South Coast
Air Quality Management District

SOx RECLAIM

WORKING GROUP MEETING

April 3, 2008

Allocations

- Tier I Allocations (note)
- Tier II Shave Factor = 34.75%
- Tier II = (1 – 0.3475) x Tier I
  = 0.6525 x Tier I

Note: Unadjusted Tier I

Allocations & Emissions

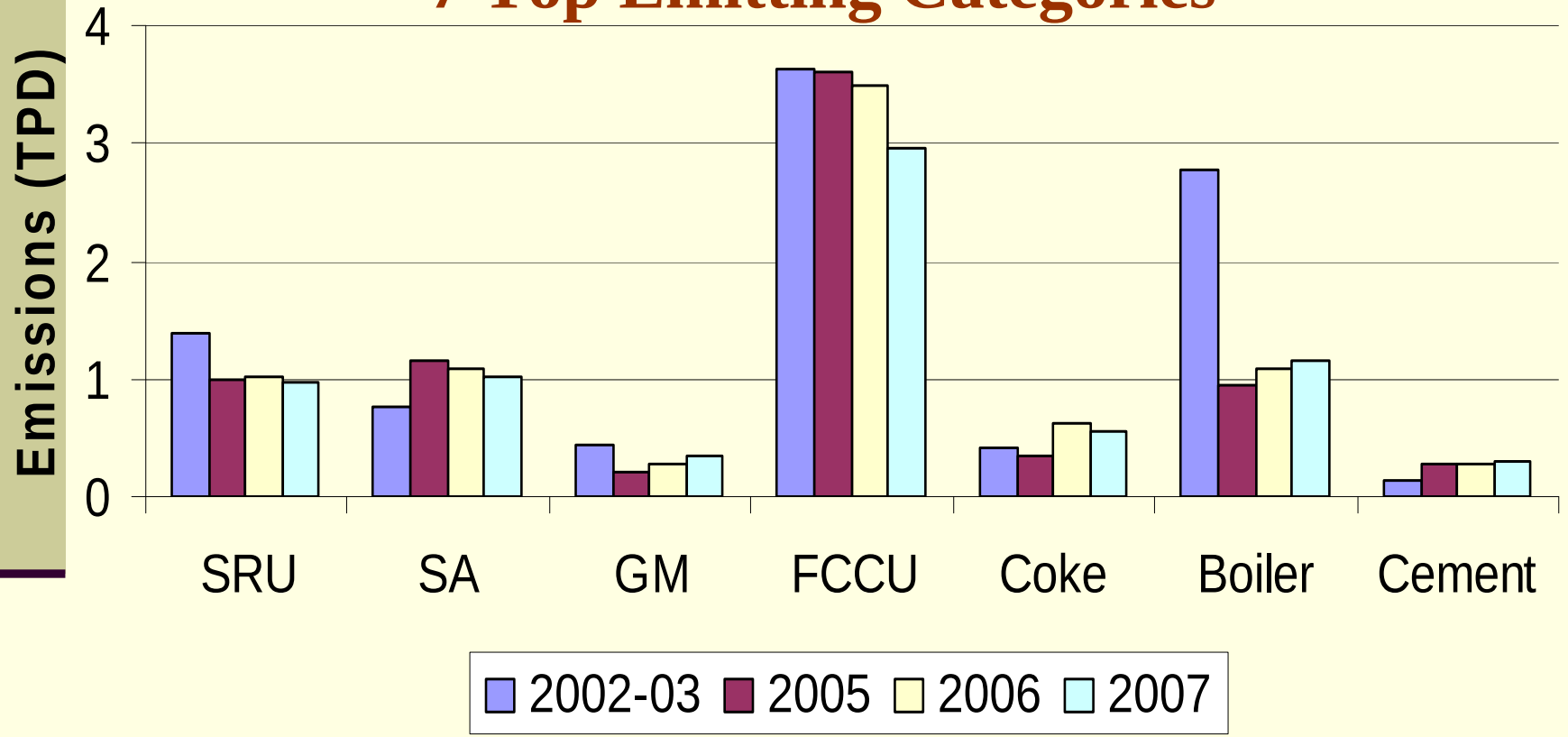
	ALLOCATIONS (TPD)**		EMISSIONS (TPD)	
FACILITY	**TIER I**	**TIER II**	**2002-03**	**2005**
BP, CARSON	1.31	0.85	2.57	1.86
EXXONMOBIL	0.75	0.78	0.74	0.91
CONOCOP, WILM	1.19	0.45	1.38	1.15
CHEVRON	1.29	0.84	1.41	0.99
TESORO	0.69	0.20	1.02	1
ULTRAMAR	0.30	0.49	0.99	0.86
CONOCOP, CARSON	0.28	0.18	0.69	0.58
BP, WILMINGTON	1.28	0.84	0.41	0.36
CPCC	0.33	0.22	0.15	0.28
RHODIA	1.71	1.12	0.78	1.13
OWENS-BROCKWAY	1.01	0.66	0.43	0.2
OTHERS	4.92	3.19	1.13	0.60
TOTAL	**15.06***	**9.81**	**11.70**	**9.92*****

*** Unadjusted, 41 facilities** **** Not Including Trades** ***** 33 facilities**

2002 – 2007 Emissions

11 Top Emitting Facilities

7 Top Emitting Categories



Total: 9.6 TPD (2002 with All Boilers/Heaters)
7.5 TPD (2005), 7.9 TPD (2006), 7.3 TPD(2007)

Survey Responses
FCCUs

- **Tier I Level: 13.7 Lbs/Mbarrels**
- 2005 Emission Rates
  - Refinery 1: 7 Lbs/Mbarrels
  - Refinery 2: 11 Lbs/Mbarrels
  - Refinery 3: 17 Lbs/Mbarrels
  - Refinery 4 & 5: 22 Lbs/Mbarrels
  - Refinery 6: 35 Lbs/Mbarrels
- **Current Average: 17.9 Lbs/Mbarrels**

Survey Responses
FCCUs

- SOx Concentrations (0% O_2)
  - **Refinery E: 11 ppmv with GRACE DAVISON**
  - **Refinery D: 12 ppmv with Hydrotreating**
  - Refinery A: 18 ppmv with INTERCAT
  - Refinery B: 36 ppmv with GRACE DAVISON
  - Refinery C: 55 ppmv with INTERCAT
  - Refinery F: 58 ppmv with INTERCAT or GRACE *

*Use SOx Reducing Catalysts When Needed. In 2007 Trials Achieved 70%-80% SOx Reduction, 15 ppmv – 23 ppmv SOx Concentrations

Survey Responses
FCCUs

- Consent Decree Limits*
  - 3 Refineries: 25 ppmv, By 2011
  - 1 Refinery: 36 ppmv
  - 1 Refinery: 50 ppmv
- All Refineries Operate At Below Limits Required By Consent Decree

* Limits are 365-day averages. At one refinery, limit is for FCCU and waste heat boiler, including start-up, shut-down, malfunction

Survey Responses

FCCUs – SOx Reducing Catalysts

- Pickup Factor = 4.0 – 7.5 Lbs SOx Per Pound of Catalyst*
- Control Efficiency = 70% - 80%
- Emission Rate = ~ 20 Lbs/Mbarrels
- Costs: $6 - $8 Per Pound Catalyst
- CE = $2,000 - $3,500 Per Ton SOx

* Based on reported data from 2 refineries

Survey Responses

FCCUs – Wet Scrubber/Wet ESP

- Wet Scrubber/Wet ESP for PM_{10} & SOx
- Estimated Impacts
  - SOx Control Efficiency = 86%
  - Emission Reduction = 1.8 TPD SOx
  - Emission Rate = 11 Lbs/Mbarrels
  - CE = $4,200 Per Ton SOx Reduced *

* Cost-Effectiveness Does Not Include PM10 Reduction Benefits and Annual Operating Costs

BARCT Top Down Analysis

FCCUs

- **Best Performance of Individual Control?**
- **Combination of Control?**
- **Cost-Effectiveness?**
- **Goal: ≤ 7 lbs/Mbarrels or ≤10 ppmv?**
- **Potential Emission Reduction = 2 TPD*?**

* Calculated from 2005 baseline assuming all 6 refineries will meet an average emission rate of 7 lbs/Mbarrels

Survey Responses
SRUs – Tail Gas Treatment

- **Tier I Level = 1.61 TPD (1988 – 1992)**
- **2005 Emissions = 0.96 TPD**
- Operating at 60% - 87% Design Capacity
- Two to Four Trains of SRUs (Claus)
- Tail Gas Treatment Units
  - SCOT, WELLMAN–LORD, FLEXSORB
- Thermal Oxidizers

Survey Responses
SRUs – Tail Gas Treatment

- SCOT: 96% - 99.5% Sulfur Recovery
  - 3 ppmv - 10 ppmv from Tail Gas Treatment System
  - 20 ppmv - 150 ppmv SOx from Thermal Oxidizer
- WELLMAN–LORD: 99.9% – 99.99%
  - 59 ppmv – 77 ppmv SOx from Thermal Oxidizer
- FLEXSORB: 99.9%
  - 16 ppmv – 20 ppmv SOx from Thermal Oxidizer

BARCT Top Down Analysis

SRUs – Tail Gas Treatment

- Wet Gas Scrubbers: 99.99% and Below 1 ppmv SOx at Other Refineries
- **Goal: 99.9% Sulfur Recovery (or 3ppmv Outlet from Tail Gas Treatment System, or 10 ppmv SOx Outlet from Thermal Oxidizer)?**
- **Cost-Effective?**
- **Potential Emission Reduction = 0.3 TPD*?**

*Calculated from 2005 Baseline and 99.9% Sulfur Recovery Efficiency

Survey Responses
Boilers/Heaters

- **Tier I Allocation = 0.89 TPD (All Units)**
- **Tier II Allocation = 0.58 TPD (All Units)**
- **Current Emissions**
  - **3 TPD (All Units)**
  - Top 15 Emitters: Crude Heaters, Delayed Coking Unit Heaters, Steam Generation Boilers
  - **1 TPD for Top 15 Emitters**

Survey Responses
Boilers/Heaters

- Current System - Fuel Gas Treatment
  - Amine for H_2S Removal At All Refineries
  - Merox for Carbonyl Sulfides, Mercaptan At Some Refineries
  - Not All Fuel Gas Treated Prior to Combustion
  - Fuel Sulfur Content = 23 ppmv – 450 ppmv+
  - SOx = 3 ppmv – 45 ppmv (Measured or Calculated from Fuel Sulfur Content)

Survey Responses
Boilers/Heaters

- Example - Performance at One Refinery
  - Amine and Merox Treatment
  - Fuel Sulfur Content: 47 ppmv Average
  - SOx: Avg 6.5 ppmv, Max 25 ppmv (3% O2)

BARCT Top Down Analysis

Boilers/Heaters

- **Goal:**
  - **Upgrading Fuel Gas Treatment System?**
  - **Wet Scrubber for Top Emitters?**
  - **25 ppmv Total Sulfur Measured As H2S**
  - **<5 ppmv Outlet SOx Concentration?**
- **Cost-Effective?**
- **Potential Emission Reduction = 0.46 TPD* - 2.42 TPD****

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* 50% Reduction for Top 15 Emitters

** 80% Reduction for All Units To Be At Tier II Allocations

Survey Responses
Sulfuric Acid Manufacturing

- **Tier I Level: 4.00 – 9.48 Lbs/Ton Acid**
- Current Emission Rates
  - **Facility 1: 0.22 – 0.36 Lbs/Ton Acid**
  - Facility 2: 1.58 – 1.84 Lbs/Ton Acid
- Current SOx Concentrations
  - Facility 1: 26 ppmv
  - Facility 2: 145 ppmv

Survey Responses
Sulfuric Acid Manufacturing

- Current Control Technology
  - **Facility 1: Wet Regenerative Scrubber**
  - Facility 2: Double Absorption
- Consent Decree Limits
  - **Facility 3: 0.2 Lbs/Ton Acid**
  - Facility 2: 1.7 Lbs/Ton Acid

BARCT Top Down Analysis

Sulfuric Acid Manufacturing

- Can Double Absorption Meet 0.2 Lbs/Ton?
- Is Wet Scrubber Cost-Effective?
- **Goal: 0.2 – 0.3 Lbs/Ton?**
- **Potential Emission Reduction = 1 TPD*?**

* Calculated from 2005 baseline assuming Facility 2 will meet an emission rate of 0.3 lbs/ton acid

Survey Responses
Container Glass

- **Tier I Level: 2.1 – 3.2 Lbs/Ton Glass**
- Current Performance
  - Two Glass Furnaces Venting To Two Dry Scrubbers and Three ESPs
  - One Scrubber At 80% Control
  - SOx: 73 ppmv Average, 445 ppmv Maximum
  - **Emission Rate: 0.63 – 1.05 Lbs/Ton**

BARCT Top Down Analysis

Container Glass

- SJVAPCD Proposed Rule: 0.8 Lbs/Ton
- **Wet Scrubber (Tri-Mer): 0.1 Lbs/Ton, 99.9% Control Efficiency**
- **Goal: <0.6 Lbs/Ton?**
- **Is Wet Scrubber Cost-Effective?**
- **Potential Emission Reduction = 0.29 TPD*?**

* Based on 2005 Emissions Reduced From 0.6 Lbs/Ton To 0.1 Lbs/Ton

Survey Responses

Coke Calciner

- **Tier I Level: 2.47 Lbs/Ton**
- Dry Scrubber Design Parameters
  - 1,296 TPD Green Coke
  - Emission Rates: **0.21 Lbs/Ton** – 1.64 Lbs/Ton
  - 90% Control Efficiency
- Current Emission Rates
  - **0.56 Lbs/Ton (2005)**
  - 0.97 Lbs/Ton (2006)
  - 0.89 Lbs/Ton (2007)

Survey Responses

Coke Calciner

- Current SOx Outlet Concentration
  - 27 ppmv (2005)
  - 52 ppmv (2006)
  - 43 ppmv (2007)
  - 82 ppmv - 84 ppmv (RATA)
- Current Control Efficiency: 98% - 99%

BARCT Top Down Analysis

Coke Calciner

- Wet Scrubber/Wet ESP Design Levels at BP Cherry Point Refiner
  - 1,301 TPD Green Coke
  - 96% Control Efficiency
  - **35 ppmv Limit (Tested: 10 ppmv – 12ppmv)**
  - **0.14 Lbs/Ton**

BARCT Top Down Analysis

Coke Calciner

- **Goal: 0.14 – 0.2 Lbs/Ton?**
- **Is Wet Scrubber Cost-Effective?**
- **Potential Emi Red = 0.23 – 0.26 TPD*?**

* Based on 2005 Emissions and 0.14 Lbs/Ton – 0.2 Lbs/Ton

Survey Responses
Cement Kilns & Coal-Fired Boiler

- **Tier I Allocations: 0.33 TPD (0.30 TPD for Coal-Fired Boiler Not In Operation)**
- **2005 Emissions: 0.27 TPD (2 Kilns)**
- Current Performance
  - Cement Kiln = 0.5 Lbs/Ton Clinker
  - Coal-Fired Boiler = 7 Lbs/Ton Coal
- SOx Concentration = 49 ppmv

BARCT Top Down Analysis

Cement Kilns & Coal Fired Boiler

- Goal: Wet Scrubber at 99% Control?
- Is Wet Scrubber Cost-Effective?
- Potential Emission Reductions?

Survey Responses
Other Industry Suggestions

- Team Effort - WSPA & AQMD
- Consultants to Conduct Research

A&WMA Conference

- **May 14, 2008**
- U.S. EPA, CARB, SCAQMD
- INTERCAT & GRACE DAVISON
- BELCO, CANSOLV, DYNAWAVE, TRI-MER
- Hydrotreating?
- Fuel Gas Treating System?

Tentative Schedule

- Next Working Group Meeting
- Public Workshop & CEQA Scoping: May-June
- Public Hearing: October - December