2013 Dry Scrubber Users Association

Scrubber Optimization Project Principles, Actions and Results

Logan Generating Plant

Swedesboro, NJ

John Kersch, PE
Maintenance Manager

LOGAN GENERATING PLANT

Plant Overview

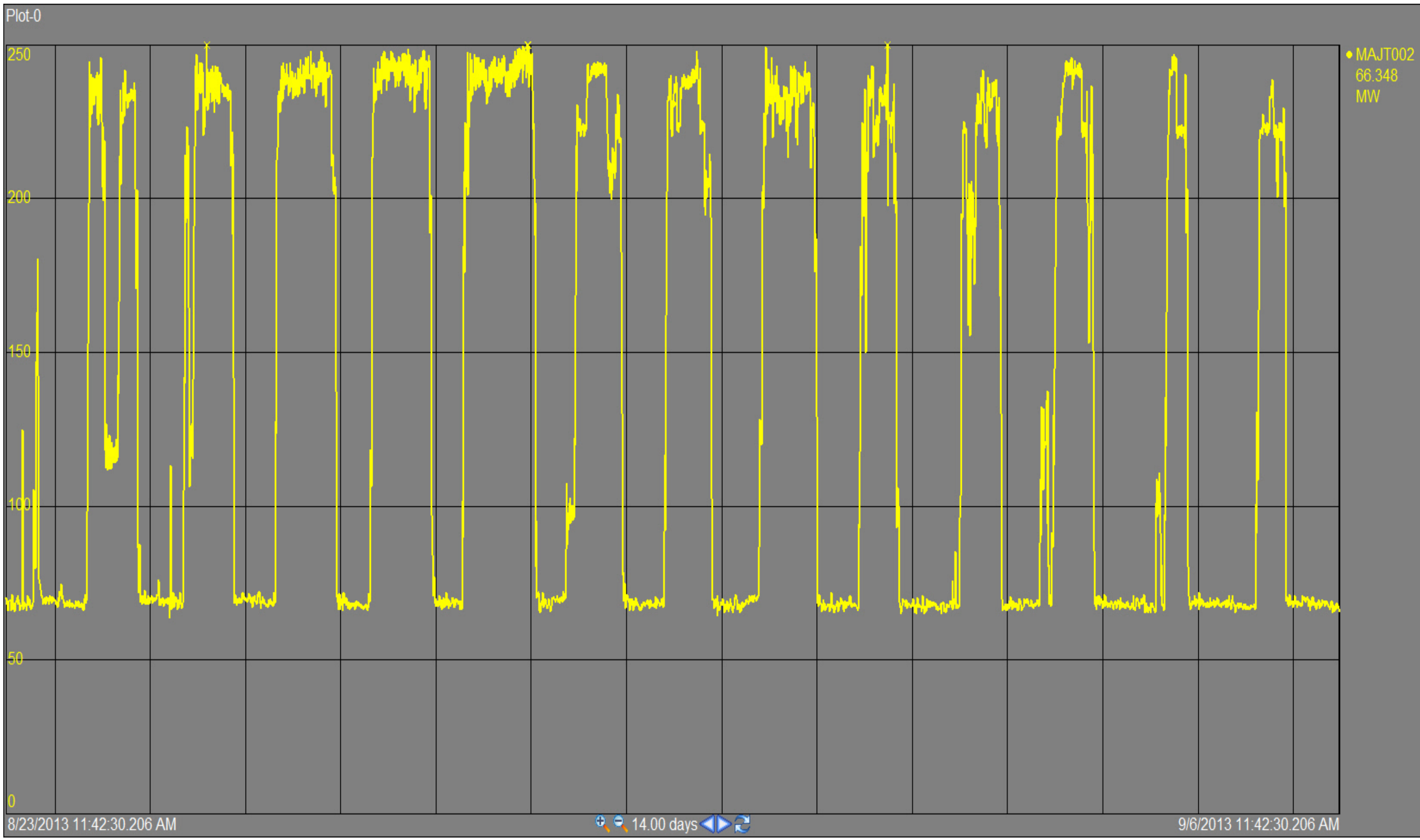
Plant Overview

- Commercial Operation – September 1994
- 245 MW Westinghouse Turbine
- Foster Wheeler Boiler burning Pulverized Coal
- ABB supplied scrubber, extensively modified by owner since startup
- Original design <1.5% sulfur, present operation at 2.0% with successful tests at 2.5%
- Permitted SO2 emission: 3 hour avg. = 75 ppm, 30 day average = 61 ppm.

LOGAN GENERATING PLANT

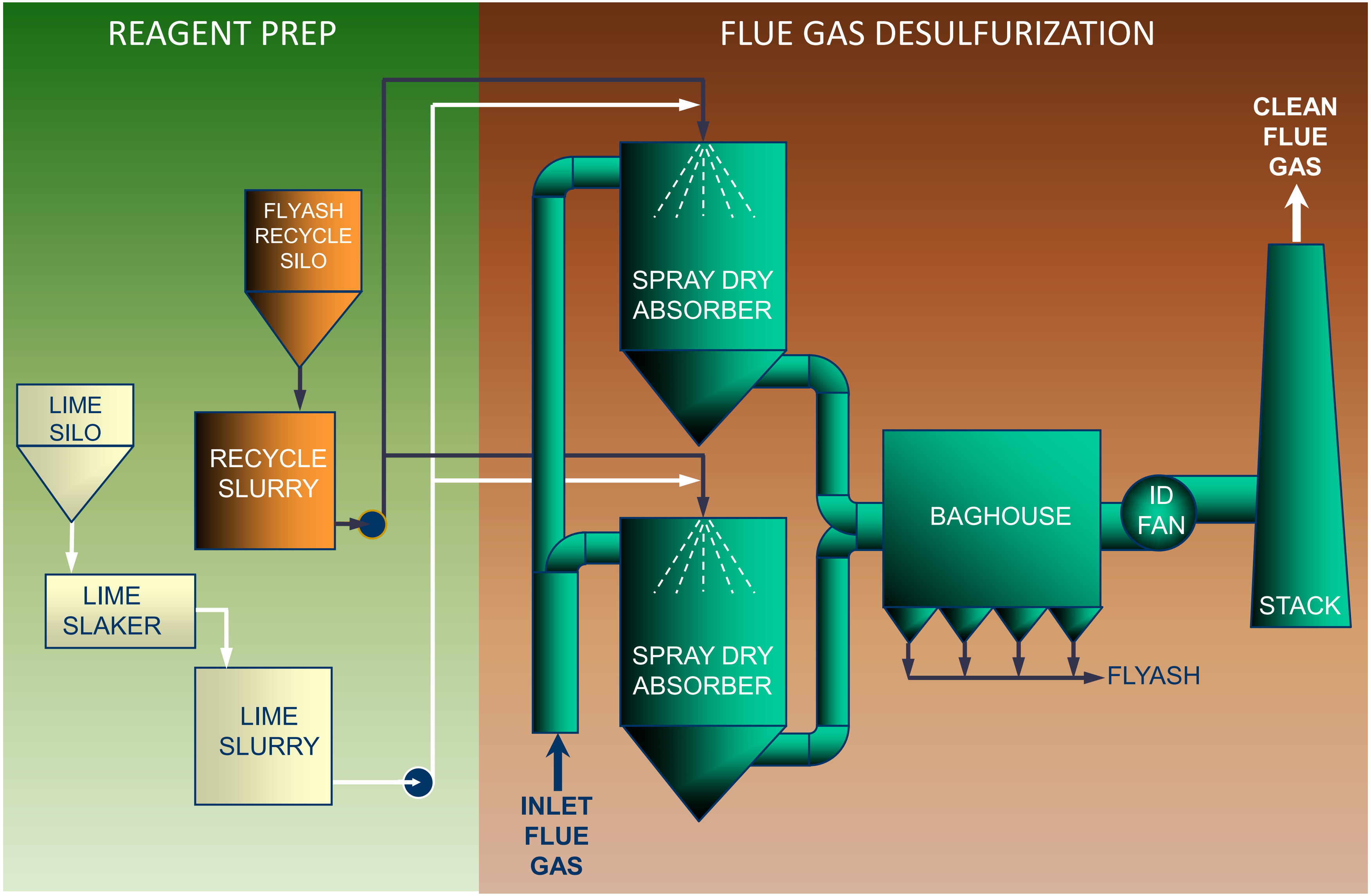
Plant Overview

Current operation is mostly up/down on load with frequent transient conditions



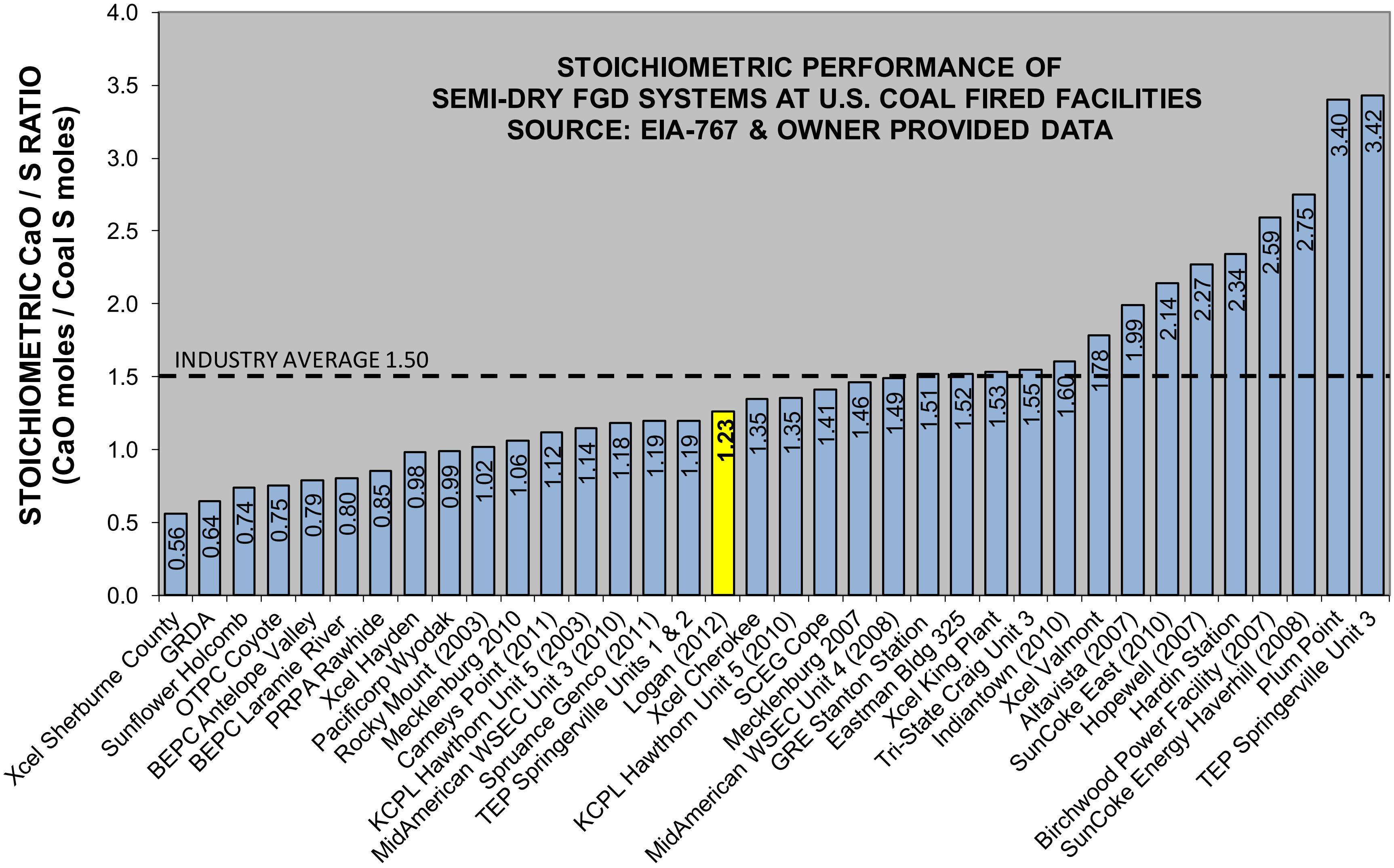
LOGAN GENERATING PLANT

Plant Overview



Plant Overview

- Calcium to Sulfur Ratio in 2012 was 1.23, better than average for dry scrubbers…



Joint Venture Optimization

Joint Venture Optimization (JVO) Project

Agreement signed April, 2012

Purpose: Optimize Scrubber Performance

Goals:

- Reduce Ca/S Ratio from 1.23 to 1.00
- Reduce combined expenditure for lime supply and flyash disposal by $ 1.00 / ton of coal, approximately equal to $0.50 / MW-hr
- At 50% capacity factor, projected operating cost savings = $400,000 per year

Joint Venture Optimization
Principles

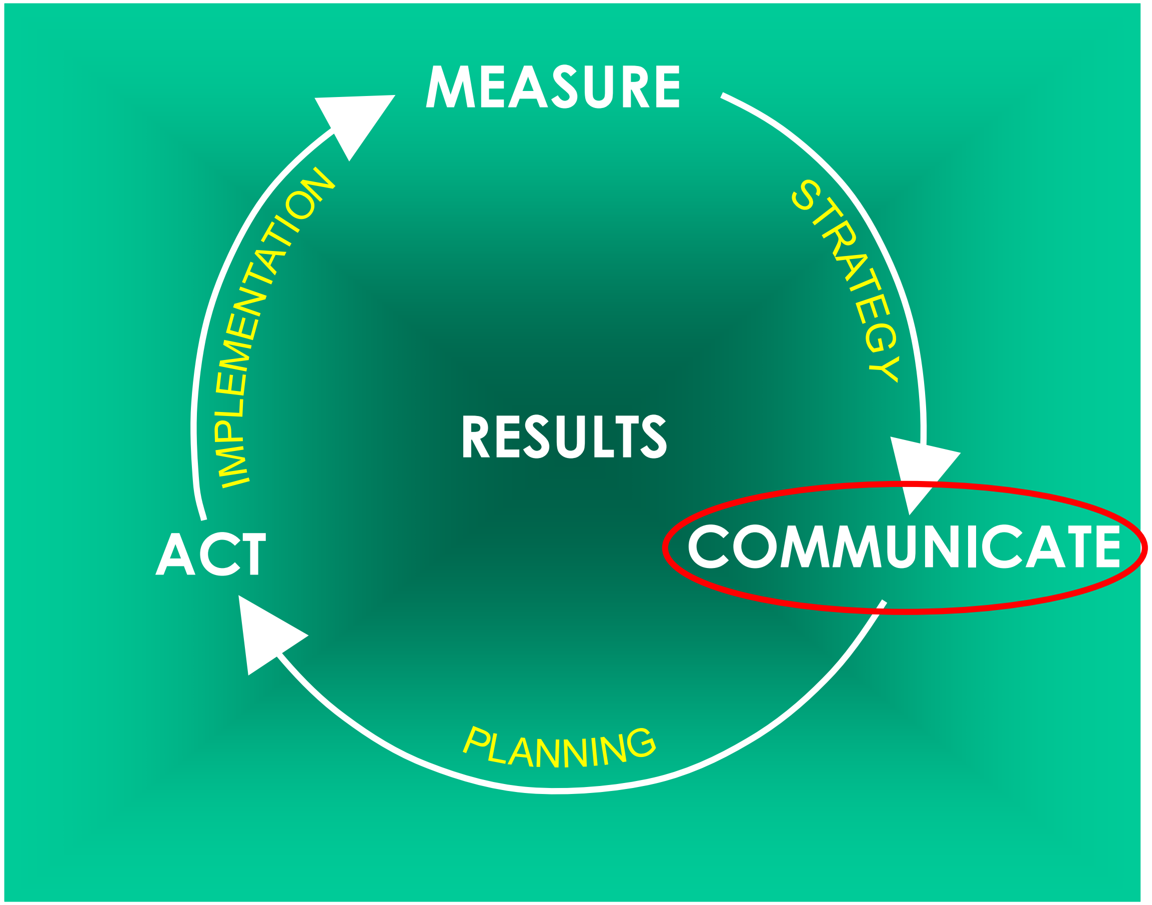
Both Parties Bring Value to the Table

NAES/PPMS		PRIMEX
The Opportunity	$$	Opportunity Identification
O & M Capability		Proprietary Technology
Inside Knowledge		Outside Knowledge
Planning/Engineering		Planning/Engineering
Capital		Capital

LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

1. **FGD Performance Optimization Training**
   Goal: Discuss goals, plan and expected results with all Ops personnel. Completed May 2012

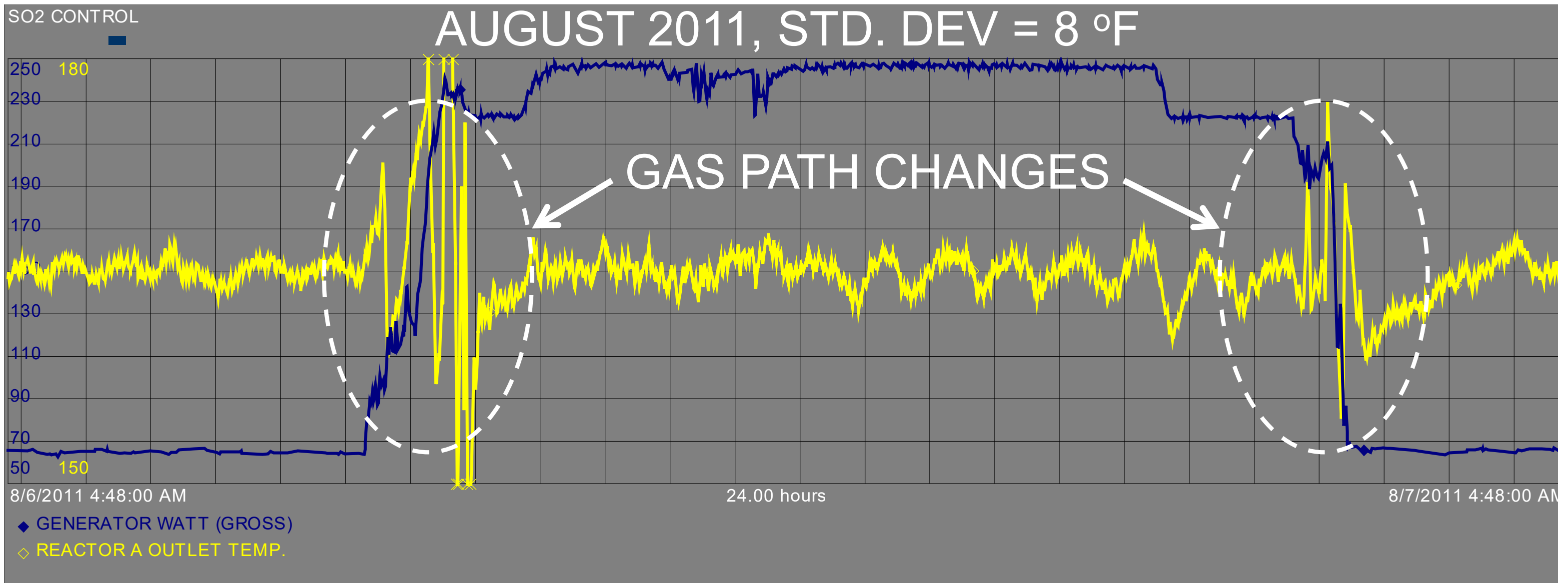


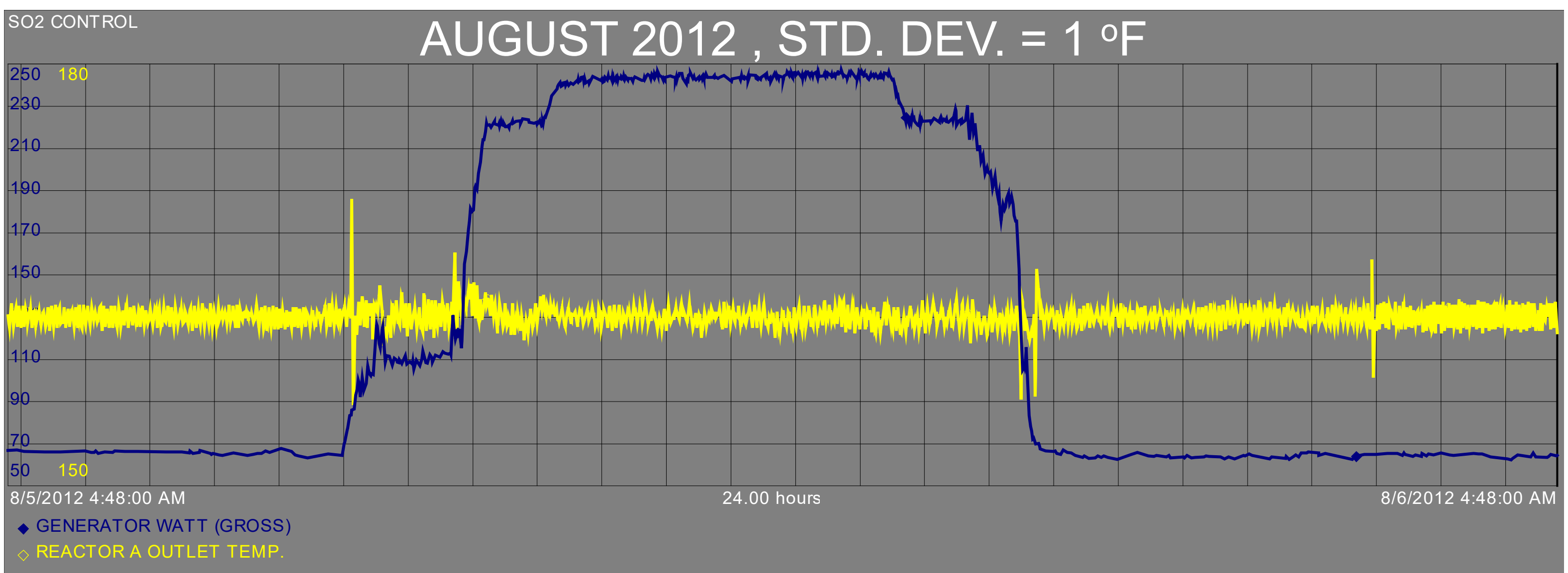
LOGAN GENERATING PLANT

Joint Venture Optimization

Actions & Results

2. Improve SDA Outlet Temperature Stability



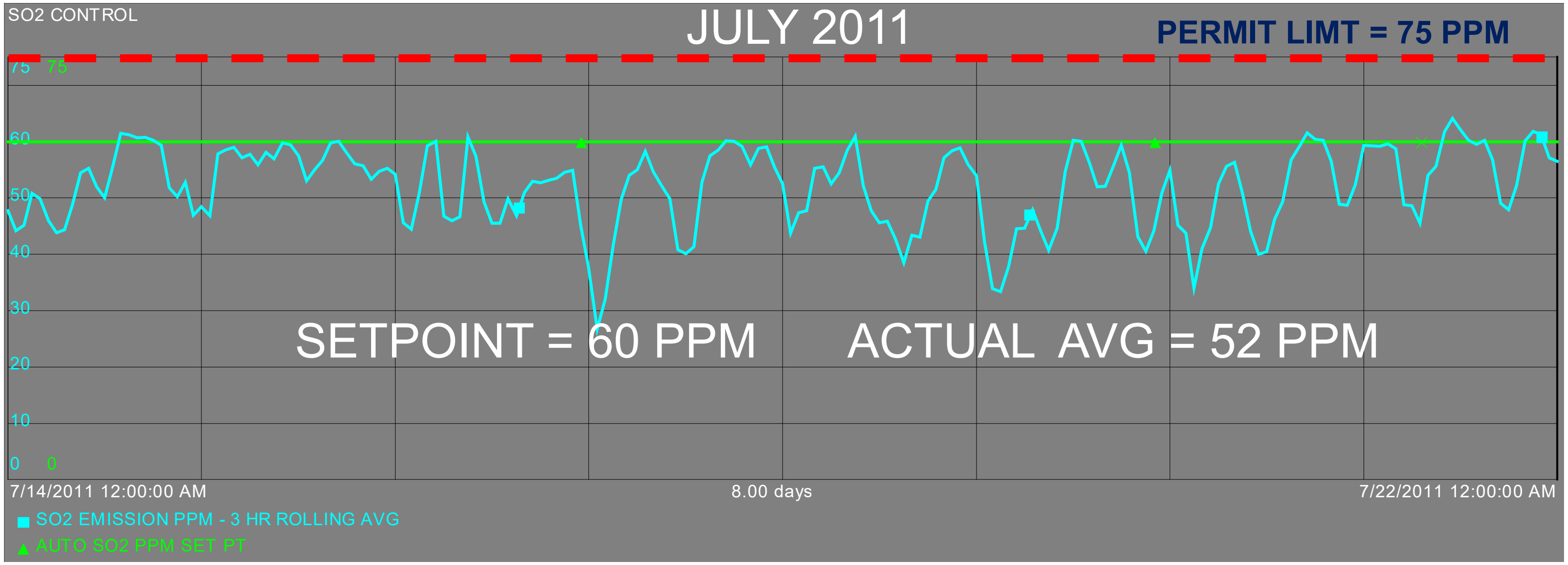


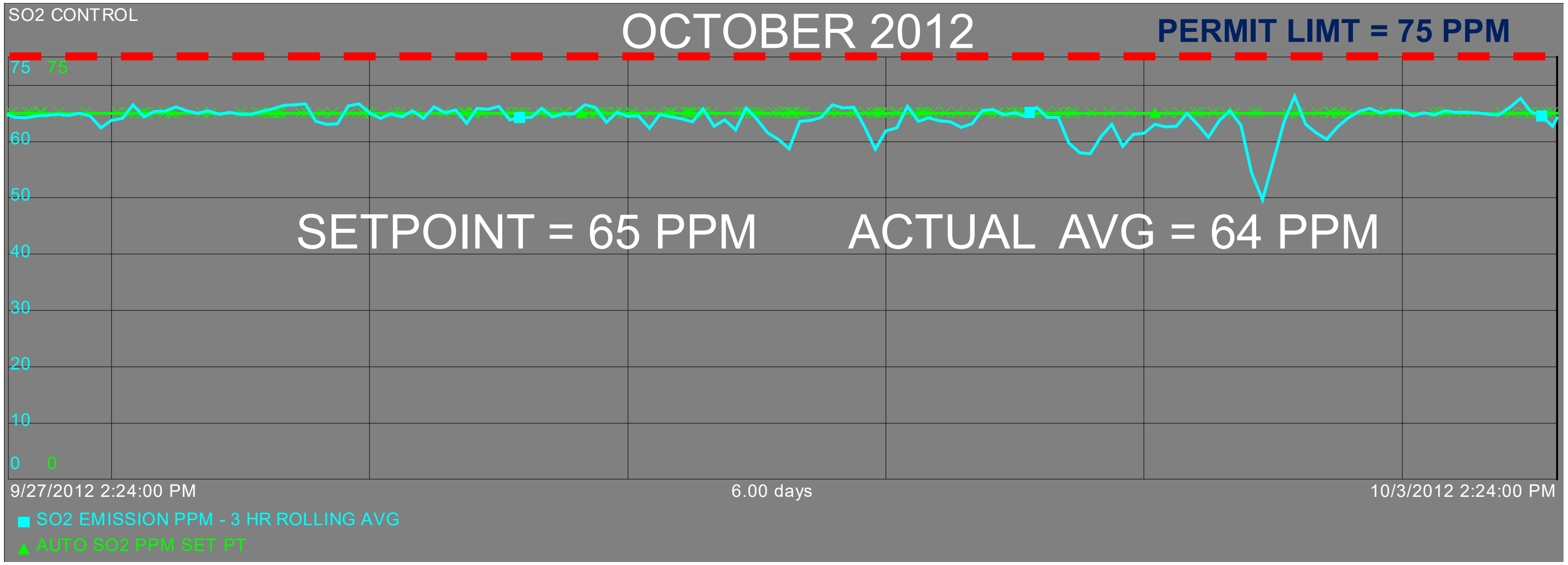
2. Improve SDA Outlet Temperature Stability
- Modified Thermocouple/Logic changes/Tuning

LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

3. Improve SO2 Control and Optimize Setpoint

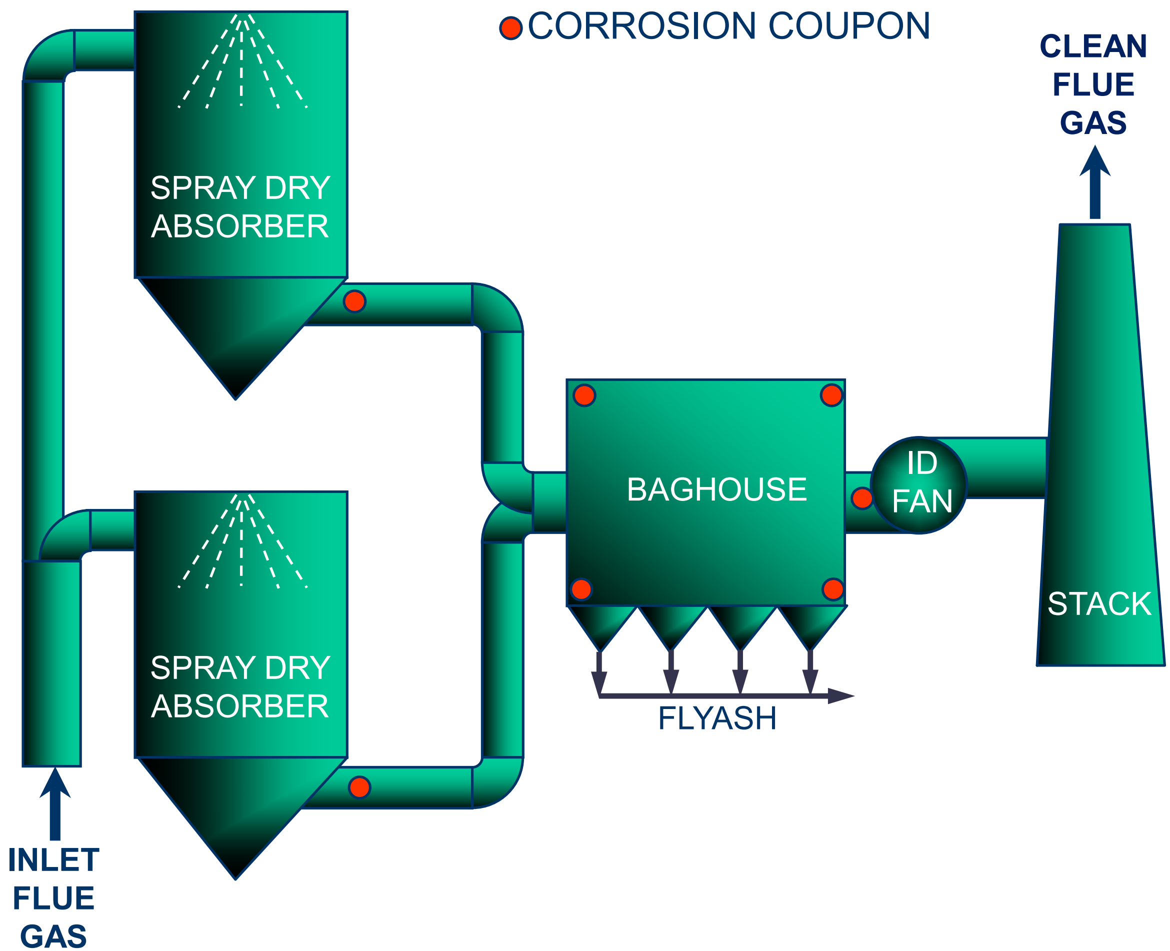




Joint Venture Optimization

Actions & Results

4. Measure & Control Approach Temperature




Corrosion Coupon

Joint Venture Optimization
Actions & Results

Logan Generating Plant

FGD SYSTEM CORROSION COUPON ANALYSIS RESULTS

Location	Coupon Removal Date: 2-Aug-12	14-Aug-12	2-Oct-12	16-Nov-12	17-Dec-12	26-Dec-12	6-Feb-13	5-Apr-13	26-Jun-13
Reactor A Outlet	6.8			2.9	1.6	1.6	2.9	1.5	7.4
Reactor B Outlet	9.4			4.2	2.6	1.2	4.4	5.6	20.7
Baghouse- B, Top	11.9		30.0	2.7	1.0	0.5	1.3	1.4	8.9
Baghouse- B, Bottom	5.0		11.0	1.8	0.6	0.4	0.3	0.2	2.3
Baghouse- M Top		8.8	6.5	1.6	2.3	0.7	3.5	4.4	8.5
Baghouse -M Bottom		9.1	16.0	1.9	0.3	0.2	0.7	0.5	5.9
Baghouse Outlet	4.5		18.0	3.7	6.1	6.7	13.1	5.8	16.7
Average Corrosion (mils/yr)	7.5	9.0	16.3	2.7	2.1	1.6	3.7	2.8	10.0
3 Period Weighted Moving Avg. (mils/yr)			10.6	9.4	8.6	8.4	7.8	7.1	7.4
Cl from Coal (lb/hr)	55	57	58	61	54	65	55	56	60
Cl from Brine (lb/hr)	47	49	54	43	43	44	44	41	51
Total Cl in (lb/hr)	103	106	111	104	97	109	99	97	111
Total Cl in (lb/ton coal)	2.6	2.6	2.7	2.4	2.5	2.4	2.5	2.4	2.6
Average Approach Temp (F)	49	48	53	57	48	44	43	40	37
Approx. Cap. Factor (%)	43	45	45	48	42	51	43	44	47

LEGEND

Color Legend (mils/yr)	% Rank
1.0	66%
2.0	80%
4.0	90%
6.0	93%

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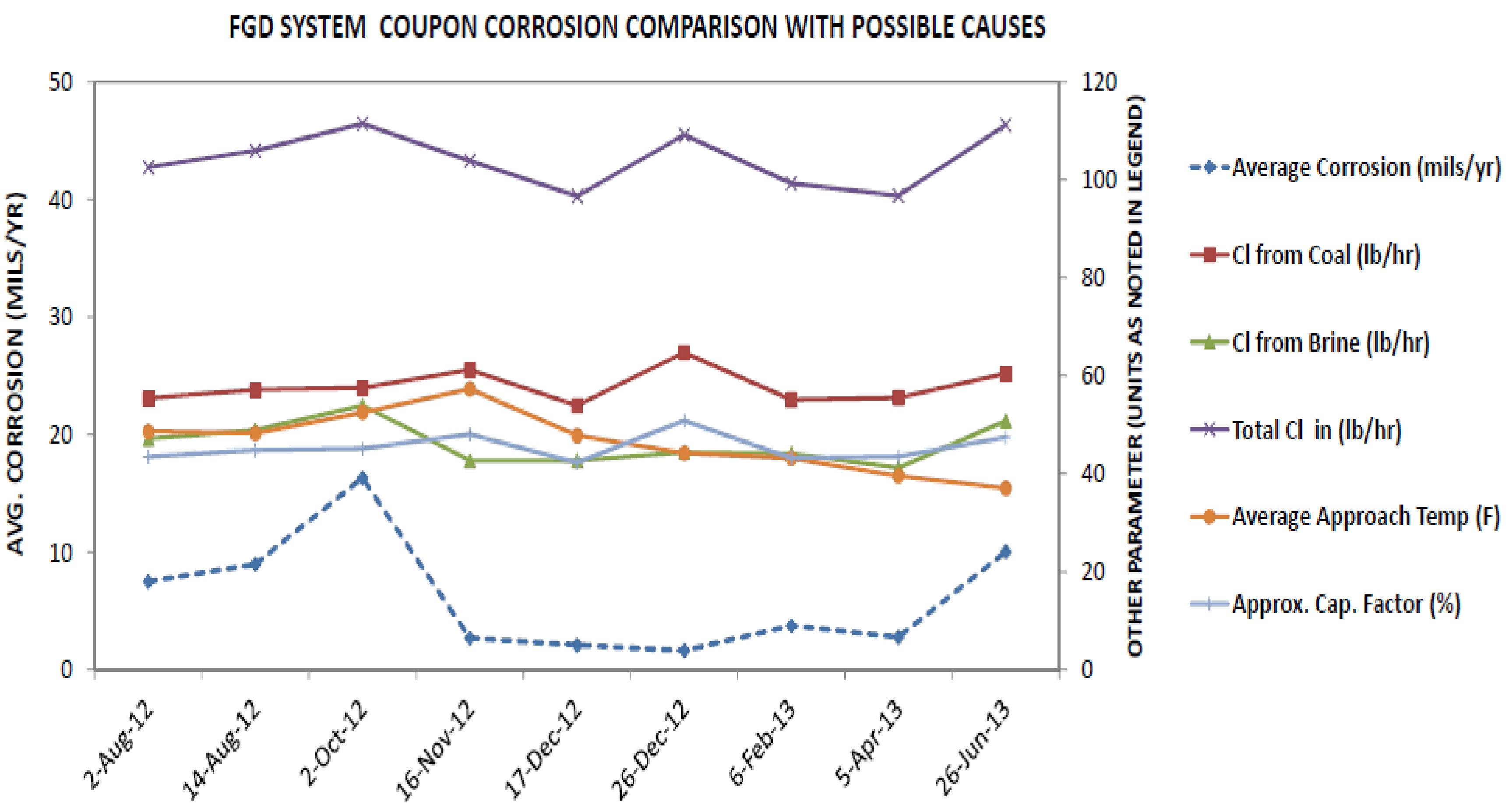
Joint Venture Optimization
Actions & Results



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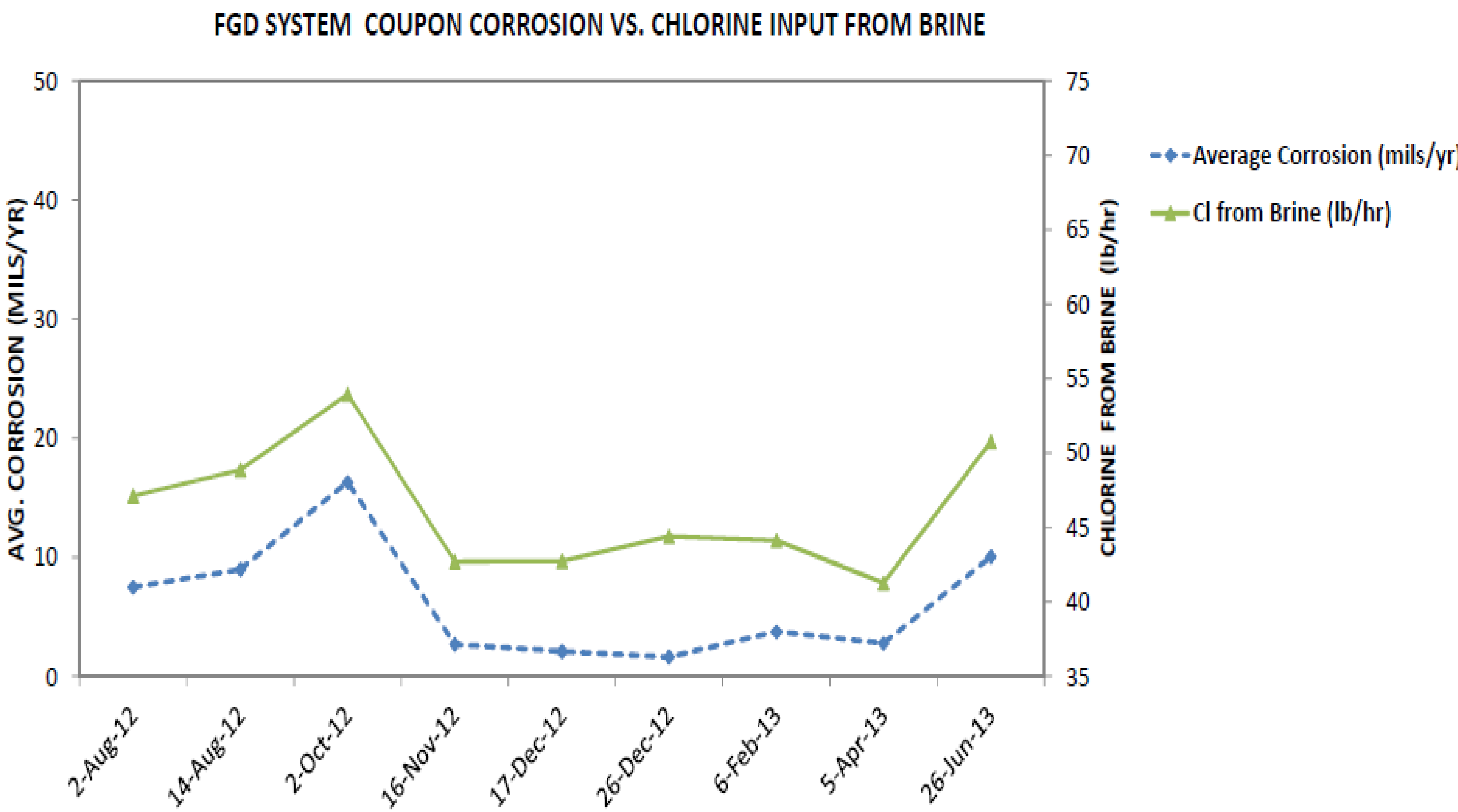
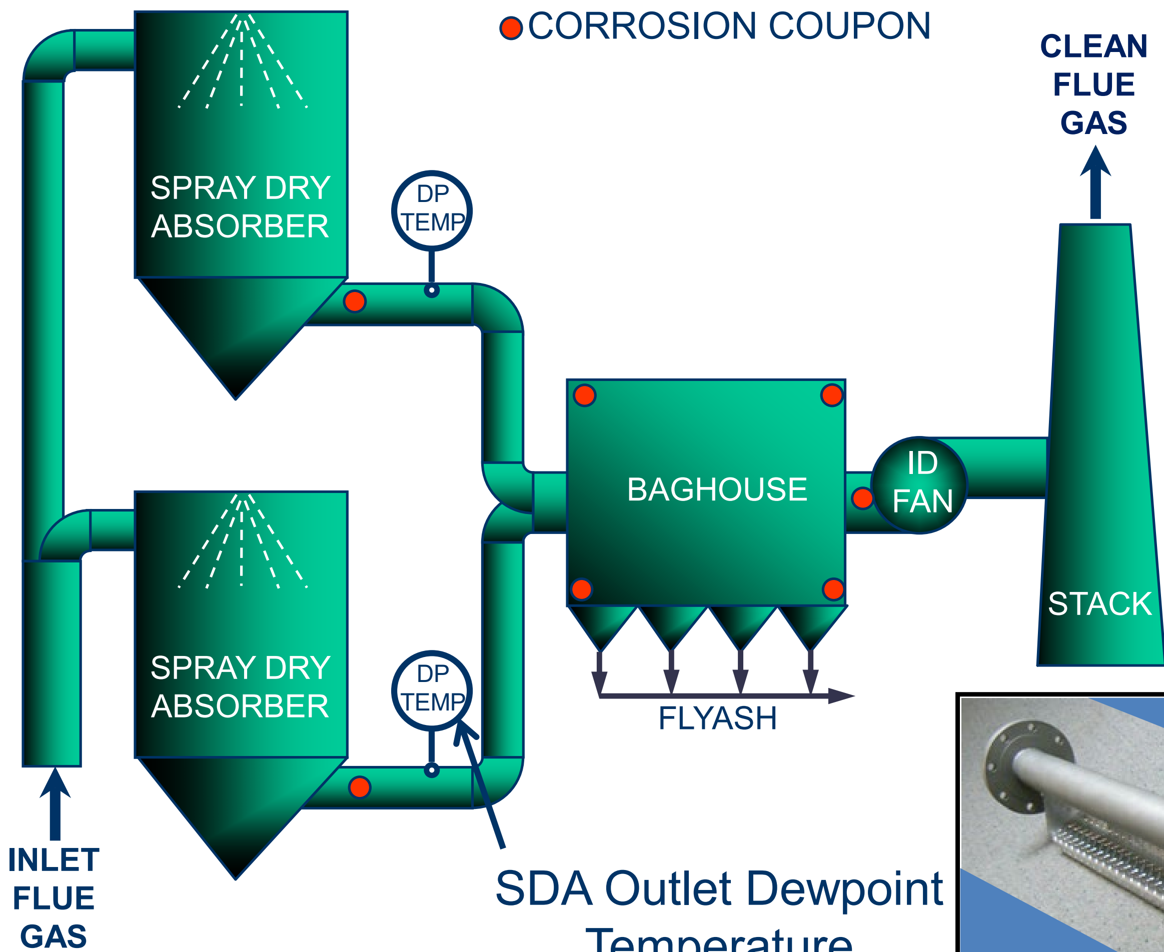
Joint Venture Optimization
Actions & Results



LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

4. Measure & Control Approach Temperature



SDA Outlet Dewpoint Temperature Transmitter (Patent Pending)

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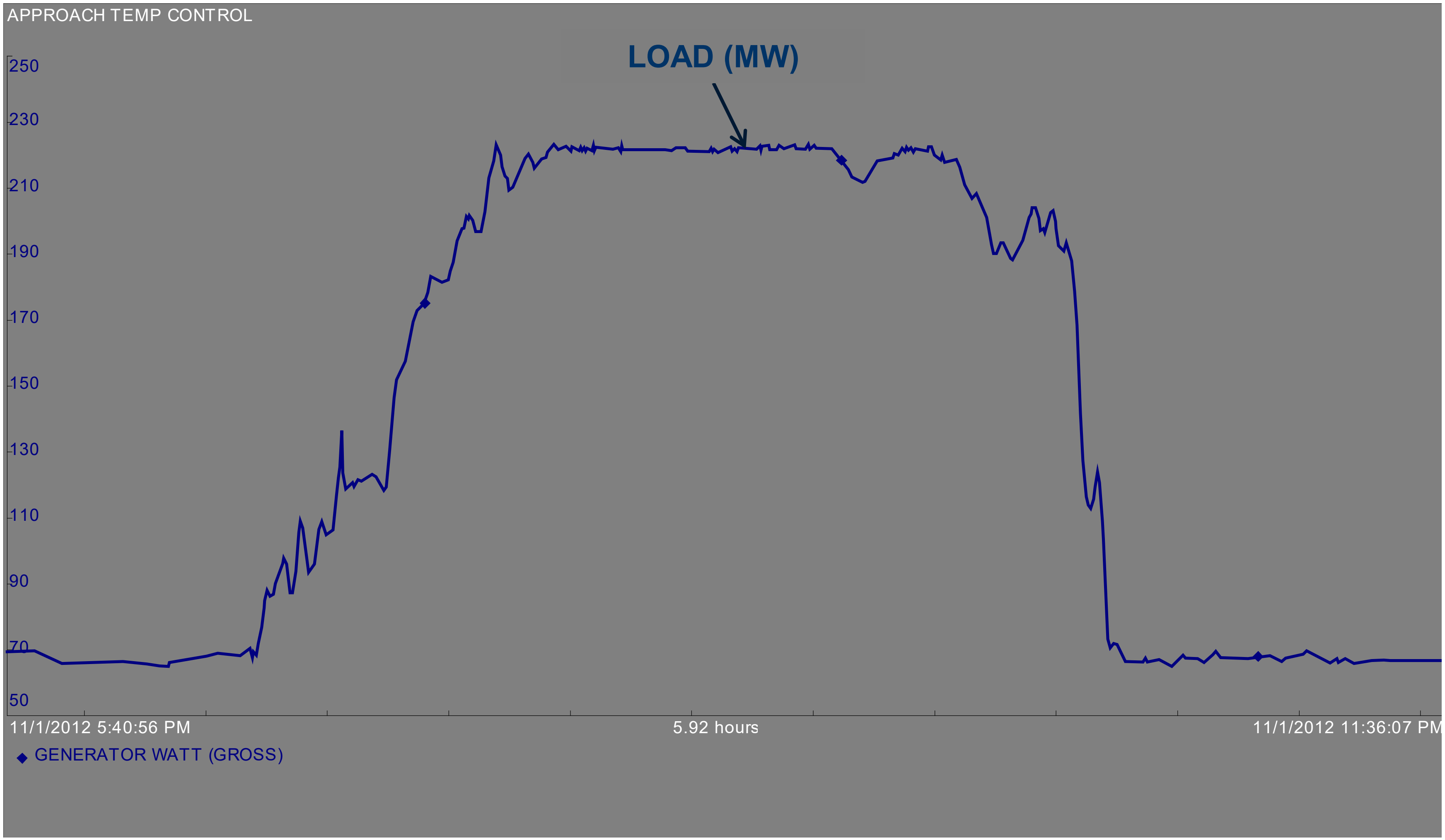
Joint Venture Optimization

Actions & Results

4. Measure & Control Approach Temperature

TYPICAL TRANSIENT LOAD PROFILE



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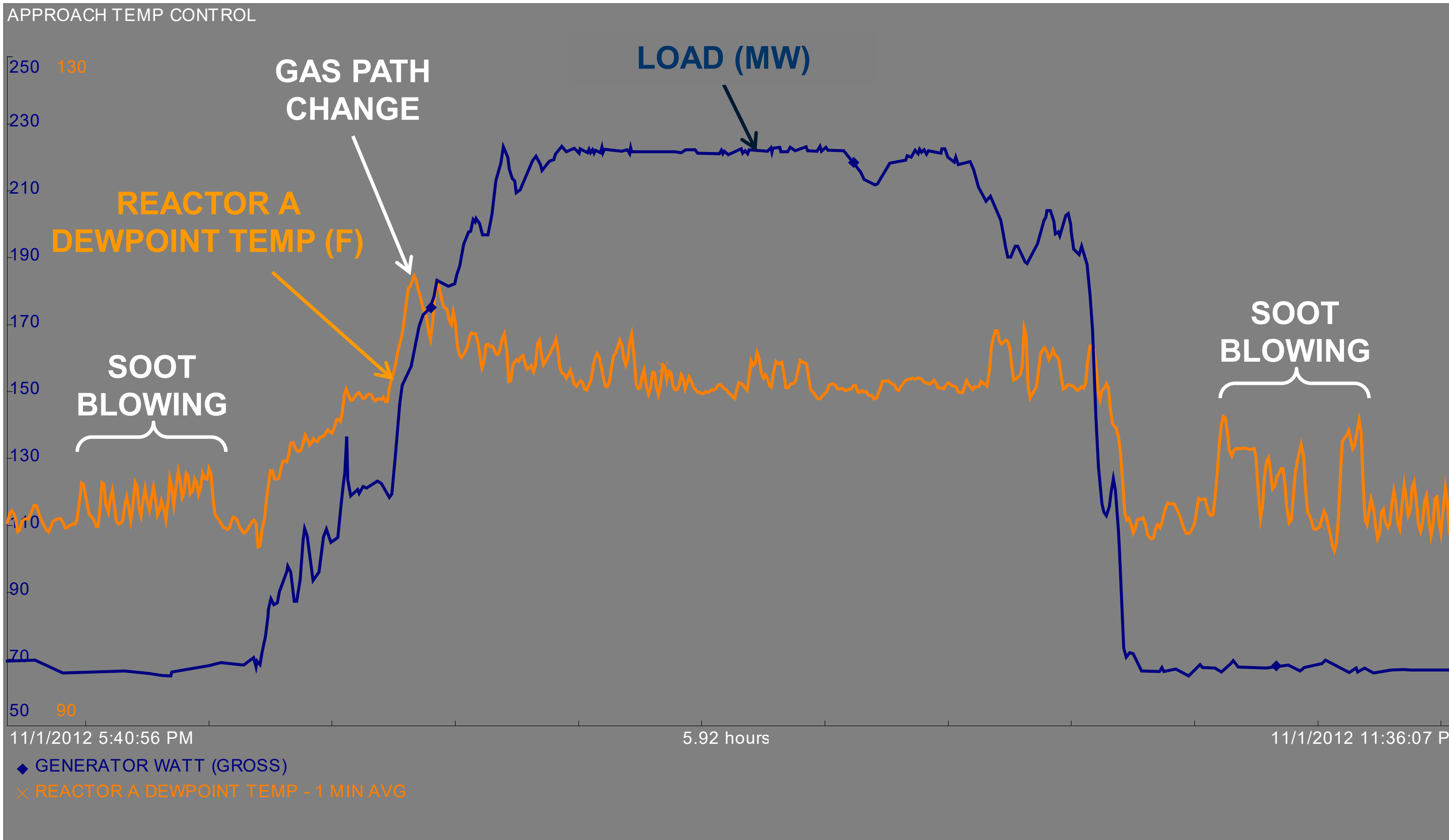
Joint Venture Optimization
Actions & Results

4. Measure & Control Approach Temperature

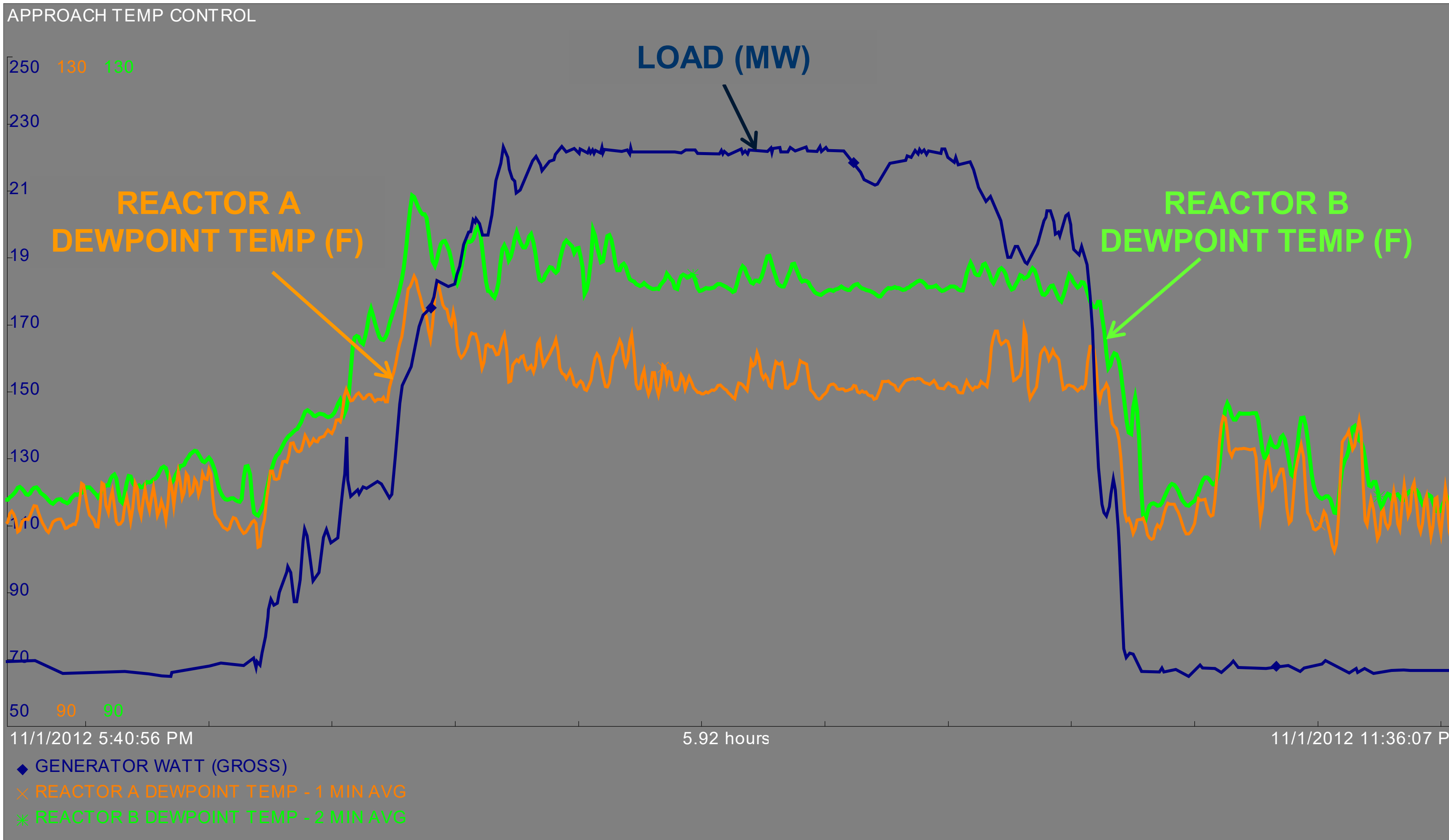
DEWPOINT VARIES CONTINUOUSLY 5-20 °F



Joint Venture Optimization
Actions & Results

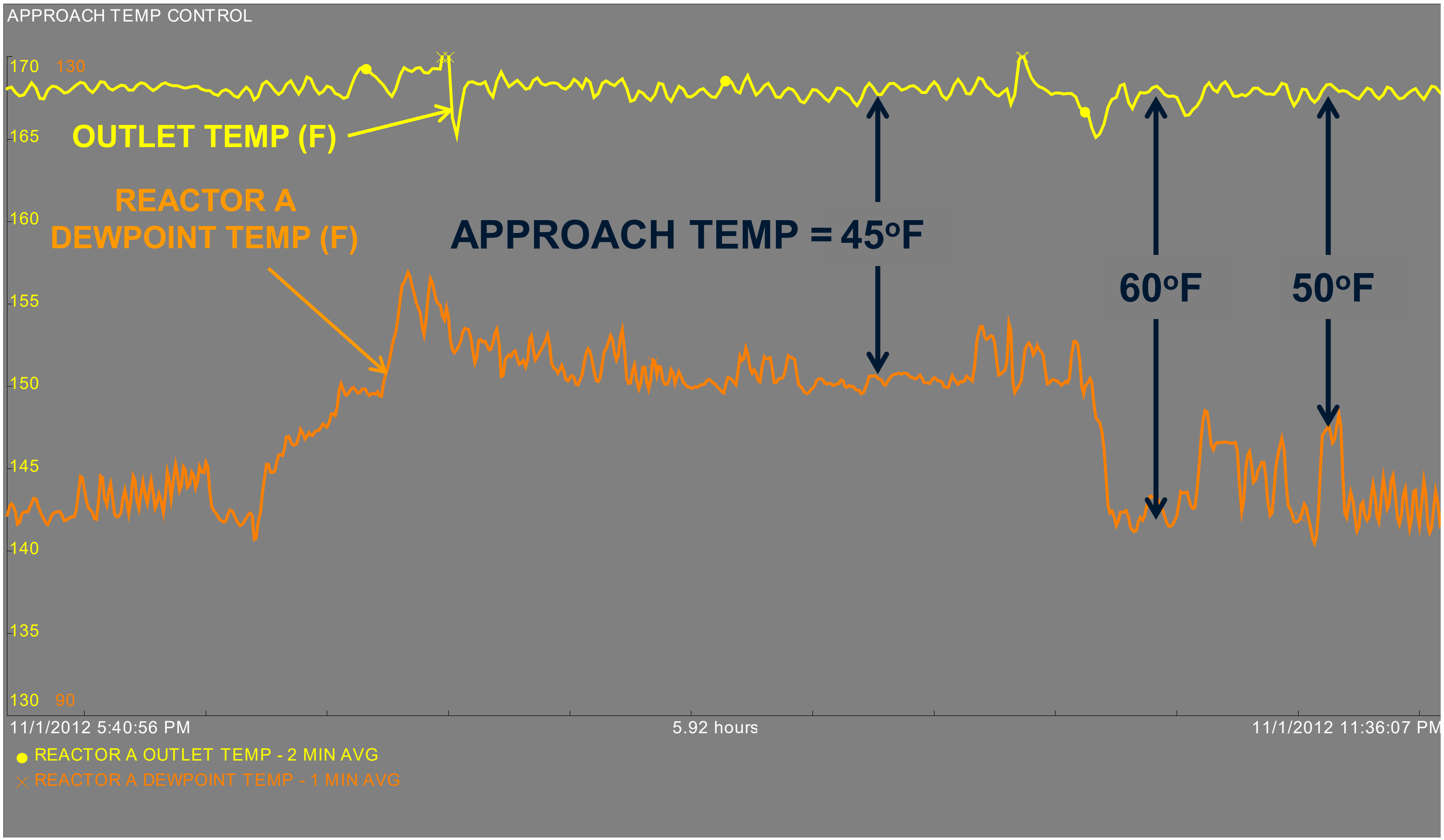
4. Measure & Control Approach Temperature

INDIVIDUAL SDA OUTLET DEWPOINTS VARY DIFFERENTLY



4. Measure & Control Approach Temperature

BEFORE: APPROACH TEMP VARIES HOURLY 5-20 °F



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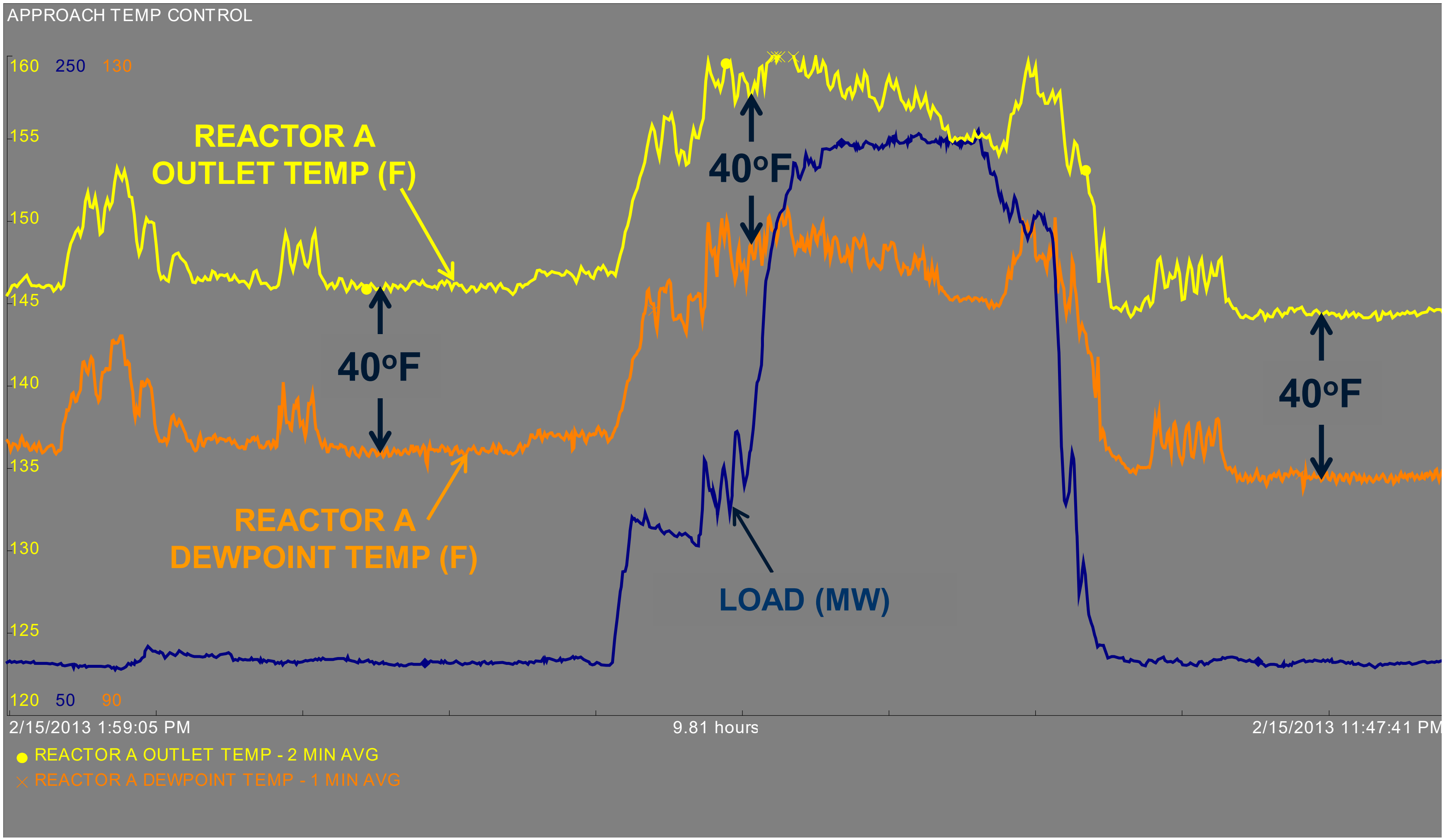
Joint Venture Optimization
Actions & Results

4. Measure & Control Approach Temperature

AFTER: APPROACH TEMP CONSTANT +/- 1°F PRECISION

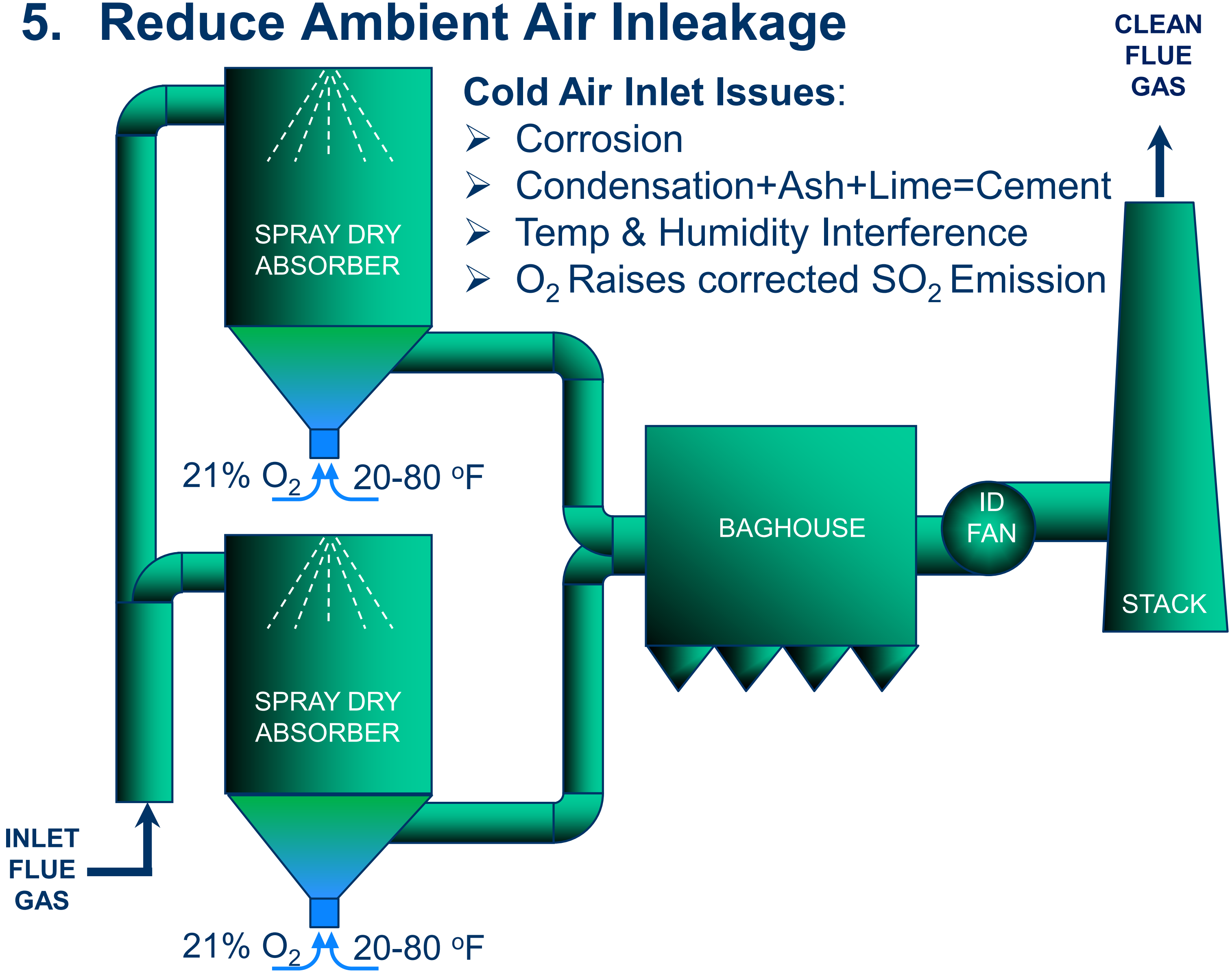


Joint Venture Optimization
Actions & Results

5. Reduce Ambient Air Inleakage

Cold Air Inlet Issues:

- Corrosion
- Condensation+Ash+Lime=Cement
- Temp & Humidity Interference
- O_2 Raises corrected SO_2 Emission



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Joint Venture Optimization

Actions & Results

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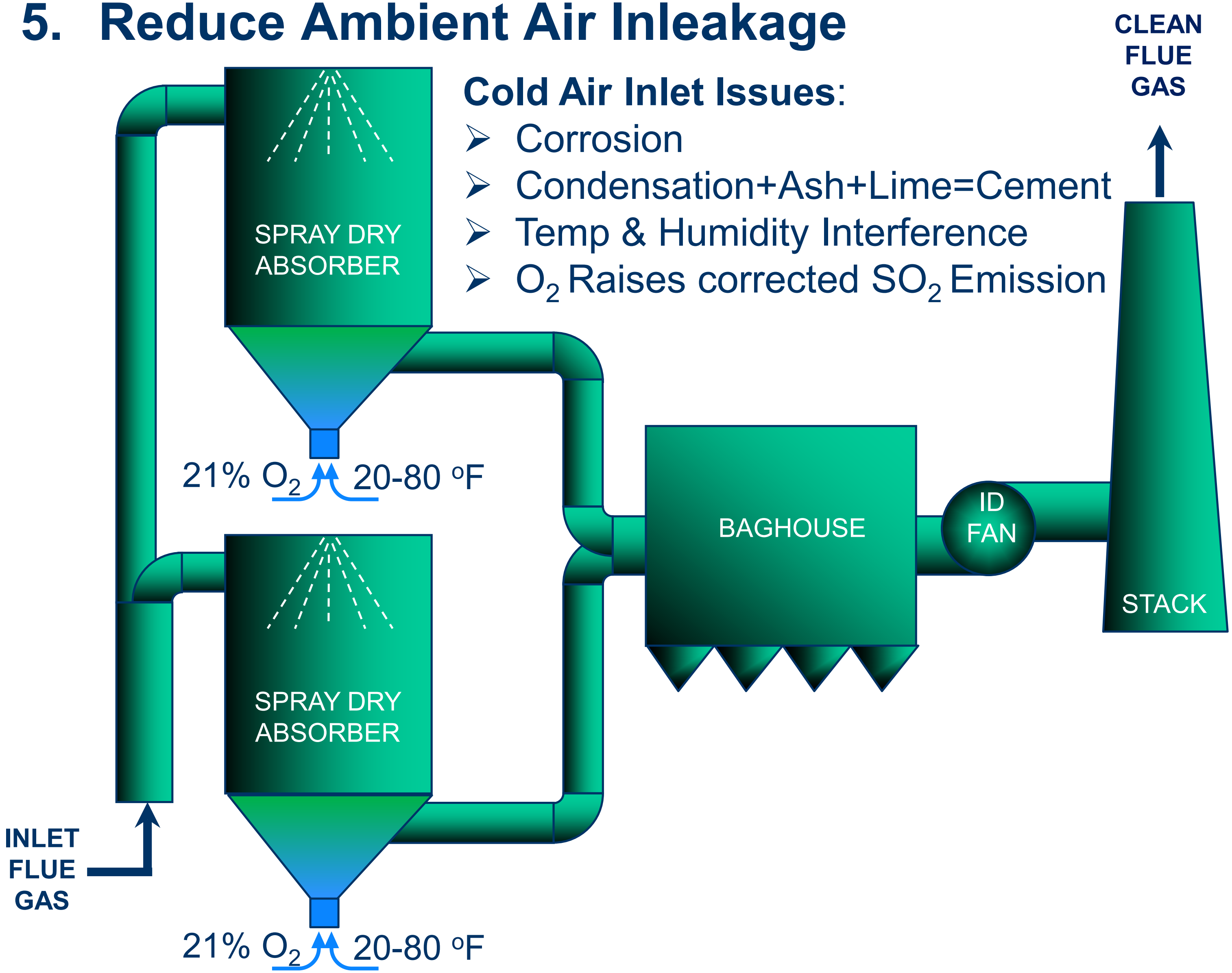

Joint Venture Optimization
Actions & Results

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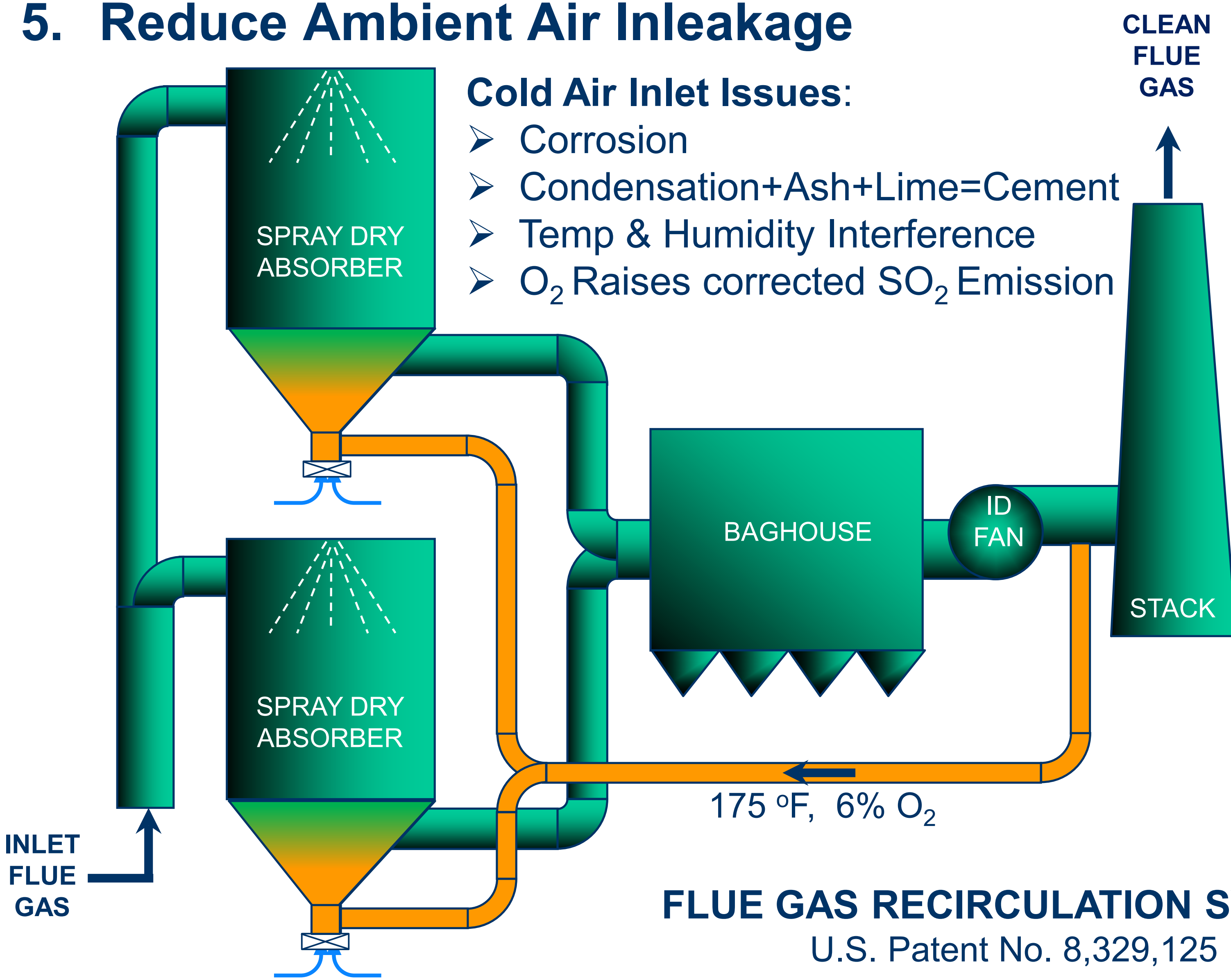


FLUE GAS RECIRCULATION SYSTEM

U.S. Patent No. 8,329,125

LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

5. Reduce Ambient Air Inleakage
- Flue Gas Recirculation Duct

Joint Venture Optimization

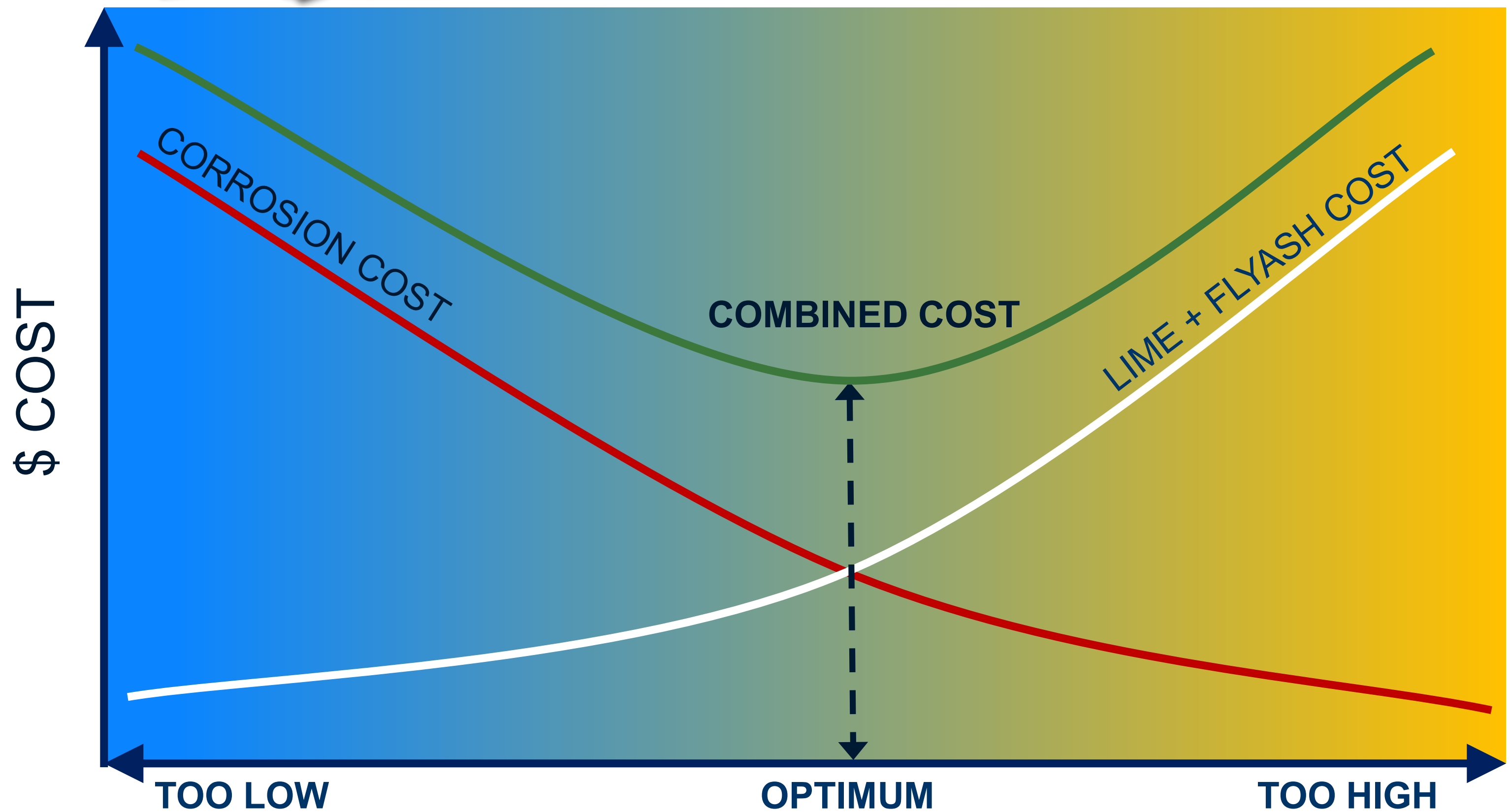
Actions & Results

5. Reduce Ambient Air Inleakage
- Flue Gas Recirculation Duct

Joint Venture Optimization
Actions & Results

6. Optimize Performance (Ongoing 3 yrs)

= CORROSION COST + LIME + FLYASH COST



LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

Dec 2012 Performance Test Results

	BASELINE - ACTUAL 2012			PROJECTED FOLA (AFTER JVO)		
	Mini load	Full Load	Total	Mini load	Full Load	Total
Coal in (2012 tons)	226632	90426	317057	226632	90426	317057
Coal Sulfur (%)	1.18	1.18	1.18	1.18	1.18	1.18
Sulfur in (tons	2674	1067	3741	2674	1067	3741
Approach Temp (F)	N/A	N/A	N/A	40	40	40
SO2 Emission Limit (ppm)	75	75	75	61	61	61
Ca/S Ratio	1.23	1.23	1.23	0.90	1.00	0.93
Lime in (tons)	6254	2495	8749	4576	2029	6605
FGD Byproduct (tons)	15635	6238	21874	11440	5072	16512
Lime Cost ($/ton)	$ 147	$ 147	$ 147	$ 147	$ 147	$ 147
Lime Spend (k$/yr)	$ 919	$ 367	$ 1,286	$ 673	$ 298	$ 971
Flyash Disp. Cost ($/ton)	$ 33	$ 33	$ 33	$ 33	$ 33	$ 33
FGD Byproduct Disp. Spend (k$/yr)	$ 516	$ 206	$ 722	$ 378	$ 167	$ 545
TOTAL SPEND (k$/yr)	**$ 1,435**	**$ 573**	**$ 2,008**	**$ 1,050**	**$ 466**	**$ 1,516**
FGD Cost ($/ton coal)	$ 6.33	$ 6.33	$ 6.33	$ 4.63	$ 5.15	$ 4.78

25% REDUCTION

$492k/yr SAVINGS AT 40% C.F.

$1.55 / TON REDUCTION

ALL GOOD – PROVIDED THAT INCREMENTAL CORROSION IS LESS THAN $492,000 /YEAR

Joint Venture Optimization
Actions & Results

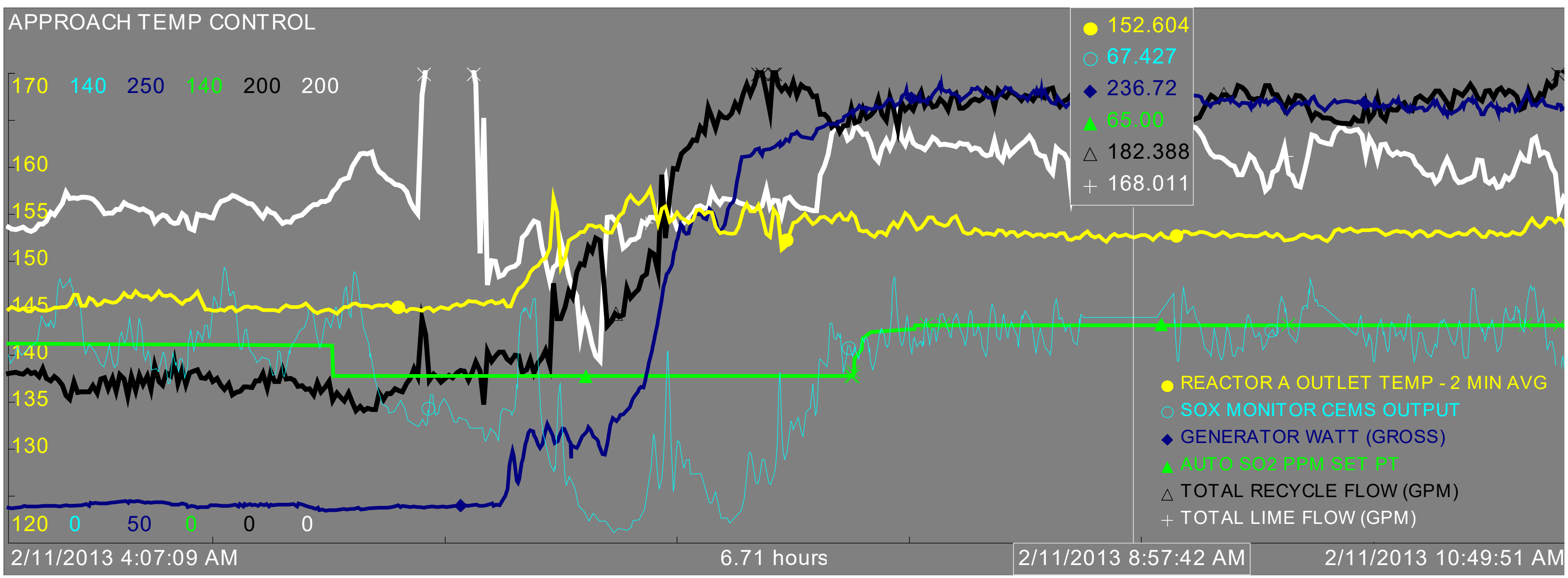
But wait, there's more:

- December 2012: Mandatory reduction of SO_2 emission limits take effect per NJDEP RACT. The limiting parameter decreases from 75 ppm to 61 ppm.
- January 2013: New coal supplier, % sulfur increases from 1.2% to 2.0%, with potential up to 2.5% in 2013.
- The plant was designed and permitted for a maximum of 1.5% Sulfur. To change the permit, NJDEP required compliance to be demonstrated at full load at 2.0% and 2.5 % sulfur
- The highest sulfur reported by any U.S. dry scrubber was 2.1%. Some said 2.5% couldn't be done….

Joint Venture Optimization
Actions & Results

….however:

- On February 11, 2013 Logan successfully achieved full load operation (237 MW gross) with 2.54% coal in compliance with permitted emission limits on a limited test basis.



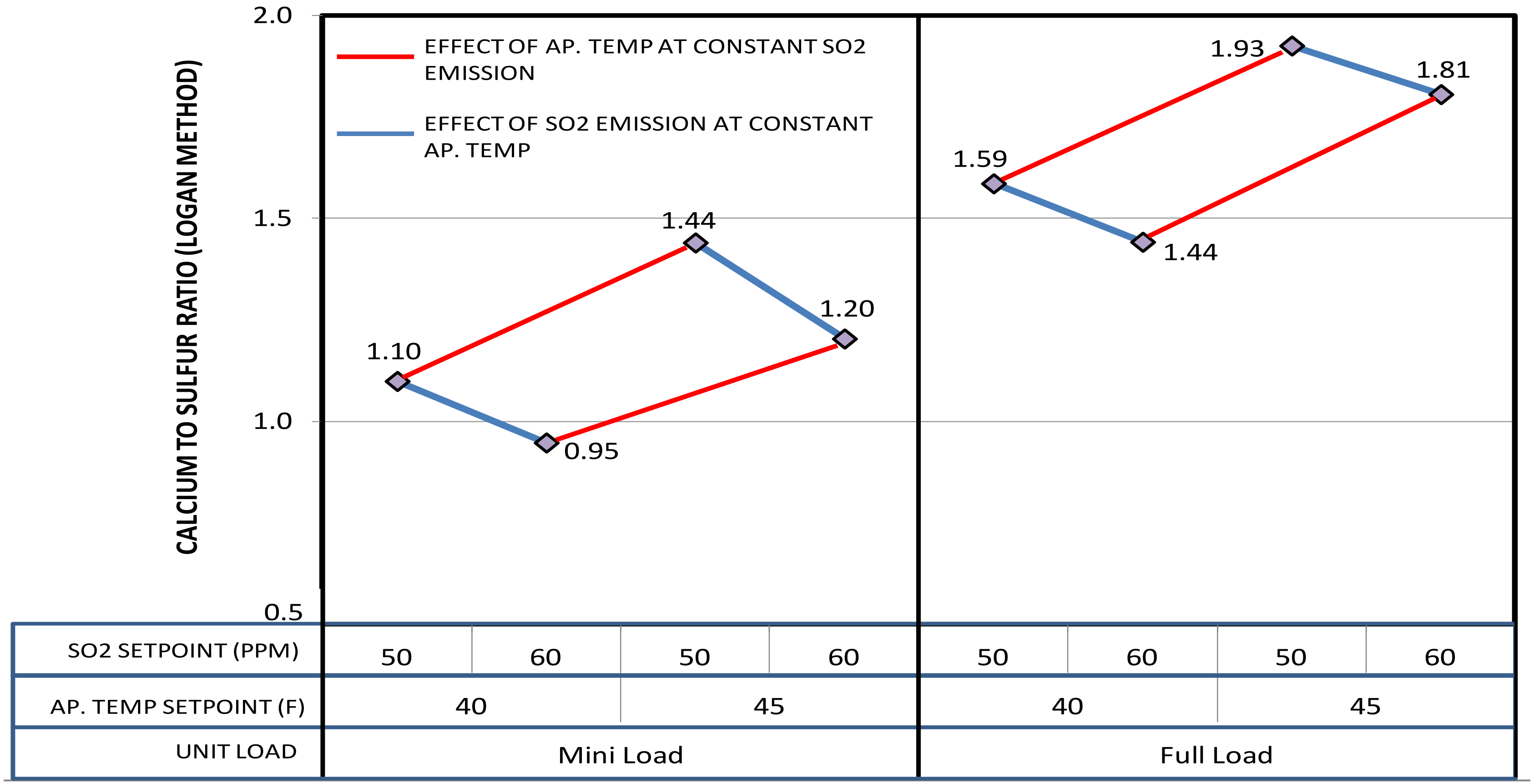
Joint Venture Optimization
Operational Issues

- Running both Slakers to meet 2.5% sulfur scrubbing demands
- Running multiple Filtered Water pumps to meet capacity for slaking
- Needed larger capacity slaking water heater for winter operation and increased slaking water flow
- Temporary modifications to Recycle Ash system to replace brine water with lime slurry
- Flyash disposal – volume and moisture %
- Extended run times on 2.5% sulfur coal at full load (Only three 2 hour tests completed)

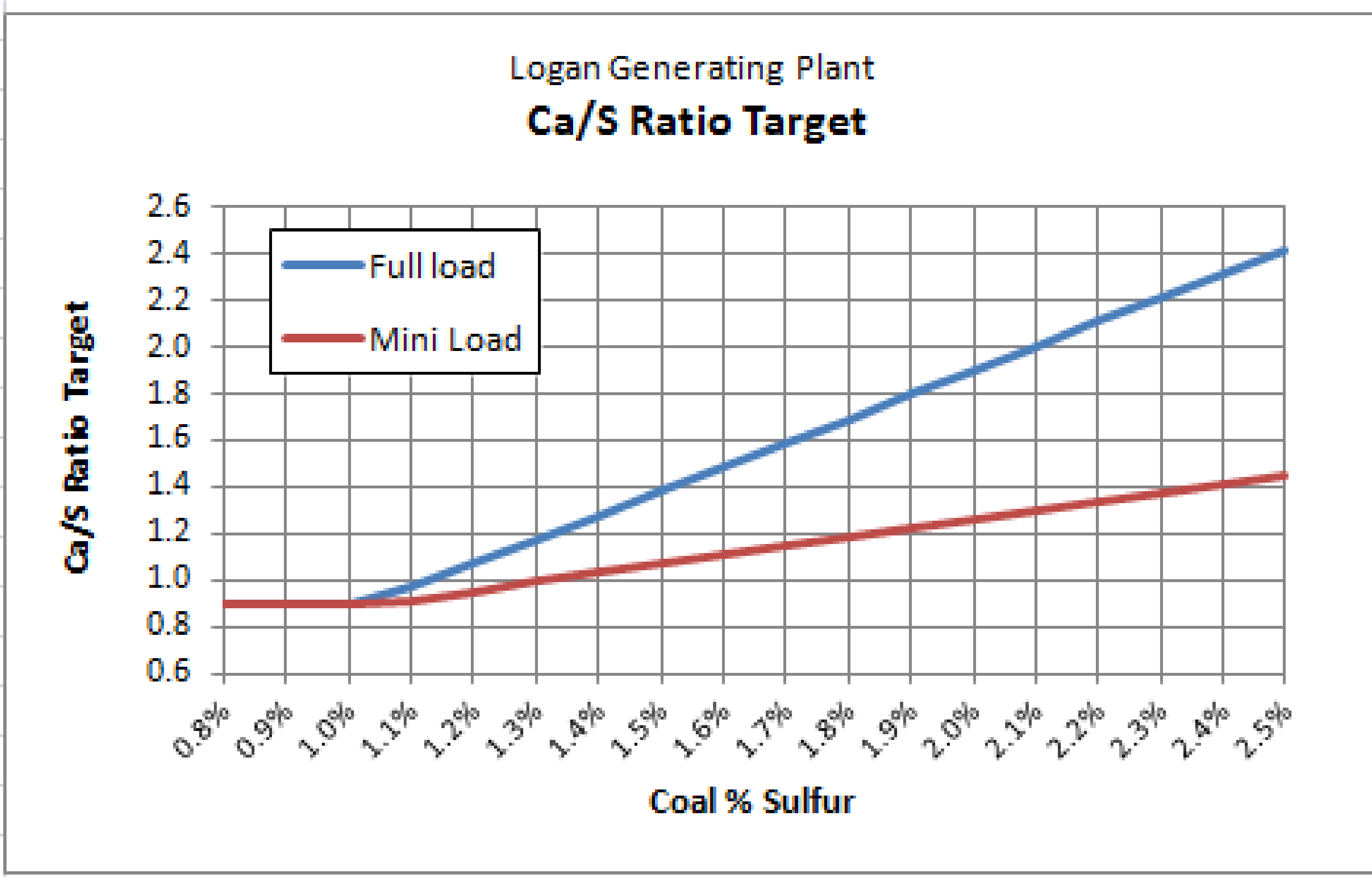
LOGAN GENERATING PLANT

Joint Venture Optimization
Actions & Results

LOGAN GENERATING PLANT
BAILEY COAL TEST RESULTS DEC 18-22, 2012
CALCIUM TO SULFUR RATIO AT VARIOUS OPERATING CONDITIONS



Joint Venture Optimization
Actions & Results



2013 Performance

- Capacity Factor – 32%
- Calcium/Sulfur Ratio – 1.28%
- Average Sulfur – 1.76%
- Operating Savings through 2Q - $174,000
- Scrubber Operating at 35F Approach Temperature and a 60 ppm set point for SO_2

Joint Venture Optimization

Critical Success Factors

- Senior Management Sponsorship (NAES/PPMS)
- Shared Risk / Shared Reward – All Parties
- Clear, measurable goals
- Everybody on board from Day 1 (training) with opportunities to contribute
- Team Leader – Inside, Authorized & Available
- New Technology – FGR and HE-V5

- Questions?