EMO® and Redox-Hg^{RPC} - Effective Stack Mercury Emission Control

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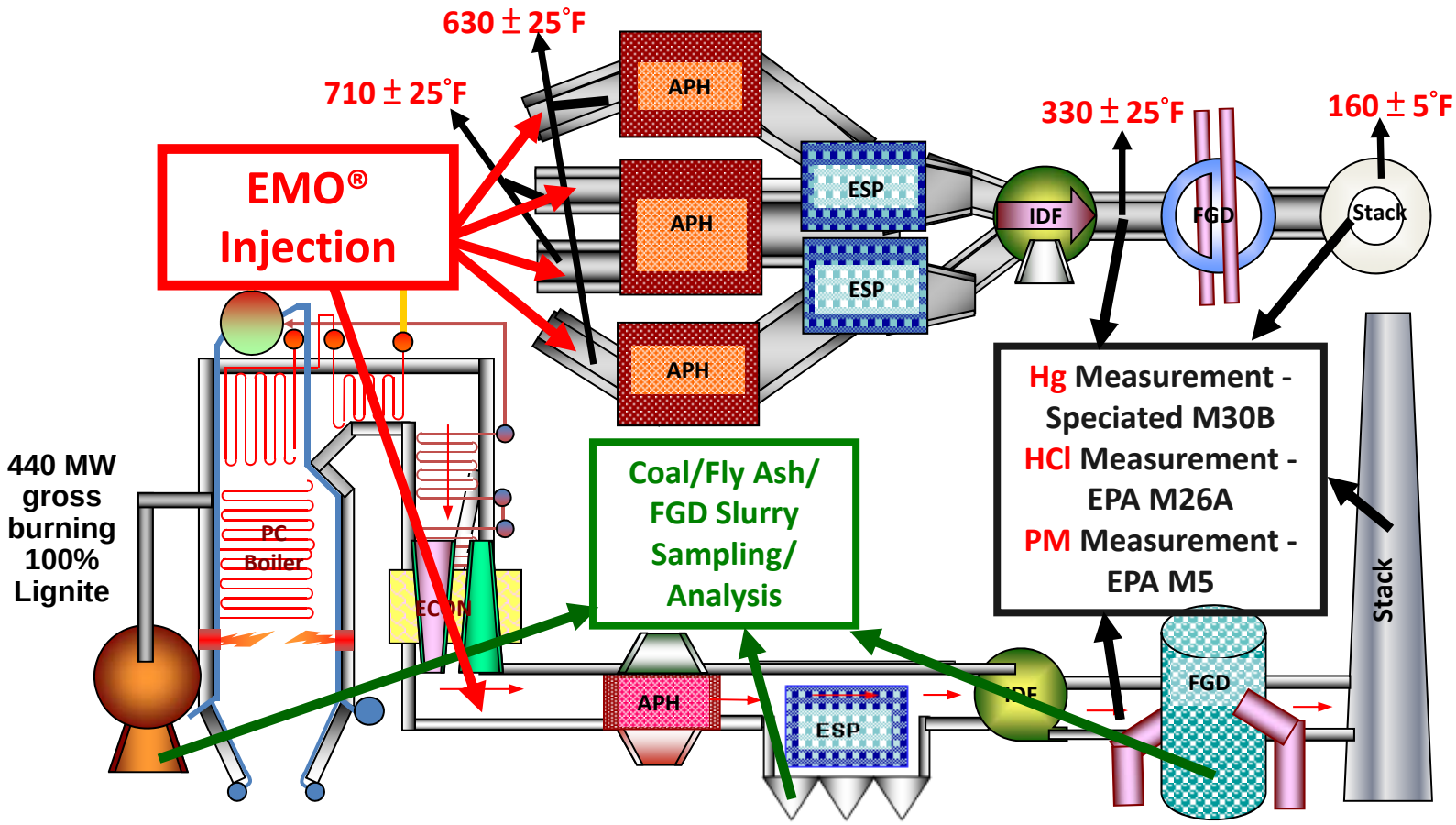
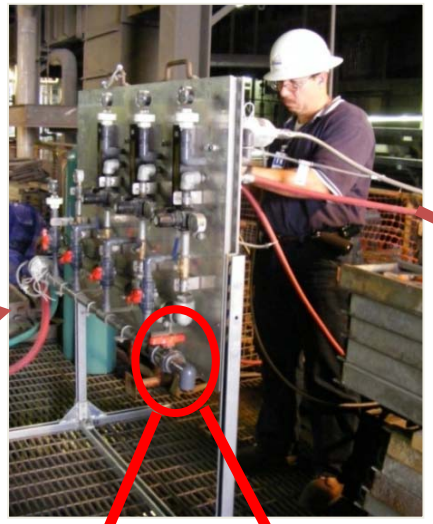
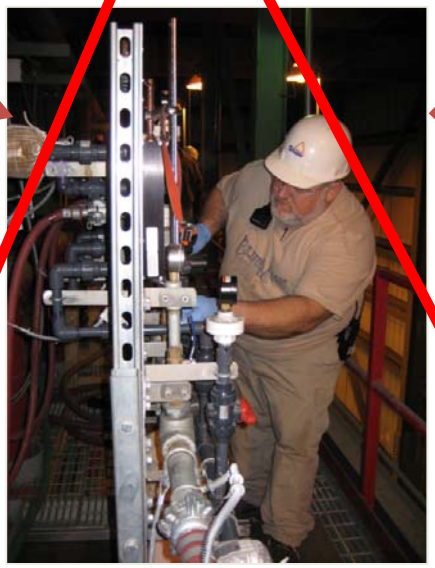
Unit Configuration and Testing Arrangements



- Injecting chemical: EMO® chemical additives
  - Mercury Oxidization: **Hg(0)** ⟶ **Hg(2+)**
  - Mercury Absorption/Adsorption: in the existing precipitator and scrubber
- Injection location and temperature: Economizer outlet (**730**˚F/**350**˚F)

EMO® Injection



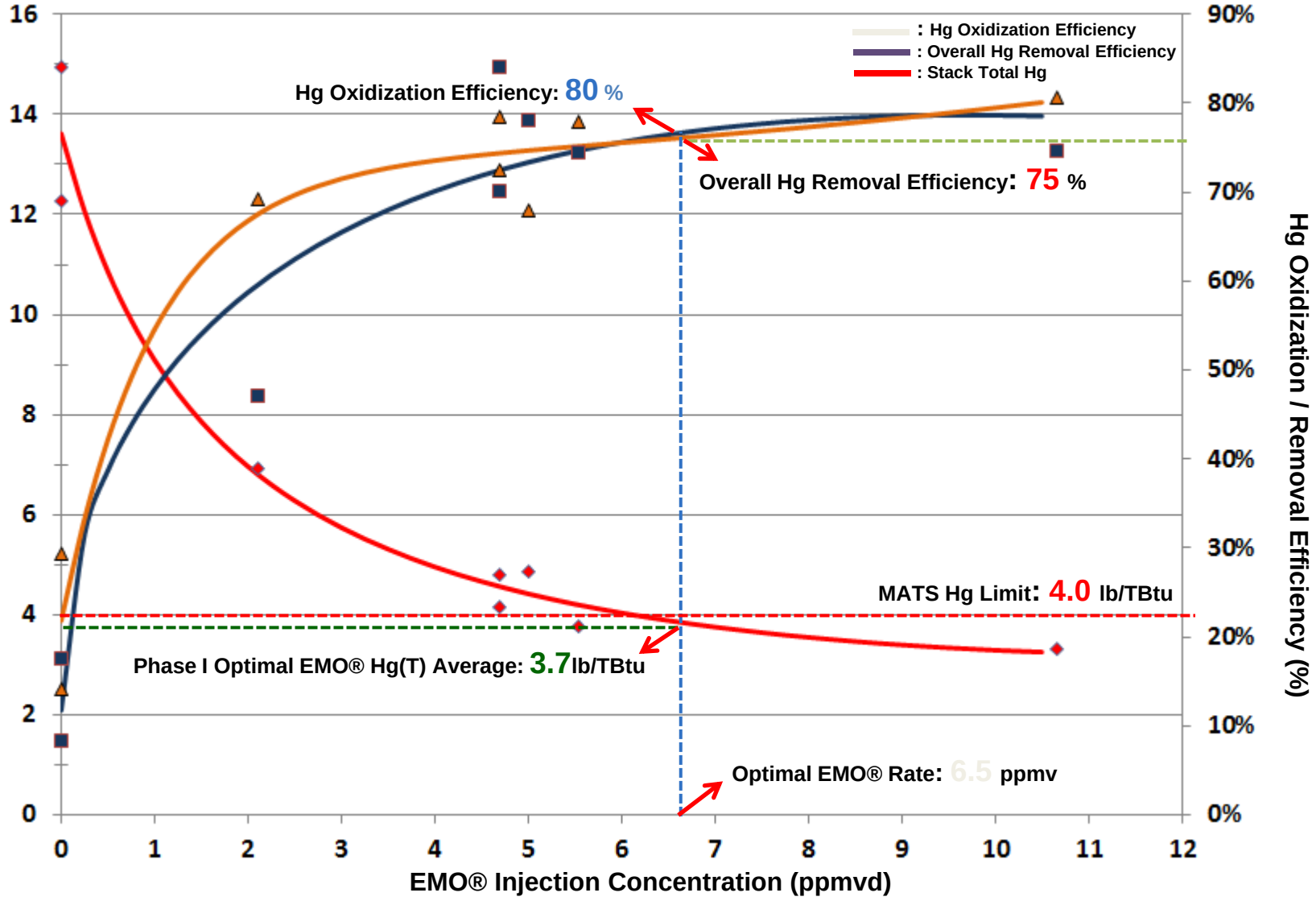


48% EMO Chemical → **2-6%** EMO Chemical

2-6% **EMO Chemical** → **X** ppmv Hg Oxidant

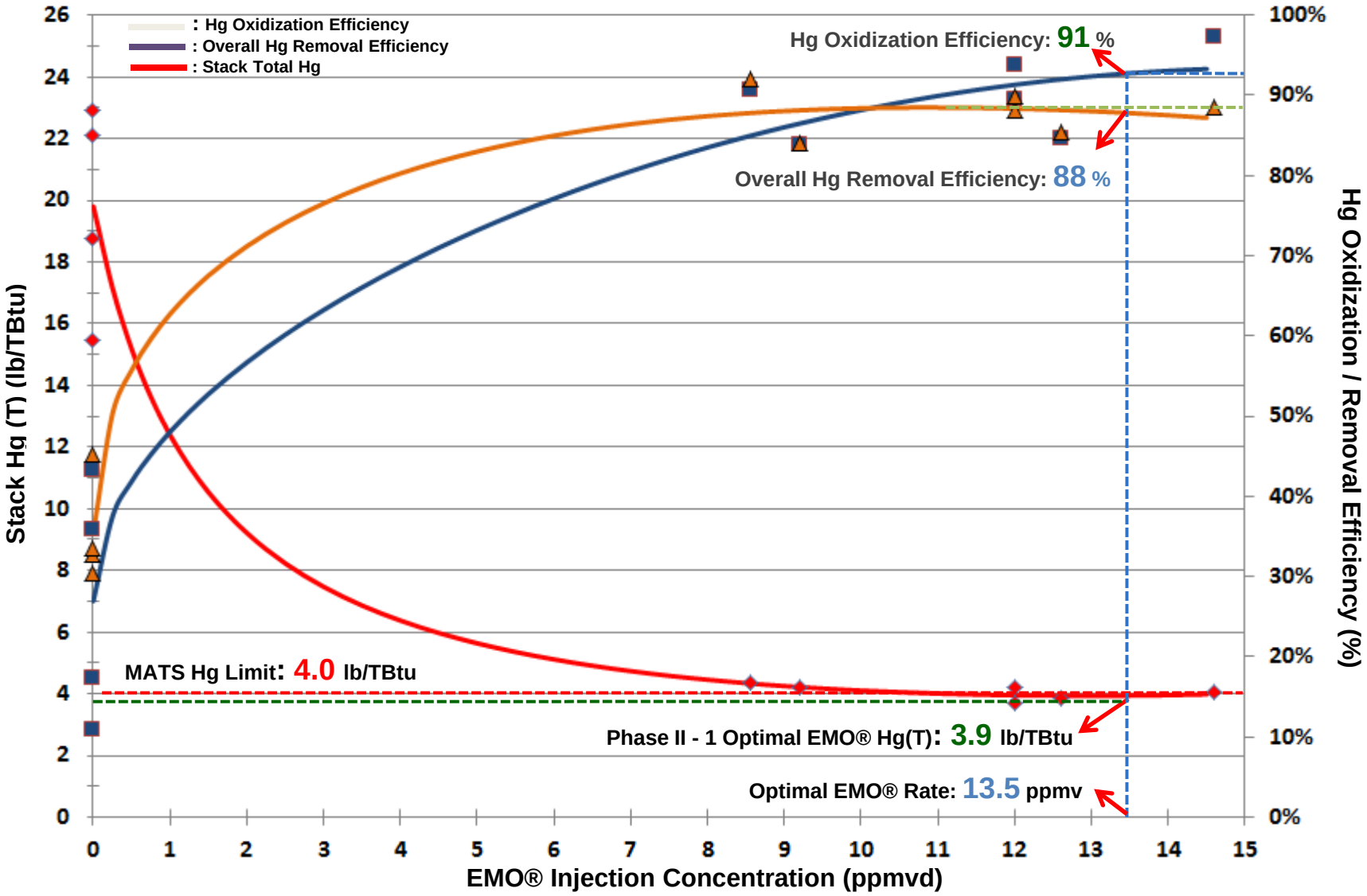
- The **X** ppmv of EMO® injection rate was precisely determined by direct sample titration

EMO® Phase I Overview (11/14/2011-11/17/2011)



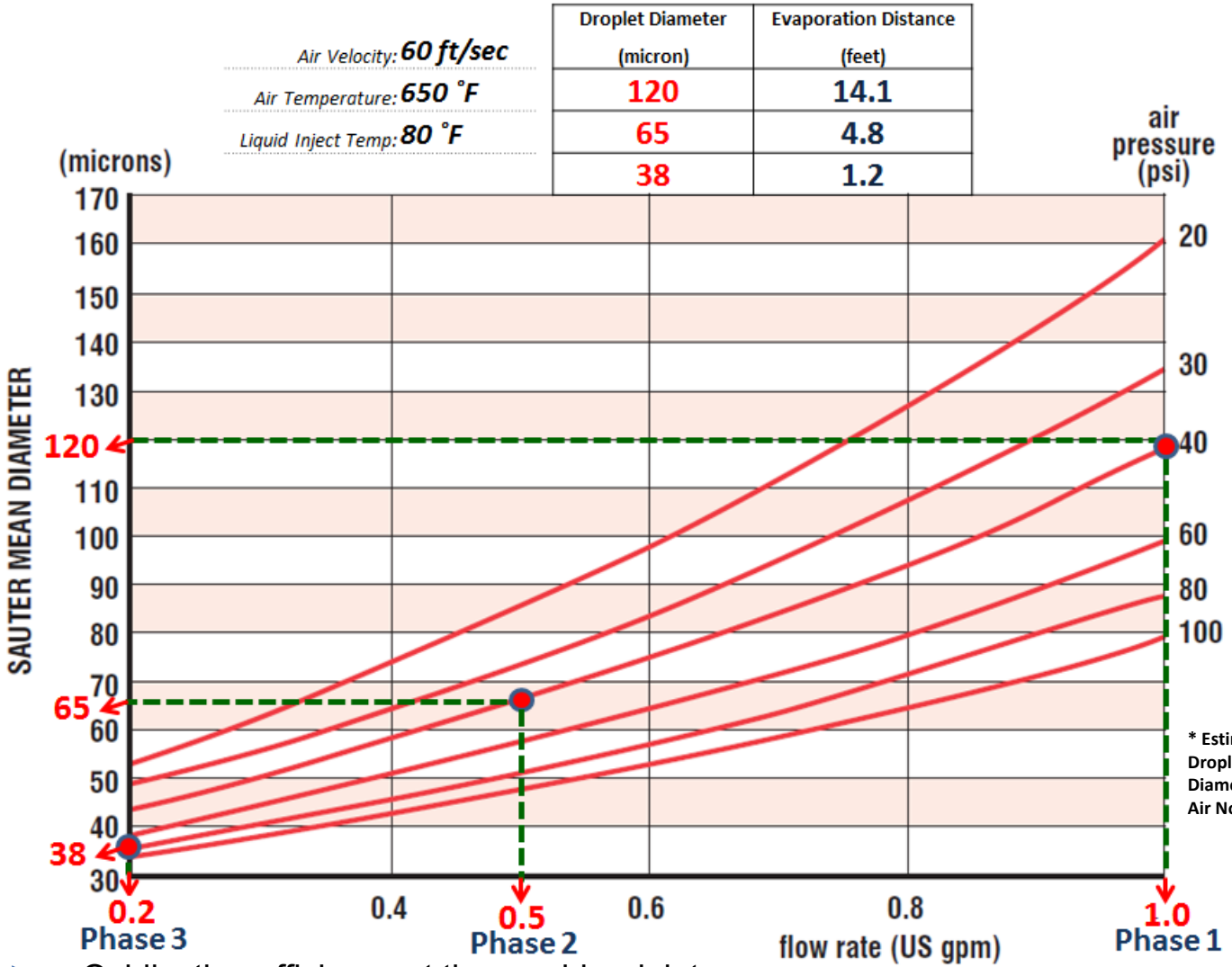
- Hg content in coal varied between **15.1** and **22.4** lb/TBtu, averaged at **18.0** lb/TBtu

EMO® Phase II - 1 Overview (5/22/2012 – 6/12/2012)



- Hg content in coal varied between **26.6** and **54.1** lb/TBtu, averaged at **33.7** lb/TBtu, Phase 1: **18.0** lb/TBtu

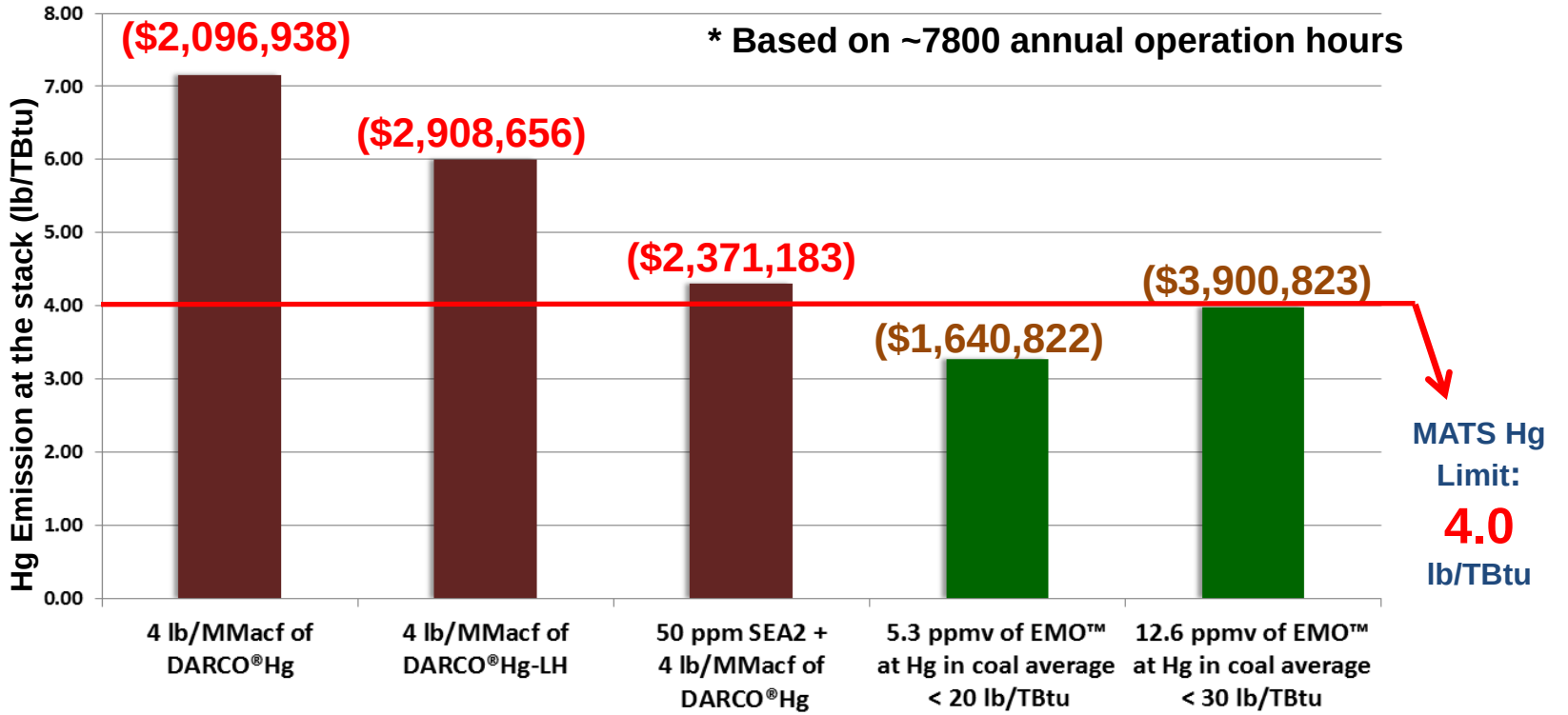
Flue Gas Flow Analysis



- Oxidization efficiency at the scrubber inlet:

Phase 3: **98**%; Phase 2: **88**%; Phase 1: **80**%;

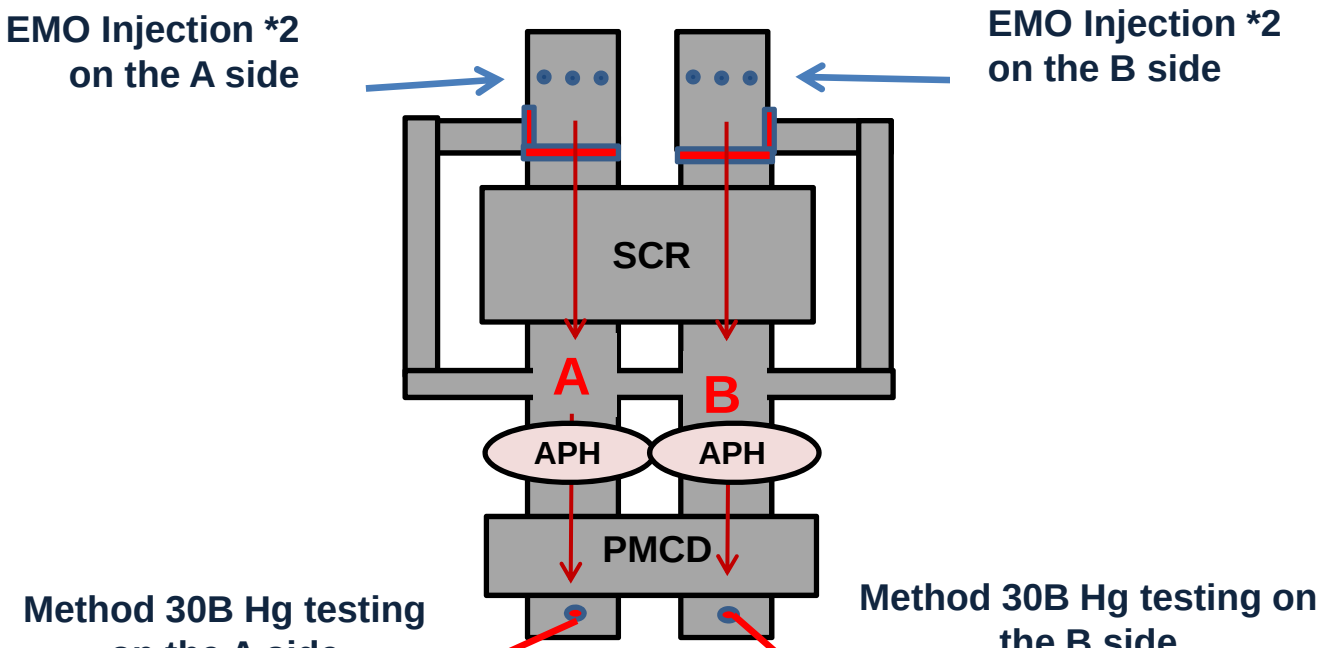
Economic Analysis – Various Hg Control Options



- The cost estimates for **the first 3 non-EMO® injection options** were based on Hg Content in coal ~ **20** lb/TBtu. **None of them demonstrated MATS compliance!**
- When the Hg content in coal ~ **20** lb/TBtu, it required ~**5.3** ppmv of EMO® chemical with the resulting stack Hg(T) at: **3.3** lb/TBtu with a cost of annual chemical consumption at **$1,640,822**
- When the Hg content in coal ~ **30** lb/TBtu, it required ~**12.6** ppmv of EMO® chemical with the resulting stack Hg(T) at: **3.9** lb/TBtu with a cost of annual chemical consumption at **$3,900,823**

EMO® on SCR Hg Oxidization Enhancement

Unit Configuration: **300 MW, SCR+PMCD+FGD, 100% Bituminous**



	Hg(T)
8/5/2013	11.72
8/6/2013	12.22
8/7/2013	3.82
8/8/2013	1.85

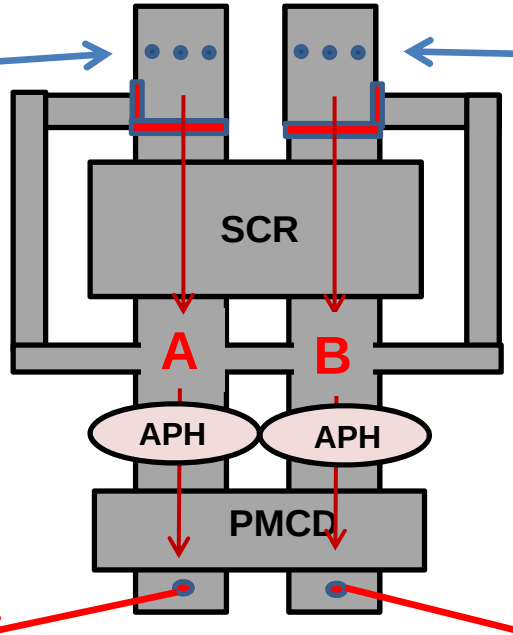
	Hg(T)
8/5/2013	14.03
8/6/2013	13.17
8/7/2013	1.69
8/8/2013	0.21

EMO® on SCR Hg Oxidization Enhancement

Unit Configuration: **250 MW, SCR+PMCD+FGD, 100% Bituminous**

EMO Injection *3 Duct A

EMO Injection *3 Duct B



Method 30B Hg Testing Duct A

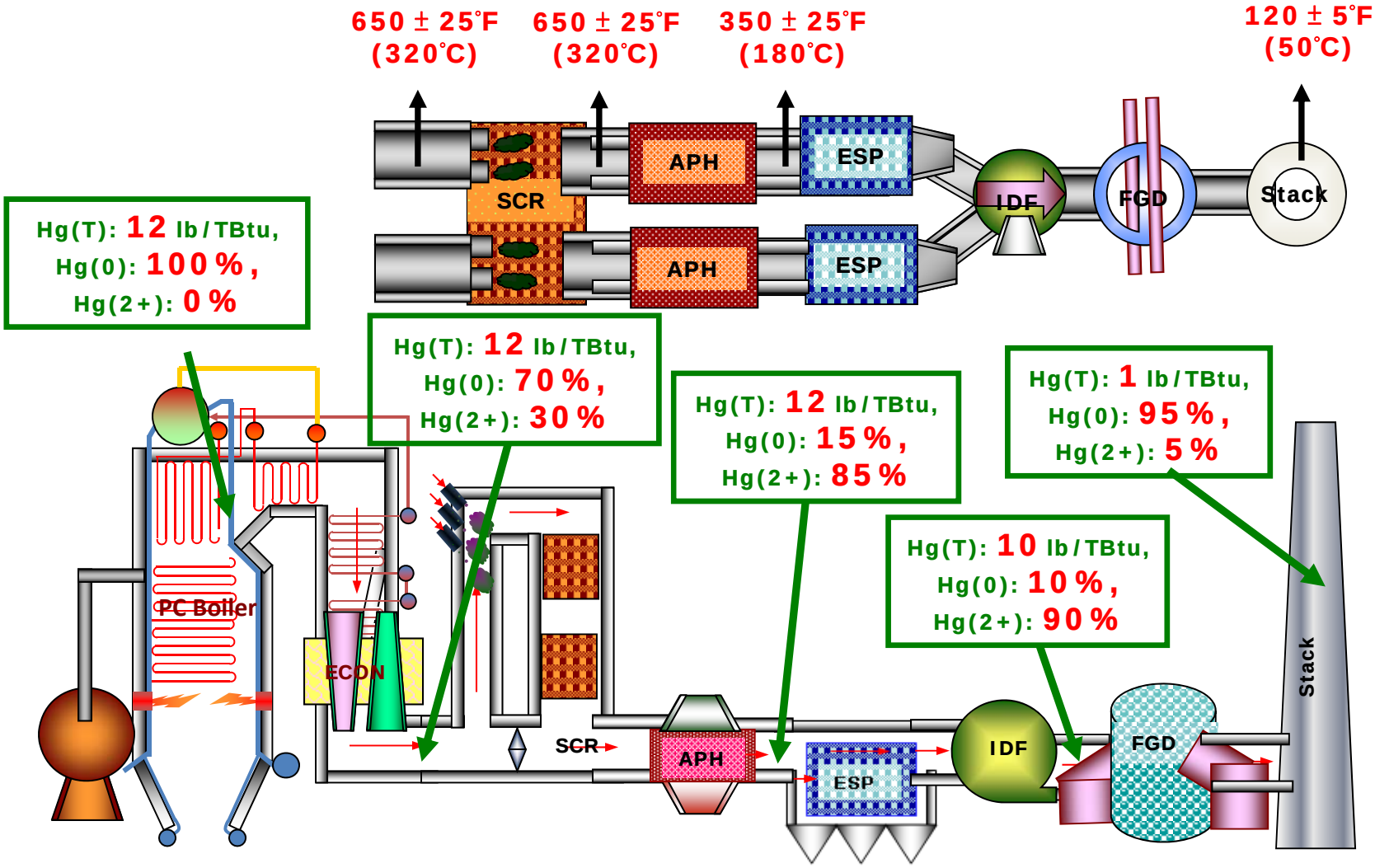
	EMO Rate	Hg(T)
7/29/13	3.3	2.28
	4.4	0.73
7/30/13	4.7	4.85
	5.3	4.30
7/31/13	7.4	0.46
	7.4	0.38

Average Hg(T) FGD inlet
4.63
4.34
6.49
6.97
1.26
1.20

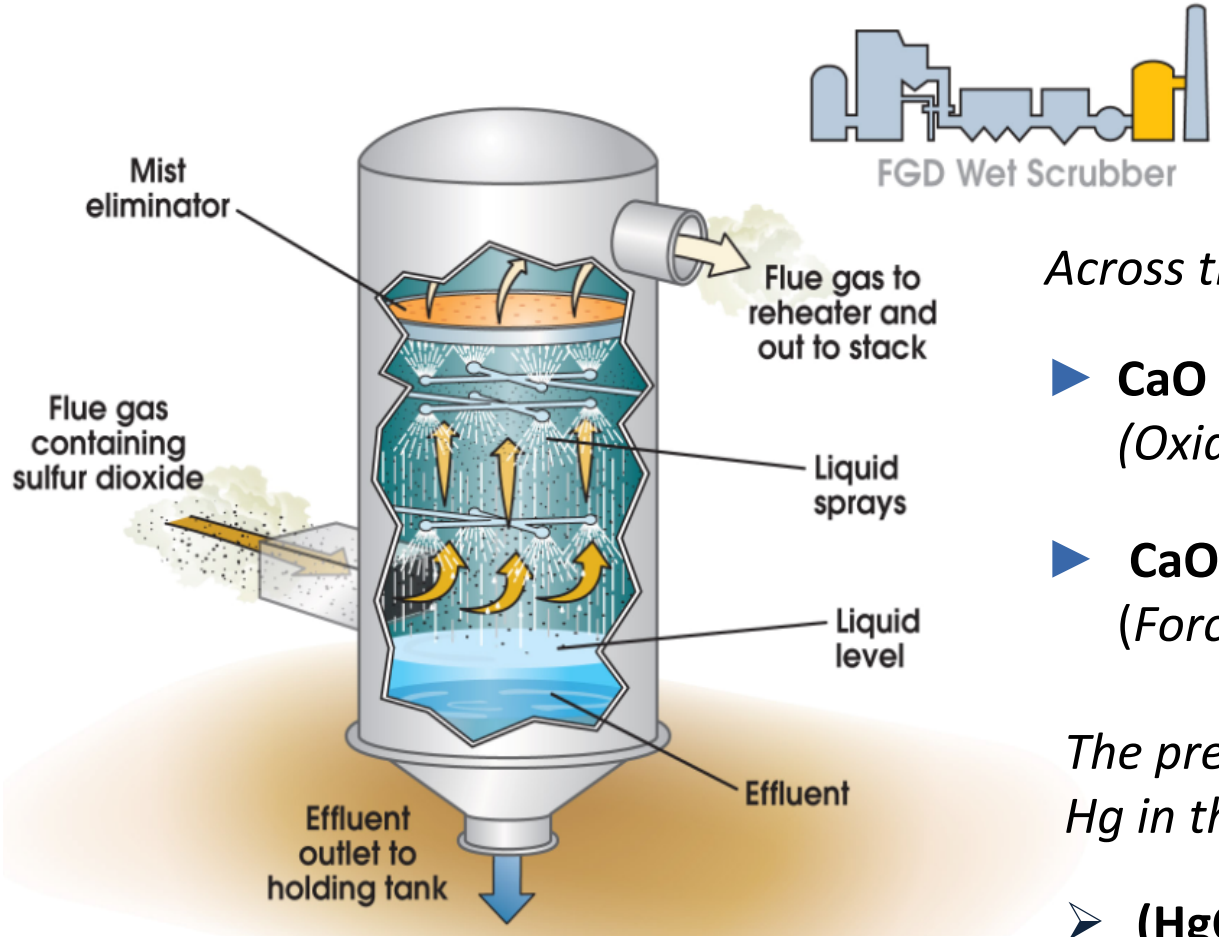
Method 30B Hg Testing Duct B

	EMO Rate	Hg(T)
7/29/13	3.3	6.98
	4.4	7.94
7/30/13	4.7	8.13
	5.3	9.64
7/31/13	7.4	2.05
	7.4	2.01

FGD Mercury Reemission



- If more than **1.0** lb/TBtu of stack Hg emission is observed, there is Hg reemission across the FGD



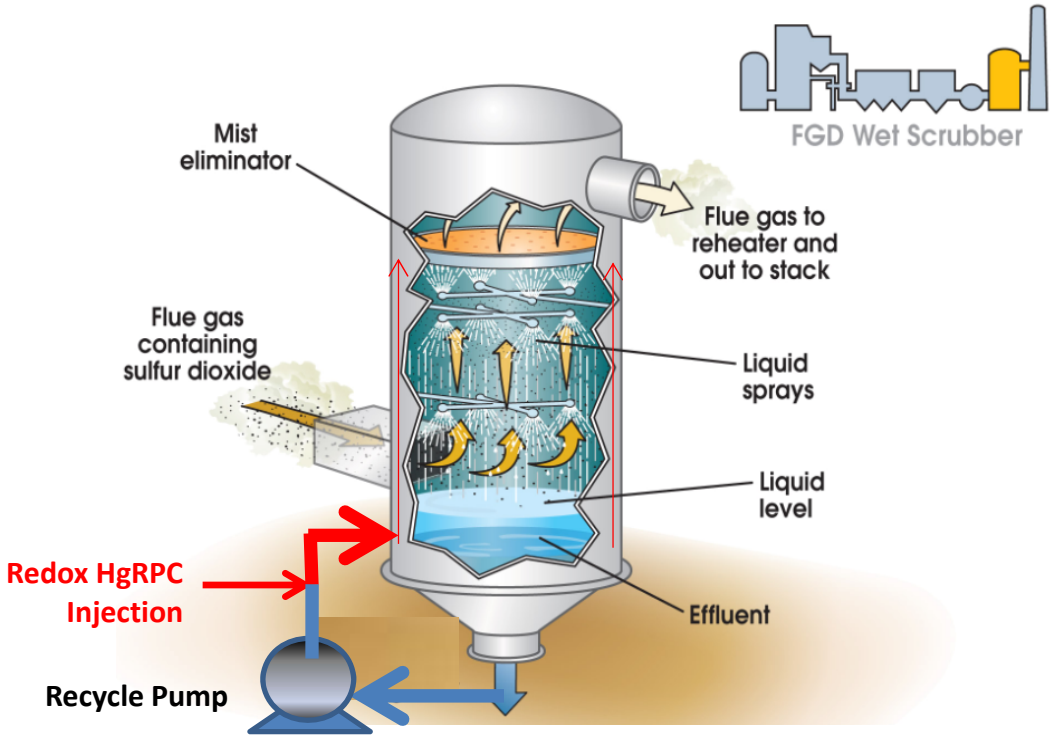
Across the FGD:

- **$CaO + SO_2 \rightarrow CaSO_3$**
  (Oxidization)
- **$CaO + O_2 + SO_2 \rightarrow CaSO_4$**
  (*Forced Oxidization)*

The predominant form of oxidized Hg in the flue gas is HgCl, HgCl2

- **(HgCl, HgCl2) → Hg(0)**
  (Reducing Reaction – Hg Reemission)

Redox- Hg^{RPC}



Date (2013)	Test	Hg in Coal Blend lb/TBtu	Dose/Scrubber Redox-Hg^{RPC} GPH	FGD Inlet			Stack			System
				Hg^0 lb/TBtu	Hg^T lb/TBtu	% Hg Oxidization	Hg^0 lb/TBtu	Hg^T lb/TBtu	% Hg Re-emission	% Overall Hg Removal
7/11	Baseline	6	0	0.68	**3.13**	88.7%	1.06	1.41	56%	76.5%
7/25	Baseline	9	0	0.15	**5.91**	98.3%	1.95	2.25	1200%	75.0%
11/11	Baseline	12	0	0.36	**6.72**	97.0%	1.21	1.46	236%	87.8%
11/12	Parametric	12	40	0.90	**10.99**	92.5%	0.40	0.59	0%	95.1%
11/19	Parametric	12	20	1.08	**9.60**	91.0%	0.30	0.46	0%	96.2%
11/19	Parametric	12	10	0.93	**8.55**	92.3%	0.23	0.33	0%	97.3%
11/20	Parametric	12	5	0.84	**9.88**	93.0%	0.31	0.50	0%	95.8%

- CB&I's EMO® technology has proven to be effective to oxidize the flue gas elemental Hg to facilitate the Hg(T) removal across the existing ESP and scrubber.
- For the SCR application, EMO® can further improve Hg oxidization efficiency regardless of SCR catalysts aging
- Comparing to PAC injection, EMO® injection is **~60%** more cost effective.
- Redox – Hg^{RPC} can effectively prevent Hg reemission across the FGD while maintaining the gypsum quality
- Comparing to all other Hg reemission chemicals, Redox-Hg^{RPC} is **~110% to ~150%** more cost effective

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