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Hydraulic Fracturing

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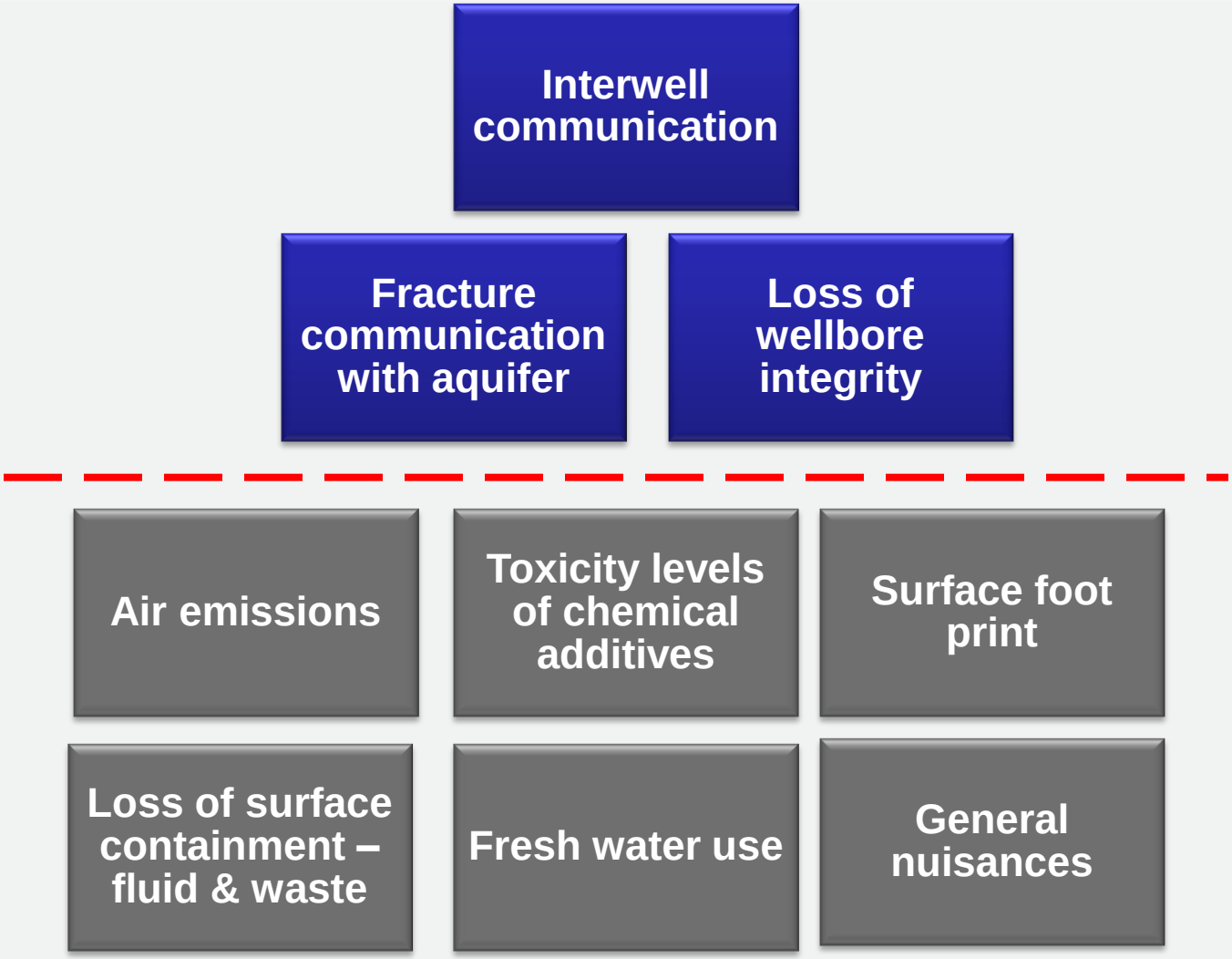
Outline - *Directive 083 Hydraulic Fracturing – Subsurface Integrity*

- Why we needed the directive?
- How we responded?
- What is the directive all about?
- What has happened since:
  - release of Bulletin 2012-02
  - directive comes into effect

Directive 083 Key Driver

Inter-wellbore communication

Problem Analysis



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AER Rules

- Well Integrity requirements
  - *Directive 008 – Surface Casing Depth Requirements*
  - *Directive 009 – Casing Cementing Minimum Requirements*
  - *Directive 010 – Minimum Casing Design Requirements*
  - *Directive 013 – Suspension Requirements for Well*
  - *Directive 020 – Well Abandonment*

AER Rules (cont.)

- *Directive 083 – Hydraulic Fracturing – Subsurface Integrity*
  - Outcome based - regulatory objective: *To prevent the loss of well integrity at a subject well.*
  - Dual barrier and single barrier well design requirements.
    - Single barrier design includes incremental demonstration of integrity beyond the dual barrier designs

Offset Well Integrity

- Offset wells are at-risk as defined by IRP-24
- Offset wells can have a greater risk for loss of well integrity than the subject well
  - Wells not designed for fracturing pressures
  - Older well condition not well known
  - Abandoned wells have limited monitoring and well control options

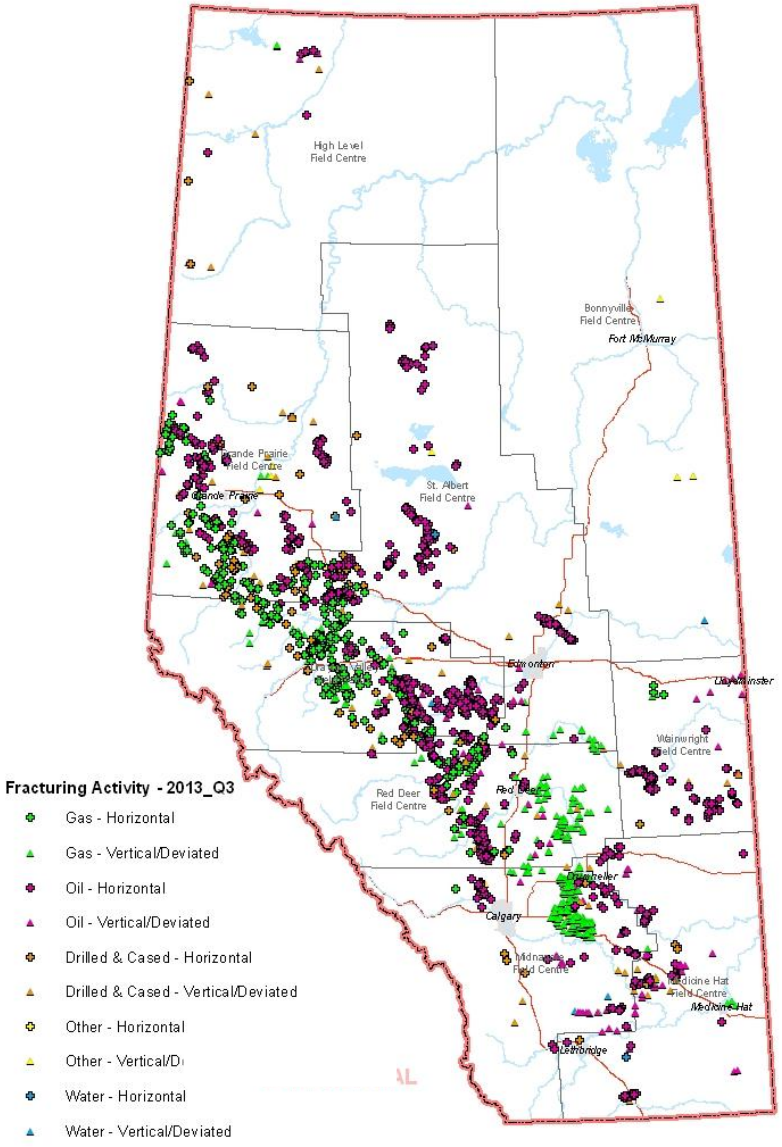
Directive 083 Implementation

- Effective August 21, 2013
- Notification in advance of operation
- Field inspections and program audits to be conducted
- Plans not required to be submitted and accepted in advance of operations, as in a safety case
- Plan acceptance has been a condition of investigations

Where is the Risk?
Directive 083 - Excel notification

Is a single barrier system being used during fracturing operations?
Is the hydraulic fracturing operation being conducted above, or within 100 metres below, the base of groundwater protection?
Is this a high vapour pressure fracture operation?
Will the fracturing operation be using an energizing fluid?
Are there any at-risk offset wells inside the fracture planning zone?
Are there any at-risk offset wells inside the fracture planning zone with active or pending downhole operations?
Is the fracture communication intended to reach offset wells?
Has IRP 24 been replaced with an alternate standard in developing the hydraulic fracturing program?

2013 Hydraulic Fracturing Activity



- 2600 HF Operations to the end Q3 2013
- 60 per cent oil
- 70 per cent horizontal wells

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2013 Communication Events High/Medium Impact

Incident	Event Date	Level/Impact	Separation Distance
1	February 16	High Low Risk SCVF	21 m
2	June 26	Medium Kick on Drilling Operation – Resulted in offset well abandonment	1165 m

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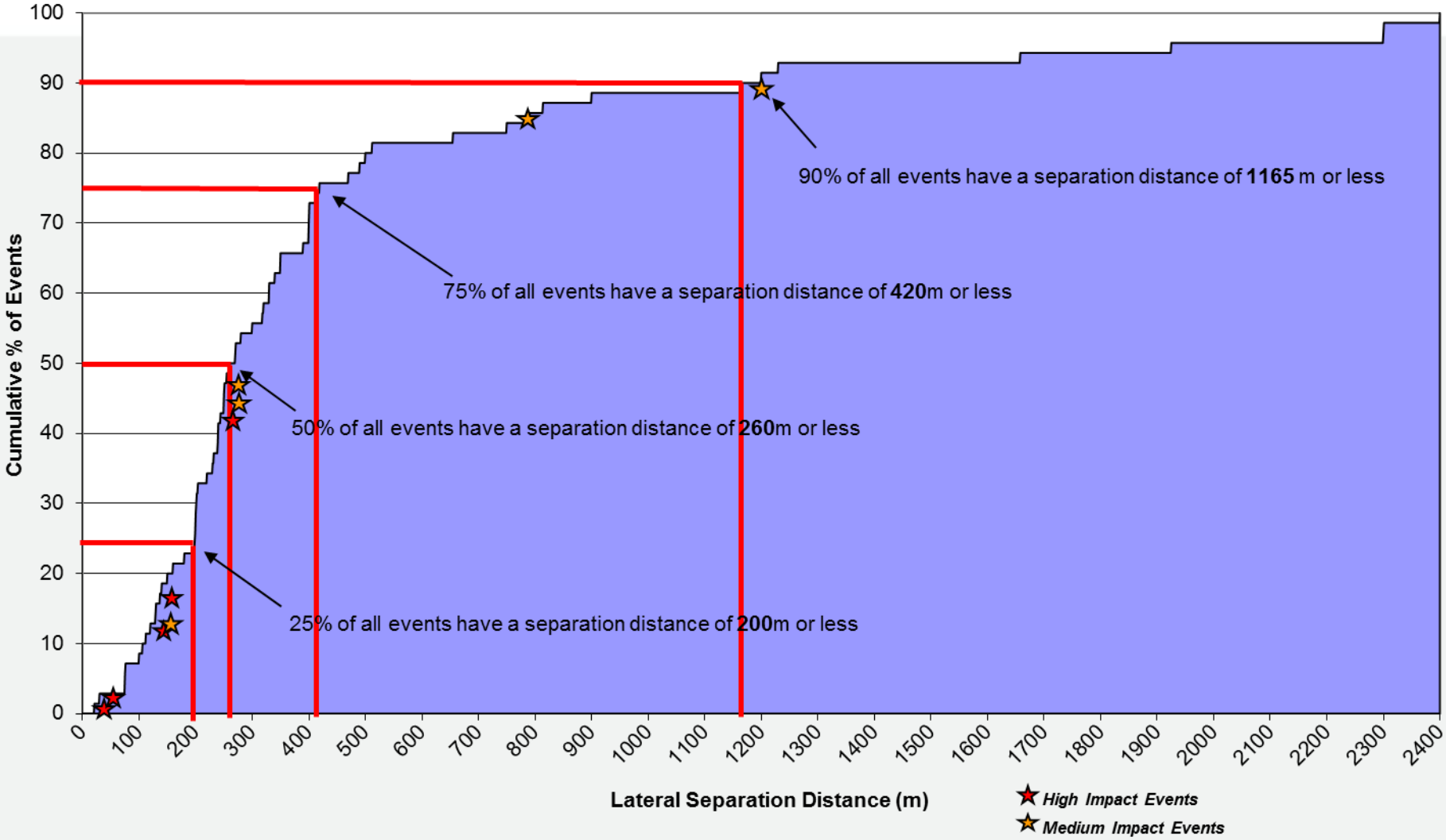
Cumulative Well Interwellbore Communication Events
Lateral Separation Distance
Ratio to total events (2012 to 2013 3rd Qrt - 70 impacted wells)



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Interim IRP 24: Fracture Stimulation: Interwellbore Communication

An Industry Recommended Practice for the Canadian Oil and Gas Industry

Interim Volume 24 – 2013

SANCTIONED

DACC
Drilling and Completion Committee

Edition	#1.0
Sanction Date	Mar 2013

IRP 24 - Scope

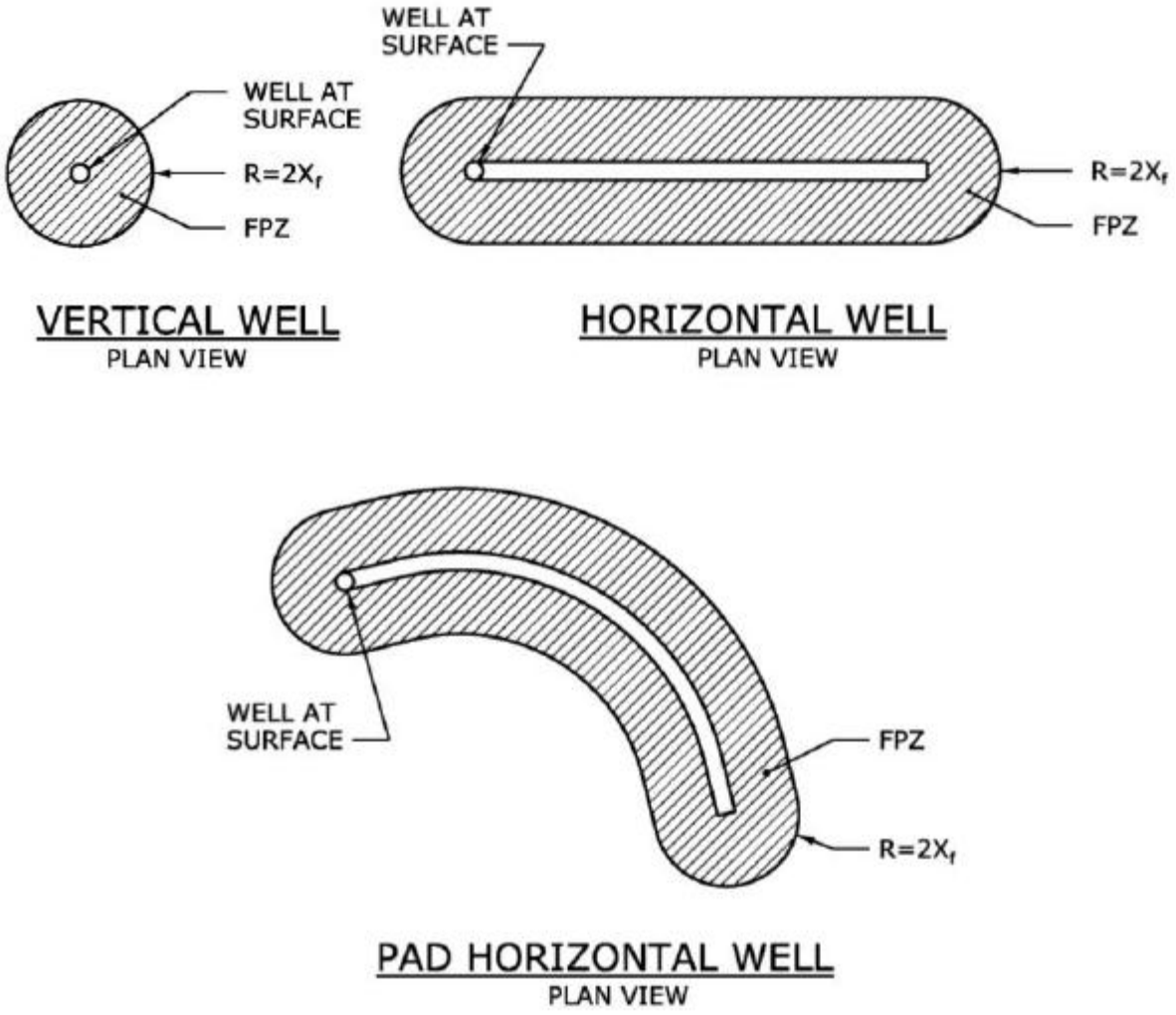
- This document is an interim IRP in response to the *ERCB 2012-02: Hydraulic Fracturing: Interwellbore Communication between Energy Wells* bulletin.
- Next two chapters in parallel
  - Subject well integrity
  - Surface operations risk

Special Consideration Wells Outside the Fracture Planning Zone (FPZ)

- SCWs are any offset wells beyond the FPZ that have unique circumstances that may put that well at-risk

- historical experience
- FPZ estimation uncertainty
- fracture azimuth
- geology (e.g., regions prone to natural faults and fractures)
- age and condition of the offset wellbore
- groundwater protection
- possible pressure communication

IRP - 24 FPZ

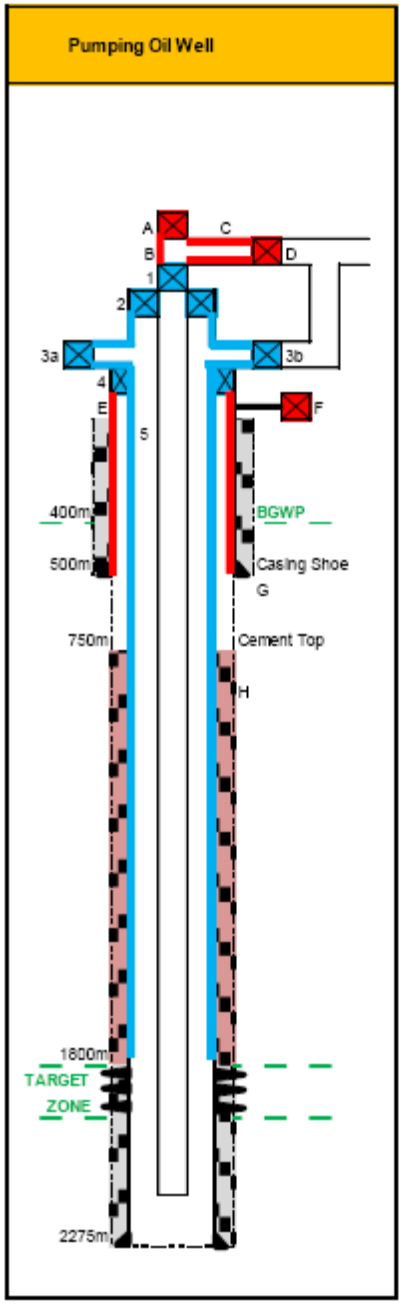


Fracture Planning Zone (FPZ) - defines a screening area around the Subject Well, making it possible to identify all offset wells proximal to the Subject Well that require risk assessment.

IRP 24
Barrier Template

- Identifies condition during the fracturing
- Specifies the adjusted maximum pressure (AMP) and monitoring plan

Figure 4. Sample IOW Barrier Schematic



* O = Open, C = Closed

Barriers	OEM Capacity (MPa)	Adjusted Max Pressure (MPa)	Barrier Status *(O / C)	IOW Monitored (Y / N)
Primary Barrier System				
1. Polished rod BOP (Radigan)	14.0	7.0	C	N
2. Tubing hanger seals	14.0	7.0	C	N
3. Prod casing head valves (a,b)	14.0	7.0	C	Y
4. Prod casing hanger seals	14.0	7.0	C	Y
5. Prod casing (burst)	28.0	7.0	C	Y
Secondary Barrier System				
A. Polished rod stuffing box	1.0	0.5	C	N
B. Flow line tee	14.0	7.0	C	N
C. Flow line	14.0	7.0	C	Y
D. Flow line valve	14.0	7.0	C	Y
Secondary Barrier System				
E. Surface Casing	4.0	4.0	C	Y
F. Surface casing vent valve	3.5	1.0	C	Y
G. Surface Casing Shoe (18 kPa/m frac gradient)	4.0	4.0	C	Y
H. Prod casing cement / annulus	untested	untested	C	Y

IRP 24 Hazard Register
11 Inter-wellbore Communication Risks

Item	Hazard Scenario	Applicable	Cause	Threats / Consequences	S
2	Adjusted Maximum Pressure (AMP) Overestimation		- No recent pressure integrity tests conducted - Challenges with determining Adjusted Maximum Pressure on a barrier flow path based on operational history of component (how to effectively derate a component) - Casing and/or downhole equipment integrity is	- Loss of barrier integrity in an IOW - Inadequate allowance for response times during wellsite operations to prevent adjusted maximum pressure from being exceeded - Pressure integrity reliability of threaded components	1
3	Adjusted Maximum Pressure (AMP) exceeded		- Rate of pressure increase in IOW too quick for effective reaction time during an interwellbore communication event '- Inadequate well control plan for IOW	- Loss of barrier integrity in an IOW - Low relative value of Adjusted Maximum Pressure in relation to potential pressures from interwellbore communication (excessive well control plan and associate cost)	1

	HSE	NPT	Industry Suggested Controls and Mitigations
	1	1	- Conduct pressure integrity tests to verify Adjusted Maximum Pressure - Replace (if possible) barrier components of concern that have been integrity tested to the Adjust Maximum Pressure.
	1	1	- Use pressure relieving system on IOW for the case where a relatively low Adjusted Maximum Pressure as compared to potential pressures from interwellbore communication - Stop fracture treatment on subject well and immediately relieve pressure on subject

Questions