the derrick section.
- Unfortunately, the derrick wasn't the only damaged equipment on location this day and this situation could have been much worse.

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Drilling

- In this incident, the operator was returning to drill and complete additional wells on an early production pad.
- During the permit application, the operator argued against temporarily abandoning the wells on this pad due to the expense and lost production days.
- The four existing wells on this pad were averaging nearly 2 MMCF/d each prior to abandonment, plus condensate and production water.

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Stimulation

- Major incidents can occur during stimulation operations as well.
- In this incident a hydraulic line on a pump truck failed causing hydraulic fluid to ignite when contacting the exhaust system.
- The fire spread quickly and as you can see consumed nearly everything on pad.

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Completions

- This incident was the result of a failure to follow regular routine and procedure.
- Well site personnel neglected to verify the connection integrity between the blowout preventer and the well head, causing the release.

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Completions

- During post-frac clean out operations this well control incident occurred due to well head seal failure and poor well construction/tubular failure.
- The loss of well control destroyed the cellar, caused burst surface casing and ejected approximately 4500 feet of coil tubing (foreground). Gas and brine escaped for 3 weeks before control was regained.
- Response was slowed due to overhead equipment striking immediate offset wells that were not protected by cages or isolated with internal barriers.

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Completions

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Workover

- Workover operations for unconventional production pads are quite active with a lot of personnel and equipment on location.
- Activity shown was the result of a frac hit from an offset pad. The operator and DOGRM agreed on an isolation plan moving forward.
- The production capable wells were isolated with mechanical barriers and caged to mitigate damage in the event of an impact or loss of well control.
- Stationary surface production equipment was located outside of the impact radius of overhead equipment. The equipment was isolated and depressurized prior to workover operations.

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INTRODUCTION

- As unconventional resource development transitioned from undeveloped to developed pads, ODNR's Division of Oil and Gas Resources Management (DOGRM) recognized the need to regulate additional development and operational functions in proximity to production capable wells as operators began to revisit developed pads.
- As regulators one key question arose ***"How to protect public, health and safety while developing resources around existing production?"***
- As regulators one major concern was:
- ***"What happens in the event of equipment failure on pad, such as drilling rig derrick or other overhead equipment collapsing on location?"***
- Industry recognizes these activities as **"Simultaneous Operations of SIMOPs"**

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Simultaneous Operations (SIMOPS)

- An operation where two or more independent activities that are close enough to interfere with each other, transfer risk or have performance implications.

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CURRENT REGULATORY PRACTICES

- Currently, DOGRM applies special permit conditions for simultaneous operations and collision avoidance for all issued directional/horizontal permits and those that request a spacing variance to existing vertical wells.
- Additionally, DOGRM currently requests operators submit simultaneous operations plans when performing workovers around other production capable wells.

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CURRENT REGULATORY PRACTICES -What is evaluated in submitted SIMOPs plans?

In evaluating the risk of an operators proposed SIMOPs plan, DOGRM considers the following:

- Proximity of existing wells to proposed locations.
- Offset well(s) HSE risk
  - Well Construction (Casing size/depth, annular pressures)
  - Production capability (Pressure/Flow)
- Proximity of surface equipment within the fall radius of overhead equipment during all operations.

- Overall, the objective is to prevent the transfer of risk and failure to offset wells and equipment.
- DOGRM is not prescriptive in the methods or procedures to secure existing wells but does expect the procedure and or equipment to perform as intended throughout the duration of SIMOPs.
- Wells and equipment that locate outside of the fall radius of overhead equipment may remain in production with certain protections.
- Wells and equipment that locate inside of the fall radius of overhead equipment must be isolated from production and any lines and tanks deenergized and vented.

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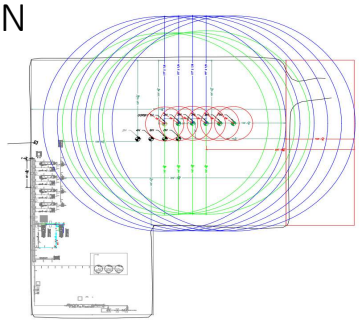
CURRENT REGULATORY ADMINISTRATION (Temporary Abandonment)

New wells proposed on existing production pads require operators to submit a simultaneous operations plan to ODNR-DOGRM for approval to demonstrate how existing well(s) and equipment will be secured to prevent uncontrolled flow from drilling through initial turn-in-line.

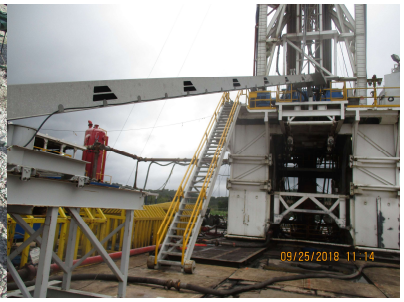
Submitted plans are field verified by DOGRM staff

- **during the application process**
- **witnessed during abandonment operations**
- **monitored during simultaneous operations.**



Back Pressure Valve Installation

Valve Recovery Plug Installation



Adding wells to developed pad

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Simultaneous Operations- (Takeaways and Talking Points)

- As operators continue to complete unconventional wells into source rock plays, regulatory agencies need to be prepared to address the complexities and challenges that will accompany the life cycle of wells and the locations where they produce.
- All risks cannot be eliminated, but through careful thought, planning, and execution most can be mitigated by striking a balance between overregulation and unimpeded development to protect public health, safety, and the environment.

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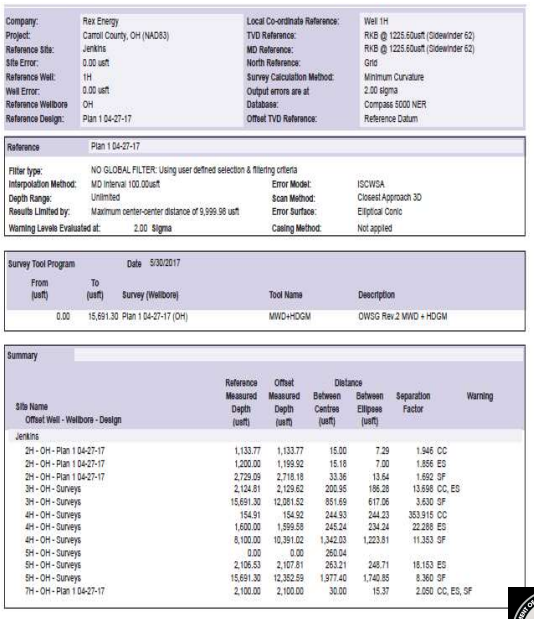
Anti-Collision- Introduction

Recent technological advancements have enabled operators to drill increasingly complex well bores to maximize resource recovery from centralized pad locations.

Constructing wells in proximity at surface serves many benefits, however locating well bores in the subsurface creates challenges that need addressed to avoid potential impacts to health, safety and the environment.

The following discussion will focus on perspectives on the potential for subsurface collisions in consideration of equipment accuracy, management practices.



Company:	Rex Energy	Local Co-ordinate Reference:	Well 1H
Project:	Carroll County, OH (NAD83)	TVD Reference:	RKB @ 1225.60usft (Sidewinder 62)
Reference Site:	Jenkins	MD Reference:	RKB @ 1225.60usft (Sidewinder 62)
Site Error:	0.00 usft	North Reference:	Grid
Reference Well:	1H	Survey Calculation Method:	Minimum Curvature
Well Error:	0.00 usft	Output errors are at	2.00 sigma
Reference Wellbore	OH	Database:	Compass 5000 NER
Reference Design:	Plan 1 04-27-17	Offset TVD Reference:	Reference Datum

Reference	Plan 1 04-27-17
Filter type:	NO GLOBAL FILTER: Using user defined selection & filtering criteria
Interpolation Method:	MD Interval 100.00usft
Depth Range:	Unlimited
Results Limited by:	Maximum center-center distance of 9,999.98 usft
Warning Levels Evaluated at:	2.00 Sigma
Error Model:	ISCWSA
Scan Method:	Closest Approach 3D
Error Surface:	Elliptical Conic
Casing Method:	Not applied

Survey Tool Program — Date 5/30/2017

From (usft)	To (usft)	Survey (Wellbore)	Tool Name	Description
0.00	15,691.30	Plan 1 04-27-17 (OH)	MWD+HDGM	OWSG Rev.2 MWD + HDGM

Summary

Site Name / Offset Well - Wellbore - Design	Reference Measured Depth (usft)	Offset Measured Depth (usft)	Distance Between Centres (usft)	Distance Between Ellipses (usft)	Separation Factor	Warning
Jenkins						
2H - OH - Plan 1 04-27-17	1,133.77	1,133.77	15.00	7.29	1.946	CC
2H - OH - Plan 1 04-27-17	1,200.00	1,199.92	15.16	7.00	1.856	ES
2H - OH - Plan 1 04-27-17	2,729.09	2,718.18	33.36	13.64	1.692	SF
3H - OH - Surveys	2,124.81	2,129.62	200.95	186.28	13.696	CC, ES
3H - OH - Surveys	15,691.30	12,061.62	851.69	617.06	3.630	SF
4H - OH - Surveys	154.91	154.92	244.93	244.23	303.915	CC
4H - OH - Surveys	1,600.00	1,599.58	245.24	234.24	22.288	ES
4H - OH - Surveys	8,100.00	10,391.02	1,342.03	1,223.81	11.353	SF
5H - OH - Surveys	0.00	0.00	260.04			
5H - OH - Surveys	2,106.53	2,107.81	263.21	248.71	18.153	ES
5H - OH - Surveys	15,691.30	12,352.59	1,977.40	1,740.85	8.360	SF
7H - OH - Plan 1 04-27-17	2,100.00	2,100.00	30.00	15.37	2.050	CC, ES, SF

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BACKGROUND

Information on well to well collisions is scarce, due in part to the infrequency of occurrences and reporting requirements.

SPE/IADC 184730 “Well Collision Avoidance Management and Principles” describes several cases of anonymously submitted documented collisions.

In some cases, collision incidents occurred due to the risk assessment identifying only a financial loss.

In other cases, the incidents were unplanned and led to HSE events (Health, Safety, Environmental) at surface.

The rig fire was not the result of a downhole collision but could potentially occur without careful planning and execution of drilling plans.

Besides, it is more interesting than blank space.

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BACKGROUND

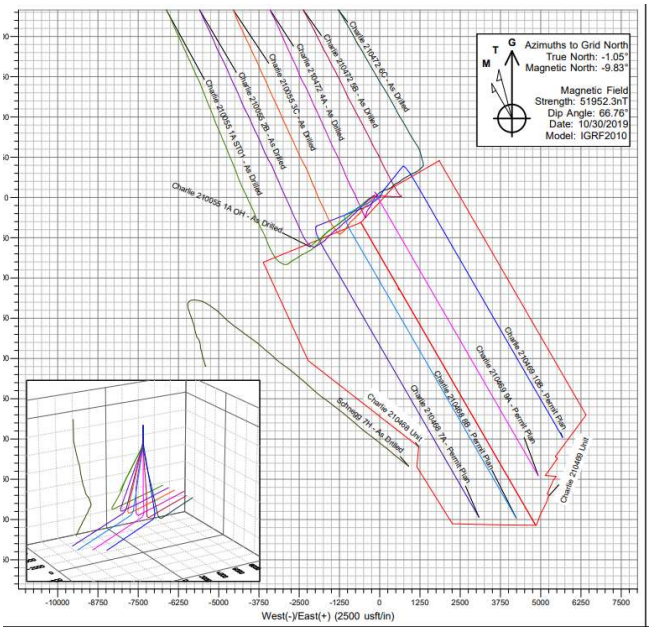
Historically speaking, documented collisions were generally limited to offshore operations due to well density.

However, the advent of land based unconventional well development has led to increased well densities from centralized pads. Thus, such operations require extra considerations for offset wells that share the target reservoirs and for those that do not.

For instance, Ohio’s two main unconventional plays, the Utica/Point Pleasant and Marcellus shales, are drilled near legacy production that target reservoirs above, between, and below the shales.

Also, in southeast Ohio, operators currently develop both the Marcellus and Utica/Point Pleasant from the same pad.

Finally, future considerations for vertical wells drilled through horizontal well fields for production or injection must be considered.



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BACKGROUND

Ohio Regulatory Code specifies minimum surface separation distances between wells unless a variance is requested and approved during the permit application process.

The challenge here is during directional drilling, the equipment used in the survey process to determine well position, like other measuring equipment, has an element of error or positional uncertainty.

The error distribution of positional uncertainty is quantified through standard deviation (sigma) to generate an ellipse of uncertainty.

The greater than sigma, the larger the ellipse becomes to capture more distribution points.

Once ellipse size is determined several calculation methods exist to measure the minimum distance between respective ellipses.

Industry uses the term 'separation factor' for the ratio between the center to center distance and the combined positional uncertainty distance between the reference well being drilled and the offset well being scanned.

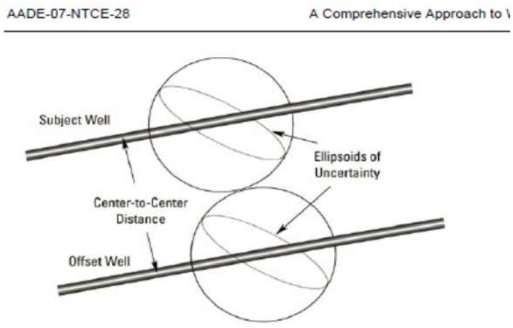
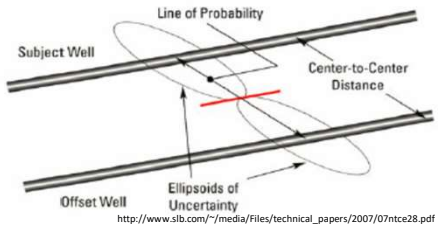


Figure 4 Traditional Separation Factor



http://www.slb.com/~/media/Files/technical_papers/2007/07ntce28.pdf

Figure 5 Oriented Separation Factor

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BACKGROUND

It goes without saying that the greater the surface separation, the less likely a downhole collision will occur for wells drilled on the same pad- or causing issues during simultaneous operations.

Conversely, operators want wells spaced as close as possible to cut down on pad construction costs, drilling costs skidding the rig, and other factors.

Currently, DOGRM mandates a minimum surface separation of 15 feet between wells to account for cellar construction and future maintenance, in addition to providing a better collision avoidance buffer during well construction.

However, directional drilling service providers acknowledge that at distances less than 25 feet, offset casing will interfere with the drilling assembly sensors.

To counteract this, operators can and will perform gyroscopic surveys at low angles to independently verify well position and update anti-collision plans to reduce the amount of positional uncertainty drilling ahead and correct course.

http://www.slb.com/~/media/Files/technical_papers/2007/07ntce28.pdf

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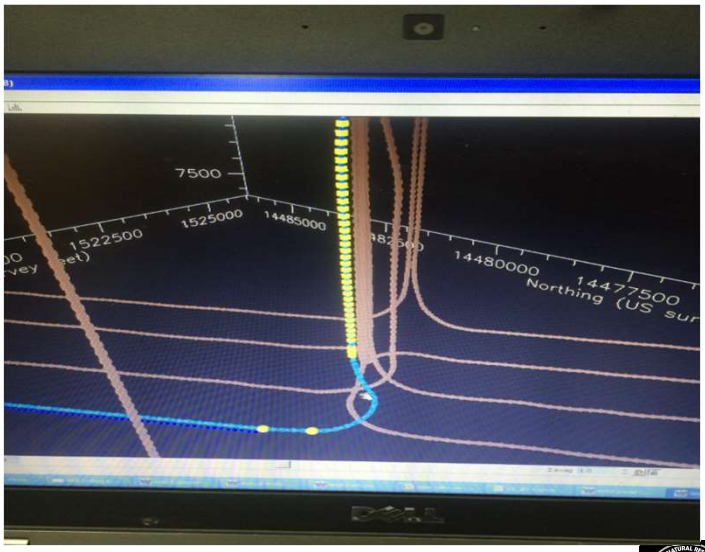
Anti-Collision- Perspectives on preventing subsurface collisions

This surface spacing is critical when drilling a well adjacent to a production capable well either on or off pad that if impacted could lead to an HSE event at surface and/or contamination of groundwater resources.

Surface limitations may prevent operators from locating a well pad in an ideal location, which has led to back-drilling a well outside of its unit boundary in order to gain additional 'vertical section' or usable formation to produce.

Reference wells that are planned near back-drilled wells require extra caution especially when planned heel to heel, and even toe to heel, which could cause issues while cementing production casing.



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CURRENT REGULATORY PRACTICES -What is evaluated in submitted plans?

In evaluating the risk of a proposed well plan, DOGRM considers the following:

- Collision risk based on separation factor
  - General alerts begin at a separation factor of 2.0 given a standard deviation or sigma of 2.0.
  - Operators are required to directly notify DOGRM staff if the projected wellbore will approach a separation factor of 1.5 or less.
  - If projections indicate the separation factor would calculate at 1.0 or less, the operator is required to cease drilling until a corrective plan to avoid the potential collision is discussed and approved by DOGRM.
- Offset well(s) HSE risk
  - Well Construction
  - Production capability
- Reference wellbore segment where risk is proposed
  - How is the well constructed prior to approaching the area of proximity (have mine voids and all sources of usable safe drinking water been isolated)?
  - Is the rig and personnel prepared and trained to identify and mitigate the unplanned flow?

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Offset TVD Reference:	Reference Datum

Plan 1 04-27-17

NO GLOBAL FILTER: Using user defined selection & filtering criteria

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	Unlimited	Scan Method:	Closest Approach 3D
d by:	Maximum center-center distance of 9,999.98 usft	Error Surface:	Elliptical Conic
Evaluated at:	2.00 Sigma	Casing Method:	Not applied

ogram Date 5/30/2017

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SIMOPs and Anti-Collision-

Future Considerations

- In recent months, DOGRM has been working toward finalizing administrative rules for SIMOPs and Anti-Collision.
- During this time, the Division has been fact finding through field oversight, technical document reviews and industry related training where simultaneous operations and collision avoidance are concerned to develop effective rules that address best practices and oversight to prevent incidents through complacency.
- Thank you for your time and the opportunity to present.

If you would like to follow up, I can be reached at

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