



OPTI-MISER
WELL CONTROL SYSTEM

HOW TO MAKE MORE PRODUCTION WITH PLUNGER LIFT

DEVELOPING UNCONVENTIONAL GAS

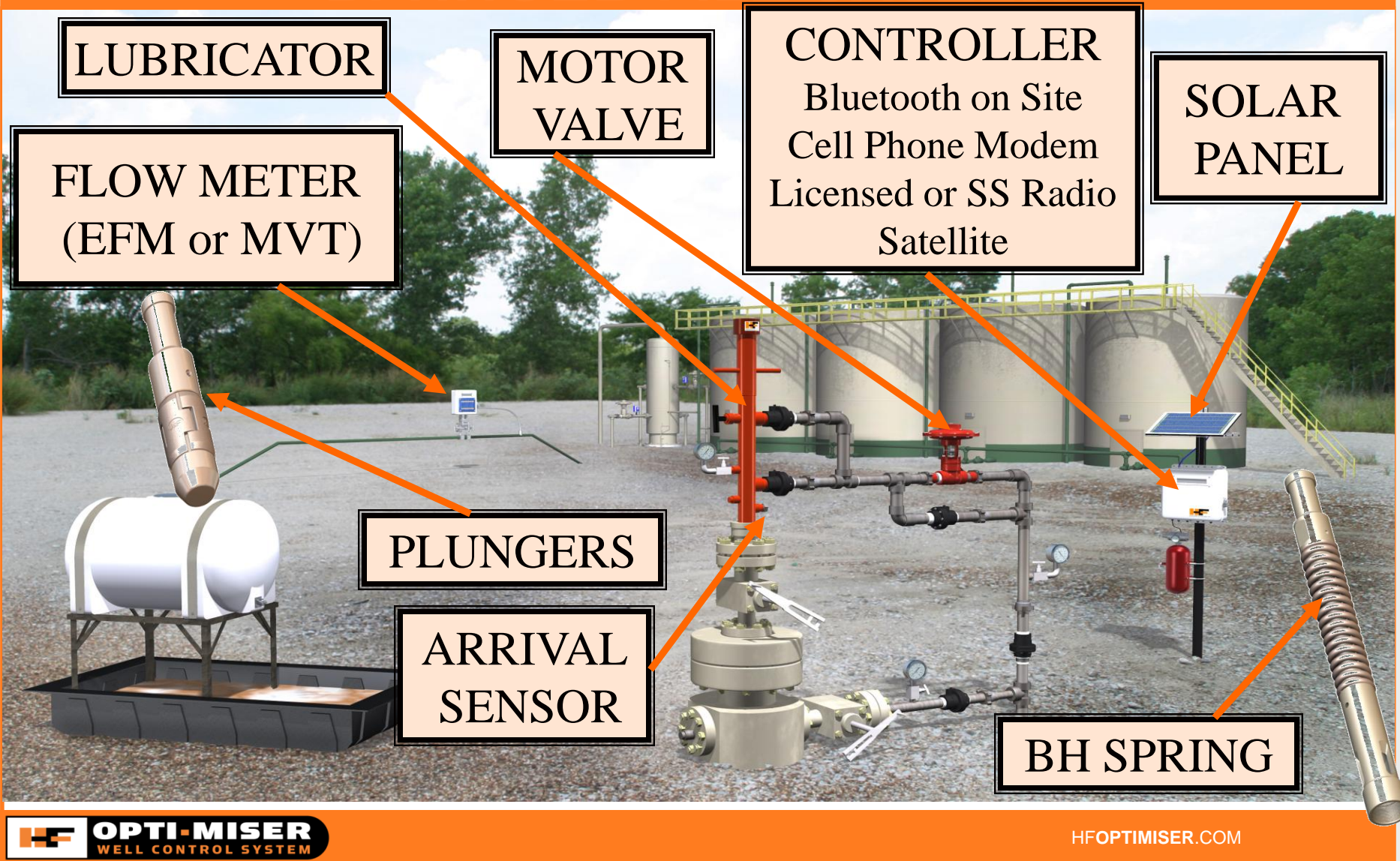
TECHNICAL WORKSHOP

MARCH 29, 2010

CONTENTS

- PLUNGER LIFT BENEFITS WITH TELEMETRY
- HOW TO OPTIMIZE PRODUCTION
- TROUBLESHOOT AND IMPROVE

PLUNGER LIFT SYSTEM



BENEFITS WITH TELEMETRY

- **Increase Production**
 - Can work on high water producing wells (200 bbls/d)
 - Lifting cost is significantly less than gas lift
 - Retards decline curve
 - Typical payback is 2 weeks to 60 days
- **Decrease unplanned downtime**
- Decrease drive time and vehicle costs
- Decrease OT and contract labor
- Decrease equipment failures

BENEFITS WITH TELEMETRY

- **Decrease lost gas due to venting**
- Detection of some EFM calibration issues
- Environmentally responsible
- **Improve site safety**

Ref:

American Gas Stars Partner Program (Oct 2003)

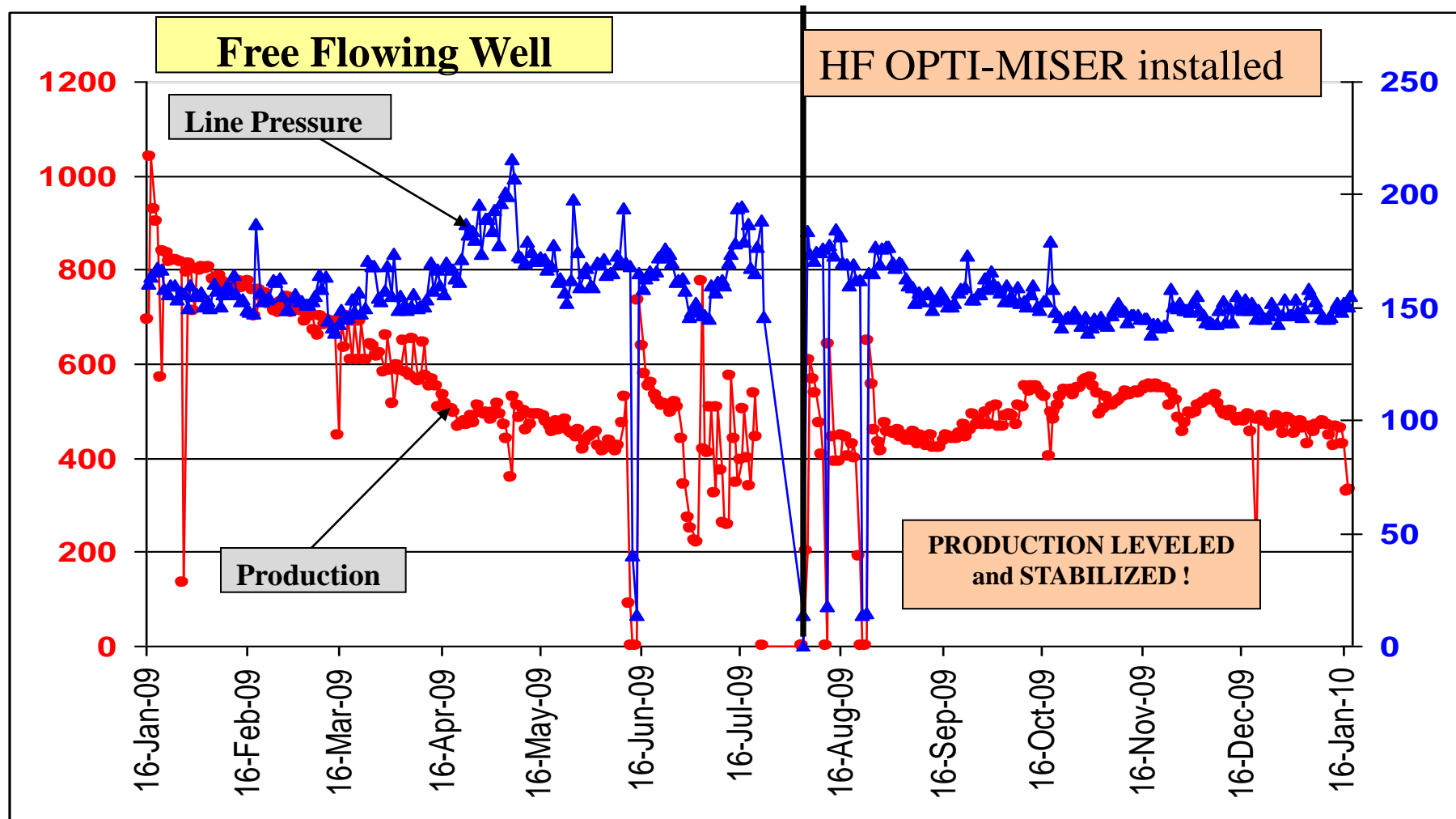
American Oil and Gas Reporter (Oct 2005)

HF Opti-MISER Case Studies (2009-2010)

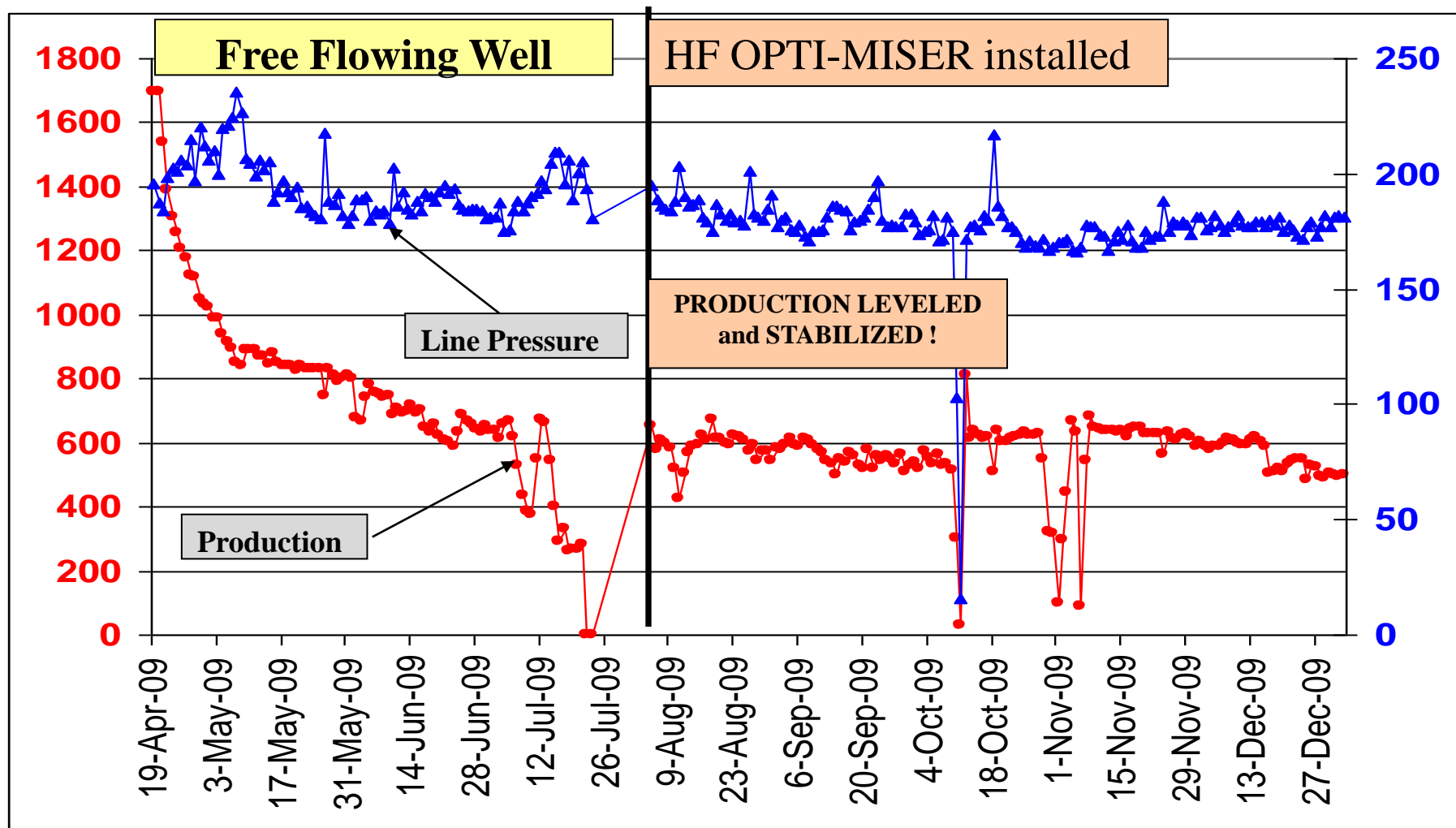
BENEFITS WITH TELEMETRY

WELL	MCF/D	BBLS/D	LINE PRESSURE	LIFT PRESSURE
Well # 1	550	204	135	500
Well # 2	550	94	180	500
Well # 3	300	61	140	720
Well # 4	550	56	60	540
Well # 5	480	54	70	400
Well # 6	600	50	180	500
Well # 7	200	35	320	540
Well # 8	477	30	140	300
Well # 9	460	27	130	300

BENEFITS WITH TELEMETRY



BENEFITS WITH TELEMETRY



HOW TO OPTIMIZE PRODUCTION

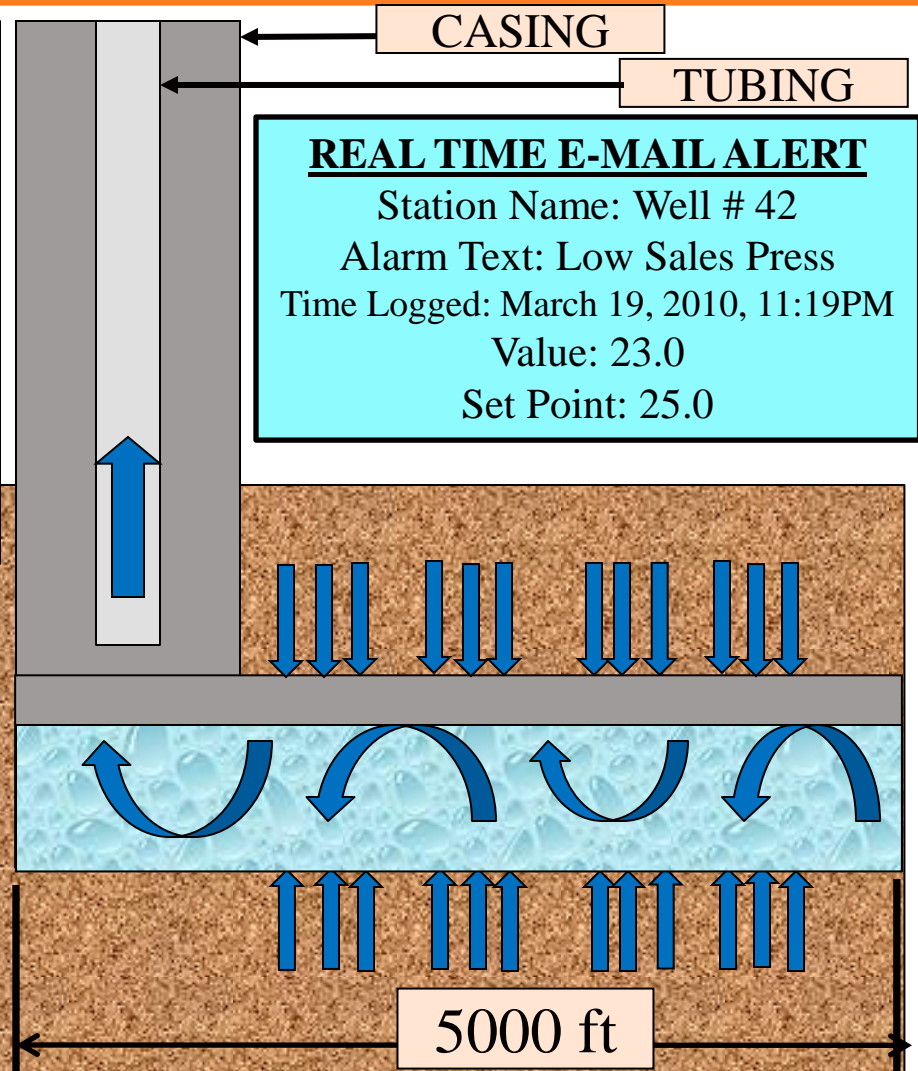
1. PREVENT or QUICKLY DETECT UNPLANNED DOWNTIME
2. ELIMINATE FLOW RESTRICTIONS
3. USE RELIABLE HARDWARE
4. USE TELEMETRY WITH CRY-OUT
5. OPERATE AT LOWEST POSSIBLE FBHP (Cycle Frequently!)
6. OPTIMIZE PRODUCTION, OBSERVE PLUNGER VELOCITY

CAUSE

1. Fluid in Tubing (CP-TP)
2. Lift Pressure (CP-LP)

EFFECT

1. Plunger Velocity
2. Production



HOW TO OPTIMIZE PRODUCTION

[Receive Page](#)
[Receive All Pages](#)
[Save Changes](#)
[Send All Changes](#)
[Cancel Changes](#)
[Normal](#)
[Print](#)
[Auto Update](#)

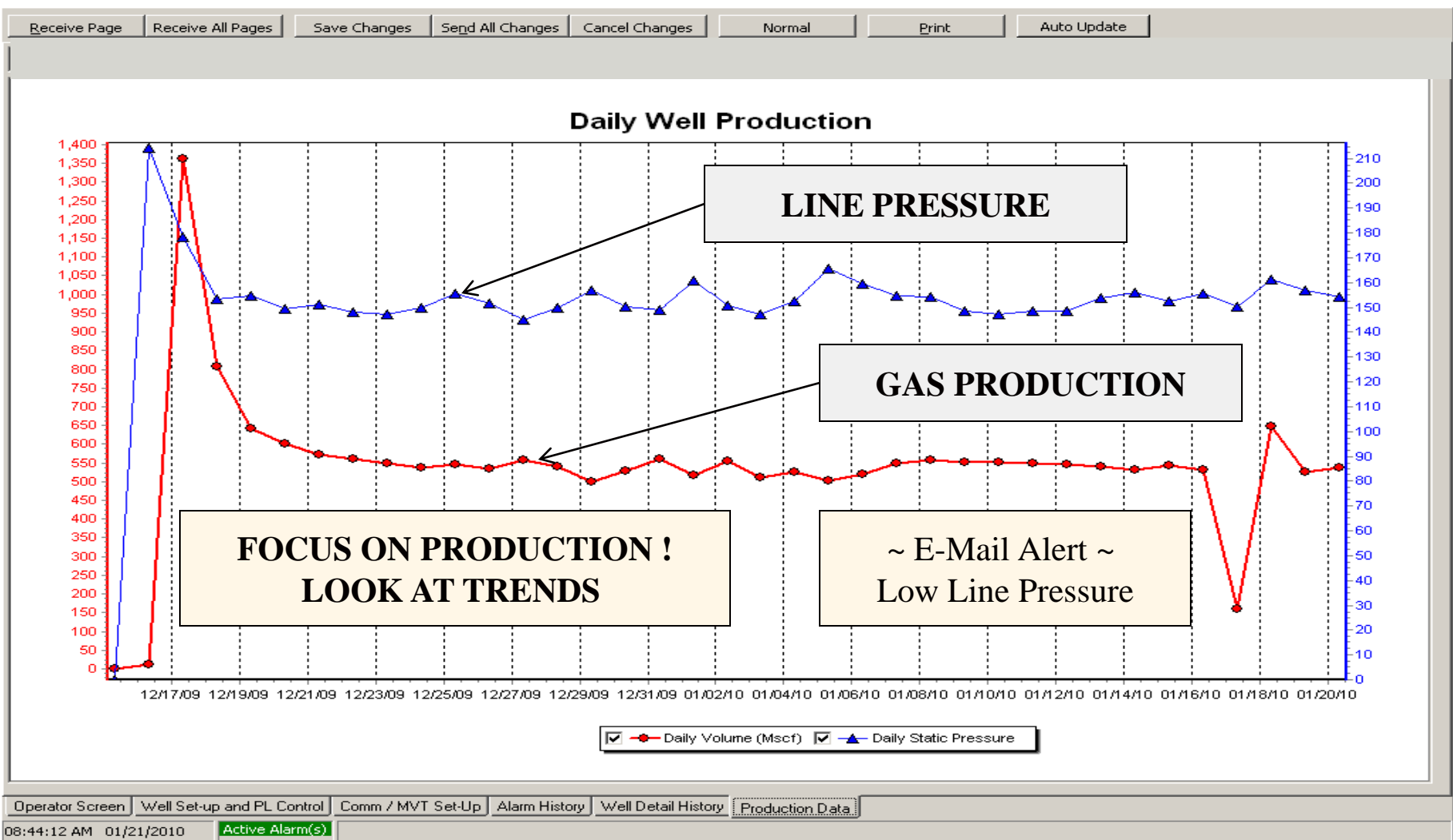
Well Name	Last Polled		Batt. Volts	State	Time Remain.	Pressures (psi)			Flow Rate	Velocity (ft/min)	Today			Yesterday			Target	
	Date	Time				Tube	Case	Sales			Gas	Arr.	Fails	Gas	Arr.	Fails	Gas	%
Well # 1	03/20/10	09:54:52	12.5	Plunger Falling	00:02:59	653	772	273	0	703	21	4	0	173	8	0	280	61.8
Well # 2	03/20/10	09:44:41	12.7	Manual Mode	00:00:00	794	797	64	0	0	0	0	0	44	7	3	600	7.4
Well # 3	03/20/10	09:43:45	12.5	Pressure Building	00:00:00	244	276	202	0	1329	30	6	0	462	12	4	600	77.1
Well # 4	03/21/10	10:19:45	12.7	Production Mode	01:25:48	290	565	281	0	561	58	3	0	351	5	0	460	82.3
Well # 5	03/20/10	09:44:09	12.7	Production Mode	01:48:36	132	284	130	506	169	66	2	0	458	4	0	650	70.5
Well # 6	03/21/10	10:16:52	12.4	Production Mode	00:59:50	200	891	148	1605	309	74	16	0	500	30	0	850	58.8
Well # 7	03/21/10	10:17:57	13.1	Manual Mode	00:00:00	58	596	1	0	0	0	0	0	0	0	0	950	0.0
Well # 8	03/21/10	10:19:40	12.8	Production Mode	01:43:23	167	672	154	0	531	83	8	0	579	16	0	775	74.8
Well # 9	03/20/10	09:49:41	12.8	Pressure Building	00:00:00	479	601	64	0	413	58	5	0	516	14	0	700	73.7
Well # 10	03/20/10	09:48:41	12.7	Pressure Building	01:07:56	608	827	152	0	189	43	3	0	246	6	0	250	98.3
Well # 11	03/21/10	10:20:23	12.9	Manual Mode	00:00:00	233	681	153	0	0	0	0	1	0	11	1	200	64.2
Well # 12	03/19/10	08:58:56	12.9	Production Mode	00:19:21	204	291	133	1250	951	30	9	0	347	22	0	440	78.9
Well # 13	03/20/10	09:52:45	12.5	Plunger Rising	01:21:09	126	364	126	499	775	49	6	0	338	17	0	400	84.4
Well # 14	03/20/10	09:56:45	12.5	Pressure Building	00:22:02	221	257	122	0	899	23	3	0	210	8	0	220	95.6
Well # 15	03/20/10	09:56:20	12.7	Production Mode	04:21:50	177	424	175	932	935	78	2	0	851	6	0	1000	85.1
Well # 16	03/20/10	09:51:51	12.7	Manual Mode	00:00:00	173	728	176	0	0	0	0	0	0	0	1	1000	0.0
Well # 17	03/18/10	18:52:08	13.1	Production Mode	09:20:57	74	178	71	555	1765	265	2	0	549	2	0	550	99.8
Well # 18	03/20/10	09:53:38	12.8	High Pressure	00:00:00	335	336	319	0	0	25	4	1	443	8	2	600	73.9
Well # 19	03/20/10	10:28:58	12.5	Plunger Falling	00:04:02	336	382	174	0	0	65	4	2	467	10	2	610	76.5
Well # 20	03/20/10	09:48:14	12.7	Production Mode	01:49:47	134	384	134	438	1186	64	4	0	479	9	0	380	126.0
Well # 21	03/20/10	09:56:42	12.7	Production Mode	00:28:10	128	256	125	625	1342	56	3	0	548	11	0	450	121.7
Well # 22	03/20/10	09:45:52	12.7	Production Mode	00:52:16	131	346	124	1057	2090	42	1	0	345	8	2	600	57.6
Well # 23	03/10/10	17:33:45	12.7	Manual Mode	00:00:00	0	0	0	0	0	0	0	0	0	0	0	0	0.0
Well # 24	03/20/10	09:53:09	12.7	Production Mode	02:02:33	124	253	121	634	1393	73	8	0	487	17	0	600	81.2
Well # 25	03/20/10	09:52:19	12.8	Plunger Falling	00:05:08	527	710	120	0	1321	33	11	0	337	17	1	0	0.0
Well # 26	03/20/10	09:47:56	12.3	Production Mode	05:26:40	125	252	121	775	2068	95	1	0	719	4	0	0	0.0
Well # 27	03/21/10	10:19:11	12.9	Production Mode	02:40:02	135	398	132	438	508	63	3	0	470	6	2	540	87.7
Well # 28	03/20/10	09:55:24	12.9	Plunger Rising	00:54:52	153	504	150	503	1065	21	6	0	173	16	0	180	96.3
Well # 29	03/19/10	09:01:09	12.8	Production Mode	01:44:49	145	222	136	1228	1019	39	5	0	442	11	0	460	96.1

[Well Summary](#)
[Production Data](#)

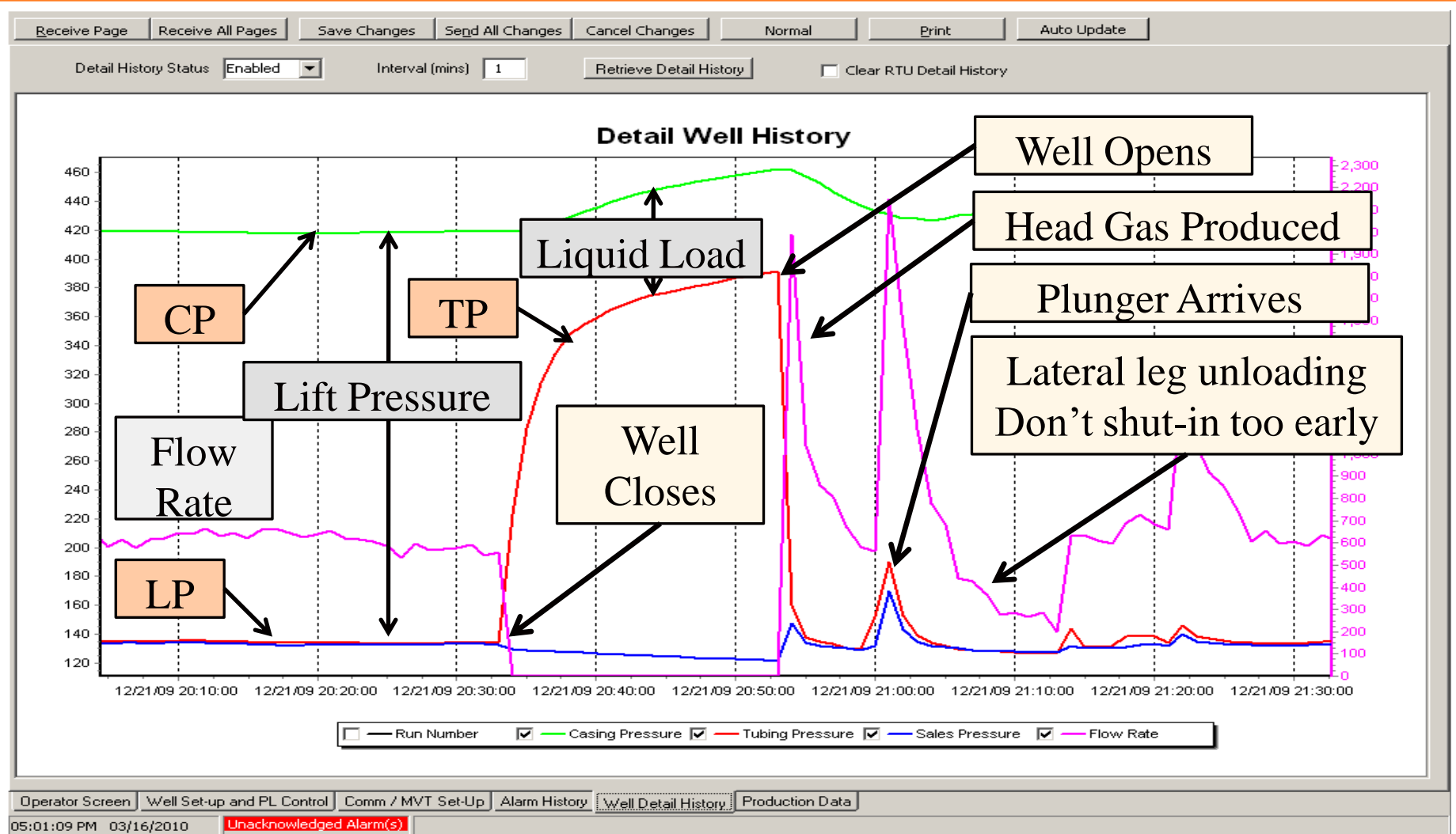
05:52:54 PM 03/21/2010

Unacknowledged Alarm(s)

HOW TO OPTIMIZE PRODUCTION



HOW TO OPTIMIZE PRODUCTION



HOW TO OPTIMIZE PRODUCTION

1. Open on Lift Pressure
 2. Be at Open Lift Pressure when plunger hits bottom
 3. Use a rapid fall plunger if pressure builds fast
 4. Allow only small amount of liquid to enter the tubing so that # 2 can be achieved
 5. Flow long enough to unload lateral line
 6. Adjust settings, review production
 7. Implement preventative maintenance program
- Plunger velocities of 200 – 300 fpm are not uncommon
 - If needed, use a standing valve

HOW TO OPTIMIZE PRODUCTION

Plunger Lift Cycle Report

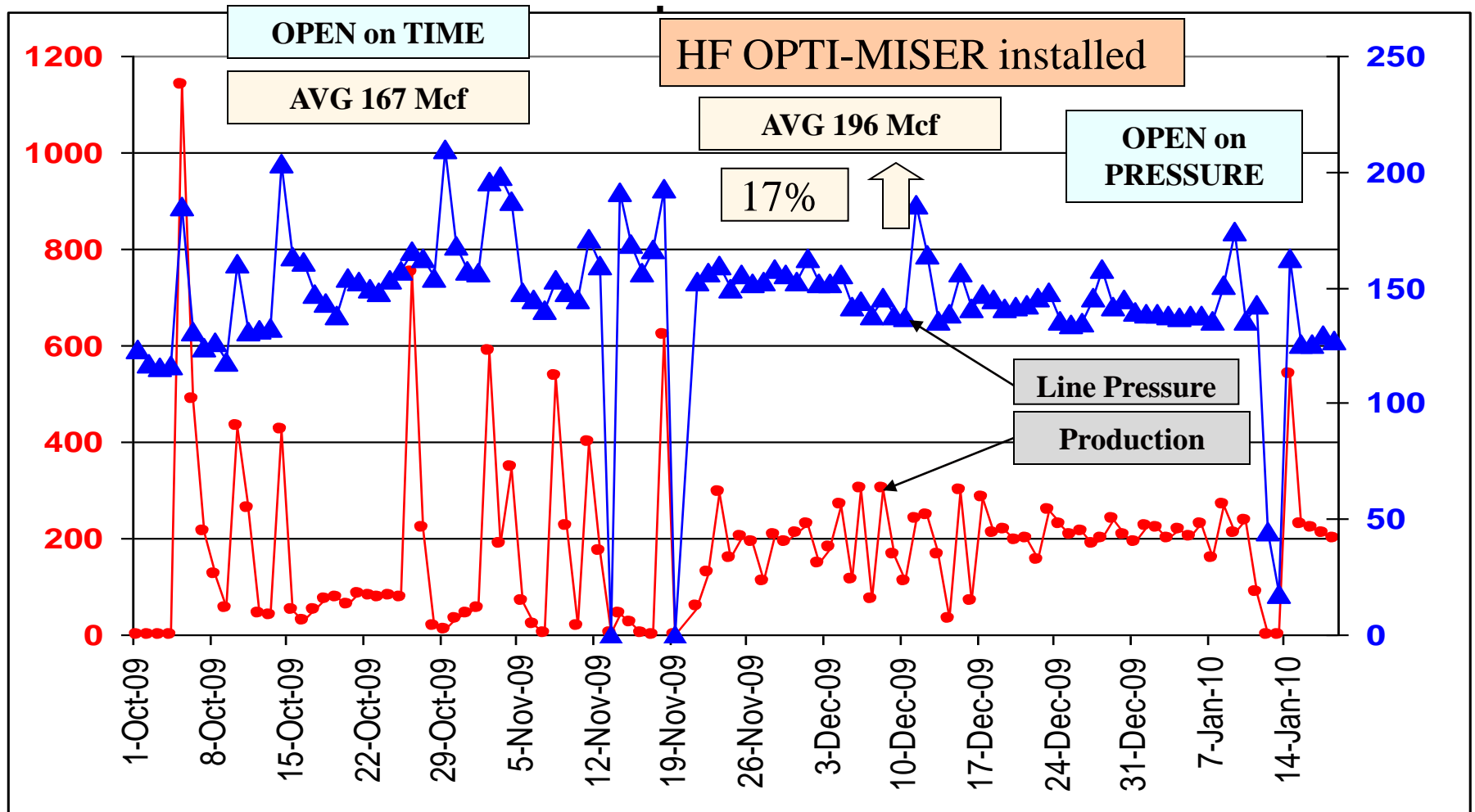
Station Name:
Report Range
Site ID:

Last Poll Time: 17-MAR-10 09:04PM
Temperature: 64°F
System Voltage: 13.1 V

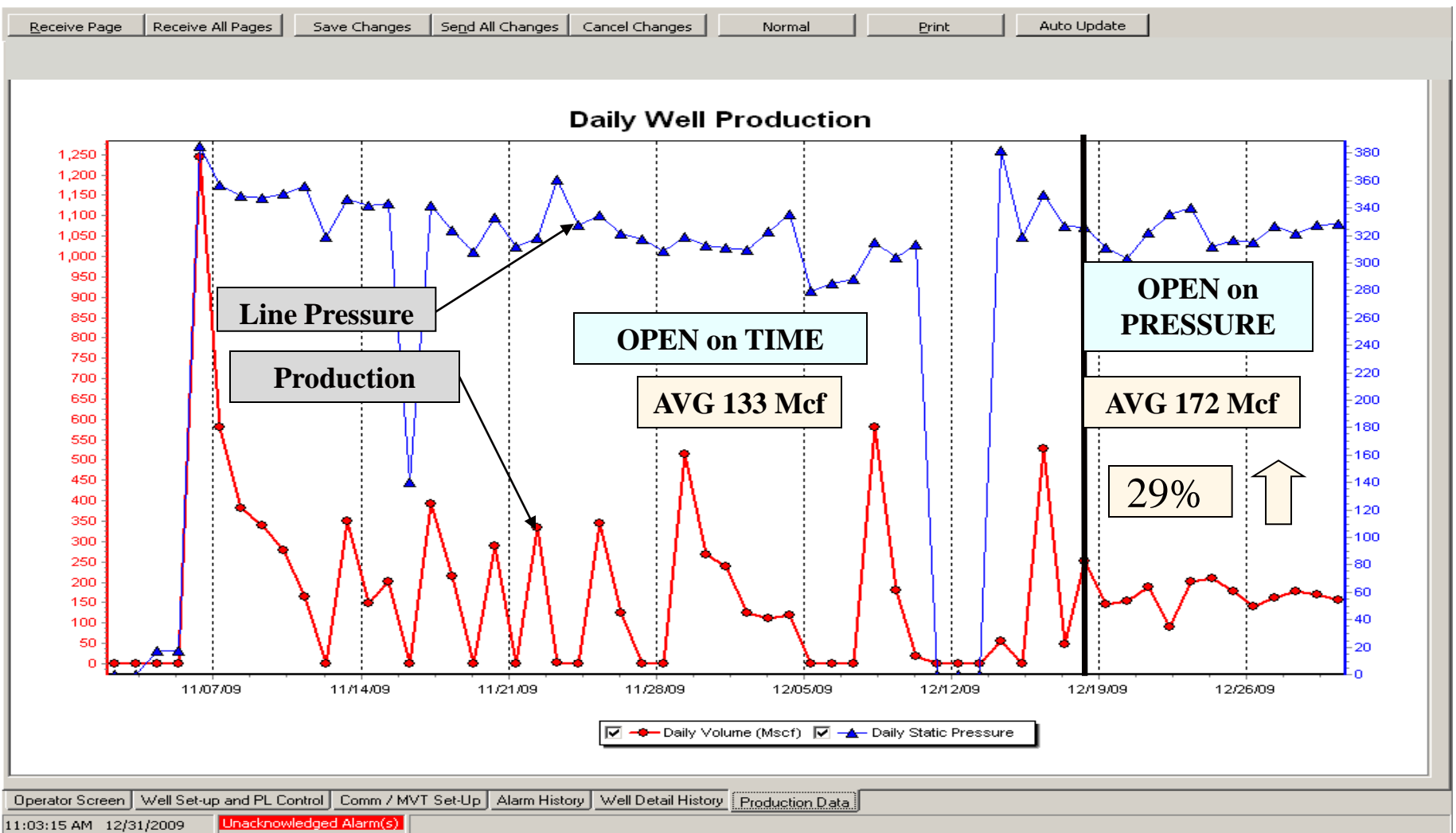


	AT CLOSE						AT OPEN						RUN DATA								PRODUCTION DATA	
		Pressures (psi)				Fluid in Tbg		Pressures (psi)				Req'd Lift	Plunger Rise		Arrivals		Open Duration	Close Duration	Gas (Mscf)	Liquid (Bbls)		
Run #	Time	CP	TP	SLP	CP-TP		Time	CP	TP	SLP	Act. Lift		Time (min)	Velocity (ft/min)	Good	Miss						
177	03/16/10 12:44AM	705	522	155	183	1.63	03/16/10 01:37AM	753	597	153	600	492	25.68	313	1		01:00	00:53	48.4	0.0		
178	03/16/10 02:38AM	691	517	160	174	1.55	03/16/10 05:21AM	777	734	177	600	483	21.58	373	1		00:56	02:42	52.7	0.0		
179	03/16/10 06:18AM	716	546	184	170	1.52	03/16/10 08:11AM	782	726	182	600	478	12.88	625	1		00:47	01:52	45.1	0.0		
180	03/16/10 08:59AM	722	565	176	157	1.40	03/16/10 10:05AM	776	662	176	600	445	10.83	743	1		00:45	01:06	44.3	0.0		
181	03/16/10 10:51AM	713	542	172	171	1.53	03/16/10 12:09PM	771	658	171	600	475	24.25	332	1		00:59	01:18	53.3	0.0		
182	03/16/10 01:09PM	703	521	168	183	1.63	03/16/10 02:06PM	756	603	156	600	492	12.55	641	1		00:47	00:57	41.9	0.0		
183	03/16/10 02:54PM	701	515	151	186	1.66	03/16/10 03:57PM	754	605	154	600	499	12.92	623	1		00:47	01:02	40.7	0.0		
184	03/16/10 04:45PM	700	511	157	189	1.69	03/16/10 05:50PM	754	606	154	600	505	13.28	606	1		00:48	01:05	41.0	0.0		
185	03/16/10 06:38PM	700	509	153	191	1.71	03/16/10 07:55PM	757	624	156	600	512	15.67	514	1		00:50	01:16	44.3	0.0		
186	03/16/10 08:46PM	700	514	156	186	1.66	03/16/10 09:57PM	757	615	157	600	501	12.63	637	1		00:47	01:11	40.8	0.0		
187	03/16/10 10:45PM	702	518	157	184	1.64	03/16/10 11:52PM	757	598	157	600	495	13.22	609	1		00:48	01:06	41.2	0.0		
188	03/17/10 12:40AM	701	507	157	194	1.73	03/17/10 01:57AM	759	620	159	600	520	13.05	617	1		00:48	01:16	40.4	0.0		
189	03/17/10 02:45AM	704	514	158	191	1.70	03/17/10 03:54AM	758	621	158	600	511	33.77	238	1		01:08	01:08	56.1	0.0		
190	03/17/10 05:03AM	694	485	158	209	1.86	03/17/10 06:36AM	757	642	158	600	550	15.57	517	1		00:50	01:33	41.9	0.0		
191	03/17/10 07:26AM	705	527	158	179	1.59	03/17/10 08:18AM	753	595	154	600	482	33.65	239	1		01:08	00:51	56.4	0.0		
192	03/17/10 09:27AM	689	481	155	209	1.86	03/17/10 11:01AM	753	629	153	600	548	14.53	554	1		00:49	01:33	40.0	0.0		
193	03/17/10 11:50AM	705	524	152	180	1.61	03/17/10 12:48PM	753	600	153	600	486	32.70	246	1		01:07	00:57	56.3	0.0		
194	03/17/10 01:56PM	690	490	157	200	1.78	03/17/10 03:48PM	757	661	157	600	531	13.20	610	1		00:48	01:52	40.3	0.0		
195	03/17/10 04:37PM	708	532	150	175	1.56	03/17/10 05:13PM	747	572	147	600	472	14.02	574	1		00:49	00:36	43.6	0.0		
196	03/17/10 06:02PM	689	501	151	188	1.68	03/17/10 07:16PM	751	602	151	600	501	13.70	588	1		00:48	01:13	41.6	0.0		

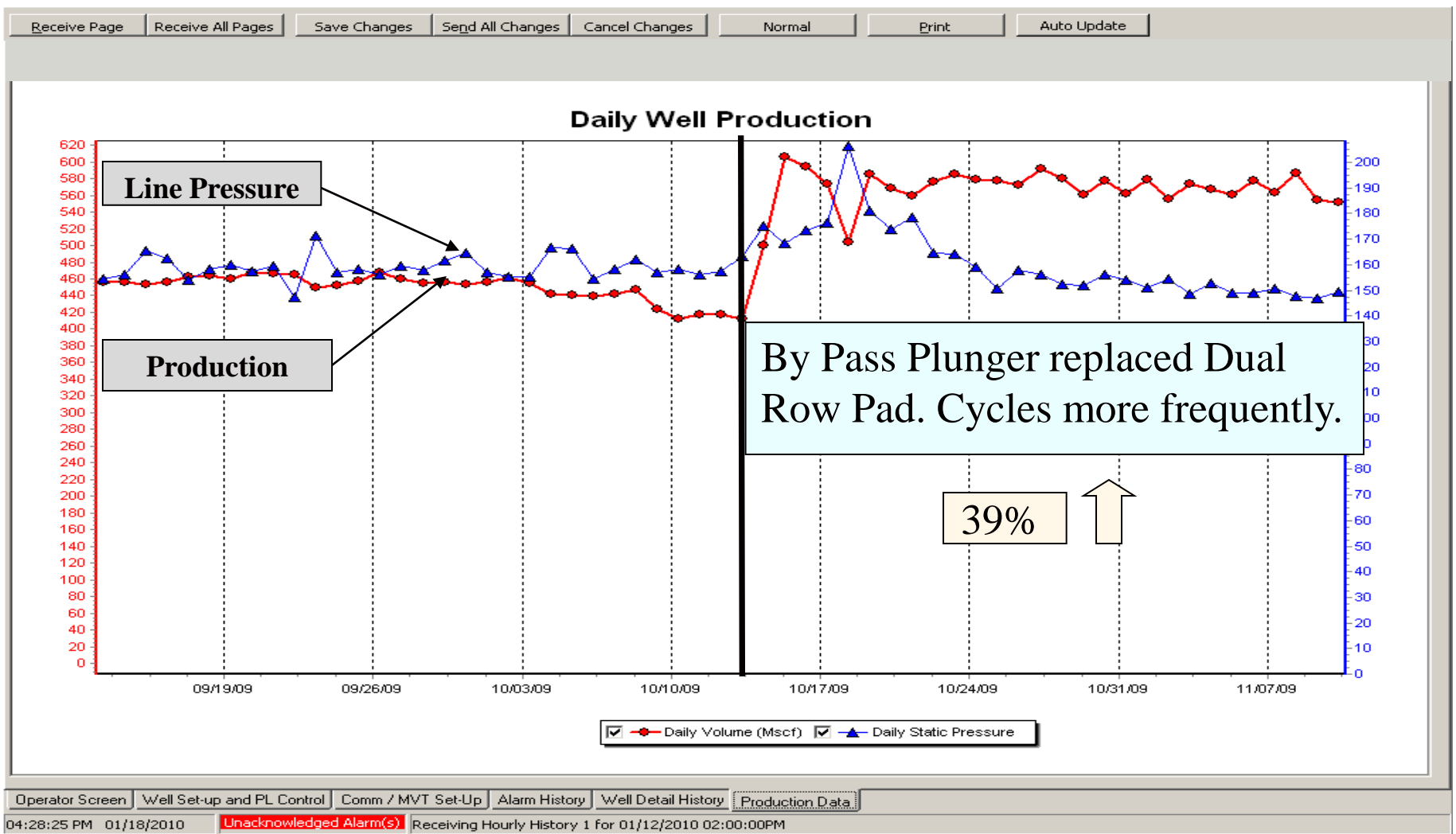
TROUBLESHOOT AND IMPROVE



TROUBLESHOOT AND IMPROVE

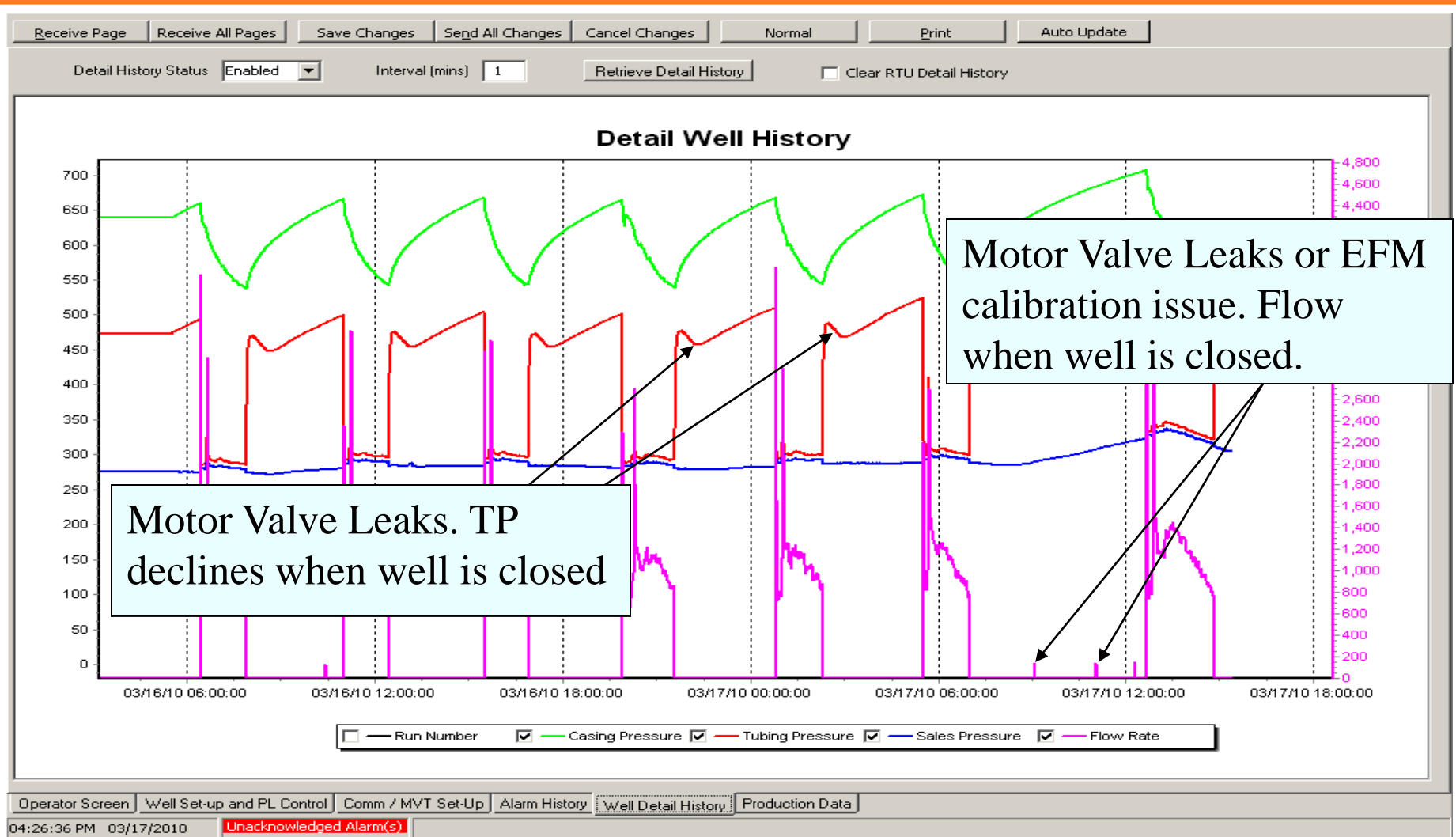


TROUBLESHOOT AND IMPROVE

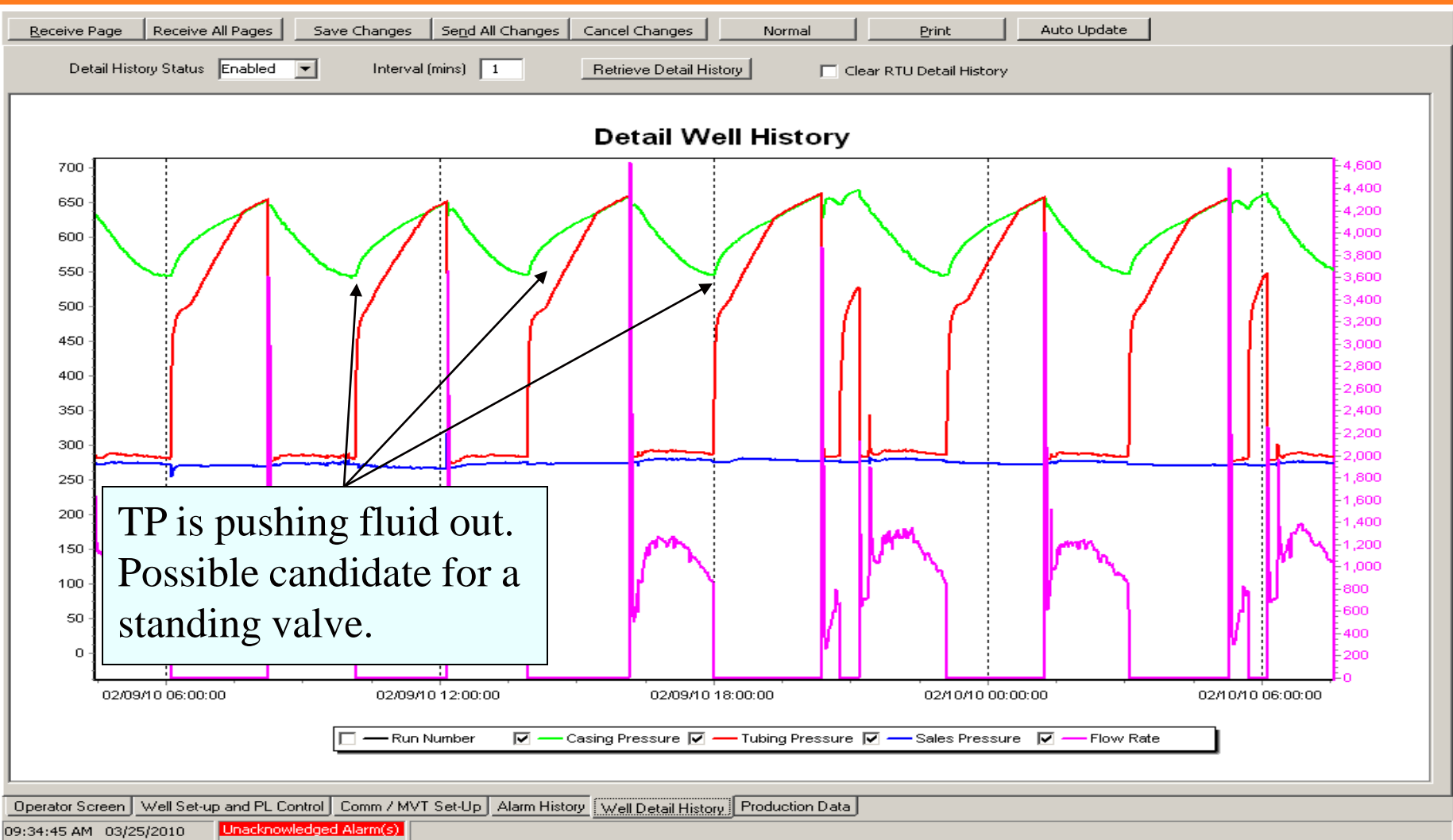


TROUBLESHOOT AND IMPROVE

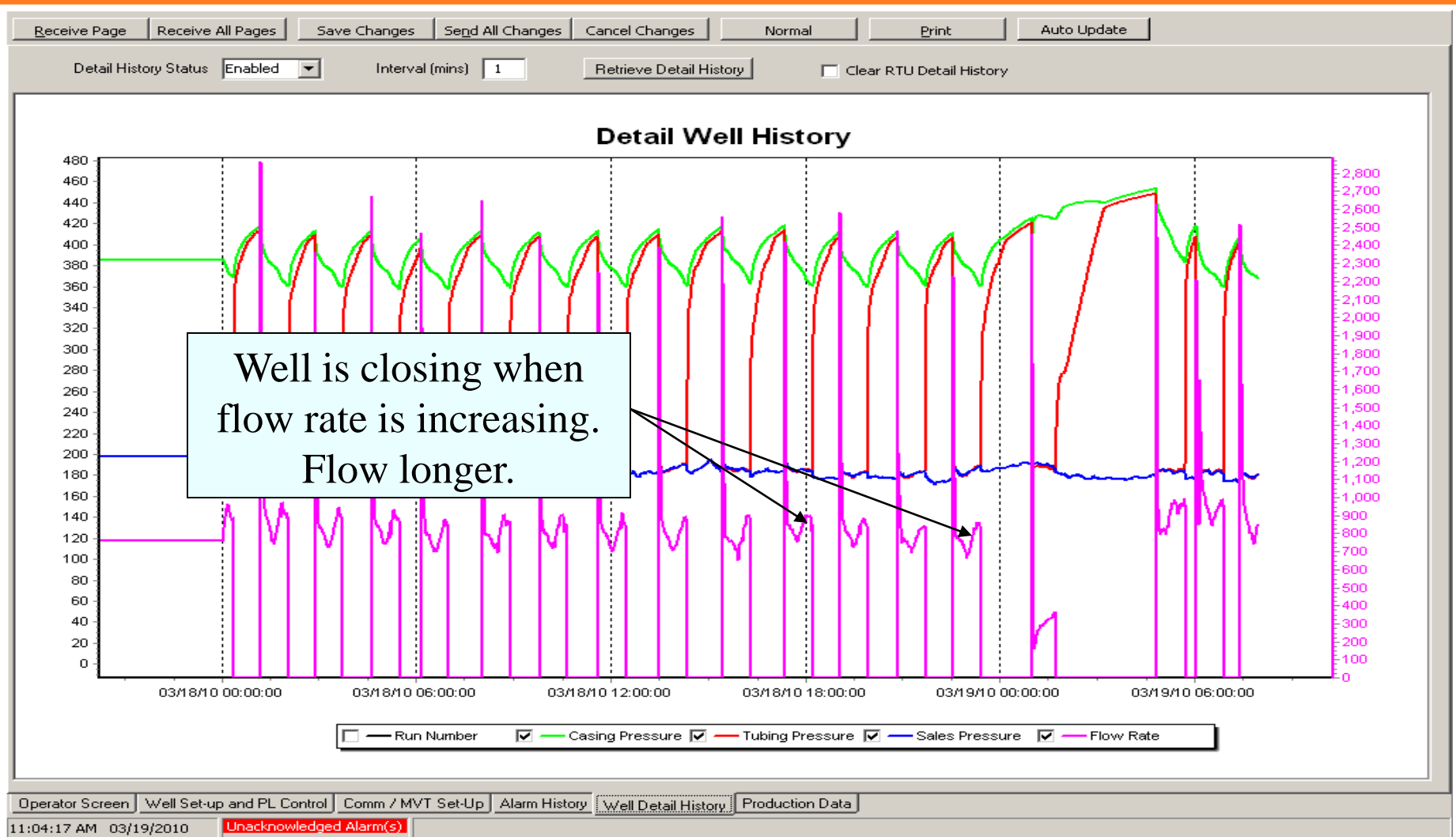
TROUBLESHOOT AND IMPROVE



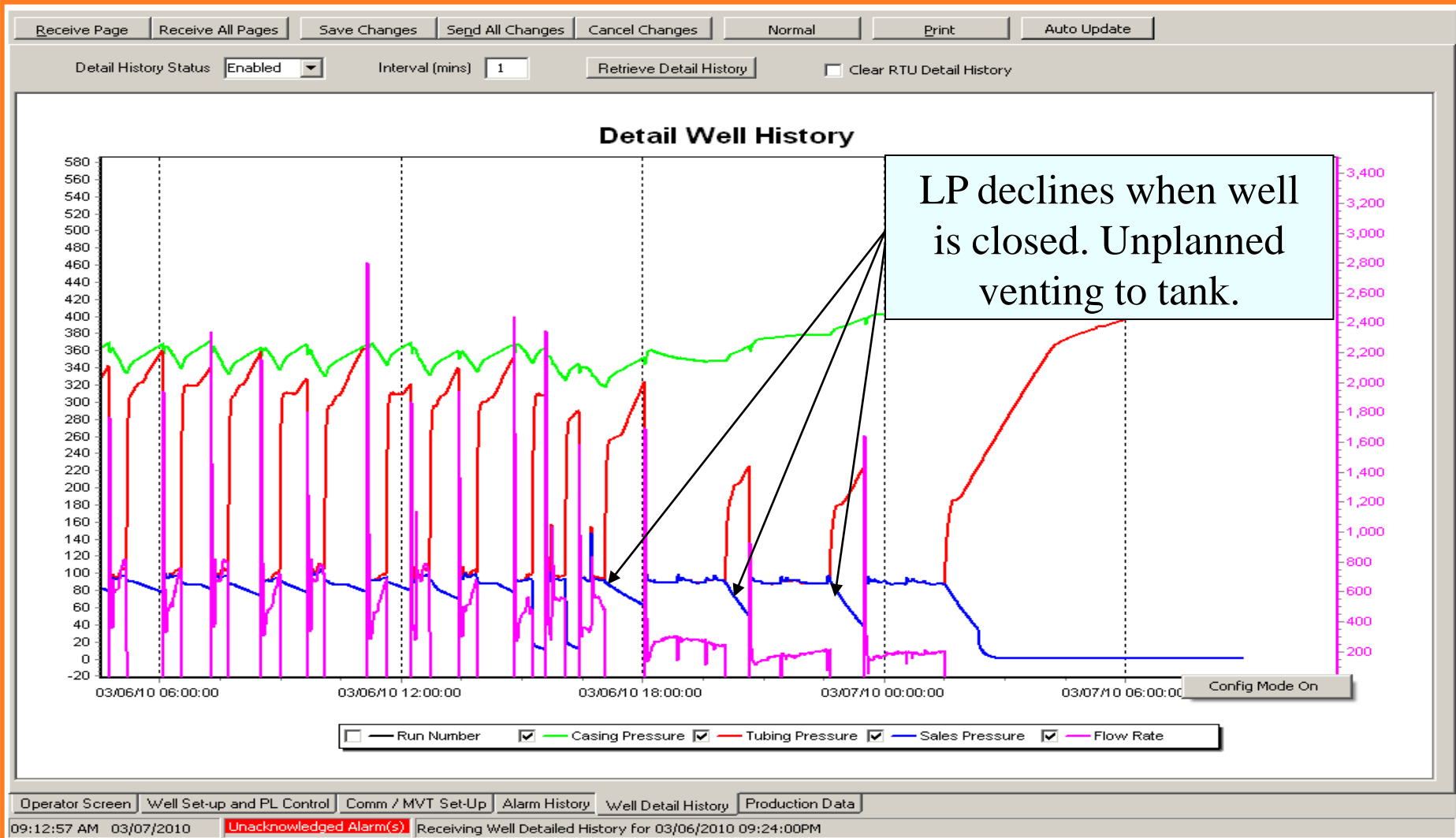
TROUBLESHOOT AND IMPROVE



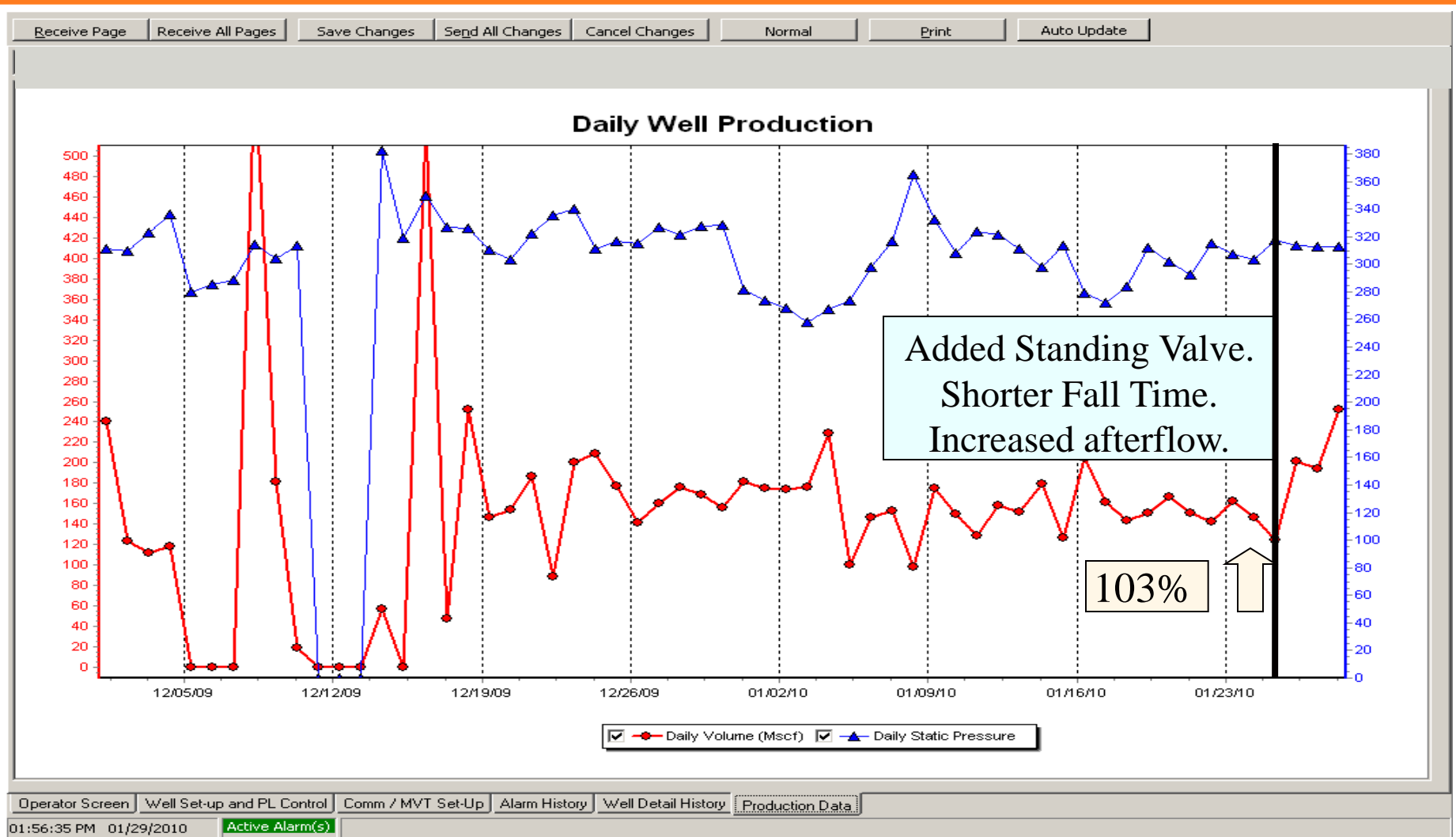
TROUBLESHOOT AND IMPROVE



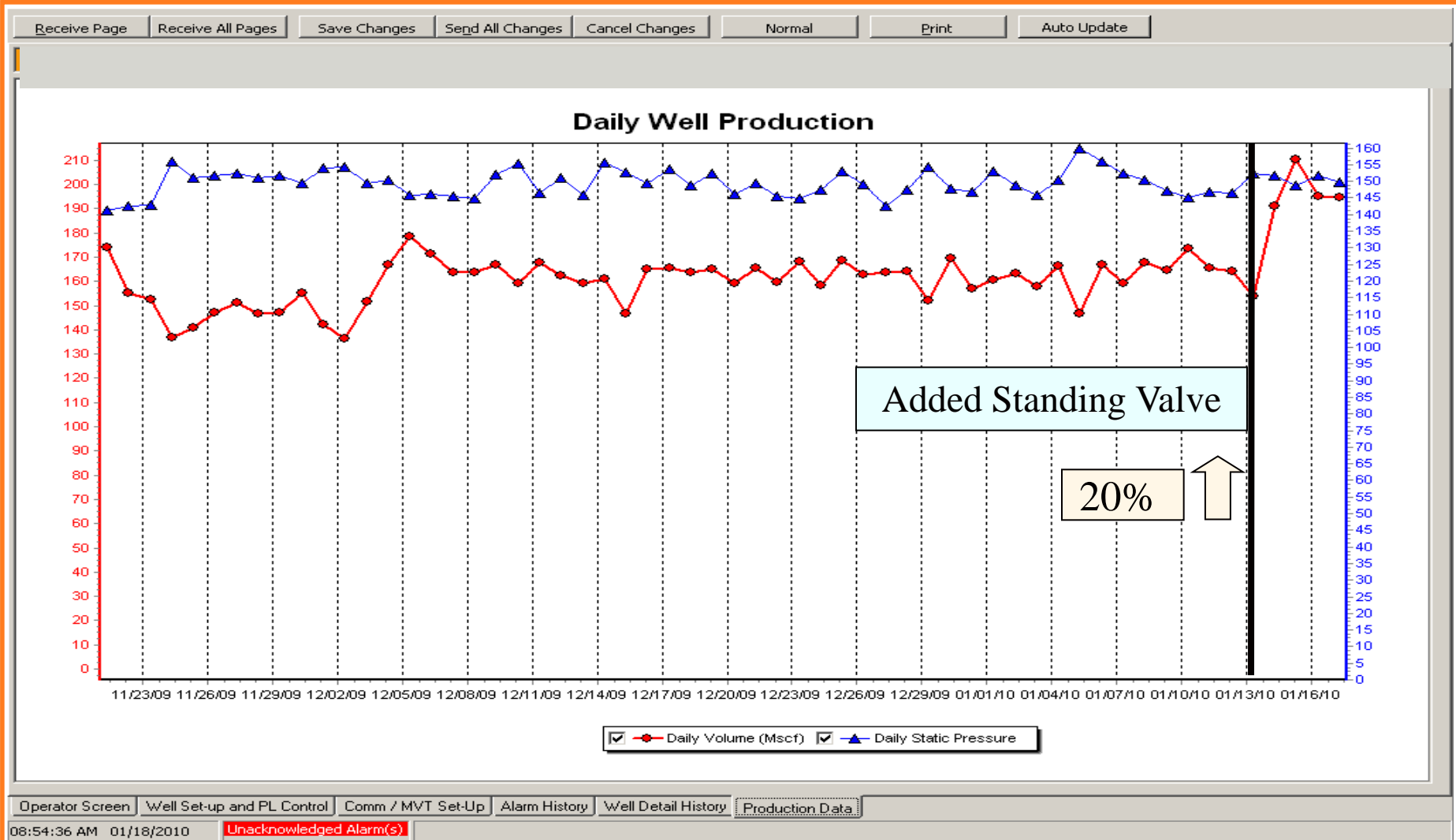
TROUBLESHOOT AND IMPROVE



TROUBLESHOOT AND IMPROVE

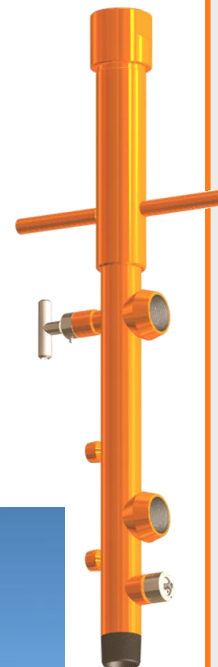
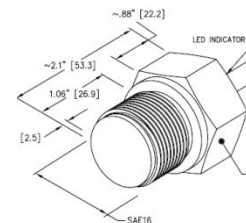


TROUBLESHOOT AND IMPROVE



HF OPTI-MISER WELL CONTROL SYSTEM

A SYSTEM THAT
ALLOWS
OPERATORS
TO INCREASE PROFITS



Group	Well #	LAST POLLED		FLOW RATE (mcf/d)					PRESSURES			ALARM STATUS	VALVE STATUS		
		Date	Time	AO	Prior 24 hr	% of AOF	COLEMAN mcf	% of Act	CSG	TBG	SALES		A Prod	B Tank	C Chem
A	Billy Bob # 2	14-May-06	10:32 AM	100	65	65%	75	115%	250	230			CLOSE	CLOSE	
A	Billy Bob # 2	14-May-06	11:15 AM	59	47	80%	65	138%	125				CLOSE	CLOSE	
A	Sally	14-May-06	2:00 PM	45	32	71%	28	88%	175				CLOSE	CLOSE	
A	H	14-May-06	8:00 AM	15	12	80%	8	67%	225				CLOSE	CLOSE	
A	H	14-May-06	9:35 PM	53	47	89%	30	64%					CLOSE	CLOSE	
A	H	14-May-06	12:52 AM	75	32	43%	25	78%	193	187	25		OPEN	CLOSE	CLOSE
B	B	14-May-06	2:00 PM	45	32	71%	28	88%	175				CLOSE	CLOSE	
B	Sn	14-May-06	8:00 AM	15	12	80%	8	67%	225				CLOSE	CLOSE	
B	Henry	14-May-06	9:35 PM	53	47	89%	30	64%	90	95			CLOSE	CLOSE	
B	Rainbow 6	14-May-06	12:52 AM	75	32	43%	25	78%	193	187	25		OPEN	CLOSE	CLOSE
B	Willow Root 4	14-May-06	10:32 AM	100	65	65%	75	115%	250	230	45		OPEN	CLOSE	CLOSE
C	GPS 40:56:75	14-May-06	11:15 AM	59	47	80%	65	138%	125	110	35		OPEN	CLOSE	CLOSE
C	Con	14-May-06	2:00 PM	45	32	71%	28	88%	175	185			CLOSE	CLOSE	
C	C	14-May-06	8:00 AM	15	12	80%	8	67%	225	205			CLOSE	CLOSE	
C	C	14-May-06	10:32 AM	100	65	65%	75	115%	193	187			CLOSE	CLOSE	
D	D	14-May-06	11:15 AM	59	47	80%	65	138%	125	110			CLOSE	CLOSE	
D	D	14-May-06	2:00 PM	45	32	71%	28	88%	175	185			CLOSE	CLOSE	
D	D	14-May-06	8:00 AM	15	12	80%	8	67%	225	205			CLOSE	CLOSE	
D	BP 05-B1476	14-May-06	9:35 PM	53	47	89%	30	64%	90	95			OPEN	CLOSE	CLOSE
D	BP 06-A1348	14-May-06	12:52 AM	75	32	43%	25	78%	193	187	25		OPEN	CLOSE	CLOSE

DATA

ACTIONABLE
INFORMATION

Phone
Book

Available
Tee Times

ADENDUM

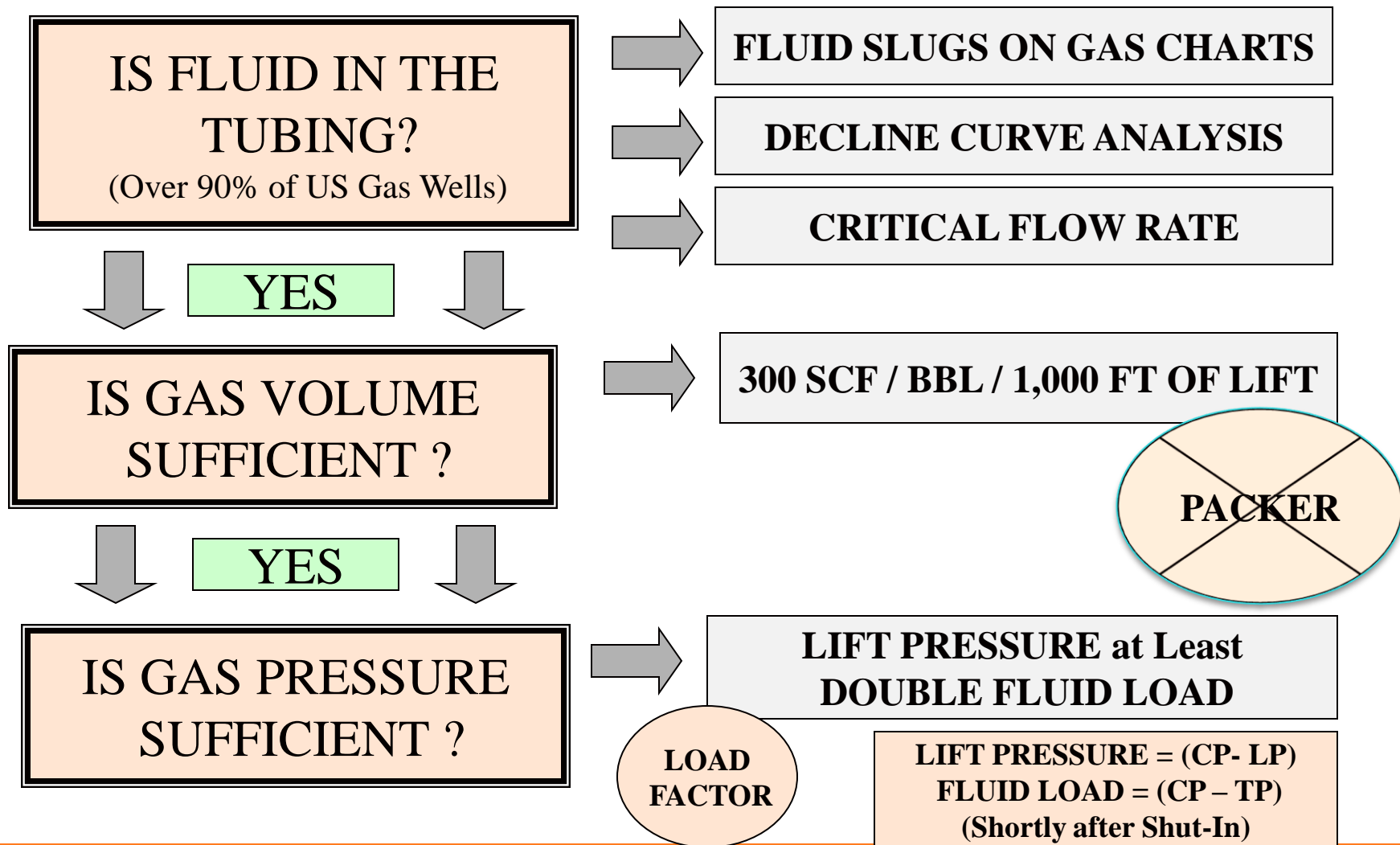
WELL REQUIREMENTS FOR PLUNGER LIFT

FLUID VOLUME VS FLUID HEIGHT IN TUBING

FLUID VOLUME VS TUBING DIAMETER

CASING PRESSURE REQUIRED (FOSS AND GAUL)

WELL REQUIREMENTS FOR PLUNGER LIFT



FLUID VOLUME vs FLUID HEIGHT

- Fluid Volume in Tubing (Barrels)
 - $FV = 0.002242 \times (CP-TP) \times (ID^2)/SG$
 - CP=Casing Pressure; TP=Tubing Pressure
 - ID=Tubing Inner Diameter (inches)
 - SG = Specific Gravity = 1.0 for Water
- Fluid Height in Tubing (Feet)
 - $FH = (CP-TP) / (0.433 \text{ psi/ft} \times SG)$
 - 0.433 psi/ft = Pressure gradient of water
 - SG = Specific Gravity = 1.0 for Water
 - If 20% of the fluid column is liquid, then divide the above results by 20% to get the actual height of the fluid column

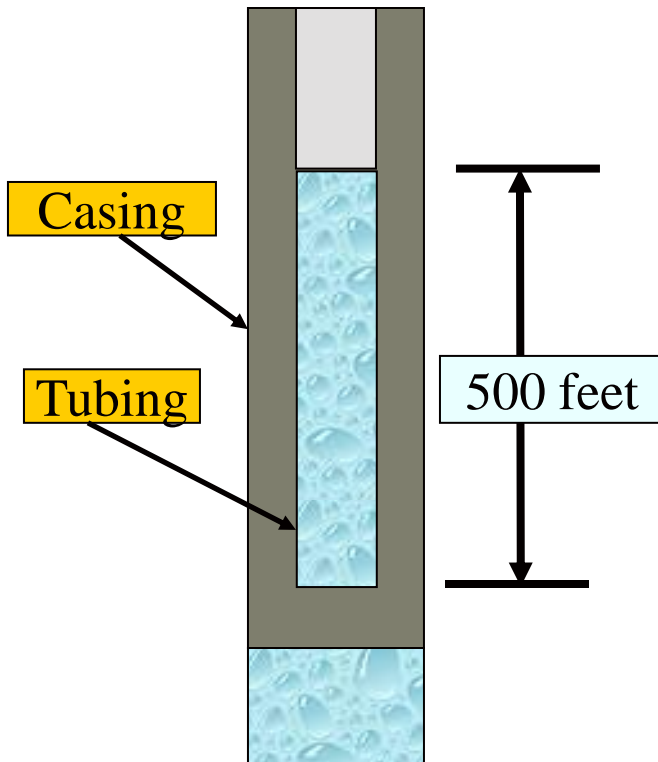
FLUID VOLUME vs TUBING SIZE

BACKPRESSURE

$$FH = (CP-TP) / (0.433 \text{ PSI/FT} \times SG)$$

$$500 \text{ FEET} = (CP-TP) / (0.433 \text{ PSI/FT})$$

$$(CP-TP) = 216.5 \text{ PSI}$$



FLUID VOLUME vs TUBING SIZE

1.90", 3.73 lb/ft Tubing (1.500" ID)

$$FV = 0.002242 \times (CP-TP) \times (ID^2) / SG$$

$$FV = 0.002242 \times (216.5 \text{ psi}) \times 1.50^2$$

$$FV = 1.09 \text{ Bbls}$$

2 3/8", 4.70 lb/ft Tubing (1.995" ID)

$$FV = 0.002242 \times (CP-TP) \times (ID^2) / SG$$

$$FV = 0.002242 \times (216.5 \text{ psi}) \times 1.995^2$$

$$FV = 1.93 \text{ Bbls}$$

2 7/8", 6.50 lb/ft Tubing (2.441" ID)

$$FV = 0.002242 \times (CP-TP) \times (ID^2) / SG$$

$$FV = 0.002242 \times (216.5 \text{ psi}) \times 2.441^2$$

$$FV = 2.89 \text{ Bbls}$$

FLUID VOLUME vs TUBING SIZE

- Foss and Gaul (CP Required to Lift Plunger)
 - $CP_{req'd} = CP_{min} \times \{(A_{ann} + A_{tbg}) / A_{ann}\}$
 - $CP_{min} = \{SLP + P_p + P_c FV\} \times \{1 + D/K\}$
- CP = Casing Pressure; SLP = Sales Line Pressure
- A_{ann} = Area Annulus; A_{tbg} = Area Tubing
- P_p = Pressure required to lift just the plunger
- P_c = Pressure Required to lift 1 bbl of fluid and overcome friction
- FV = Fluid Volume above the Plunger
- K = Constant accounting for gas friction below the plunger
- D = Depth of the Plunger

Tubing	K	Pc
2 3/8	33,500	165
2 7/8	45,000	102
3	57,600	67