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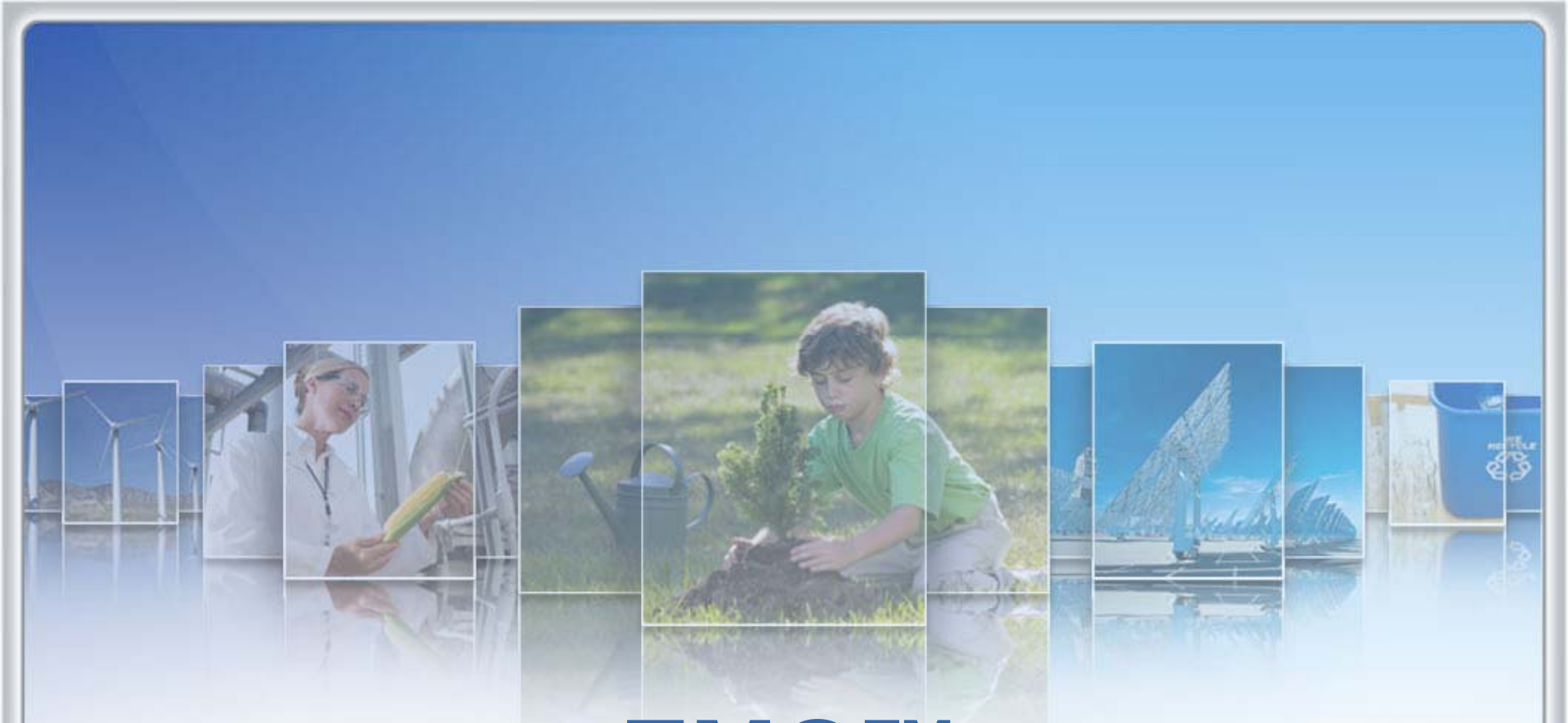

EMO™

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Client Program Manager

Shaw's Environmental & Infrastructure Group

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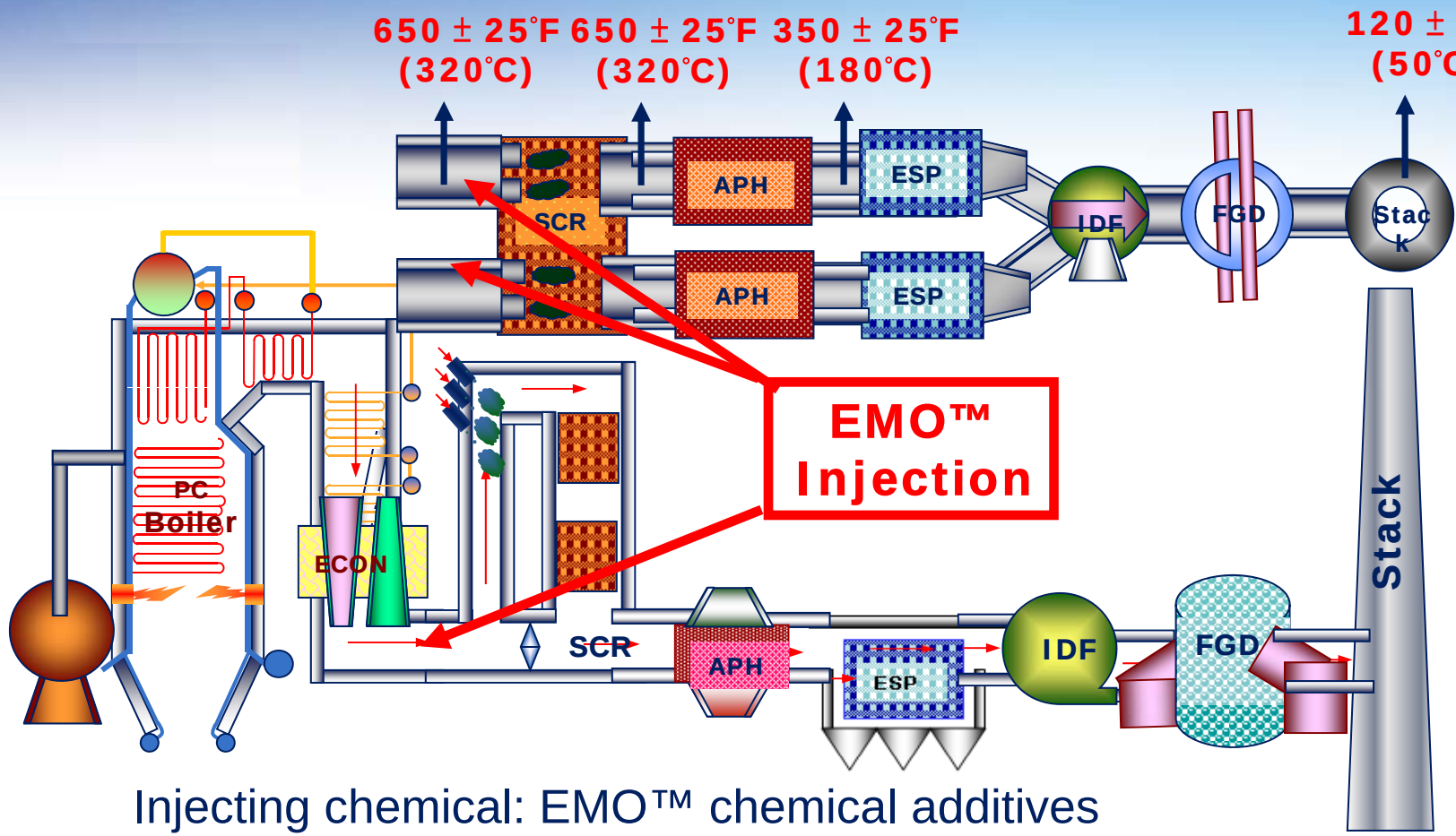
Regulatory Updates

- Generally speaking, the Hg(0)/Hg(2+) ratio (native mercury oxidization) at the economizer outlet:
  - Bituminous: 70% Hg(0) / 30% Hg(2+), **12** lb/TBtu in total Hg
  - Sub-bituminous: 90% Hg(0) / 10% Hg(2+), **7** lb/TBtu in total Hg
  - Lignite: 80% Hg(0) / 20% Hg(2+), **30** lb/TBtu in total Hg

Subcategory	Total Filterable Particulate Matter	Hydrogen Chloride	Mercury
Existing coal-fired unit degigned for coal > 8,300 Btu/lb	**0.030** lb/MMBtu (**0.30** lb/MWh)	**0.0020** lb/MMBtu (**0.020** lb/MWh)	**1.2** lb/TBtu (**0.010** lb/GWh)
Existing coal-fired unit degigned for coal < 8,300 Btu/lb	**0.030** lb/MMBtu (**0.30** lb/MWh)	**0.0020** lb/MMBtu (**0.020** lb/MWh)	**4.0** lb/TBtu (**0.040** lb/GWh)

- To reach 90% or above on mercury emission reduction for any coal-fired application – requirements from Mercury and Air Toxics Standards (MATS) published on 2/16/2012, which will be effective 60 days later.

EMO™ Injection for Hg Control



Injecting chemical: EMO™ chemical additives

- Mercury Oxidization: Hg(0) → Hg(2+)
- Mercury Absorption/Adsorption: in existing ESP, FGD

Injection location and temperature: Economizer outlet (650°F)

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EMO Chemical Injection Process

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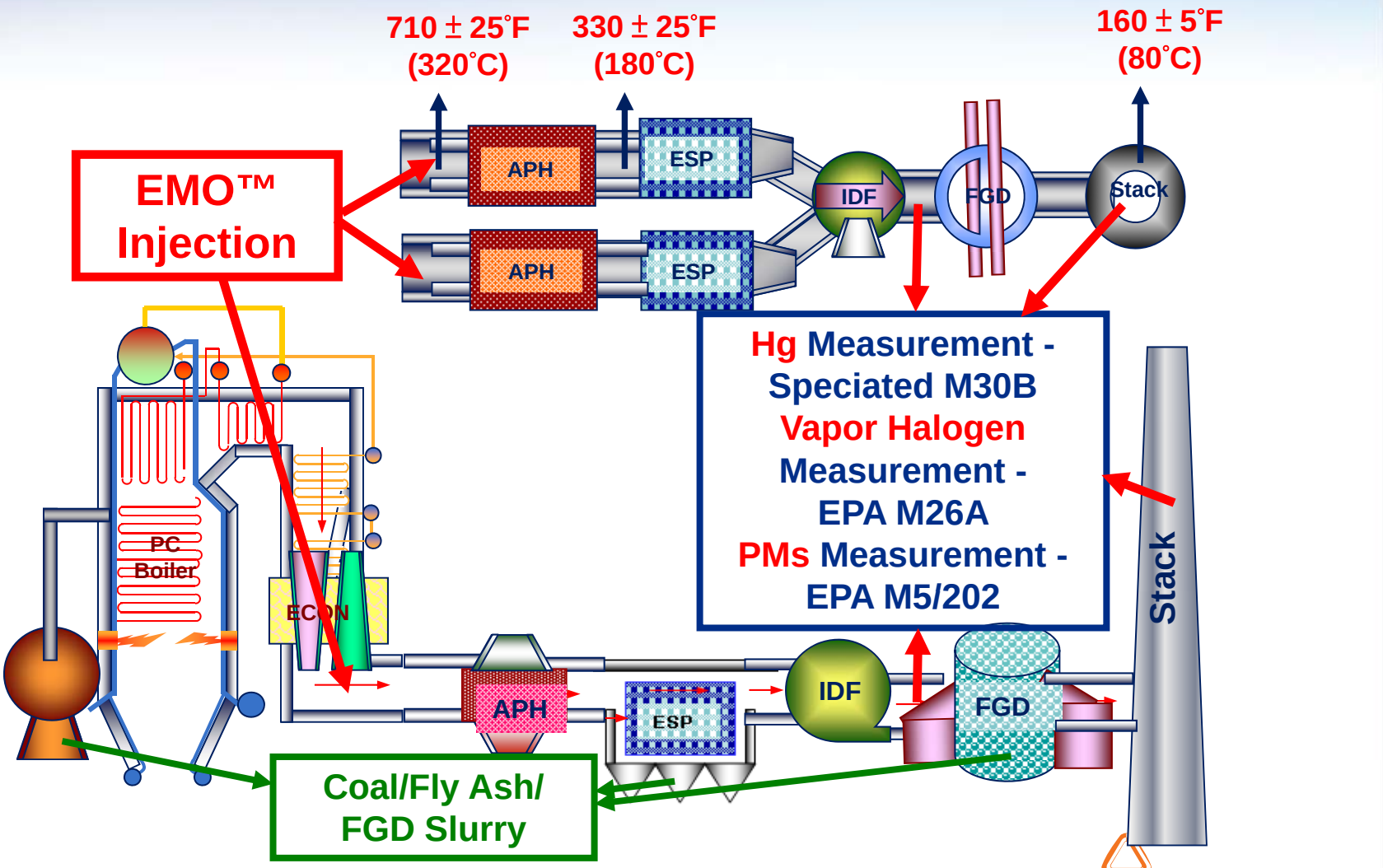
Reference Unit Configuration

Unit Configuration: 440 MW burning 100% Lignite. CESP + WFGD



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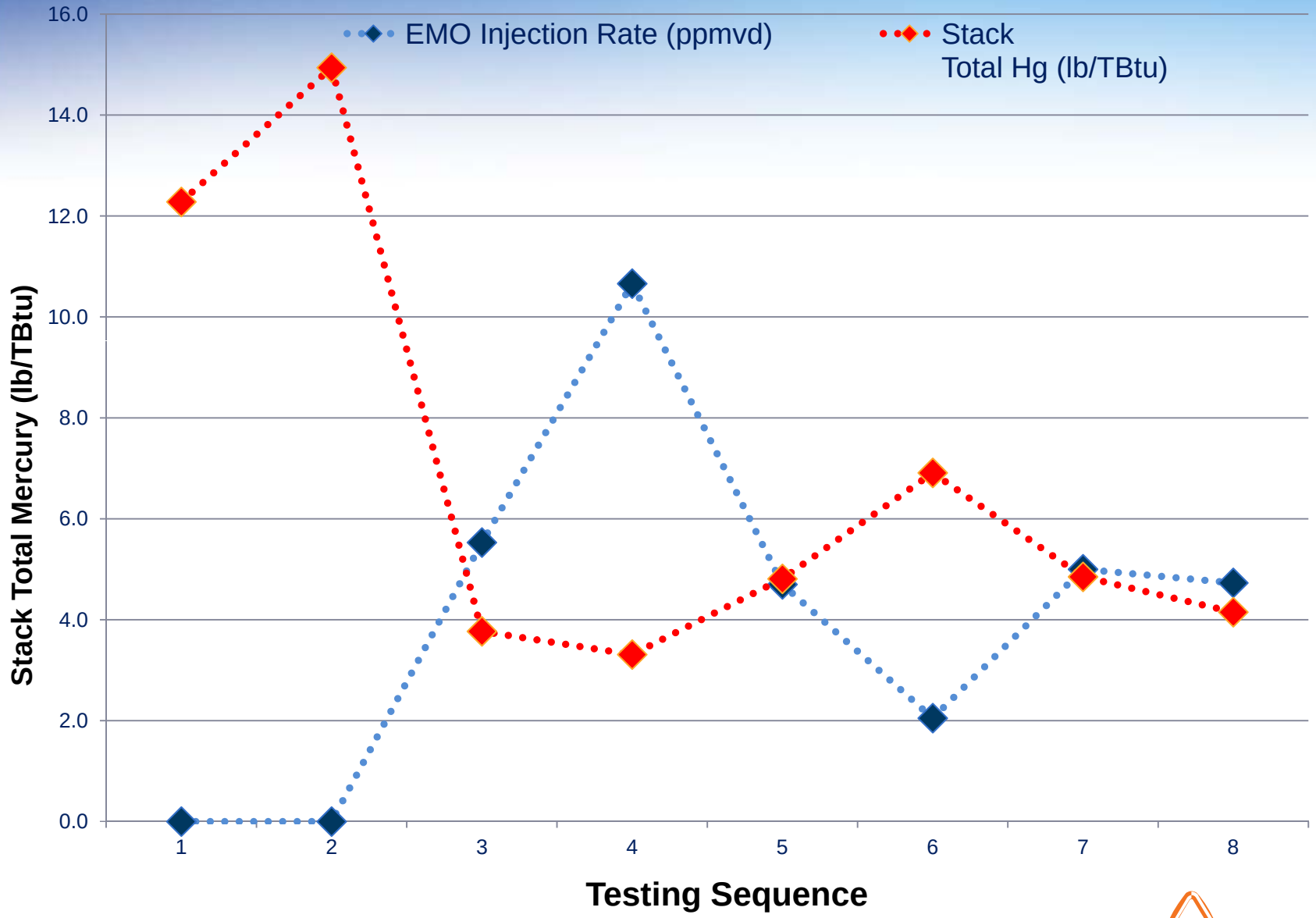
Reference Unit Data Results

- Testing performed
  - Baseline tests
  - Varying EMO™ chemical injection rates at the boiler outlet

Date	Unit Load	Max. Hg in Coal	EMO Injection Rate	FGD Inlet Total Hg	ESP Hg Capture	Stack Total Hg	Hg Oxidization Stack	Overall System Hg Removal (Normalized)	Stack SO2	Stack Opacity
mm/dd/yy	(MW)	(lb/TBtu)	(ppmvd)	(lb/TBtu)	(%)	(lb/TBtu)	(%)	(%)	(lb/MMBtu)	(%)
11/14/11	436	26.7	0.0	18.57	30.3%	12.28	54.4%	59.2%	0.51	2.30
	438	26.7	0.0	15.23	42.9%	14.94	50.1%	50.4%	0.51	2.25
11/15/11	438	25.9	5.5	4.64	82.1%	3.77	85.6%	87.5%	0.56	2.88
	437	25.9	10.7	4.68	82.0%	3.31	90.2%	89.0%	0.51	3.12
11/16/11	435	39.9	4.7	7.97	80.0%	4.81	89.3%	84.0%	0.68	2.17
	438	39.9	2.1	13.08	67.3%	6.91	83.2%	77.0%	0.78	1.89
11/17/11	440	27.7	5.0	4.99	82.0%	4.85	83.3%	83.9%	0.43	2.09
	439	27.7	4.7	3.47	87.5%	4.15	85.6%	86.2%	0.61	1.95

Mercury Control VS. EMO Operations



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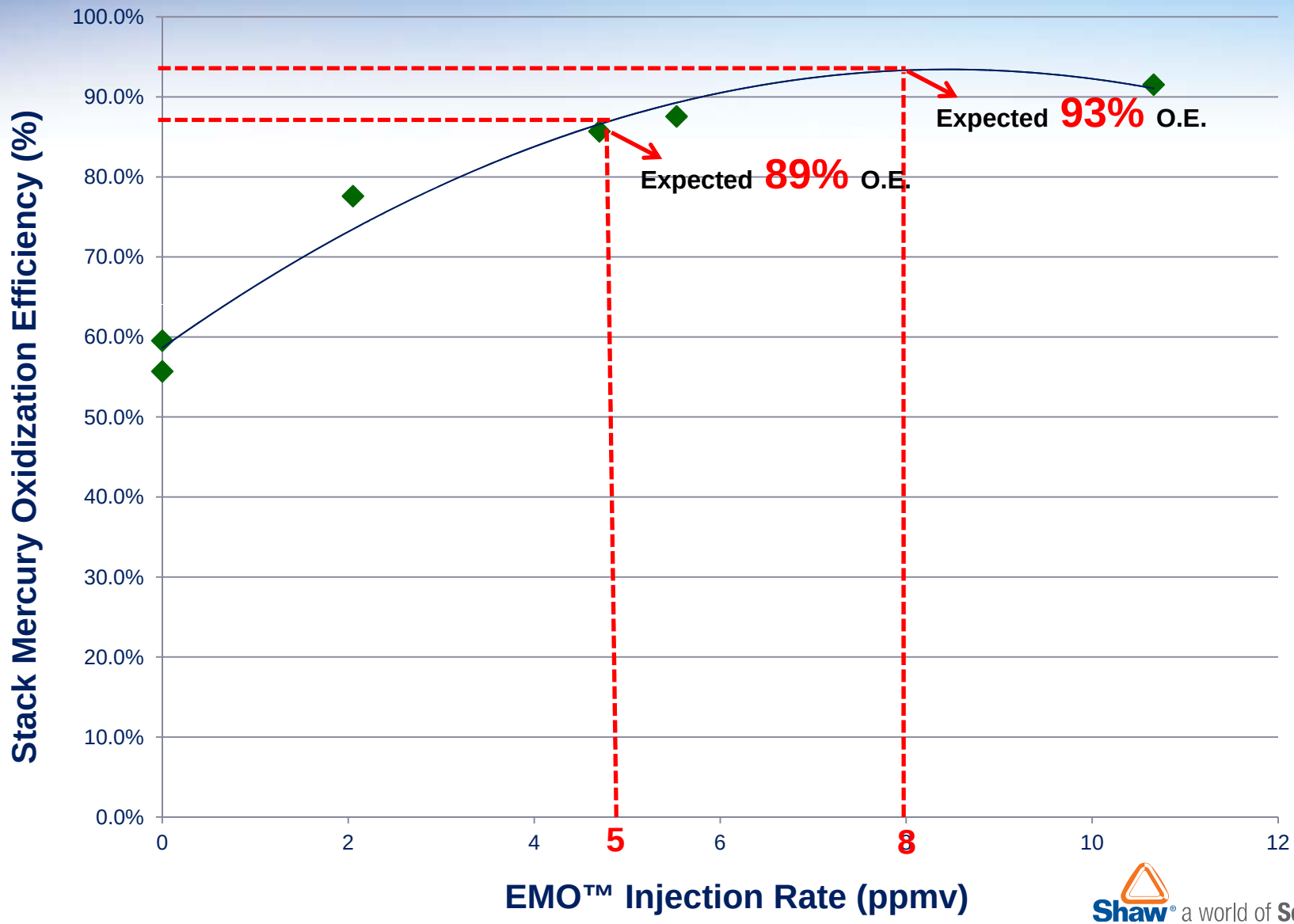
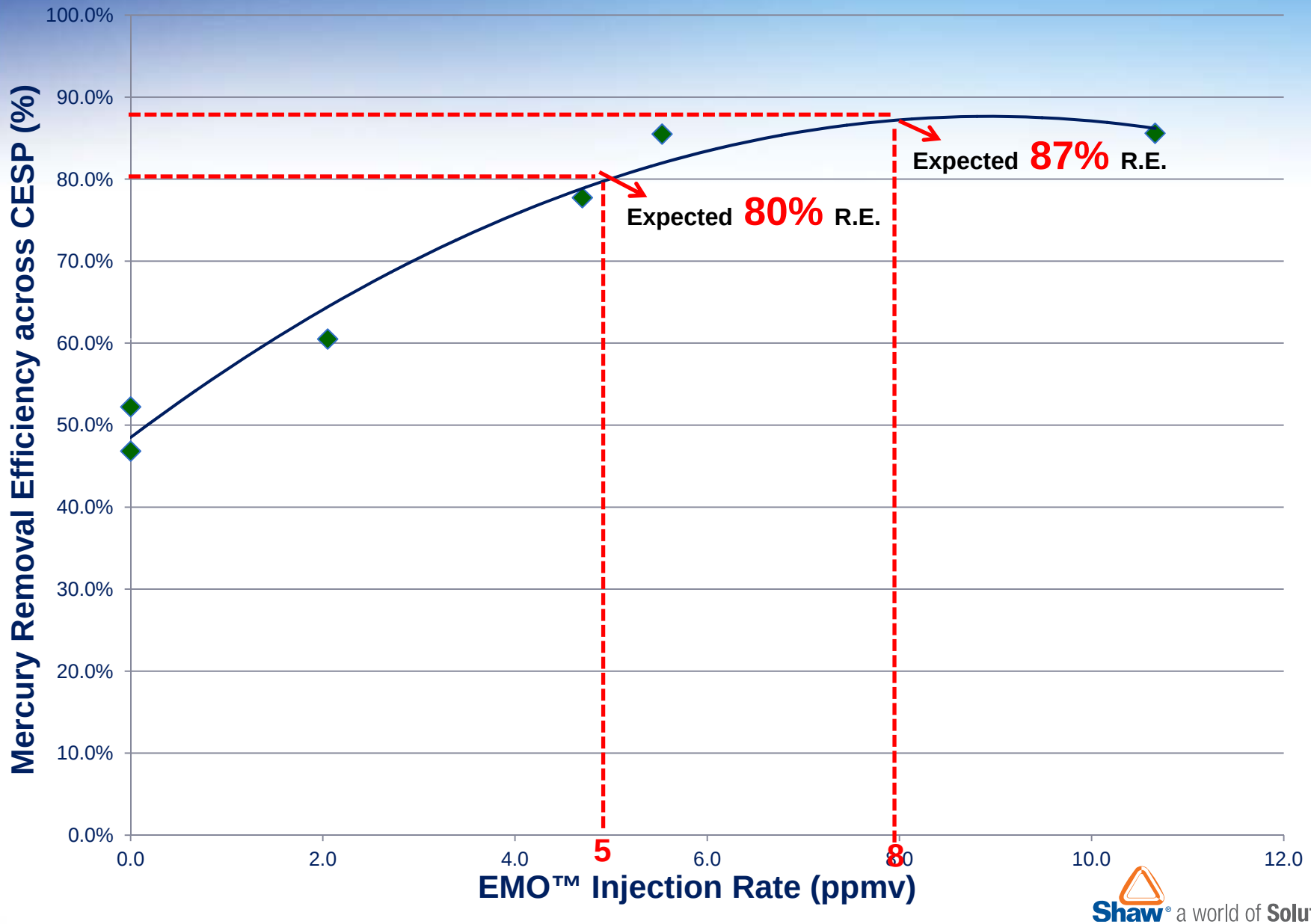
Mercury Oxidization Efficiency



Mercury Reduction Across CESP



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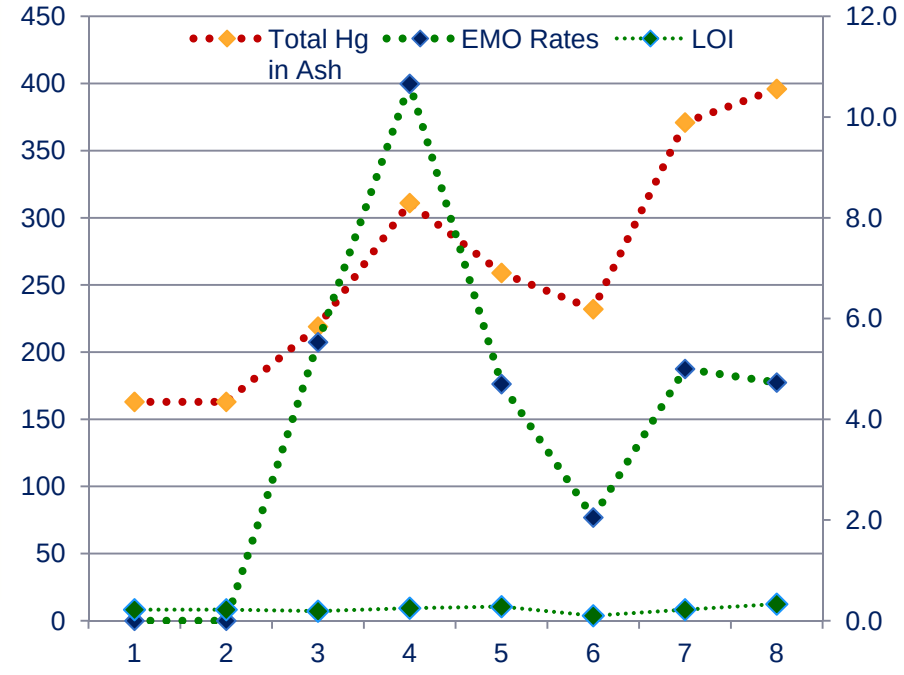
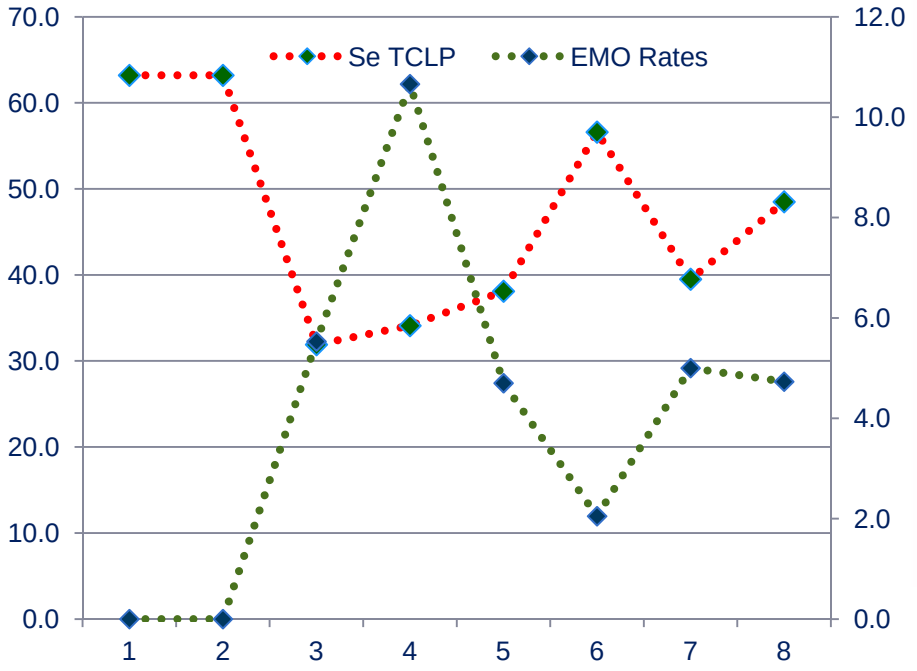
Fly Ash Samples Analyses

Client sample ID:		SMU1 FA 111411 AM	SMU1 FA 111511 AM	SMU1 FA 111511 PM	SMU1 FA 111611 AM	SMU1 FA 111611 PM	SMU1 FA 111711 AM	SMU1 FA 111711 AM
Testing Conditions		Baseline	EMO™ 5.5 ppmv	EMO™ 10.7 ppmv	EMO™ 4.7 ppmv	EMO™ 2.1 ppmv	EMO™ 5.0 ppmv	EMO™ 4.7 ppmv
LOI (%)		0.22	0.19	0.25	0.28	0.10	0.22	0.33
Total Mercury, µg/Kg		163	219	311	259	232	371	396
TCLP Chromium, µg/l	* 5,000	42.1	35.2	41.5	43.7	42.4	39.0	49.7
TCLP Arsenic, µg/l	* 5,000	32.4	26.5	35.8	30.3	26.7	26.3	36.0
TCLP Selenium, µg/l	* 1,000	63.2	31.9	34.1	38.1	56.6	39.5	48.5
TCLP Silver, µg/l	*5,000	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
TCLP Cadmium, µg/l	*1,000	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0
TCLP Barium, µg/l	* 100,000	235	269	267	263	280	253	279
TCLP Mercury, µg/l	* 200	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
TCLP Lead, µg/l	* 5,000	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0	<20.0





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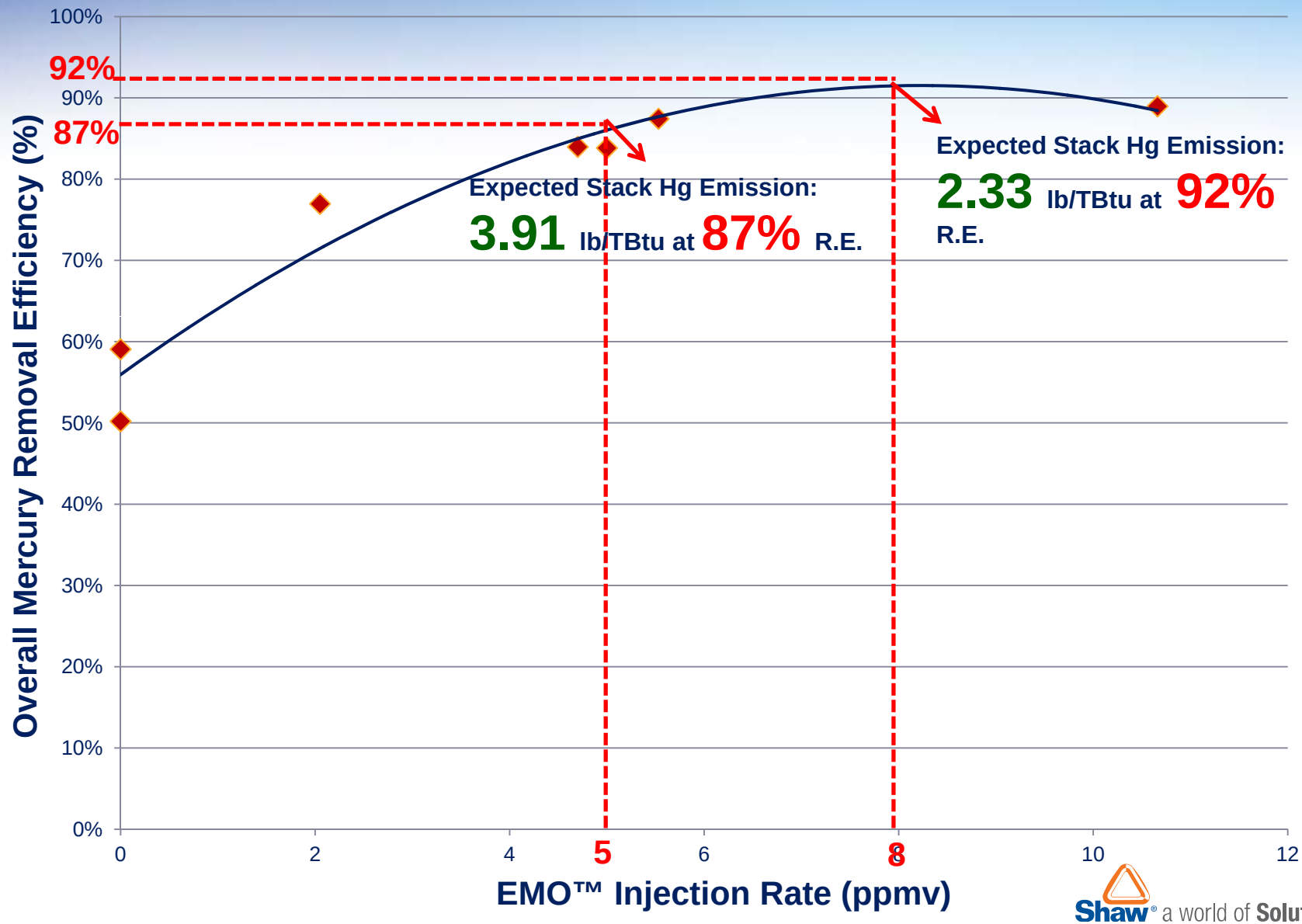
Overall System Hg Control Efficiency



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Impacts on Stack PMs

Date	Start	End	Unit Load	EMO™ Injection Rate	Stack FPM	Stack CPM	Stack TPM*
mm/dd/yy	HH:MM	HH:MM	(MW)	(ppmvd)	(lb/MMBtu)	(lb/hr)	(lb/MMBtu)
11/14/11	**9:35**	**11:35**	436	**0.0**	**0.0022**	**0.0049**	**0.0071**
	14:30	**15:30**	438	**0.0**	**0.0019**	**0.0055**	**0.0073**
11/17/11	**10:05**	**11:05**	440	**5.0**	**0.0017**	**0.0052**	**0.0069**
	14:30	**15:30**	439	**4.7**	**0.0016**	**0.0052**	**0.0068**

- EGU MACT filterable PM (FPM) limit: **0.03** lb/MMBtu
- Baseline FPM was measured between 0.0019 and 0.0022 lb/MMBtu
- Under the optimal EMO™ rate, the FPM was measured between 0.0016 and 0.0017 lb/MMBtu
- EMO™ yielded no impact to the stack FPM

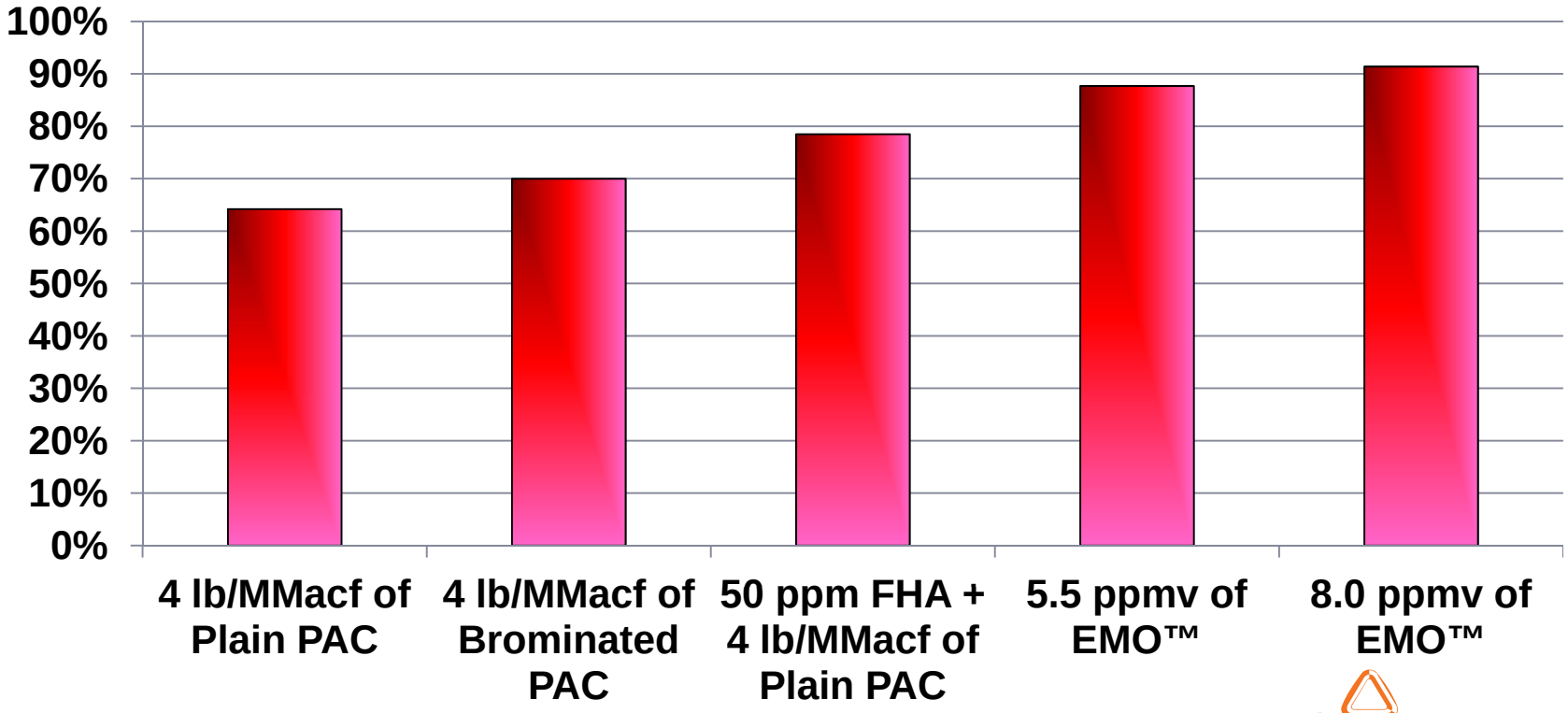
Impacts on Stack Halogen Gases

Date	Start	End	Unit Load	EMO™ Injection Rate	Stack HCl*	Stack HBr	Stack Cl2	Stack Br2
mm/dd/yy	HH:MM	HH:MM	(MW)	(ppmvd)	(lb/MMBtu)	(lb/MMBtu)	(lb/MMBtu)	(lb/MMBtu)
11/14/11	**9:35**	**11:35**	436	**0.0**	**5.89E-08**	5.09E-08	1.61E-07	1.61E-07
	14:30	**15:30**	438	**0.0**	**6.25E-08**	4.93E-08	1.75E-07	1.75E-07
11/17/11	**10:05**	**11:05**	440	**5.0**	**8.47E-08**	5.35E-08	1.39E-07	1.39E-07
	14:30	**15:30**	439	**4.7**	**8.33E-08**	5.10E-08	1.76E-07	1.47E-07

- EGU MACT HCl limit: **0.002** lb/MMBtu, **(2.0E-03** lb/MMBtu**)**
- Baseline stack HCl was measured between 5.89E-08 and 6.25E-08 lb/MMBtu
- Under the optimal EMO™ rate, the HCl was measured between 8.33E-08 and 8.47E-08 lb/MMBtu
- EMO™ yielded no impact to the stack HCl emissions

Performances/Economics Analyses

Flue Gas Treatment	Expected Hg Reduction	Projected Stack Hg (lb/TBtu)	Estimated Annual Cost ($)
4 lb/MMacf of Plain PAC	64%	8.95	$2,356,110
4 lb/MMacf of Brominated PAC	70%	7.50	$3,268,153
50 ppm FHA + 4 lb/MMacf of Plain PAC	79%	5.38	$2,664,250
5.5 ppmv of EMO™	88%	3.44	$1,519,122
8.0 ppmv of EMO™	91%	2.41	$2,068,420



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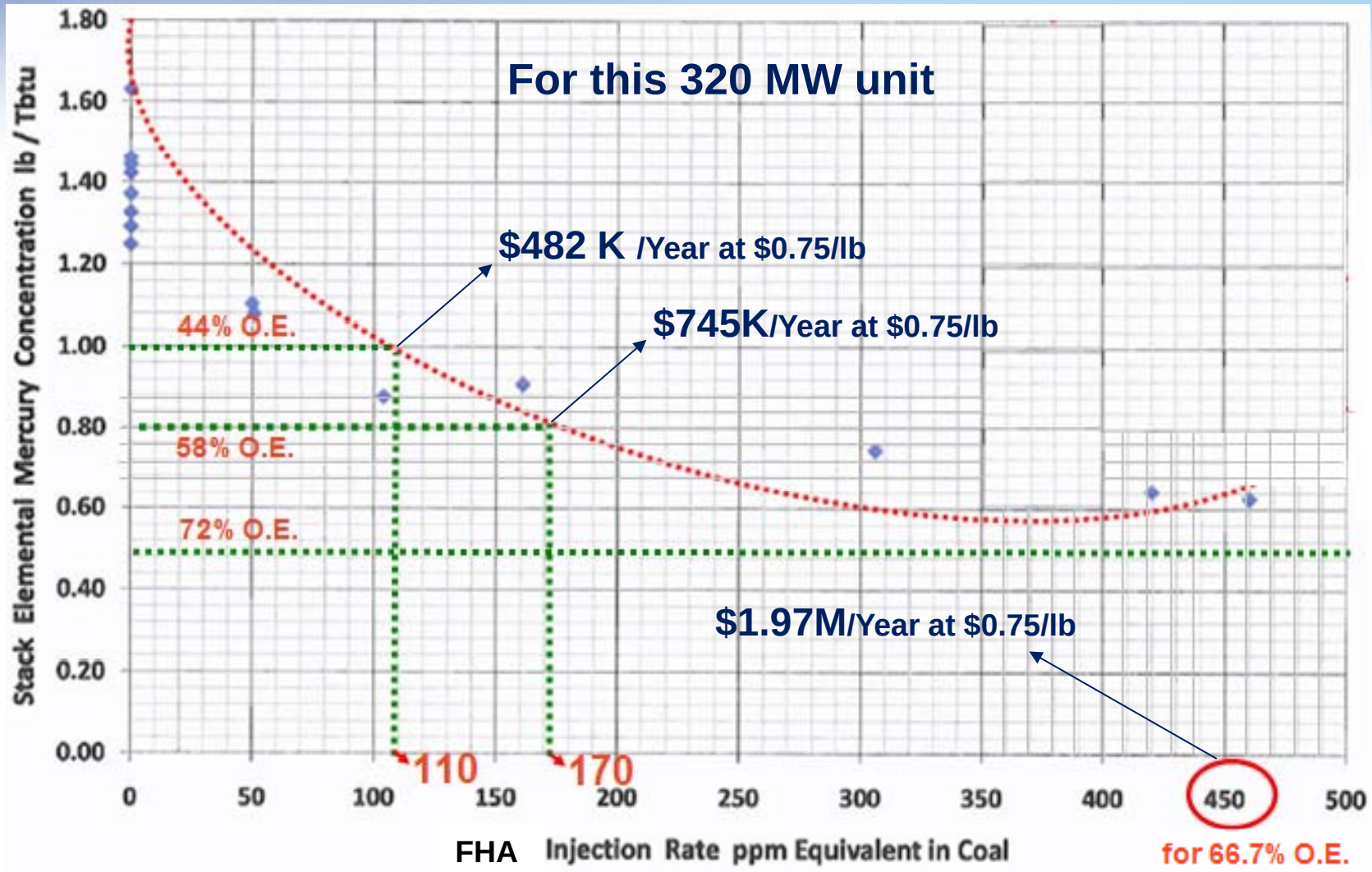
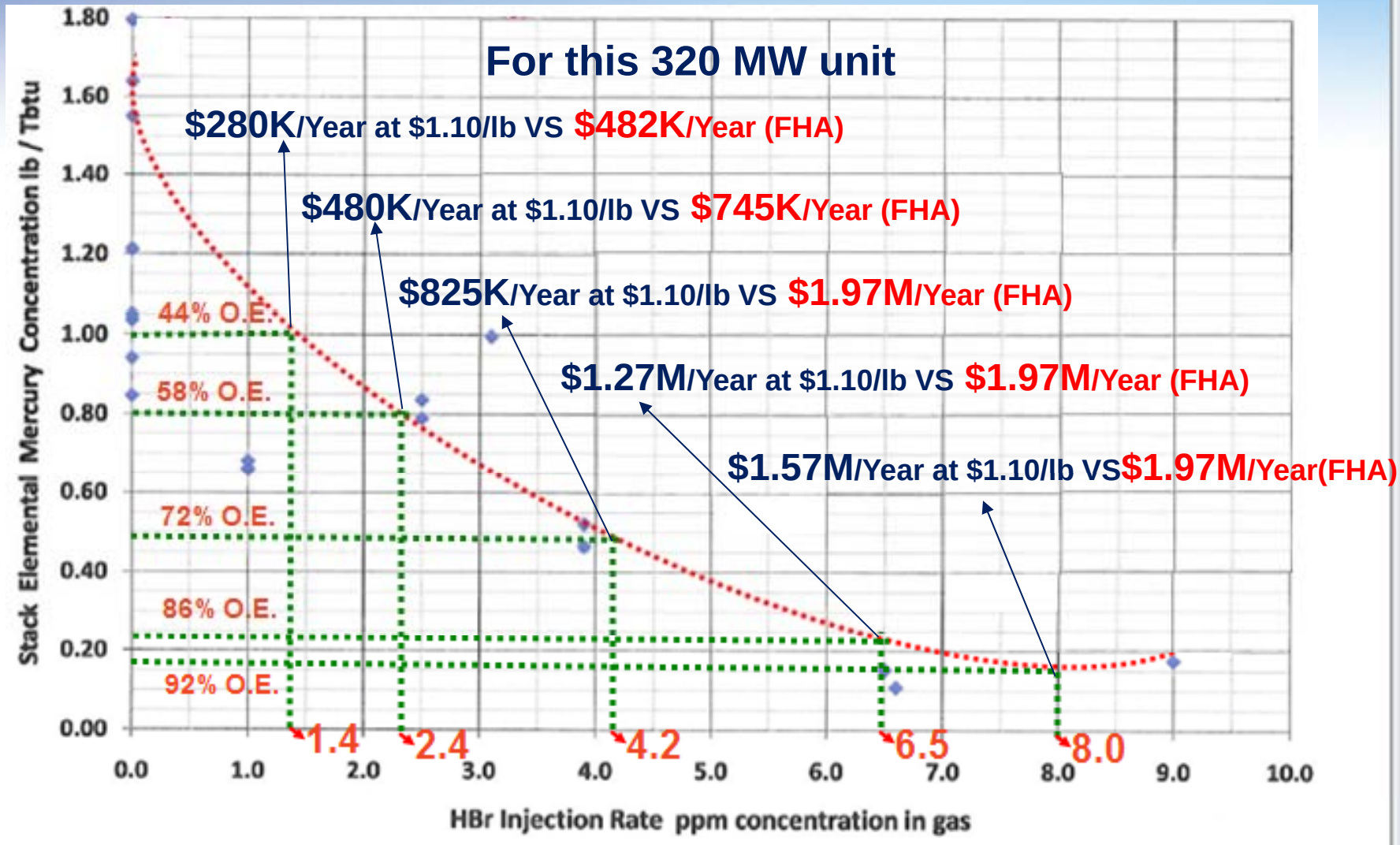
FHA Performance on Hg Oxidization



EMO™ Performance on Hg Oxidization



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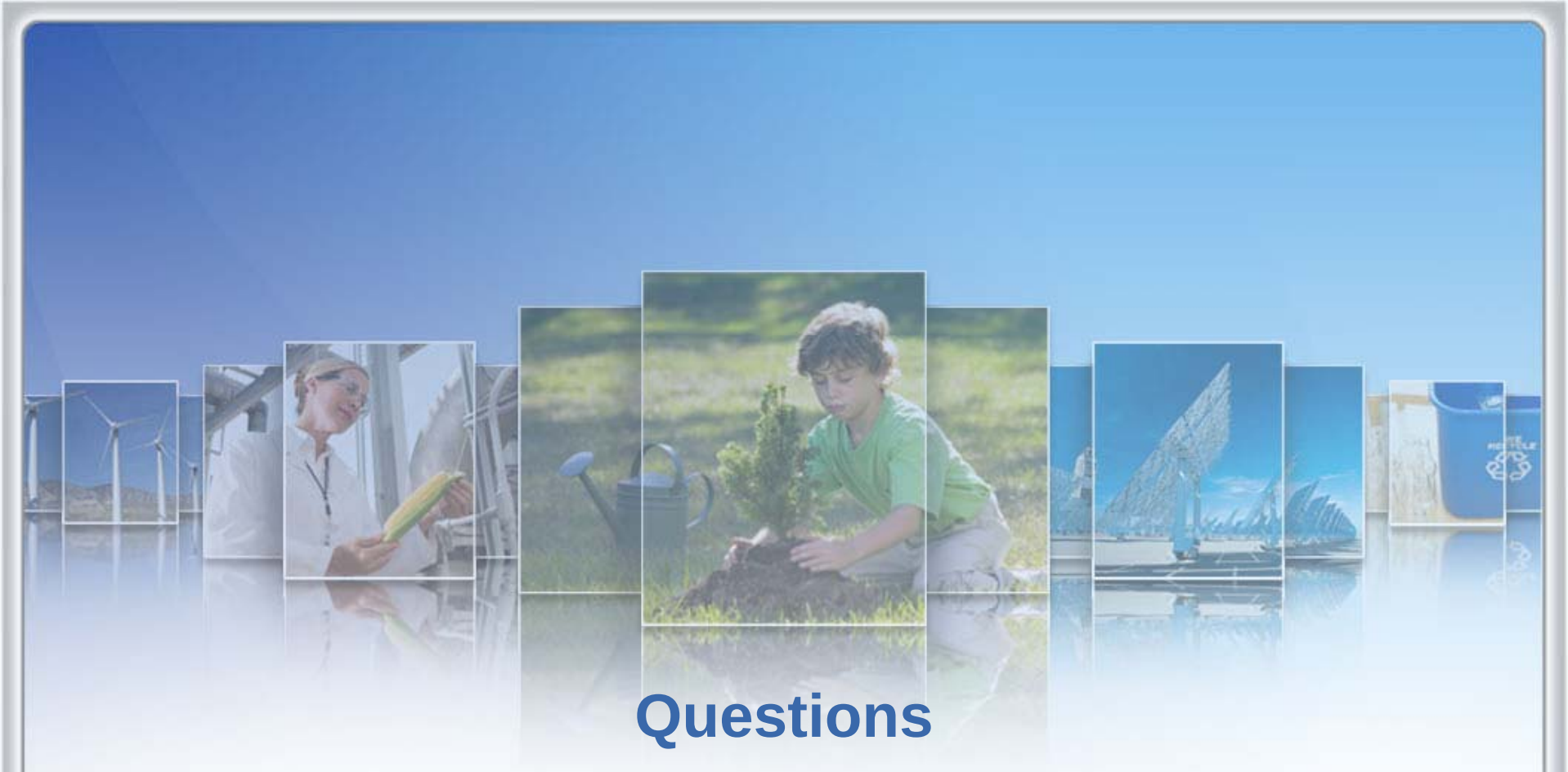
Conclusions & Recommendations

- ✓ EMO™ Injection successfully demonstrated Hg compliance to the final EPA EGU MACT (>90% plus stack Hg oxidization and Hg removal efficiency)
- ✓ EMO™ yielded no impact to the stack FPM, and HCl emissions
- ✓ EMO™ injection does not create fly ash disposal problems (No metal leaching issues observed)
- ✓ Some applications require a combination of EMO and PAC for efficient Hg control and to be cost-effective



Questions

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