



Canadian Natural

**PRIMROSE/WOLF LAKE CSS
2016 WELL INTEGRITY ANNUAL PRESENTATION**

April 28, 2017

PREMIUM VALUE. DEFINED GROWTH. INDEPENDENT.

Agenda

1. Review 2016 well failure statistics
2. Review 2016 well integrity initiatives



2016 WELL FAILURE STATISTICS

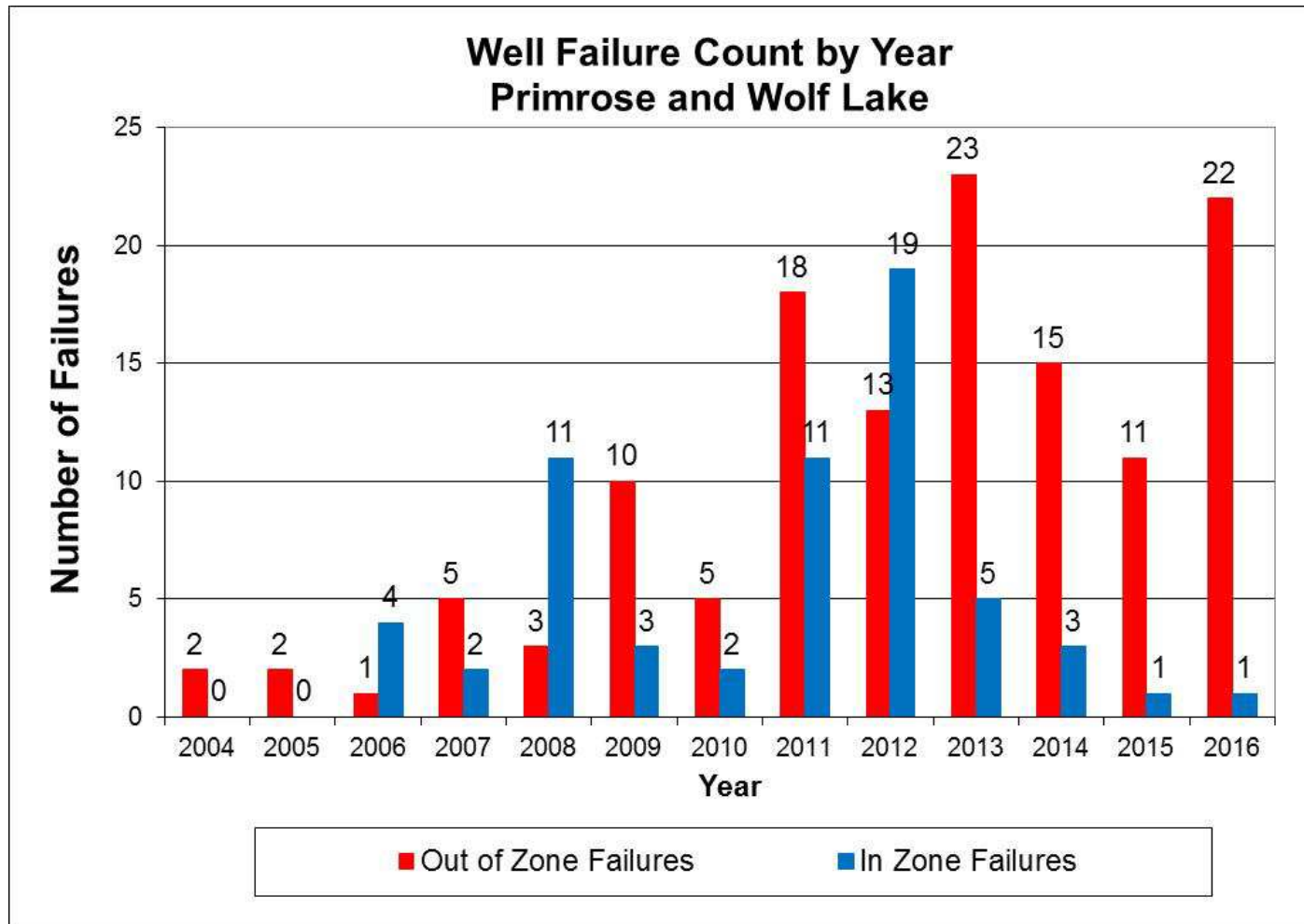
Definitions of Well Failure Locations

- Near-surface failure: 0 m – 25 m TVD
- Out of zone failure: failure depth is between 25 m TVD and the interface of the Grand Rapids/Clearwater formation
 - Includes failures within the Grand Rapids, Colorado, and Quaternary formations
- In zone failure: occurs within the Clearwater formation
 - Includes failures within the Clearwater capping shale and the Clearwater sands

Well Failure Statistics - Summary

	Out of Zone	In Zone
Number	22	1
Area	Concentrated in PRN A2 and PRE A1	PRN A3
Connection/Pipe Body	connection	connection
Cycle	73% of failures in cycle 5+	cycle 4
Formation	91% Colorado Shale	Clearwater Sand
Pressure During Failure	22 during low P or when well was killed	1 on dilation P (flowback)

Well Failure Count by Year

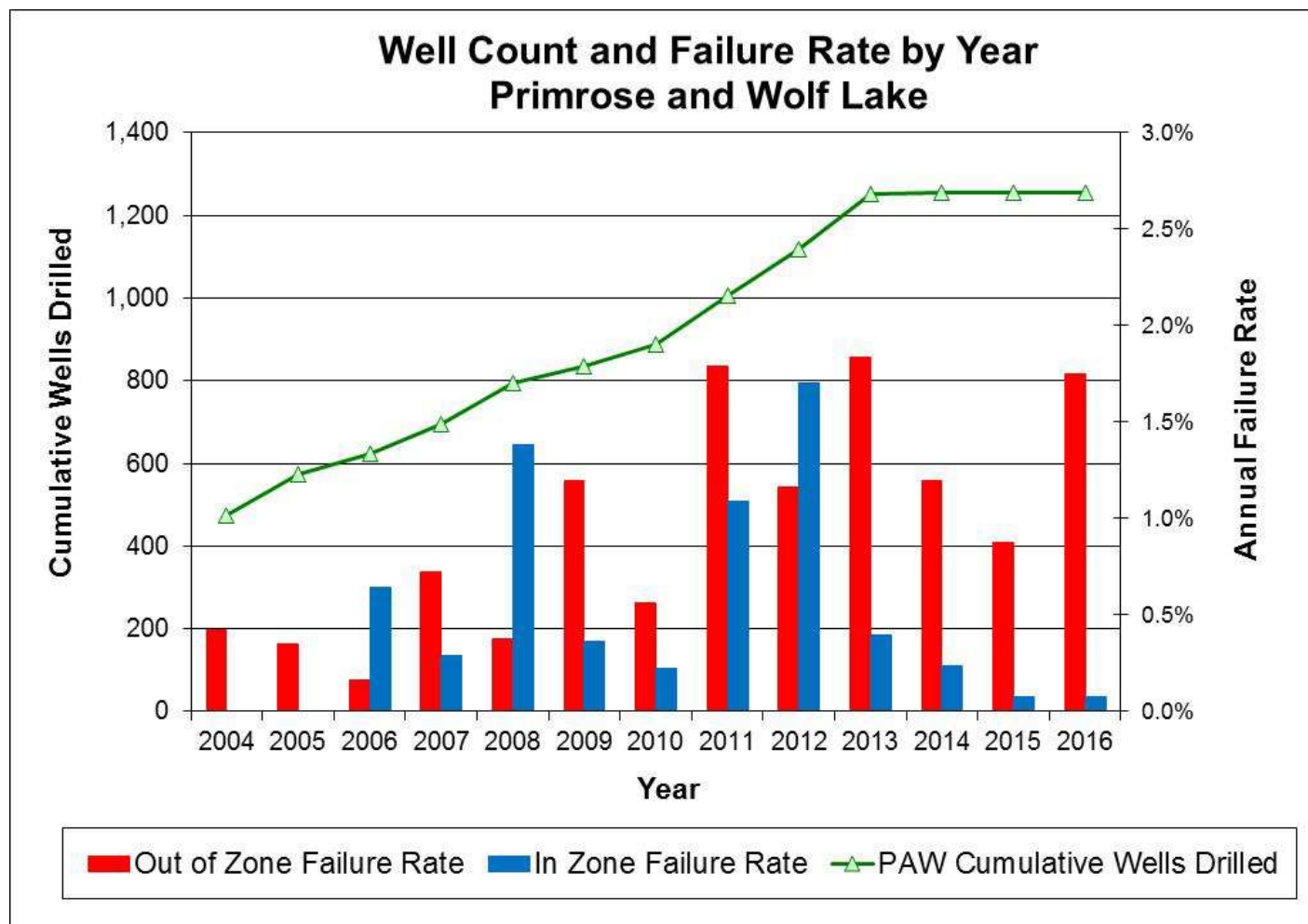


In 2016:

- 22 wells had an out of zone failure
- 1 well had an in zone failure

2016 failure rate higher than in 2015 due to PRE pipeline downtime shut-ins

Well Failure Rates by Year



In 2016:

- 1.75% of wells had an out of zone failure
- 0.08% of wells had an in zone failure

2016 Out of Zone Well Failures

22 primary out of zone failures: concentrated in PRE A1, 21/22 failures caught by passive seismic

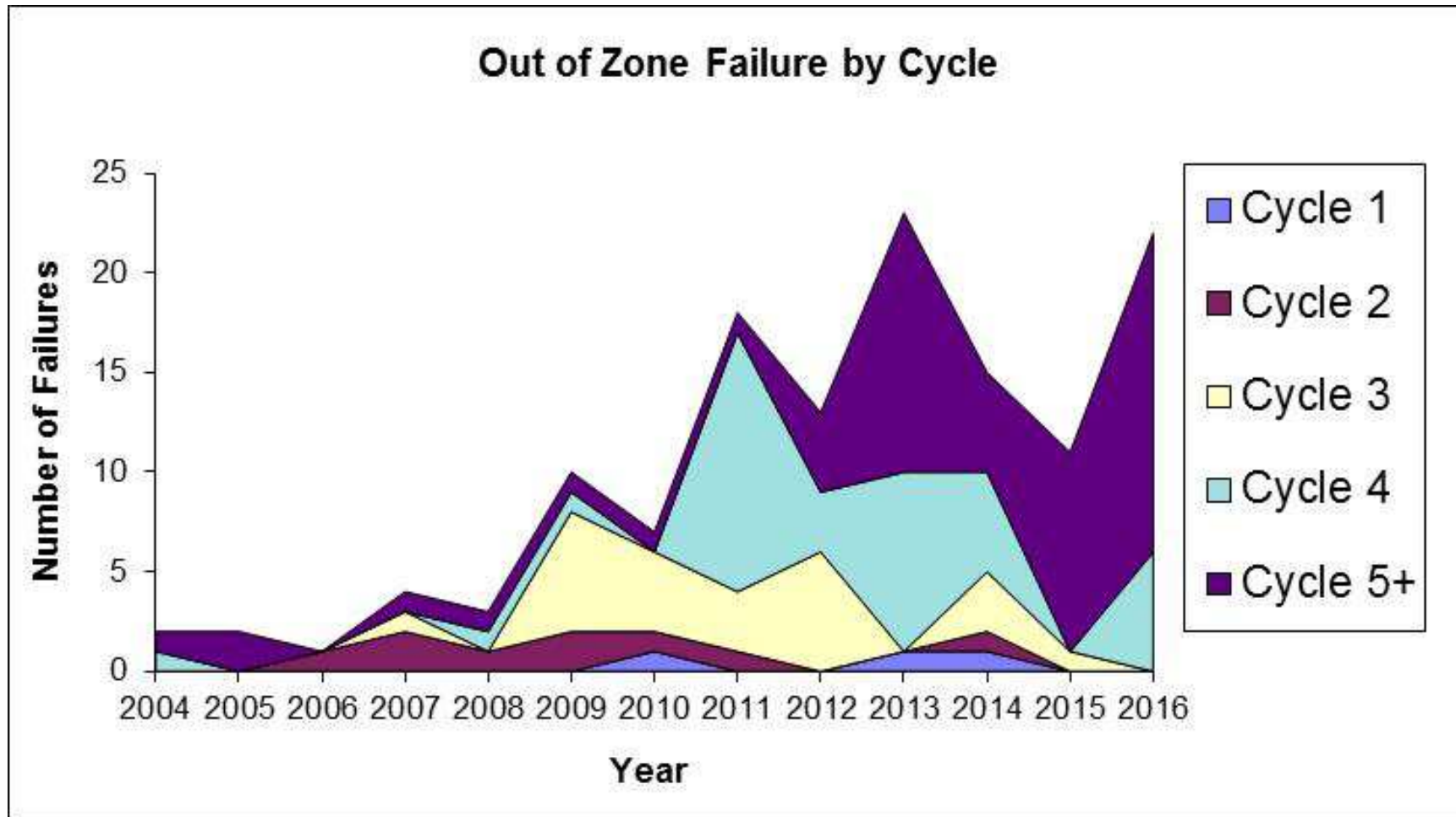
Well	Area	License #	Failure Of	Detection Method	Reason Detection Method not Passive Seismic	Confirmation Date	Depth (mKB)	Depth (mTVD)	Formation
11A24	PRS	424565	CASING	PS		4-Oct-16	256.3	256.0	BELLE FOURCHE
2A24	PRS	424510	CASING	PS		1-Oct-16	206.8	206.5	NIOBRARA
TF51	PRN A1	323335	CASING	PS		12-Nov-16	173.7	173.7	NIOBRARA
2B52*	PRN A1	317129	CASING	PS		5-May-16	265.3	265.0	WEST GATE
8C52	PRN A1	317147	CASING	PS		1-Dec-16	278.9	274.6	WEST GATE
13A58*	PRN A2	396759	CASING	PS		11-Oct-16	246.0	245.9	BELLE FOURCHE
2A58*	PRN A2	396748	CASING	PS		20-Jun-16	250.0	248.2	BELLE FOURCHE
19A62*	PRN A2	402540	CASING	PS		19-Jun-16	263.7	259.1	BELLE FOURCHE
11A63*	PRN A2	409740	CASING	PS		21-Jan-16	254.0	253.7	BELLE FOURCHE
19A63	PRN A2	409754	CASING	EM LOG	2015 wildfire, PS down	6-Apr-16	257.1	254.1	BELLE FOURCHE
3A74	PRE A1	380831	CASING	PS		25-Jun-16	266.5	264.2	BELLE FOURCHE
6A75	PRE A1	381910	CASING	PS		8-Feb-16	262.3	261.6	BELLE FOURCHE
13A75	PRE A1	381918	CASING	PS		20-Jan-16	260.5	260.1	BELLE FOURCHE
14A75	PRE A1	381919	CASING	PS		28-Apr-16	261.1	260.7	BELLE FOURCHE
7A75	PRE A1	381911	CASING	PS		23-May-16	261.0	260.7	BELLE FOURCHE
17A77	PRE A1	378782	CASING	PS		20-Jan-16	268.0	266.1	BELLE FOURCHE
18A77*	PRE A1	378783	CASING	PS		9-Jun-16	267.8	266.1	BELLE FOURCHE
1A77	PRE A1	378144	CASING	PS		18-Oct-16	277.8	275.9	FISH SCALES
8A78	PRE A1	375387	CASING	PS		5-Jun-16	327.0	325.2	WEST GATE
14A78*	PRE A1	375421	CASING	PS		13-May-16	294.8	293.6	WEST GATE
TF60	PRN A3	444188	CASING	PS		8-Aug-16	265.5	265.5	BELLE FOURCHE
5A60	PRN A3	445792	CASING	PS		14-Nov-16	273.0	267.8	BELLE FOURCHE

2016 Out of Zone Well Failures

All failures at the connections; 20 TENARIS HYDRIL 563, 2 STC

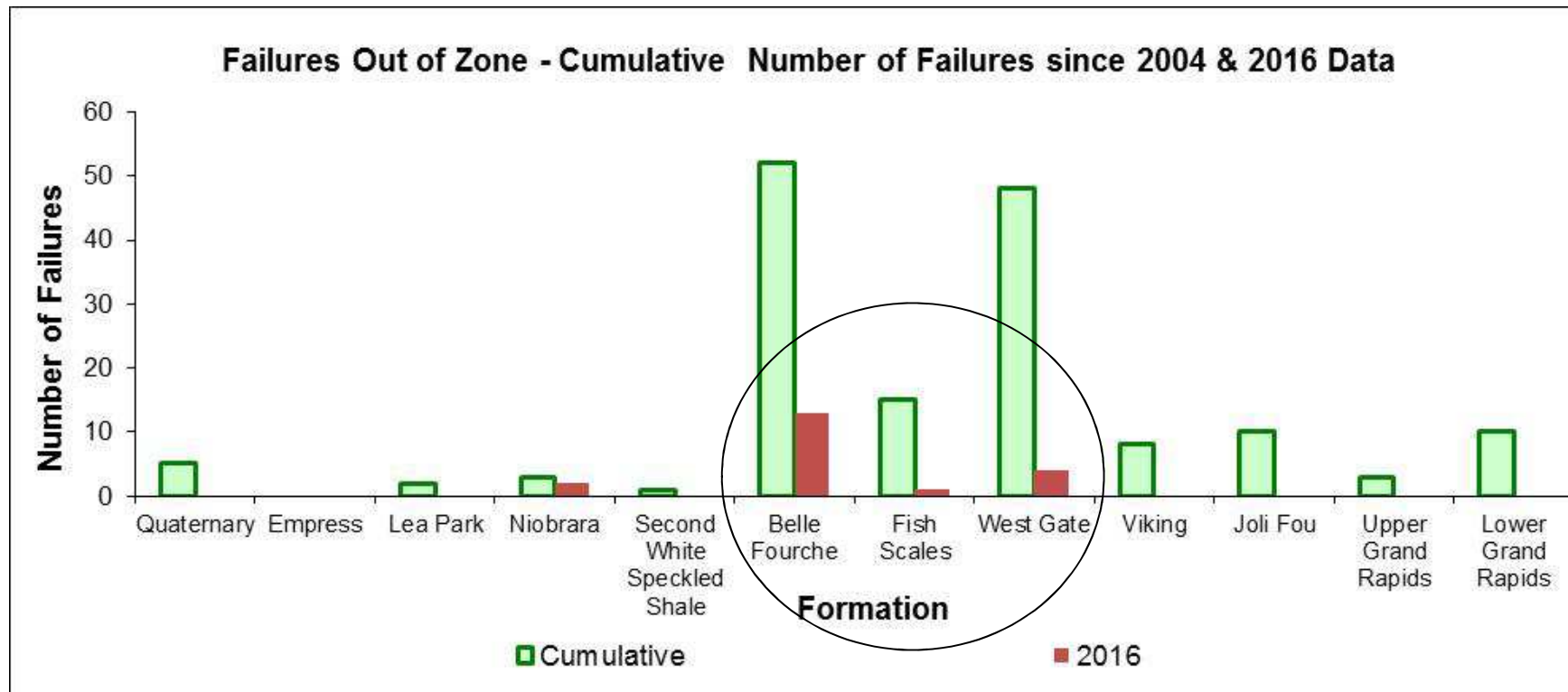
Well	Tubular OD (mm)	Failure In	Connection Type	Commercial Cycle of Failure	Well Phase During Failure	Repair Method
11A24	244.5	CONN	TENARIS HYDRIL 563	5	PUMP	SLIMHOLE
2A24	244.5	CONN	TENARIS HYDRIL 563	5	PUMP - SHUT IN (OPS)	PATCH
TF51	139.7	CONN	STC	4	N/A (PHASE 51 ON PUMP)	ABANDON
2B52*	177.8	CONN	TENARIS HYDRIL 563	4	PUMP - SHUT IN (W/O)	ABANDON
8C52	244.5	CONN	TENARIS HYDRIL 563	4	PUMP	PATCH
13A58*	244.5	CONN	TENARIS HYDRIL 563	7	PUMP - SHUT IN (OPS)	PATCH
2A58*	244.5	CONN	TENARIS HYDRIL 563	7	PUMP - SHUT IN (OPS)	SLIMHOLE
19A62*	244.5	CONN	TENARIS HYDRIL 563	6	PUMP - SHUT IN (W/O)	SLIMHOLE
11A63*	244.5	CONN	TENARIS HYDRIL 563	4	PUMP - SHUT IN (STIM)	ABANDON
19A63	244.5	CONN	TENARIS HYDRIL 563	4	PUMP - SHUT IN (W/O)	SLIMHOLE
3A74	244.5	CONN	TENARIS HYDRIL 563	5 (STEAMFLOOD)	PUMP - SHUT IN (W/O)	PATCH
6A75	244.5	CONN	TENARIS HYDRIL 563	6 (STEAMFLOOD)	STEAMFLOOD - SHUT IN (OPS)	PATCH
13A75	244.5	CONN	TENARIS HYDRIL 563	6 (STEAMFLOOD)	PUMP - SHUT IN (OPS)	PATCH
14A75	244.5	CONN	TENARIS HYDRIL 563	6 (STEAMFLOOD)	STEAMFLOOD - SHUT IN (OPS)	PATCH
7A75	244.5	CONN	TENARIS HYDRIL 563	6 (STEAMFLOOD)	PUMP - SHUT IN (OPS)	PATCH
17A77	244.5	CONN	TENARIS HYDRIL 563	5 (STEAMFLOOD)	PUMP - SHUT IN (OPS)	PATCH
18A77*	244.5	CONN	TENARIS HYDRIL 563	5 (STEAMFLOOD)	STEAMFLOOD - SHUT IN (OPS)	PATCH
1A77	244.5	CONN	TENARIS HYDRIL 563	4 (STEAMFLOOD)	PUMP - SHUT IN (OPS)	PATCH
8A78	244.5	CONN	TENARIS HYDRIL 563	5 (STEAMFLOOD)	STEAMFLOOD - SHUT IN (OPS)	PATCH
14A78*	244.5	CONN	TENARIS HYDRIL 563	6 (STEAMFLOOD)	STEAMFLOOD - SHUT IN (OPS)	SLIMHOLE
TF60	139.7	CONN	STC	6	N/A (PHASE 60 - FLOWBACK)	PATCH
5A60	244.5	CONN	TENARIS HYDRIL 563	6	PUMP - SHUT IN (STIM)	SLIMHOLE

Out of Zone Failures by Cycle



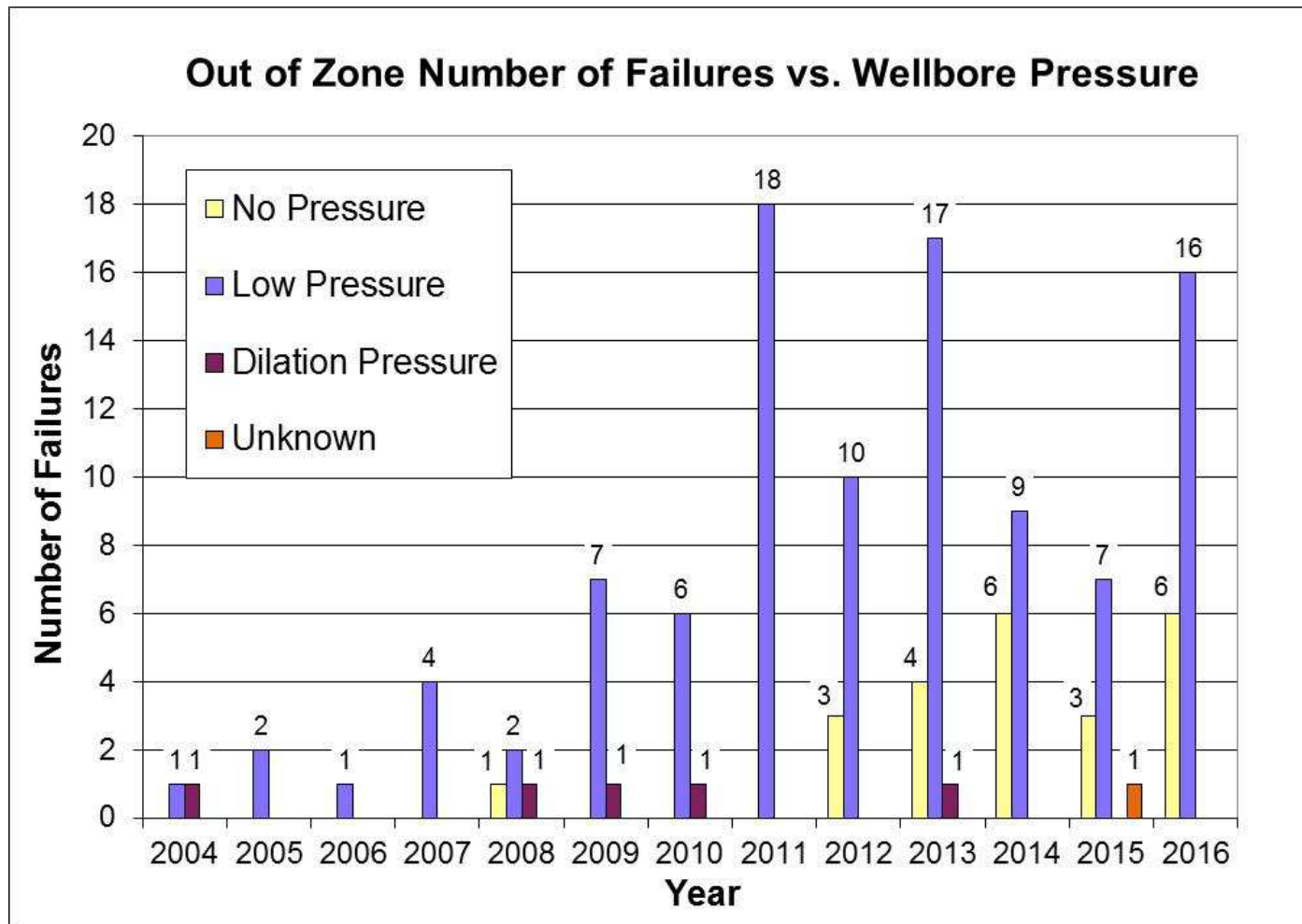
In 2016, 16/22 (73%) of out of zone failures occurred in commercial cycle 5 or higher

Out of Zone Failures by Formation



91% of 2016 out of zone failures occurred in the Colorado Shale group

Out of Zone Number of Failures vs. Pressure



No dilation pressure
out of zone failures
in 2016

2016 In Zone Failures

One 2016 in zone failure: 11A65, on flowback

Well	Area	License #	Failure Of	Detection Method	Reason Detection Method not Passive Seismic	Confirmation Date	Depth (mKB)	Depth (mTVD)	Formation
11A65	PRN A3	448439	CASING	PS		24-Nov-16	526.7	484.7	CLEARWATER

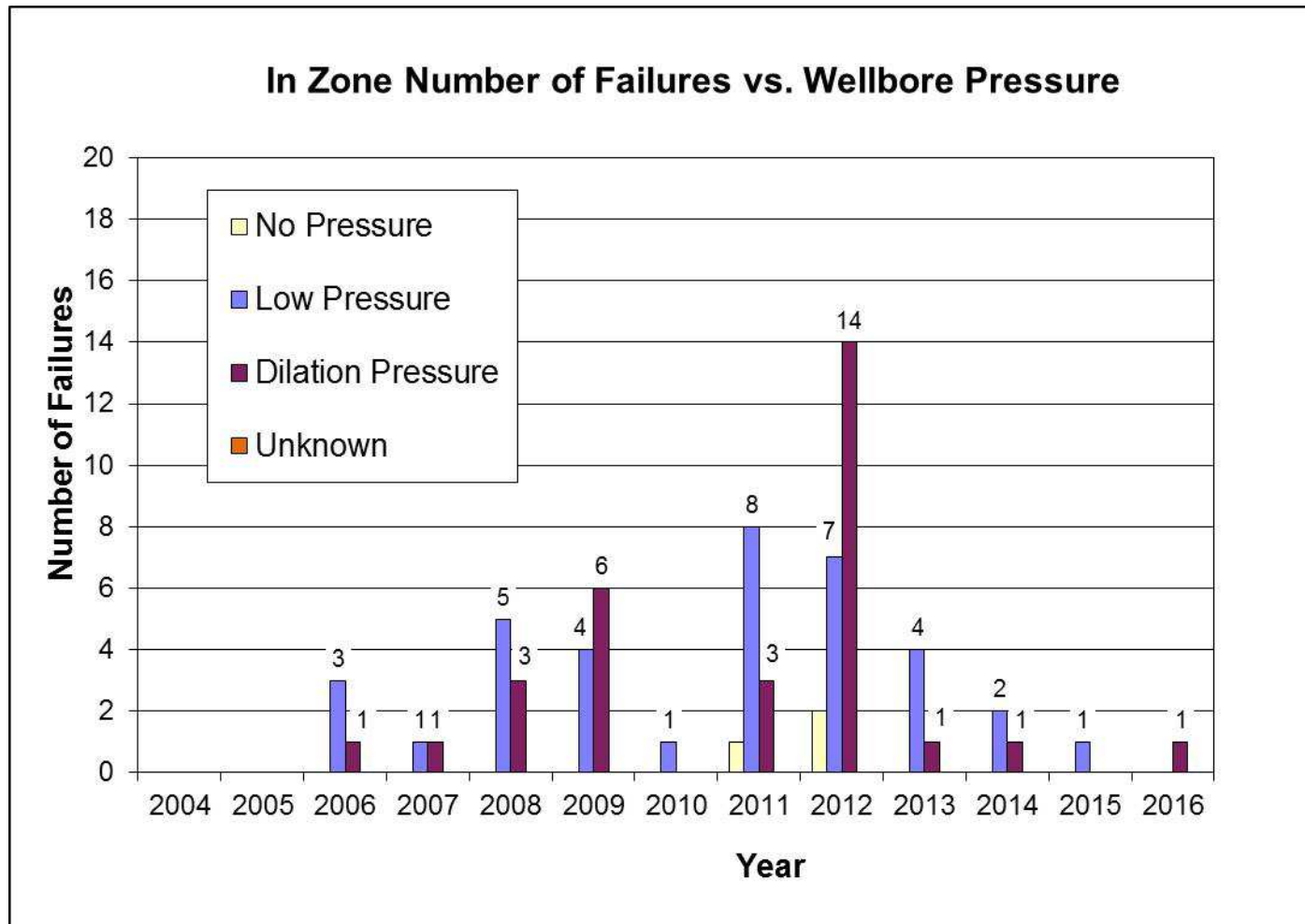
Well	Tubular OD (mm)	Failure In	Connection Type	Commercial Cycle of Failure	Well Phase During Failure	Repair Method
11A65	244.5	CONN	TENARIS BLUE	4	FLOWBACK	TBD

In Zone Failures by Cycle



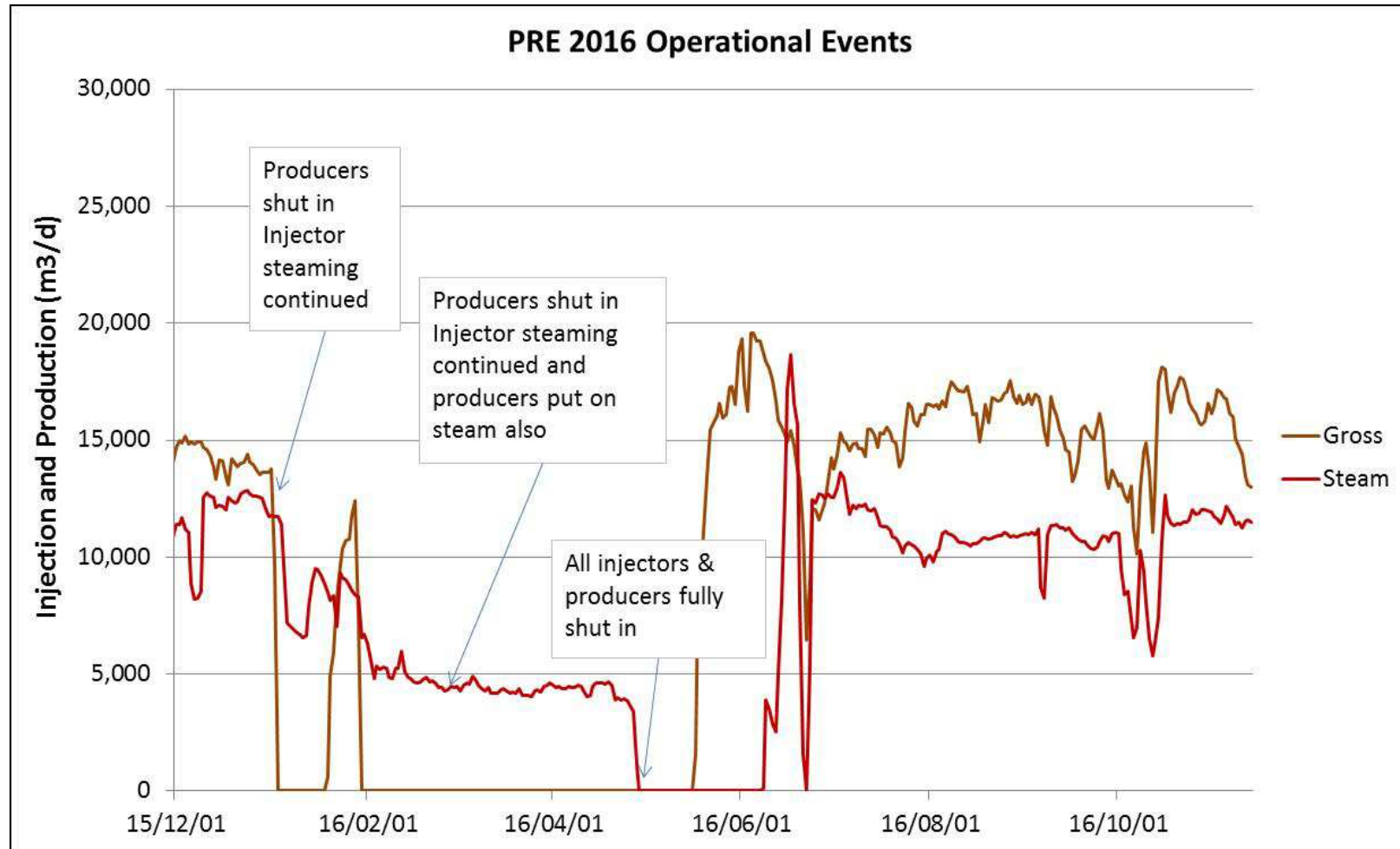
In 2016, there was one in zone failure which occurred in commercial cycle 4

In Zone Number of Failures vs. BHP



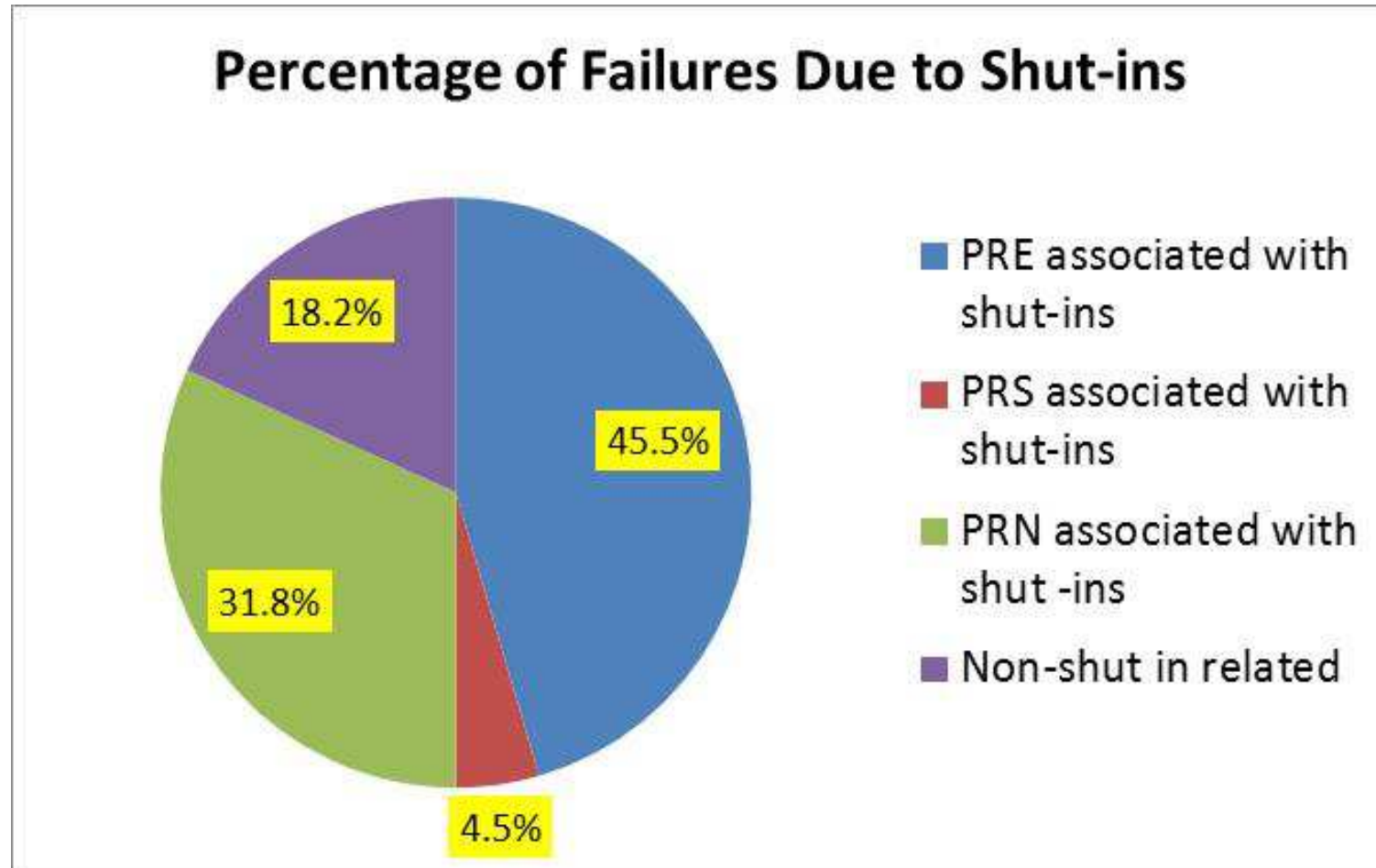
One dilation
pressure failure in
2016

PRE Pipeline Shut-ins Precipitated 10 Failures



10/10 PRE breaks occurred during well shut-ins due to PRE pipeline downtime

Breakdown by Shut-ins vs. Non-shut-ins

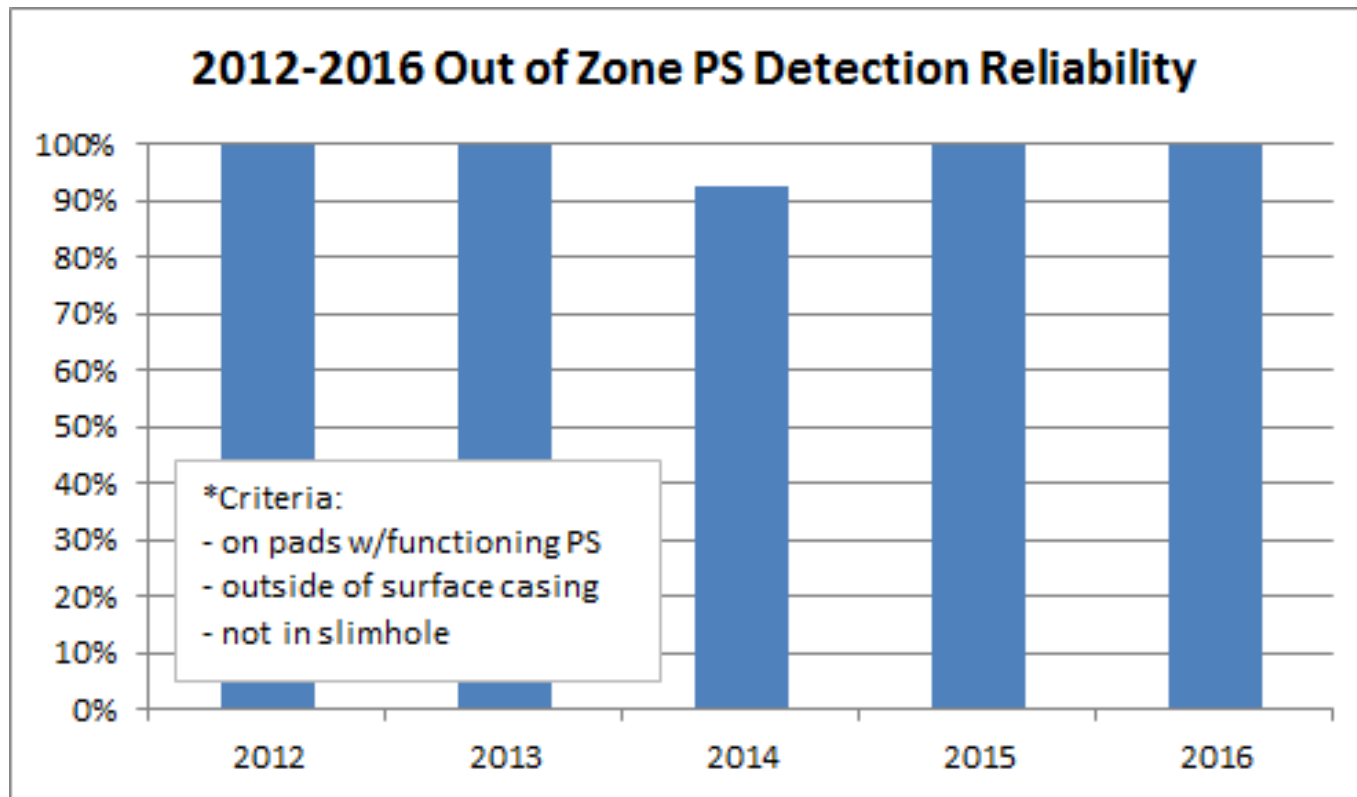


82% of 2016 well failures are associated with shut-ins

Passive Seismic Detection Reliability

2016 out of zone PS detection rate 100%

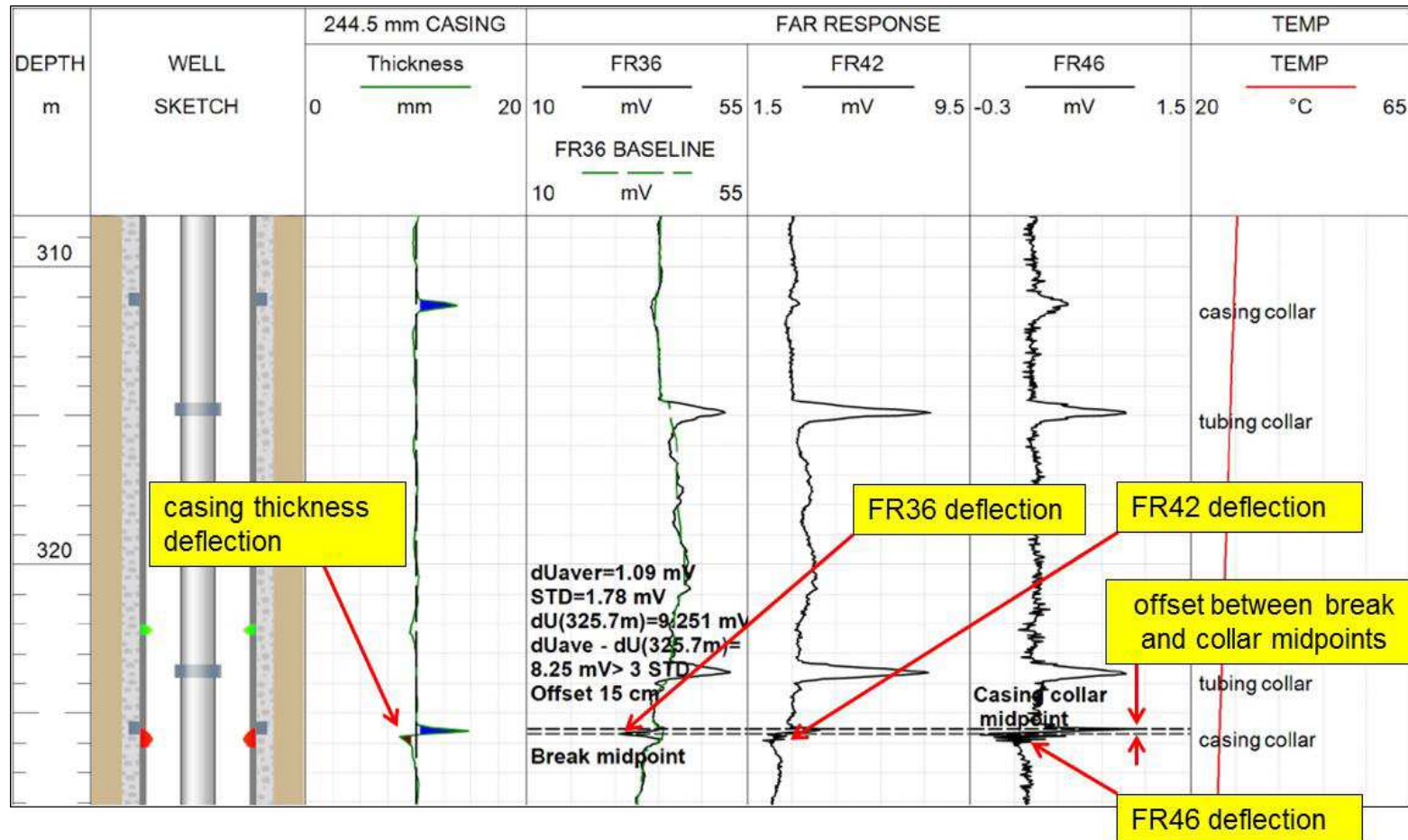
21/21 casing failures on pads with functioning PS systems were detected by PS





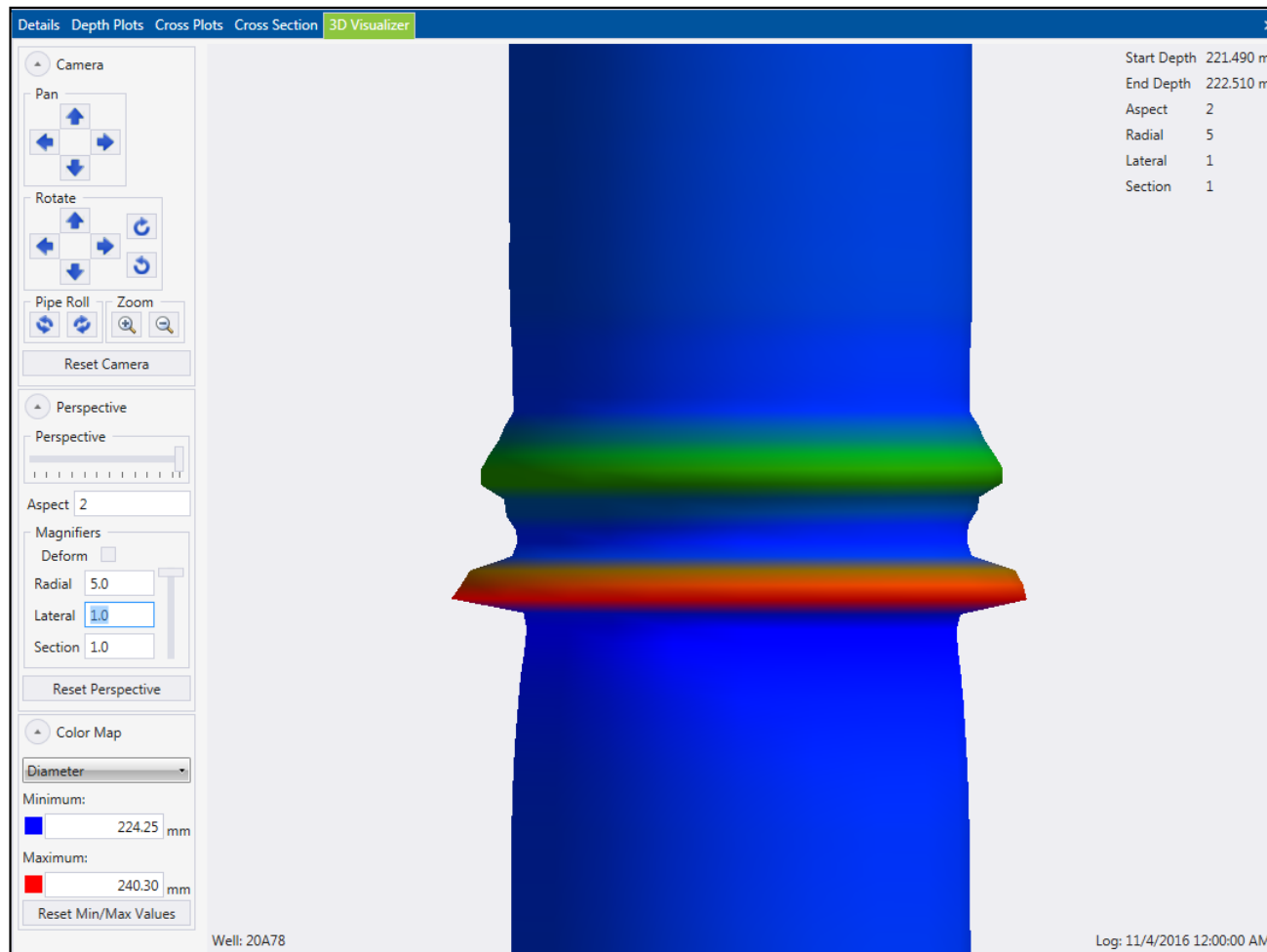
2016 INITIATIVES

EM Logging Clear and Consistent Break ID



- 70 EM logs run to end of 2016
- Clear and consistent casing break identification achieved
- EM logging became the standard CI check in May 2016

Caliper Log Software



- Upgraded software implemented in Spring 2016
- New version enables faster, more detailed caliper log analyses

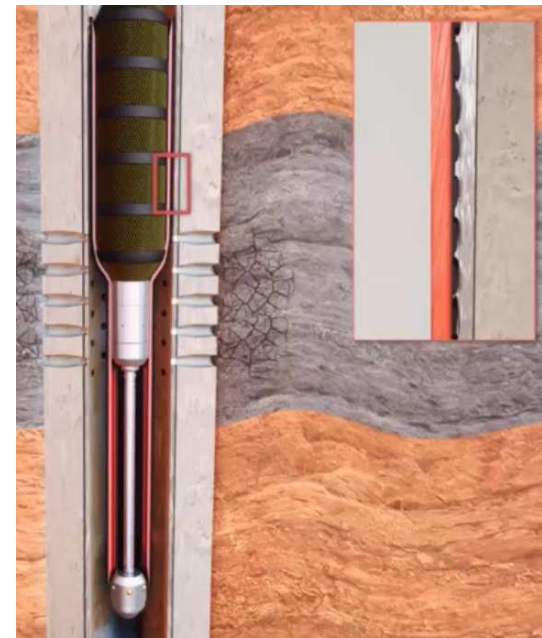
HT CSS Patches Installations

Goal: find a technical solution as an alternative to slimhole repairs

- Trialing HT rated packer-installed and expandable patches
- 1 expandable and 8 packer-installed patches in the ground (mix of steamflood producers, injectors, and an in-zone patch on a CSS well)
- Plan to confirm casing integrity post-steam



MH patch: pipe spring,
setting element and slips



expandable patch



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SUMMARY

Summary

- 2016 well failure statistics:
 - 22 out of zone and 1 in zone breaks concentrated in the Colorado Shale
 - Number of out of zone breaks (22) increased over 2015 (11); the increase over 2015 is attributed to prolonged area-wide Primrose East shut-ins
 - All failures occurred at the casing connections
 - 100% of out of zone breaks occurred during low pressure
- 2016 well integrity initiatives:
 - Electro-magnetic log became the standard means for casing integrity checks
 - Completed the implementation of upgraded caliper log software
 - C-FER Alternate Cement JIP Phase 2 nearing completion
 - High temperature patches trialing continues
- CNRL continues advancing knowledge of well failures and implementing proactive measures to increase casing life



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PROVEN

EFFECTIVE

STRATEGY