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Energy Resources Conservation Board  
640 - 5th Avenue SW  
Calgary, Alberta  
T2P 3G4

Attention: Mr. Ken Schuldhaus, P. Eng.  
In Situ Section Leader  
Resources Applications Group

Mr. Schuldhaus:

**Re: 2008 Annual Summary Report on Casing Integrity**

This report is being issued to satisfy the conditions of EUB Decision 99-22, Condition #9 and clause 6.2 of AEUB Approval 8558.

This report has been submitted annually since 2000, and as such builds on information that was included in previous reports, with focus on 2008 performance.

Imperial Oil firmly believes that the comprehensive casing integrity program that is in place at Cold Lake provides the necessary operating practices and procedures to ensure integrity within our operations.

Should you wish to meet and discuss the contents of this report further, please do not hesitate to contact me at (403) 237-3684.

Sincerely,

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Blair Temple, P. Eng.  
Subsurface Engineering Manager

cc. Don Hennessey                      ERCB - Bonnyville  
Anna Louie                              ERCB - Calgary  
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bcc. John Elliott  
Dan Lemoing  
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# **2008 Annual Summary Report on Casing Integrity**

Submitted: March 27, 2009

## EXECUTIVE SUMMARY

### Casing Failures

#### *Near Surface*

- 5 failures in 2008.
- 2 detected with casing integrity checks, 3 detected operationally.
- None in 2008 were assessed above a level 0 environmental consequence.
- No multi-well failures occurred in 2008.
- 2 wells in 2008 proactively repaired or taken out of steam service due to excessive wall loss.

#### *Intermediate Depth*

- 39 failures in 2008 (36 primary failures & 3 secondary failures) versus 36 failures in 2007.
- 27 detected with casing integrity checks (incl. all 3 secondary failures), 12 detected operationally which includes 6 with passive seismic.
- None in 2008 were assessed above a level 0 environmental consequence.
- 91 wells in 2008 proactively repaired or taken out of steam service due to impairment or deformation.

#### *Clearwater*

- 81 failures in 2008.
- No adverse environmental impact identified.

### Casing Integrity Initiatives

#### *Targeted Selection*

- Risk based process to identify which wells should receive minimum required casing integrity checks, as well as to identify wells that should be checked incremental to the minimum standard.

#### *Casing Shrouds to Reduce Surface Corrosion*

- Investigation commenced in 2008. Several designs submitted for review and construction of prototypes.

#### *Casing Retrieval*

- Plan to retrieve sections of casing from up to 4 wells with casing failures in order to have them analyzed. Operations complete on first well.

#### *Material Testing*

- Initiated a series of tests using L80 grade material to determine the onset of sulphide stress corrosion cracking as a function of temperature and H<sub>2</sub>S partial pressure.

#### *Wellbore Environment Investigation*

- Instrumented Well – equipped well T06-09 with downhole instrumentation to measure temperature, pressure, H<sub>2</sub>S concentration, and take liquid samples to determine acidity.
- Wellbore Environment Model – a numerical model has been developed which can predict partial pressure of H<sub>2</sub>S as a function of wellbore temperature and pressure. Data from instrumented well will be used to tune the model which may then be used to predict downhole conditions based on surface measurements.

#### *Geological Study*

- Geological review of the Colorado Shales undertaken in 2008 examining stratigraphy and depositional environment of the shales at multiple pads.

#### *Coupled Well Load and Resistance Model*

- Layered rock property model coupled with sub-models incorporating well properties, to predict distribution and magnitude of plastic strain and material failure.

*JIP on Synergistic Casing Loads*

Noetic JIP to study synergistic thermo-mechanical and environmental loads on casing.

*Steaming Practices*

- Imposed volume limit on 8 acre spaced wells equal to those of 4 acre spaced wells in 2008.
- Ensuring greater than 50% overlap is achieved.
- Problem pad assessments standardized in 2008.

*Wellbore Redesign Assessment*

- Investigating alternative materials, connection designs, and completion techniques to assess technical and economic feasibility for cyclic steam stimulation service.

## 1 INTRODUCTION

Pursuant to the requirements of AEUB Decision 99-22, condition #9 and clause 6.2 of AEUB Approval 8558, Imperial Oil Resources hereby submits the 2008 annual summary report on casing integrity and remediation efforts.

This report has been submitted annually since 2000, and as such builds on information that was included in previous reports, with focus on 2008 performance.

For the purpose of this report, a casing failure is defined as a break or crack in the production casing that results in the well's inability to contain pressure. A primary failure is defined as being limited to a single well; a secondary (or multi-well) failure occurs when fluid loss from a primary failure results in immediate adjacent well failures. Casing failures have been classified according to the following three depth intervals:

- Near surface (0 to ~25 mTVD).
- Intermediate depth including the Quaternary, Colorado group, and Grand Rapids formations.
- Clearwater, at the interface between the Clearwater formation and the Grand Rapids formation or lower.

Undetected near surface and intermediate well failures in the upper part of the wellbore have potential for environmental consequence due to potential aquifer contamination or breach to surface. Clearwater failures only affect the serviceability of the well, and thus the recovery from the production zone (Clearwater reservoir). The existing casing integrity program for Cold Lake was designed to address the concerns associated with the near surface and intermediate depth intervals, and was not intended to deal with failures within the production zone.

Near surface and intermediate depth casing failures with potential for adverse environmental impact are assigned an environmental consequence level. Clearwater failures do not have an adverse environmental impact, and therefore are not assigned one. Casing failures that occur within the Glacial Till or within 75 meters of the Bedrock top, and have potential for fluid loss are Alberta Environment reportable; the response follows the Cold Lake Operations Incident Response Plan. Consequence levels are assigned jointly by environmental and engineering personnel utilizing the descriptions provided in Table 1.

Table 1: Environmental Consequence Matrix for Casing Failures

Consequence Level	Environmental Consequence Description
Level 0	<ul style="list-style-type: none"> <li>- Failure occurred within the bedrock with fluid loss below the typical threshold required to cause a multi-well failure (approximately 1000 – 5000 m<sup>3</sup> produced fluid, dependant on proximity of wellbores at failure depth)</li> <li>- Failure occurred within the Glacial Till, but only released inert fluid (e.g. N<sub>2</sub> gas) or minimal produced fluid not requiring remediation</li> </ul>
Level 1	<ul style="list-style-type: none"> <li>- Failure occurred within the bedrock with fluid loss above the typical threshold required to cause a multi-well failure (approximately 1000 – 5000 m<sup>3</sup> produced fluid, dependant on proximity of wellbores at failure depth)</li> <li>- Failure released fluid into the Glacial Till and there is low potential of the fluid migrating to a freshwater aquifer (i.e. volume released from failure is low, or the aquitard layer is thick)</li> </ul>
Level 2	<ul style="list-style-type: none"> <li>- Failure with fluid release to surface or fresh water aquifer requiring longer term remediation efforts</li> </ul>

Note: Bedrock is defined as solid rock that underlies unconsolidated surface material (i.e. Bedrock includes the Lea Park and/or Colorado Group and lower formations).

For the purpose of the report, failures are defined as being detected either operationally, or through a casing integrity (CI) check. An operational detection is defined as a failure detected with the differential flow & pressure (DFP), nitrogen soak, or passive seismic (PS) systems, or detected by visual means. A casing integrity detection is defined as a failure detected as part of the pre-steam casing integrity process (identified through a service rig based casing integrity check).

## 2 CASING INTEGRITY DATA

A historical summary of casing failures by depth interval at Cold Lake is provided in Table 2. Of the 39 intermediate depth casing failures detected in 2008, 36 were classified as primary commercial intermediate failures and 3 were classified as secondary (multi-well) commercial intermediate failures. None of the failures in 2008 were assessed an environmental consequence above level 0. Of the 44 surface and intermediate failures detected in 2008, 13 were detected operationally and 31 were detected through casing integrity checks.

Table 2: Historical Failure Summary by Depth Interval

Depth Classification	Year				
	2004	2005	2006	2007	2008
Surface	0	1	1	5	5
Intermediate	21	16	26	36	39
Clearwater	57	51	70	71	81
Total	78	68	97	112	125

Casing integrity data for the three failure depth intervals is presented in the following subsections.

### 2.1 Near Surface Casing Integrity Data

Since 1991, 91 commercial wells have failed near surface, including five surface failures detected in 2008. In addition to failed wells, a further 109 wells have either been proactively repaired or taken out of steam service due to excessive wall loss. Details describing these failures (including primary cement tops) are provided in Table 3. Note that the current cement tops are at ground level, and have been maintained at ground level since the implementation of the casing integrity program in 1996 either through bentonite or cement top-ups. Three out of the five failures detected in 2008 occurred above the primary cement top reinforcing strong maintenance and inspection of bentonite top-ups.

Table 3: 2008 Surface Depth Failures Summary

No.	WELL INFORMATION				FAILURE INFORMATION						
	Well	License	UWI	Primary Cement Top mGL	Detection Date mm/dd/yy	Detection Method		Depth		Cycle	Environmental Consequence Level
1	B04-10	103494	106/13-13-065-04W4	7.9	01/21/08	Operational	Visual	5.5	1.8	11	0
2	H33-16	179353	110/05-35-065-04W4	0.3	02/03/08	CI Check	CI Check	4.8	0.1	8	0
3	NN-26	193179	110/03-06-065-03W4	1.1	05/15/08	CI Check	CI Check	4.8	0.5	7	0
4	A06-12	103874	100/08-15-065-04W4	13.4	07/31/08	Operational	N2 Soak	5.3	1.4	9	0
5	B02-40	179951	112/05-13-065-04W4	1.1	12/03/08	Operational	Visual	4.3	-0.2	5	0

Historic consequence levels associated with near surface casing failures since 1996 are displayed in Figure 1. All near surface failures, except H01-03 in 1996, were assessed at a level 0 environmental consequence, including the five near surface failures detected in 2008.

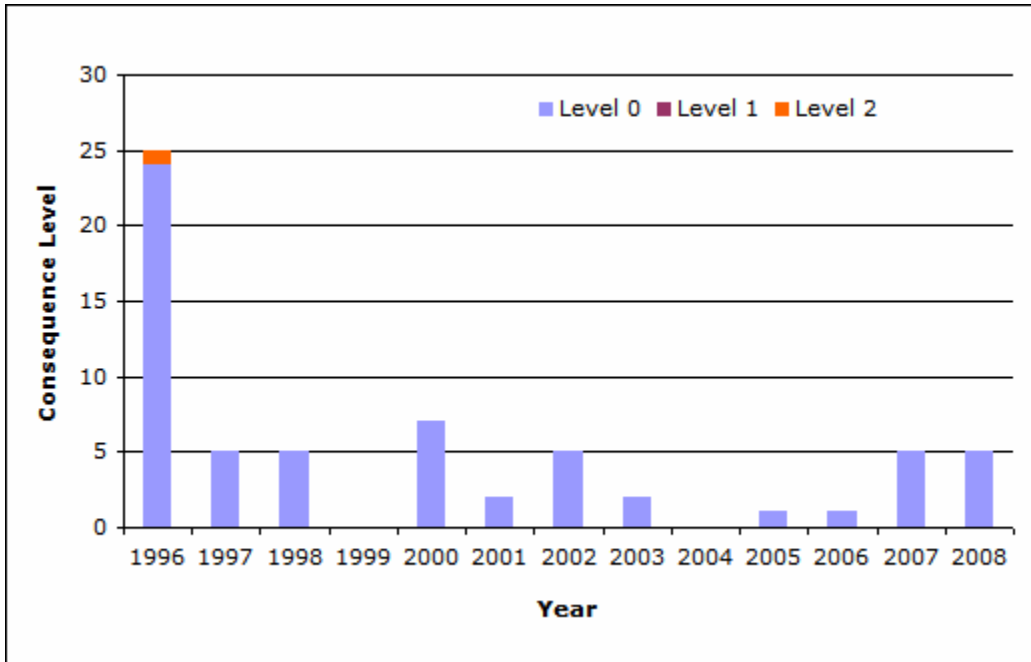


Figure 1: Cold Lake Surface Failures by Consequence Level

The number and frequency of primary intermediate casing failures for the commercial casing design in Cold Lake are summarized in Figure 2. Failure frequency is the number of failures divided by the total number of wells operating. The peak failure rate in 1996 corresponds to failures identified through pre-steam casing integrity checks implemented as part of the casing integrity program. The number and frequency of failures have remained relatively constant since 1997, indicating the effectiveness of Cold Lake’s cementing, top-up, and Casing Integrity Operating Practices. These existing operating practices have also been successful in selectively removing damaged wells from active operations, and thus minimizing the risk of near surface failures.

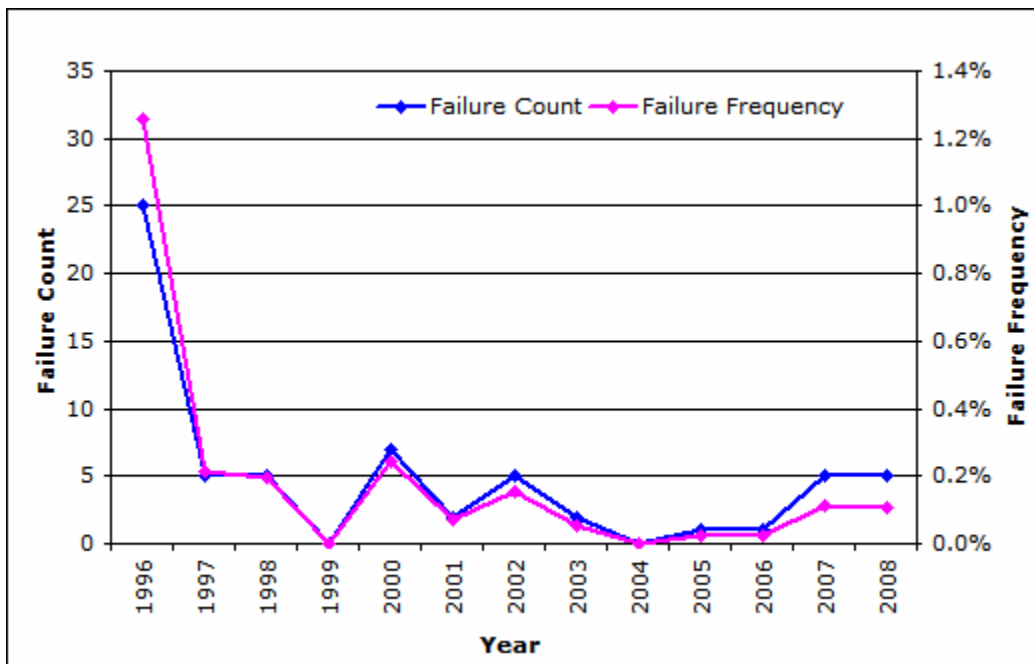


Figure 2: Commercial Surface Failures and Failure Frequency

Surface failure detection method is displayed in Figure 3.

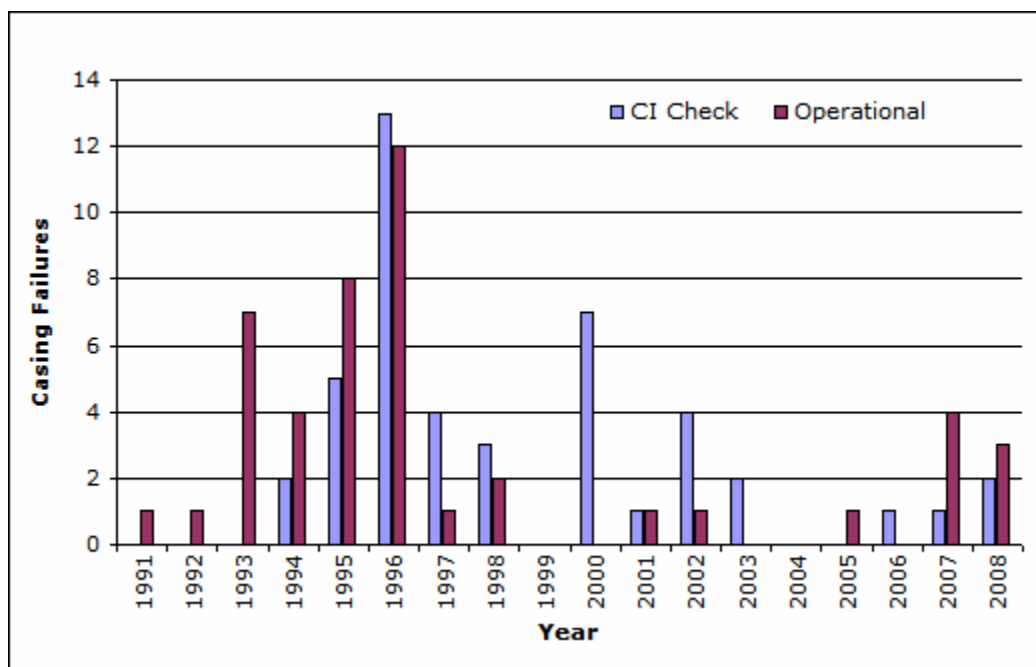


Figure 3: Commercial Surface Failures by Detection Method

## 2.2 Intermediate Depth Casing Integrity Data

The scope of this document includes intermediate depth failures that have occurred in wells with L-80 or IK-55 casing (also referred to as ‘commercial’ design), and does not include early casing designs, such as SOO-95. There were no failures in wells of earlier casing design in cyclic steam stimulation (CSS) operation in 2008.

Since the implementation of the Casing Integrity Operating Practices in 1996, a total of 273 primary intermediate casing failures have been detected in wells with the L-80 or IK-55 casing designs. 185 of these failures (approximately 68%) were identified during pre-steam casing integrity checks. 408 additional wells were taken out of steam service or repaired due to intermediate impairments or excessive deformation. 2 intermediate failures have required aquifer remediation (H15-10 in 1999 and H39-H04 in 2006). 2 multi-well failure events have occurred since 1996:

- T09-01 primary intermediate casing failure in 2006 with one secondary failure on T09-07 in 2006.
- H33-06 primary intermediate casing failure in 2007 with secondary failures on H33-08 and H33-10 in 2007, as well as H33-01, H33-12, and H33-15 in 2008.

39 intermediate casing failures were detected in 2008, including 3 secondary failures. Details on these failures are provided in Table 4.

Table 4: 2008 Intermediate Depth Failures Summary

No.	WELL INFORMATION				FAILURE INFORMATION									
	Well	License	Unique Well Identifier	Detection Date mm/dd/yy	Detection Method		Depth		Depth Class	Pipe Body / Connection	Connection Type	Primary / Secondary	Cycle	Environmental Consequence Level
							mKB	mTVD						
1	D31-11	225503	110/13-02-065-04W4	01/17/08	Operational	N2 Soak	257.8	246.6	Westgate Fm	C	NSCC	P	7	0
2	U05-24	253333	102/15-04-065-03W4	01/28/08	Operational	DFP	250.0	250.0	Fish Scale Fm	N/A	NSCC	P	6	0
3	H33-16	179353	110/05-35-065-04W4	02/12/08	CI Check	CI Check	414.0	369.0	GP Member	C	OBTC	P	8	0
4	D54-6A	127786	108/13-35-064-04W4	03/06/08	CI Check	CI Check	297.0	278.3	Viking Fm	C	OBTC	P	9	0
5	H47-16	302908	104/03-10-066-04W4	03/10/08	CI Check	CI Check	211.0	210.4	Fish Scale Fm	C	NSCC	P	4	0
6	T07-22	248858	104/15-28-064-03W4	03/15/08	Operational	PS - LP	281.0	279.6	Fish Scale Fm	C	NSCC	P	5	0
7	U05-09	253318	104/06-09-065-03W4	03/18/08	Operational	N2 Soak	247.2	246.6	Fish Scale Fm	C	NSCC	P	6	0
8	D24-12	114835	105/13-01-065-04W4	03/19/08	CI Check	CI Check	255.0	253.8	Westgate Fm	Pipe	OBTC	P	11	0
9	V03-03	253939	100/09-28-064-03W4	03/30/08	CI Check	CI Check	242.0	241.4	Fish Scale Fm	C	NSCC	P	5	0
10	K22-01	129061	104/01-17-065-04W4	04/04/08	CI Check	CI Check	433.9	368.5	GP Member	C	OBTC	P	6	0
11	E01-03	291794	102/07-12-065-04W4	04/15/08	Operational	PS - HP	218.0	218.0	Fish Scale Fm	C	NSCC	P	5	0
12	T07-21	248857	103/15-28-064-03W4	04/16/08	CI Check	CI Check	276.0	275.3	Fish Scale Fm	Pipe	NSCC	P	5	0
13	D31-14	225506	103/12-02-065-04W4	04/18/08	Operational	N2 Soak	317.0	285.0	Joli Fou Fm	C	NSCC	P	7	0
14	U03-19	253380	100/13-03-065-03W4	04/23/08	Operational	N2 Soak	249.3	247.6	Fish Scale Fm	C	QB2	P	6	0
15	V03-04	253940	102/09-28-064-03W4	04/27/08	CI Check	CI Check	246.3	246.1	Fish Scale Fm	Pipe	NSCC	P	5	0
16	T07-15	248853	105/02-33-064-03W4	04/30/08	CI Check	CI Check	276.0	276.0	Fish Scale Fm	Pipe	NSCC	P	5	0
17	H33-01	179338	102/11-35-065-04W4	05/01/08	CI Check	CI Check	235.5	222.7	Fish Scale Fm	C	OBTC	Sec	9	0
18	NN-08	193161	110/06-06-065-03W4	05/08/08	CI Check	CI Check	271.2	258.8	Fish Scale Fm	C	OBTC	P	7	0
19	J12-15	124322	107/08-15-065-04W4	05/21/08	CI Check	CI Check	255.0	247.9	Westgate Fm	C	OBTC	P	9	0
20	NN-30	193183	100/15-31-064-03W4	06/30/08	CI Check	CI Check	333.0	303.6	Westgate Fm	C	OBTC	P	7	0
21	L08-10	276364	105/11-29-065-04W4	07/08/08	CI Check	CI Check	515.1	418.8	McLaren Mbr	C	QB2	P	6	0
22	E05-21	287876	108/02-01-065-04W4	07/10/08	CI Check	CI Check	312.0	302.0	Joli Fou Fm	C	QB2	P	5	0
23	H33-15	179352	102/03-35-065-04W4	07/15/08	CI Check	CI Check	209.9	205.7	Belle Fourche Fm	C	OBTC	Sec	9	0
24	H33-12	179349	109/05-35-065-04W4	07/16/08	CI Check	CI Check	229.7	223.8	Westgate Fm	N/A	OBTC	Sec	9	0
25	A04-08	103838	105/04-14-065-04W4	07/18/08	CI Check	CI Check	267.0	266.0	Joli Fou Fm	Pipe	OBTC	P	12	0
26	D67-20	241782	100/10-26-064-04W4	07/23/08	CI Check	PS - LP	318.0	313.8	Joli Fou Fm	C	NSCC	P	6	0
27	A03-16	104411	105/07-14-065-04W4	08/08/08	CI Check	CI Check	270.0	238.9	Westgate Fm	Pipe	OBTC	P	10	0
28	T07-10	248837	100/14-28-064-03W4	08/22/08	Operational	PS - HP	358.8	355.2	Joli Fou Fm	C	NSCC	P	6	0
29	E01-16	291807	108/03-12-065-04W4	08/22/08	Operational	N2 Soak	275.0	273.7	Viking Fm	C	NSCC	P	6	0
30	F02-21	204951	109/10-18-065-03W4	08/30/08	CI Check	CI Check	450.0	386.8	McLaren Mbr	Pipe	OBTC	P	7	0
31	BB-23	130567	102/15-07-065-03W4	09/23/08	CI Check	CI Check	274.5	271.5	Westgate Fm	C	OBTC	P	7	0
32	D66-11	241896	110/01-35-064-04W4	09/28/08	CI Check	CI Check	285.8	282.6	Westgate Fm	P	NSCC	P	2	0
33	V05-07	291633	103/15-34-064-03W4	10/13/08	Operational	N2 Soak	(270.2)	(269.0)	Fish Scale Fm	Unk	NSCC	P	6	0
34	B01-10	103383	100/03-13-065-04W4	10/13/08	CI Check	CI Check	291.7	265.6	Westgate Fm	C	OBTC	P	12	0
35	F05-06	213325	106/05-17-065-03W4	10/30/08	CI Check	PS - LP	276.0	261.0	Westgate Fm	C	OBTC	P	7	0
36	D67-01	241383	107/01-35-064-04W4	11/14/08	CI Check	CI Check	140.0	140.0	Glacial Till	Pipe	NSCC	P	7	0
37	U06-04	273179	105/02-09-065-03W4	11/21/08	CI Check	PS - LP	243.0	243.0	Fish Scale Fm	C	NSCC	P	6	0
38	K22-10	129070	109/04-16-065-04W4	11/27/08	CI Check	CI Check	51.0	51.0	Glacial Till	C	OBTC	P	6	0
39	H26-02	179211	100/07-03-066-04W4	12/11/08	CI Check	CI Check	272.8	257.6	Westgate Fm	C	OBTC	P	8	0

Note: (mKB/mTVD) indicates diagnostics with rig are not complete. Depths are estimated from fluid levels during initial response.

A summary of the connection type for primary intermediate connection failures detected in 2008 is provided in Table 5. Secondary and pipe body failures are excluded from the count, as well as the well (V05-07) listed in Table 4 where diagnostics have not been completed yet. Note that both NSCC & QB2 thread designs have a metal-to-metal seal. It is difficult to draw any conclusions from the data presented due to the varying installation phases with the different connection types, and limited sample size with the QB2 design. Currently in operation there are 2610 OBTC, 1004 NSCC, and 514 QB2 wells.

Table 5: 2008 Primary Intermediate Connection Failures by Connection Design

Connection Type	Cycle Number												Total
	1	2	3	4	5	6	7	8	9	10	11	12	
OBTC					2	4	2	2				1	11
NSCC				1	3	5	2						11
QB2				1	2								3
Total	0	0	0	1	4	9	6	2	2	0	0	1	25

Historic consequence levels associated with intermediate casing failures since 1996 are displayed in Figure 4. None of the 39 intermediate failures that occurred in 2008 were assessed higher than a level 0 environmental consequence.

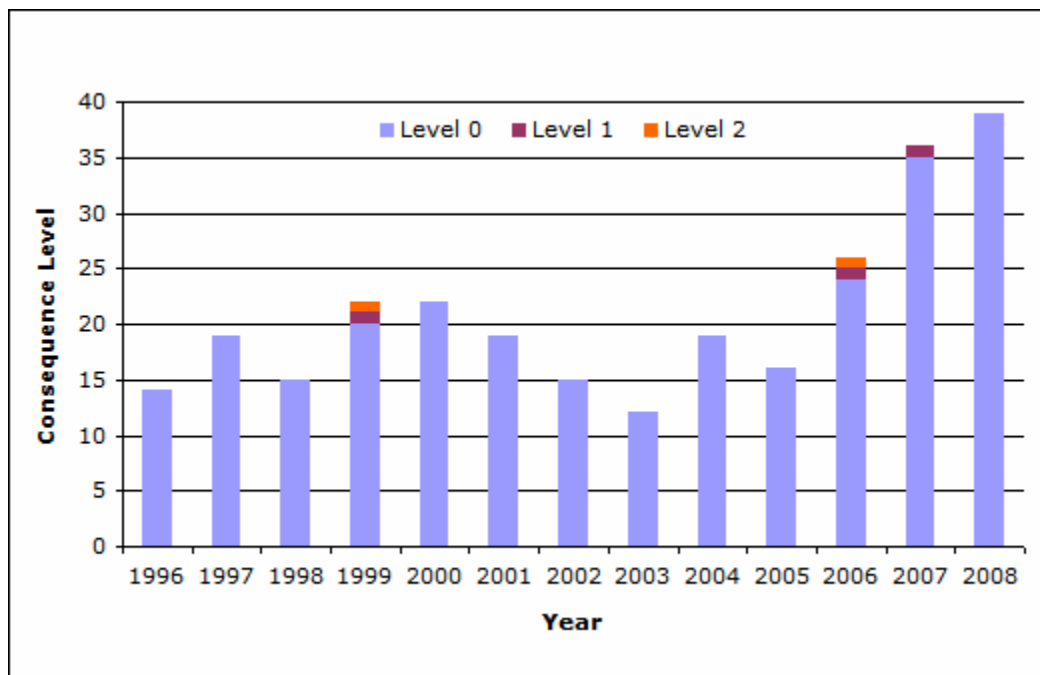


Figure 4: Cold Lake Intermediate Failures by Consequence Level

Prior to 2008 five intermediate failures were assessed above the level 0 environmental consequence level. Details are summarized below.

- The H33-06 intermediate casing failure detected in August 2007 was assessed at a level 1 environmental consequence due to resulting fluid loss into the bedrock that was above the threshold to cause a multi-well failure. It was estimated that the primary failure, H33-06, released 1000 - 5000 m<sup>3</sup> of produced fluid (primarily produced water) into the Colorado group at 229 mKB, which resulted in the secondary intermediate failures at H33-01, H33-08, H33-10, H33-12, and H33-15. All of the secondary failures were assessed at a level 0 consequence. Because the release was contained within the Colorado group, no adverse environmental impact occurred.
- The H39-H04 intermediate failure detected in July 2006 was assessed at a level 2 environmental consequence due to aquifer contact. It was estimated that H39-H04 released 3200 – 5400 m<sup>3</sup> produced fluid (approximately 25% bitumen) into the Glacial Till. Imperial Oil is currently actively remediating this area.
- The T09-01 intermediate casing failure detected in May 2006 was assessed at a level 1 consequence due to resulting fluid loss estimated to be 6000 m<sup>3</sup> (primarily steam). The release occurred within the Colorado group, and no adverse environmental impact occurred.

- The E10-12 intermediate failure detected in December 1999 was assessed at a level 1 environmental consequence. It resulted in an estimated release of 1700 m<sup>3</sup> which was contained within the Colorado group.
- The H15-10 intermediate failure detected in March 1999 was assessed at a level 2 environmental consequence. It resulted in an estimated release of 200 m<sup>3</sup> produced fluid into the Empress 1 aquifer, which was successfully remediated.

The number and frequency of primary intermediate casing failures for the commercial casing design in Cold Lake are summarized in Figure 5. The number and frequency of failures have been trending upwards since 2003.

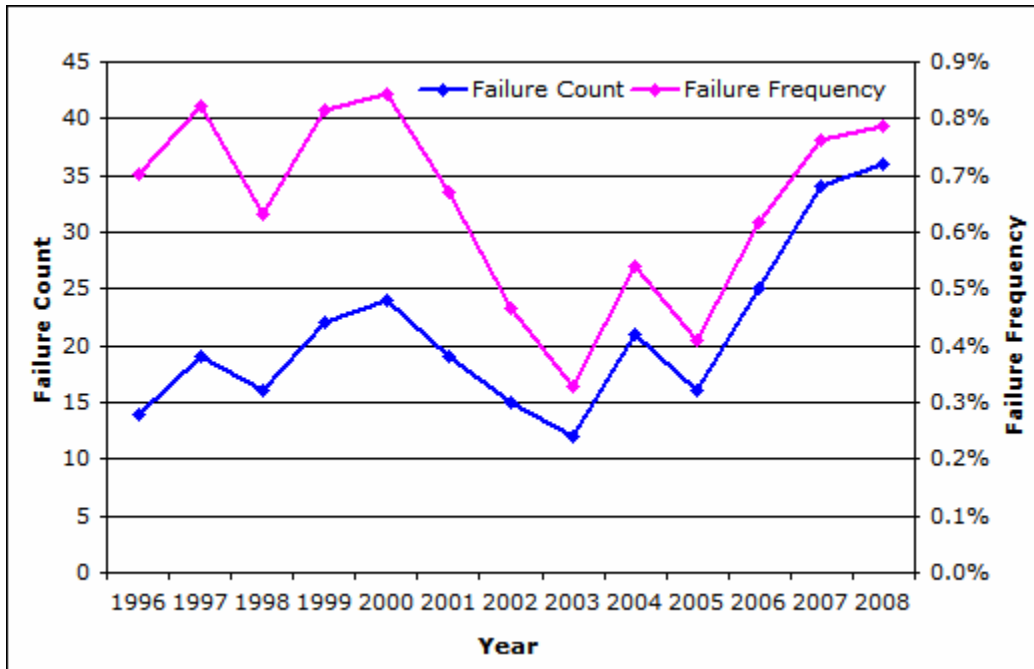


Figure 5: Primary Intermediate Commercial Failures and Failure Frequency

The primary intermediate casing failures for the commercial casing design in Cold Lake are summarized in Figure 6. The data is stacked into early (1-4), mid (5-7), and late (8-12) cycle classifications. The number of early cycle failures has historically been lower than mid and late cycle failures. Mid cycle failures have generally been increasing since 1996. Late cycle failures have generally been declining since 1995.

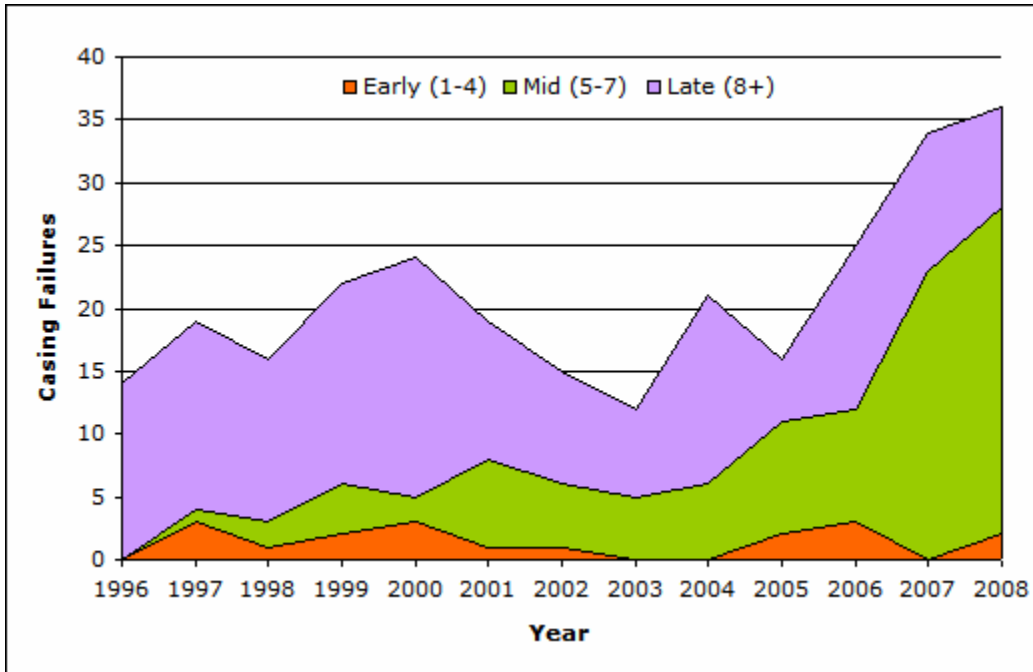


Figure 6: Primary Intermediate Commercial Failures by Cycle Range

Historical primary intermediate failure frequency for the commercial casing design is provided in Figure 7. The data is divided into early (1-4), mid (5-7), and late (8-12) cycle classifications. Early cycle failure frequency peaked in 2006; however, it remains lower than mid and later cycles over time. Mid cycle failure frequency has continued to increase since 2004. The failure frequency for later cycle wells has been historically higher than for early and mid cycle wells, but has declined since 1995 due to the combination of removing wells with impaired casing from steam service and effectively controlling the wellbore environment.

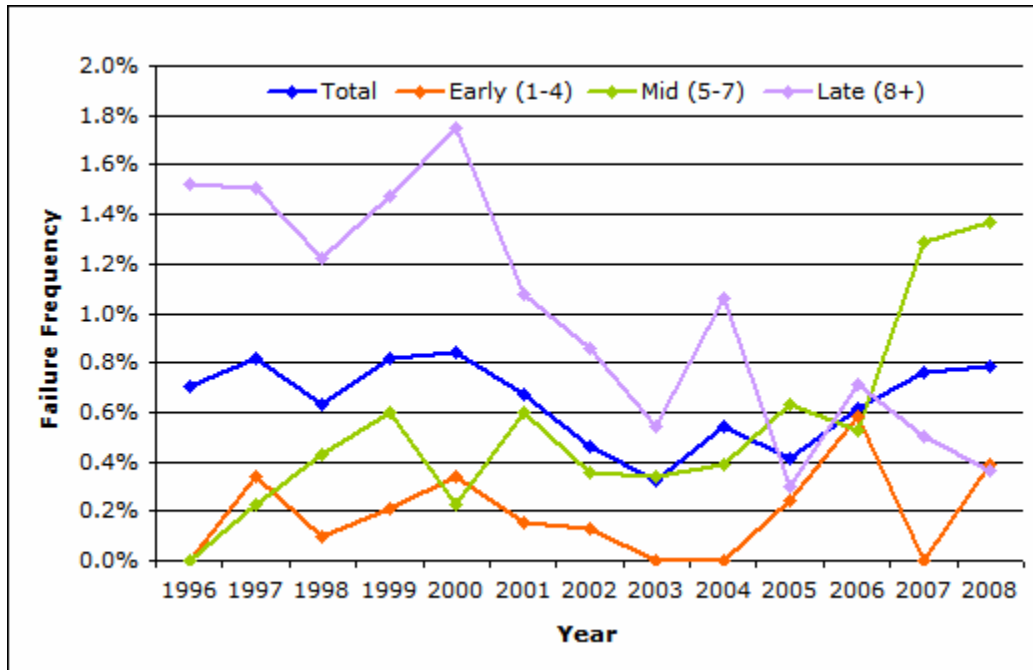


Figure 7: Primary Intermediate Commercial Failure Frequency by Cycle Range

Primary intermediate failure detection method is displayed in Figure 8. The pre-steam casing integrity process has detected a significant portion (approximately 68%) of the casing failures at Cold Lake since its inception in 1996. The percentage of operationally detected casing failures has generally increased since 2002, primarily due to the increased detection capabilities and enhancements with passive seismic and the nitrogen soak monitoring program. The number of casing failures detected through casing integrity checks has also increased significantly in recent years. This is in large part due to the increased frequency of casing integrity checks as a result of enhancements made to the Casing Integrity Operating Practices. The number of casing integrity checks performed since 2001 is displayed in Figure 10.

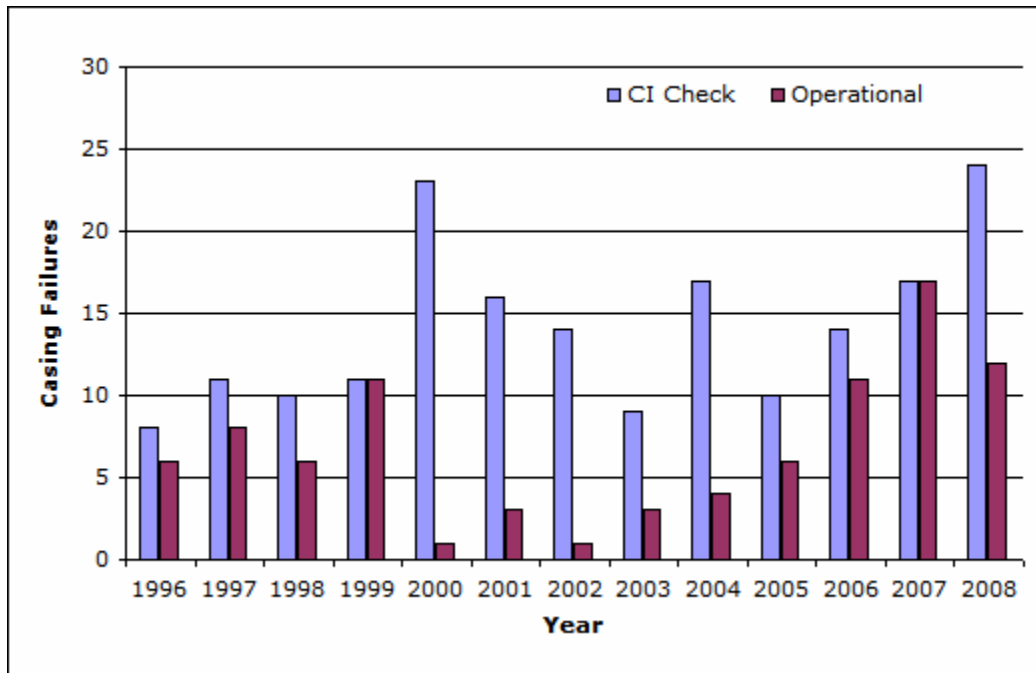


Figure 8: Primary Commercial Intermediate Failures by Detection Method

### 2.3 Clearwater Casing Integrity Data

81 Clearwater casing failures were detected in 2008. Details of these failures are provided in Table 6.

Table 6: 2008 Clearwater Failures Summary

No.	WELL INFORMATION			FAILURE INFORMATION			No.	WELL INFORMATION			FAILURE INFORMATION		
	Well	License	UWI	Detection Date mm/dd/yy	Cycle	Depth mKB mTYD		Well	License	UWI	Detection Date mm/dd/yy	Cycle	Depth mKB mTYD
1	A05-08	103926	100/06-14-065-04W4	01/04/08	10	430.6 416.6	42	E04-04	290179	107/16-01-065-04W4	05/28/08	5	461.3 428.8
2	Y31-12	256930	109/12-31-064-03W4	01/05/08	6	490.0 475.2	43	E01-11	291802	105/03-12-065-04W4	05/30/08	5	420.0 419.0
3	U01-10	253499	106/02-04-065-03W4	01/20/08	5	490.0 475.5	44	E05-24	287879	104/02-01-065-04W4	06/02/08	5	537.0 420.0
4	H25-03	181195	103/04-03-066-04W4	01/06/08	7	493.6 413.4	45	NN-16	193169	103/02-06-065-03W4	06/05/08	7	452.0 448.6
5	H42-22	285608	109/15-27-065-04W4	01/08/08	4	728.1 429.2	46	H36-14	190159	105/04-02-066-04W4	06/08/08	7	460.6 436.1
6	Y31-03	256918	103/12-31-064-03W4	01/09/08	6	514.0 454.0	47	L08-04	276359	103/10-29-065-04W4	06/11/08	6	472.5 422.1
7	A05-15	103933	107/06-14-065-04W4	01/10/08	10	472.8 417.5	48	V05-16	291642	100/09-34-064-03W4	06/12/08	5	513.0 482.5
8	U01-09	253497	105/02-04-065-03W4	01/14/08	5	487.0 479.0	49	V05-09	291635	105/15-34-064-03W4	06/15/08	5	496.9 471.5
9	D28-05	293139	109/11-01-065-04W4	02/01/08	4	768.0 421.6	50	U02-09	273341	103/05-03-065-03W4	06/16/08	5	522.4 484.6
10	U03-15	253376	105/09-04-065-03W4	02/02/08	5	467.0 455.6	51	U02-10	273342	104/04-03-065-03W4	06/17/08	5	488.5 480.9
11	E01-H02	291793	100/06-12-065-04W4	02/08/08	5	467.0 420.2	52	V05-10	291636	104/10-34-064-03W4	06/20/08	5	488.4 470.8
12	MM-07	192720	108/13-06-065-03W4	02/08/08	7	478.0 428.8	53	Y34-12	224596	109/15-31-064-03W4	06/22/08	8	538.0 450.6
13	T08-02	237202	103/08-32-064-03W4	02/08/08	7	667.5 478.0	54	U02-17	273349	102/03-03-065-03W4	06/23/08	5	502.0 476.5
14	H46-23	314333	102/12-03-066-04W4	02/14/08	3	466.2 410.6	55	U07-20	329255	109/11-03-065-03W4	06/26/08	2	512.5 476.1
15	U06-11	273185	103/01-09-065-03W4	02/17/08	5	514.0 451.2	56	E05-10	287865	106/08-01-065-04W4	06/29/08	5	517.0 451.0
16	E01-10	291801	105/06-12-065-04W4	02/21/08	5	429.3 419.2	57	E04-13	290174	105/09-01-065-04W4	07/01/08	5	488.0 426.6
17	E01-09	291800	104/06-12-065-04W4	02/22/08	5	463.2 420.0	58	L08-14	276368	106/07-29-065-04W4	07/01/08	6	449.4 423.3
18	U03-10	253370	103/09-04-065-03W4	02/23/08	5	465.0 454.0	59	D67-10	241758	107/13-25-064-04W4	07/04/08	6	451.5 439.2
19	E02-17	291781	106/02-12-065-04W4	03/02/08	5	426.4 416.1	60	T10-01	248813	105/02-31-064-03W4	07/09/08	6	627.0 449.6
20	E02-23	291784	107/02-12-065-04W4	03/07/08	5	506.0 414.6	61	H34-11	189412	106/13-35-065-04W4	07/17/08	7	471.0 428.4
21	T01-09	238002	102/10-33-064-03W4	03/09/08	5	592.0 486.0	62	Y34-07	224584	104/15-31-064-03W4	07/20/08	8	465.0 458.3
22	E01-21	291811	111/03-12-065-04W4	03/12/08	3	560.0 417.7	63	K22-07	129067	105/01-17-065-04W4	07/24/08	6	448.7 427.3
23	U01-17	253511	102/16-33-064-03W4	03/12/08	5	539.0 475.0	64	K22-05	129065	105/04-16-065-04W4	07/27/08	6	548.8 440.1
24	U03-14	253375	104/09-04-065-03W4	03/13/08	5	516.0 454.7	65	T03-02	236989	104/11-32-064-03W4	08/08/08	7	620.0 469.0
25	E02-08	21772	102/02-12-065-04W4	03/15/08	5	490.5 419.4	66	D67-03	241763	103/16-26-064-04W4	08/22/08	6	522.0 438.0
26	H47-23	302926	104/14-03-066-04W4	03/19/08	4	545.0 411.9	67	K22-08	129068	107/04-16-065-04W4	08/22/08	6	429.0 425.0
27	D55-14	127640	105/06-35-064-04W4	03/22/08	8	444.0 427.6	68	Y34-14A	230180	110/10-31-064-03W4	08/28/08	5	536.4 451.2
28	H47-18	302906	102/03-10-066-04W4	03/25/08	4	410.0 407.4	69	D57-14	241850	107/03-35-064-04W4	09/15/08	2	764.0 459.7
29	E02-11	291775	106/01-12-065-04W4	03/28/08	5	442.7 429.8	70	T03-09	236995	104/06-32-064-03W4	09/30/08	7	490.0 474.2
30	D55-12	127638	103/06-35-064-04W4	04/03/08	8	454.9 429.7	71	U06-05	273180	106/02-09-065-03W4	10/04/08	5	587.5 452.5
31	K22-01	129061	104/01-17-065-04W4	04/04/08	6	520.9 423.9	72	H24-02	172062	150/01-03-066-04W4	10/07/08	8	492.7 431.1
32	H37-07	206959	100/09-03-066-04W4	04/13/08	7	496.4 424.6	73	F02-26	204961	104/16-18-065-03W4	10/19/08	8	486.0 417.7
33	V02-17	253850	105/04-34-064-03W4	04/28/08	5	560.0 492.2	74	T03-24	237010	104/02-32-064-03W4	10/20/08	7	735.0 487.7
34	HH-08	128264	105/06-06-065-03W4	05/01/08	8	490.0 445.6	75	T03-15	237001	102/07-32-064-03W4	10/26/08	7	489.0 477.0
35	K23-19	198018	102/05-09-065-04W4	05/03/08	7	594.0 432.7	76	G02-31	222286	100/14-09-065-03W4	10/27/08	5	526.0 427.0
36	Y34-04	224581	109/02-06-065-03W4	05/07/08	7	516.4 451.0	77	T08-06	237206	100/16-29-064-03W4	11/04/08	7	714.0 481.3
37	V01-10	254036	102/12-34-064-03W4	05/08/08	5	496.0 485.8	78	T11-04	268179	108/10-29-064-03W4	11/11/08	6	636.0 478.0
38	NN-14	193167	100/03-06-065-03W4	05/11/08	7	492.0 451.5	79	H58-14	323682	102/15-09-066-04W4	11/16/08	2	491.0 424.6
39	V01-09	254035	107/13-34-064-03W4	05/12/08	6	492.9 483.2	80	Y31-09	256924	107/12-31-064-03W4	11/18/08	7	511.8 489.7
40	V03-10	253946	105/09-28-064-03W4	05/17/08	5	469.3 456.0	81	U04-11	253423	104/11-04-065-03W4	11/27/08	6	467.0 454.0
41	J27-03	199344	109/10-10-065-04W4	05/21/08	7	498.2 422.2							

The number and frequency of Clearwater casing failures for the commercial casing design in Cold Lake are summarized in Figure 9. The frequency of failures has remained relatively constant since 2002.

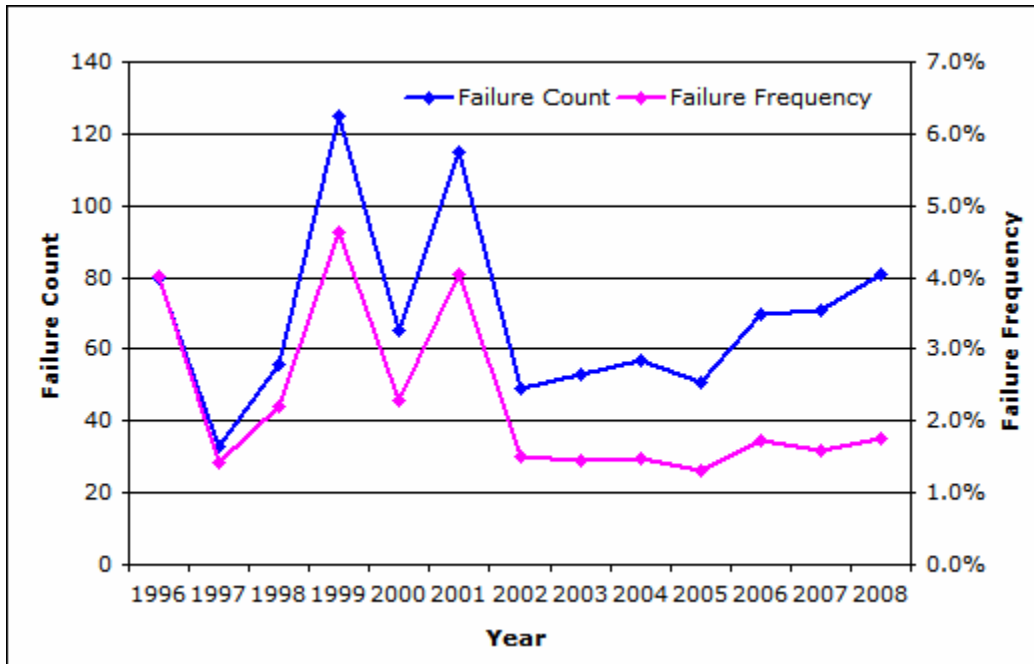


Figure 9: Commercial Clearwater Failures and Failure Frequency

### 3 COLD LAKE CASING INTEGRITY MANAGEMENT

Casing integrity is a critical component of the Operations Integrity Management in Cold Lake. Continuous improvement with respect to casing integrity has been made throughout the history of Cold Lake Operations. Failure mechanisms that have been identified in Cold Lake wells are external corrosion (near surface failures), stress corrosion cracking, and sulphide stress corrosion cracking (SSCC) with contributing factors such as metal fatigue (high strain – low cycle) and formation movement. The Cold Lake Casing Integrity Operating Practices were formally introduced in 1996 providing improvements in three major areas – prevention and detection of, and response to casing failures. Through a continuous improvement approach, the Casing Integrity Operating Practices have been enhanced, modified, and updated with new learnings since their implementation. The Casing Integrity Operating Practices are reviewed and updated annually.

Improvements and initiatives in detection and prevention of (with respect to the three depth classifications), and response to casing failures relevant to 2008 and the future will be discussed in the following sections.

#### 3.1 Casing Failure Detection

The manner in which casing failures are detected at Cold Lake has evolved through time. Imperial continues to rely on several overlapping detection systems including:

- Differential Flow and Pressure (DFP) alarms during steam injection.
- Nitrogen Soak pressure and fluid level monitoring during soak and shut-in.
- Steam trend analysis.
- Passive seismic monitoring.
- Groundwater monitoring.
- Casing integrity check process.

Current initiatives and recent improvements in detection methods will be discussed in the following subsections.

##### 3.1.1 Alarm Management

The nitrogen soak and fluid shot program is the primary monitoring system for casing failure detection during soaking. After steam or during shut-in periods wells are purged with nitrogen to eliminate an environment susceptible to SSCC, and to provide a liquid free annulus to enable casing pressure and fluid level monitoring. Wellhead pressures are monitored with the SOAK program. The computer system monitors the real time wellhead pressures on a 30 minute frequency and alarms if the current 60 minute average pressure changes as little as a 30 kPa compared to the prior 60 minute average. Fluid levels are taken 1 hour, 24 hours, 3 days, 7 days, and every 28 days thereafter the initial purge to monitor for casing failures. All alarms and/or rises in the fluid level are investigated and potential casing failure events are responded to immediately in order to confirm the potential casing failure.

The current monitoring system used during the steam injection portion of the cycle is known as the Delta Flow and Pressure (DFP) program. Steam injection and pressure trends are analyzed on a 15 minute frequency to detect pressure drops and corresponding flow increases. All alarms are investigated and potential casing failure events are cross referenced to passive seismic alarms and responded to immediately in order to confirm the potential casing failure.

##### 3.1.2 Passive Seismic Monitoring

Passive seismic alarm coordination was implemented in 2007, triggering immediate action on potential intermediate casing failures. If the well with a potential casing failure is at low pressure (< 4 MPa), the well is checked with a service rig within 60 days of the event. If the well is at high pressure, the well is immediately put on nitrogen soak to confirm integrity. Beginning in 2007 additional geophones have been

added within the Glacial Till on all new Passive Seismic installations to enhance casing failure detection within the upper portion of the wellbore.

Imperial Oil has been utilizing the passive seismic system to aid in the detection of Clearwater top (CWT) failures. When a medium to high probability Clearwater top passive seismic event (within 30 mTVD of CWT) is detected, the well is operated below the fracture pressure until a casing integrity check is performed (required prior to the next steam cycle). No action is required for low probability Clearwater top passive seismic events.

### 3.1.3 Casing Integrity Check Process

Since the inception of the Casing Integrity Operating Practices in 1996, casing integrity checks have been conducted pro-actively to detect casing failures. A basic casing integrity check consists of both a 21 MPa pressure test and a gauge ring/scrapper run to at least the top of the Clearwater formation. If the gauge ring/scrapper combination identifies a new impairment or casing deformation, or there is a previously identified severe impairment requiring follow-up, a multi-sensor caliper is run to determine the extent of the deformation. Thus, although a well may pass a 21 MPa pressure test, the information from the gauge ring/scrapper combination can trigger additional diagnostics, which are used to confirm whether or not the wells integrity is adequate for steaming operations. Corrosion inspection logs in the top 50 meters of the wellbore are performed in later cycles on wells that were installed prior to 1996 and additionally as required.

The number of casing integrity checks performed on a pad prior to steaming is defined as part of the Casing Integrity Operating Practices, and is provided as Attachment 1. As described in the 2007 Annual Report, the casing integrity check frequencies were increased in 2007 for wells with metal-to-metal connections and for pads without passive seismic wells to enhance pre-steam confirmation of well integrity. Certain circumstances (including such things as known impairments, passive seismic events, suspect fluid levels and nitrogen soak trends) can trigger additional checks incremental to this minimum standard.

A risk-based decision process is used to select wells that should be checked prior to being placed on steam. In 2007 phase 1 of our Targeted Selection process was implemented to select which wells should receive casing integrity checks, as well as to identify wells that should be checked incremental to the minimum standard. Targeted Selection phase 1 is aimed at reviewing data indicating a potential casing failure and includes a mandatory review and close-out of passive seismic casing events, suspect nitrogen soak trends and fluid levels, DFP alarms, and suspect steam trends. There are defined standards describing when Targeted Selection requirements are to be completed and closed out prior to steam injection. Targeted Selection phase 2 is currently being developed and will be introduced in 2009. Phase 2 is aimed at reviewing data that may be a contributing factor in casing failures including such things as drilling documents noting any problems (mud rings, overpressure, lost circulation, difficulty running casing to final depth), connection make-up plots, nitrogen purge compliance, and thermal cycling.

The number of wells in Cold Lake and the frequency of casing integrity checks required have increased. Figure 10 shows the number of casing integrity checks performed each year since 2001. The relatively high number of casing integrity checks performed in 2002 was due to pro-active checks being performed on H trunk wells looking for Clearwater top failures, as well as checks being performed on F trunk wells looking for casing failures because of an oil-in-shale anomaly. These checks confirmed that the F trunk oil-in-shale anomaly was not due to casing failures.

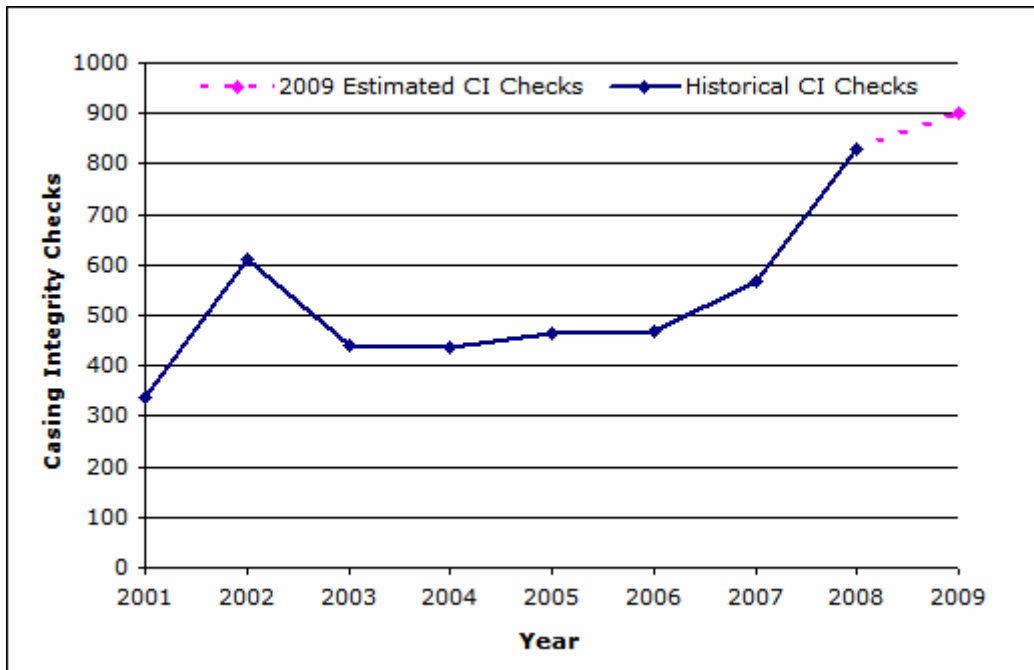


Figure 10: Casing Integrity Check History

### 3.2 Near Surface Casing Integrity Prevention

The primary mechanism for near surface casing failures is external corrosion. Minor wellhead packing leaks and surface water run-off collect in the conductor pipe - production casing annulus forming a corrosion cell. Water typically accumulates in the conductor annulus due to cement slumping (after primary cementing) or cement degradation over time.

Corrosion inspection logs (electromagnetic flux leakage) and casing pressure tests are completed as part of the ongoing casing integrity program. Wells identified with corrosion concerns are either pressure tested to ensure suitability for service, repaired, or taken out of steam service. Improved primary cementing practices for new wells enhance the ability to achieve and maintain cement tops at surface. However, if the cement quality is not adequate in the production casing, the well will be repaired or taken out of steam service. Wells that have cement tops near surface are topped up with bentonite during the first steam cycle; the bentonite top-ups are maintained throughout the life of the wellbore. Wells that have cement tops below the conductor pipe are repaired by running wash pipe down over the production casing to the top of cement and cementing it in place.

As evidenced by the data presented in section 2.1, it is Imperial Oil's belief that the Casing Integrity Operating Practices are effective in the prevention and detection of external corrosion, and hence the protection of near surface casing integrity. However, an initiative to investigate casing shrouds to further reduce surface corrosion was pursued in 2008. Several designs have been submitted for review and construction of prototypes and testing is expected to commence in early 2009. A decision on the feasibility of casing shrouds is expected in the second quarter of 2009.

### 3.3 Intermediate Depth Casing Integrity Prevention

Consistent with past annual reports, the dominant failure mechanism for the intermediate casing section is believed to be environmental cracking, with low-cycle fatigue considered a contributing factor. More recent analyses and investigations have confirmed that in most cases the combined actions of both mechanisms lead to intermediate depth casing failures. Since 2006, in response to an increased frequency of casing failures, Imperial implemented a number of changes to its operations to improve performance, including:

- Improved nitrogen purge management
- Adjusted steam strategy

In addition to these changes, Imperial has developed a number of initiatives whose ultimate goal is to reduce the frequency of intermediate section casing failures. These initiatives will be discussed in the following subsections.

### 3.3.1 *Failure Investigation*

In order to design an appropriate intervention strategy, Imperial currently has four initiatives underway to increase understanding of the combined failure mechanisms. These initiatives are:

1. **Casing Retrieval** - Imperial is planning to retrieve sections of casing from up to four wells with casing failures. A few samples were retrieved from well T11-09 and have been sent for analysis to ExxonMobil's Upstream Research Company. It is unclear whether the samples will yield useful information due to the damage sustained during the retrieval. Retrieval operations on the second well are expected to begin in April 2009, incorporating lessons learned from the first well. Results from the analysis should be available in mid-2009.
2. **Material Testing** - Imperial has initiated a series of tests using L80 grade material to determine the onset of SSCC as a function of temperature and H<sub>2</sub>S partial pressure. Current Cold Lake Casing Integrity Operating Practices are designed under the assumption that SSCC may occur at temperatures below 100°C and an H<sub>2</sub>S partial pressure greater than 0.35 kPaa. Results of this testing may determine whether these operating practices require adjustment, and the test procedure itself may be used to investigate the suitability of alternate material grades. Results from the testing should be available in mid-2009.
3. **Instrumented Well** - past gas samples obtained from producing wells and pads have indicated a wide range of H<sub>2</sub>S concentrations; however, these are surface samples and the partial pressure and temperature in the wellbore are not measured directly. Imperial has equipped well T06-09 with downhole instrumentation to measure temperature, pressure, and H<sub>2</sub>S concentration. In addition, the well is equipped to obtain liquid samples from the wellbore to determine the acidity of the wellbore environment. Once operational, data collected from this well will provide insight into how the wellbore environment can change throughout the producing portion of a cycle. Also, the impact of shut-ins and nitrogen purging on the wellbore environment will be measured.
4. **Wellbore Environment Model** - a numerical model has been developed which can predict the partial pressure of H<sub>2</sub>S as a function of wellbore temperature and pressure. Actual data from the instrumented well will help tune the model, which may then be used to predict downhole conditions based on surface measurements and determine the level of risk for SSCC.

### 3.3.2 *Geological Study of the Colorado Shales*

A geological review of the Colorado Shales was also undertaken in 2008. The review examined detailed stratigraphy and depositional environment of the shales at a number of pads, in an attempt to correlate casing failures and deformations to the geology of the Colorado Shales. By correlating certain characteristic log traces of open-hole dual induction lateral logs of the Colorado Shale section, small scale normal faults were observed at varying depths and frequencies throughout the Colorado Shales. A strong correlation has been discovered between the presence of these faults and well deformations and failures, and it is theorized that the shales may shift along these faults during steaming and cause casing to deform. In some cases these deformations will contribute to a casing failure with additional thermal cycles.

The study continues to be expanded to other Cold Lake pads with available log data. Results of this study and its implications for current and future operations at Cold Lake are still being assessed.

### 3.3.3 *Well Load and Resistance Studies*

Imperial recognizes that wellbore strain and deformation in the overburden due to Clearwater formation dilation and compaction is a contributing factor in intermediate casing failures, and the proportion of wells with intermediate depth deformations and failures in the pipe body has increased in the last three years. To better understand the forces acting on the wellbore during CSS operations, a coupled numerical model was developed over the past 24 months with preliminary results delivered in 2008. Using a layered model with geomechanical rock properties to represent the Colorado Shales, and predicted Clearwater top dilation due to steam injection and fluid production, the near-wellbore lateral forces can be determined. This model is coupled with well and connection sub-models incorporating the metallurgical properties of the casing body and connections. The coupled model can predict the distribution and magnitude of plastic strain in the casing and estimate when the material will fail. The failure prediction incorporates Clearwater dilation, thermal stresses, and potential weak layers within the Colorado Shales.

The model has been built and results analyzed for T04 pad. Additional history-matching work is required to validate model results and expand the work to other parts of Cold Lake incorporating available failure and well deformation data. Future work in 2009 includes a sensitivity study varying controllable operating parameters (steam rates, volumes, and pad configuration), a study of focus pads to be steamed in 2009 with recommendations on alternate strategies to consider, and a study of potential alternate completion designs. Results from the sensitivity study should be available in the second quarter of 2009.

In addition to performing in-house modeling studies, Imperial is participating in a joint industry project (JIP) led by Noetic Engineering to study synergistic thermo-mechanical and environmental loads on casing. Project work is currently underway and Imperial has provided input to the scope of the project.

### 3.3.4 *Steaming Practices*

Cold Lake steaming practices were revised in 2008 to impose steam volume limits on 8 acre spaced wells equal to those of 4 acre spaced wells, and to ensure greater than 50% overlap is achieved. Where greater than 50% overlap cannot be achieved, additional review and documentation is required. The intent of the revision was to reduce shear stress potential. The long term recovery impact of the new practices is to be assessed and the feasibility determined.

Problem pad assessments were also standardized in 2008. Problem pads are classified as having 3 or more class 5 impairments, or 2 or more failures within 5 true vertical meters of each other. When problem pads are identified, detailed assessments, revised steam strategies, and shear stress modeling are required.

Additional studies on steaming practices are planned in 2009, and will incorporate results from the well load and resistance studies described in the preceding section.

### 3.3.5 *Well Environment*

Since 1996, Imperial Oil's operating practices have specified wellbore operating conditions that prevent corrosive environments within the wellbore. In the course of the soaking or shut-in portions of a cycle, the wellbore annulus is purged with nitrogen, mitigating the potential for sulfide stress corrosion cracking. Since implementing this standard, Imperial has purged all wells that have completed their steam cycle and gone into the soak portion of the cycle.

Modifications to the wellbore environment control standards were implemented April 2007, requiring all wells to be purged within 48 hours of being shut-in. Nitrogen purging is used to reduce the presence of H<sub>2</sub>S in the casing - tubing annulus during shut-in periods, which helps to mitigate the occurrence of failures due to SSCC. Through a continuous improvement approach, a sustainable improvement in purge compliance has been observed since the revised purging standards were first implemented. Improved nitrogen purge management will aid in the detection of low-rate casing failures. Nitrogen purge compliance for 2008 is displayed in Figure 11, and it can be seen that current performance was at or near 100% throughout the year.

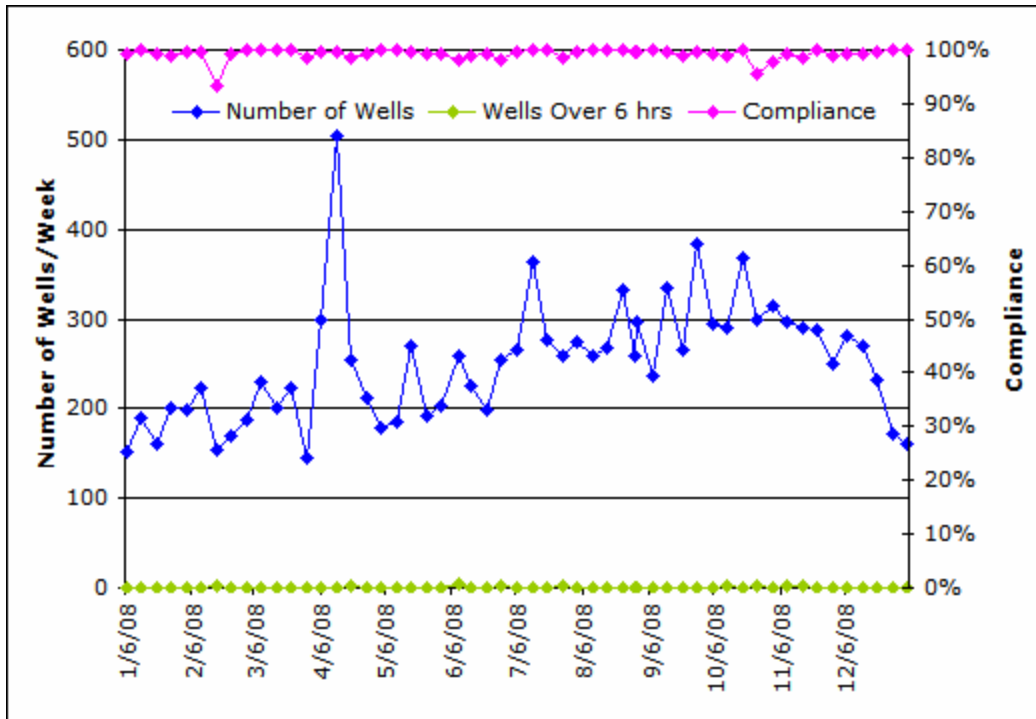


Figure 11: Weekly Nitrogen Purge Compliance

### 3.3.6 Well Design

To date, Imperial Oil has invested significantly in the design and testing of various types of casing connections for use in cyclic steam stimulation (CSS) service. Full-scale testing confirmed that metal-to-metal seal connections improve connection seal ability and, in turn, casing integrity. Since September 1999, metal-to-metal connections have been installed on all new CSS wells drilled in Cold Lake, minimizing the potential for future failures as a result of stress corrosion cracking.

Imperial believes that the current material selection and well design have been optimized based on years of research and operating experience, and that further optimization using commercially available materials will not yield a dramatic reduction in the number of intermediate section casing failures. However, a wellbore redesign assessment is currently underway and Imperial plans to use information from the preceding studies to guide the assessment. The scope of the wellbore redesign assessment includes:

- Alternative material evaluation - some newer commercially available grades of material may be more suitable for CSS service.
- Alternative connection design(s) - changes to the pin and coupling design may improve performance.
- Alternate completion design will be considered for technical and economic feasibility.

### 3.4 Clearwater Casing Integrity Management

Formation movement is the primary mechanism for Clearwater casing failures. As a result of the CSS process, shear stresses develop which results in slip along structurally weak planes existing at the Clearwater / Grand Rapids interface. As this shear is localized, there is no impact on intermediate casing integrity. There is no evidence that Clearwater failures cause, or are related to other intermediate depth or near surface casing failures. Although there is no adverse environmental impact, serviceability of the well can be restricted. The existing casing integrity program for Cold Lake was designed to address the concerns associated with the near surface and intermediate depth intervals, and was not intended to deal with the Clearwater failures.

When Clearwater casing failures are detected the well is steamed below fracture pressure, unless the failure is repaired or the location of the failure is such that steam will not encroach into the overlying formation (Grand Rapids). Occasionally, Clearwater failures (or severe Clearwater impairments) are mitigated through the installation of shear liners for structural support.

### 3.5 Casing Integrity Response

Currently, Imperial keeps on-site 2 pre-mix tanks, a return tank, 240 tonnes of barite, 360 tonnes of hematite, and all necessary kill fluid additives in order to respond to high pressure casing failures quickly.

In 2008, emergency response was initiated 9 times due to high pressure casing failures. In all cases, fluid loss to the break was minimized. Mud kills were required 4 times in 2008, details of which are provided in Table 7.

Table 7: 2008 Casing Failures Requiring Mud Kills

Well	Failure Detected gg/mm/dd hh:mm:ss	Successful Mud Kill gg/mm/dd hh:mm:ss	Time to Well Control hours	Reservoir Pressure MPa	Fluid Lost to Formation				Total m3
					N2 m3	Steam m3	Water m3	Liquid Hydrocarbon m3	
E01-16	08/08/21 15:55:00	08/08/25 13:10:00	93	10.6	21.0	0.0	69.0	4.0	94.0
U03-19	08/04/23 01:20:00	08/04/24 22:00:00	45	9.0	124.9	0.0	21.0	1.1	147.0
U05-09	08/03/17 22:00:00	08/03/21 17:30:00	92	10.3	35.9	0.0	0.6	0.1	36.6
V05-07	08/10/13 07:22:00	08/10/16 18:30:00	83	11.0	33.5	9.2	2.6	0.0	45.3

**ATTACHMENT 1: CASING INTEGRITY CHECK FREQUENCY**

### Casing Checks by Cycle and Design

Beginning Cycle #	Commercial Old	Commercial New/Upgraded w/o PS	Commercial New/Upgraded w/ PS	Environmental Old	Environmental New/Upgraded
%	%	%	%	%	%
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	33	33	0	100	50
6	33	33	33	100	50
7	33	33	33	100	100
8	100 <sup>1</sup>	100	33	100 <sup>1</sup>	100
9	100 <sup>2</sup>	100	50	100 <sup>2</sup>	100
10	100 <sup>2</sup>	100	50	100 <sup>2</sup>	100
11	100 <sup>2</sup>	100	100	100 <sup>2</sup>	100
12	100 <sup>2</sup>	100	100	100 <sup>2</sup>	100
12+	100 <sup>2</sup>	100	100	100 <sup>2</sup>	100

**Notes:**

1. Wells require a Vertilog at or before this cycle.
2. Corrosion assessment (incremental 3.5%/yr from last Vertilog to projected steam in date) to be applied to determine operating strategy unless a current Vertilog is run to confirm.

**Additional Notes:**

If a surface failure is detected all remaining wells in the current or next CI check require Vertilogs or a corrosion assessment to assess pad condition.

Horizontals and Infill wells are included in the above designs.

Commercial: L/MN-80 or IK-55 casing design with OBTC,NKEL or QB2 connections  
 Non-Commercial: All casing designs prior to Commercial.  
 'Old' Wells: Wells beginning steam prior to OP#9 inception, improved steam quality and lower volume steam injection (Jan 96).  
 'New' Wells: Wells beginning steam after OP#9 inception, improved steam quality and lower volume steam injection (Jan 96).  
 Environmental: Pads or wells within 500m of the historical high water level of a designated water body.  
 Water Bodies: Leming Lake, McDougal Lake, Bourque Lake, Un-named Lake in sec 35-64-04W4.  
 Upgraded Commercial: New casing design coming out in 1998 with NSCC-M phosphate coated 'metal-to-metal' connections (VAM SWNA, Tenaris Blue, NSCCM, NSCC, QB2).  
 Known Surface Failures: Wells located on a pad which have had corrosion related surface failures (0-25m).