

Attachment 5-1

Development of NO_x/PM₁₀ and SO₂/PM₁₀ Inter-pollutant Offset Ratio for Fresno County

1.0 Introduction

The San Joaquin Valley Unified Air Pollution Control District is a PM₁₀ non-attainment area with respect to both the federal and California ambient standards for this pollutant. The Panoche Energy Center proposed for Fresno County would result in PM₁₀ emissions from various onsite stationary source units. Because the background concentrations already exceed the National and California ambient standards for this pollutant, such emissions increases in PM₁₀ have the potential to exacerbate existing exceedances. Accordingly, SJVAPCD regulations require a project that will cause an increase in PM₁₀ emissions to provide offsets in sufficient amounts to provide a net air quality benefit.

Reductions of SO_x and NO_x emissions can be used to offset the PM₁₀ impact from a new source within the SJVAPCD, because sulfates and nitrates are precursors of particulate matter. In order to quantify the offset requirement when such interpollutant trading is used, the appropriate ratios between PM₁₀ and SO_x and PM₁₀ and NO_x must be calculated. According to SJVAPCD policy (Sweet, 2006), inter-pollutant trading ratios specific to the Panoche project area can be calculated using results of Chemical Mass Balance (CMB) modeling conducted by SJVAPCD staff as part of the District's 2003 PM₁₀ Attainment Plan. As recently as the spring of 2006, URS was informed by SJVAPCD that the assumptions, monitoring data, emissions inventory data and calculation methods used in the Attainment Plan are sufficiently recent to be considered valid for the purpose of estimating current SO_x/PM₁₀ and NO_x/PM₁₀ interpollutant offset ratios.

2.0 CMB Modeling Results and Annual Roll Back Analysis

Receptor modeling using the chemical mass balance model was conducted by SJVAPCD for sites in the project area that currently do not comply with the federal PM₁₀ air quality standards. This method uses chemical analysis of collected air monitoring samples and information about the chemical composition of contributing sources to evaluate the link between observed concentrations and contributing emission sources. The SJVAPCD used the results of its CMB analysis with a modified rollback approach to calculate the effects on design particulate values that would result from implementation of adopted and proposed control measures to reduce PM₁₀ pollution and other predicted emission trends for the most recent PM₁₀ Attainment Plan. The results can also be used to support calculation of interpollutant offset ratios, as described later. The data used for this purpose were taken from an Excel workbook titled N2-Annual Rollback Analysis which was provided by SJVAPCD. Tables 1-4 summarize the data from the N2 Rollback Analysis that are relevant to this application

Table 1 presents monthly and annual average CMB modeling results for Fresno County. This includes measured PM₁₀ concentrations at the Fresno Drummond monitoring site

and model predicted contributions to these concentrations due to various source types. Table 2 shows the annual average CMB modeling results and design values for the SJVAPCD areas that are noncompliant with the PM₁₀ standards from Table 1, including Fresno Drummond results. The design values were determined using EPA calculation methods (EPA 2004) and the air quality monitoring data collected in Fresno County. In Table 2, 'Sum of Species' represents the summation of the mass concentrations across all source categories, including 'Burning', 'Motor Vehicle', 'Tire/Brake', 'Sulfate', 'Nitrate', and 'Geological'. The value difference between 'Sum of Species' and 'Design Value' was left in the "unassigned" column.

The rollback analyses conducted by SJVAPCD used a speciation model with the CMB results. This modified rollback analysis showed not only the speciation, but also how the species were distributed and estimated source attributions for both primary and secondary pollutant species. The rollback analysis also considered other factors, including geological information, PM, VOC, and NO_x inventory totals, and other relevant information. Separate modeling was conducted in the rollback analysis for each county to account for conditions and characteristics that are unique to specific areas of the SJVAPCD. The rollback analysis for Fresno County is shown in the tab labeled "Fresno" within the Excel Workbook provided in Attachment 1 "N2-Annual Rollback Analysis".

The SJVAPCD rollback analysis was conducted as follows. Line 1 in Table 3 shows the concentration values influenced by the local area emissions. The 'Annual design value' equivalent to the chemistry of the CMB monthly analysis of the Fresno Drummond data in the Table 2 matches with the 'General Note' in Line 1 of Table 3. The mass concentrations of 'Geological', 'Mobile', 'Tire/Brake', and 'Unassigned' in Table 2 are equivalent to the corresponding attributes in line 1 of Table 3. The cells in Line 1 for vegetative burning and organic carbon represent 70% and 30% respectively of the value for 'Burning' in Table 2.

Line 2 of Table 3 shows concentration values for the natural and transport contributions for each attribute, which come from background concentration measurements. Line 3 is the 'net for rollback' concentrations, which means the differences in values between Line 1 and Line 2. The values of Line 3 are distributed to Line 4 through Line 7 based on the area of influence and the percentage distribution of PM₁₀ source categories used by SJVAPCD. The attributes of 'Geological and Construction', 'Tire/Brake', and 'Unassigned' follow the corresponding percentages of PM₁₀ distribution. The attributes of 'Mobile', 'Organic Carbon', 'Vegetation Burning', 'Ammonium Nitrate', and 'Ammonium Sulfate' follow the percent of PM_{2.5} distribution. Lines 4 and 5 represent the local contribution of PM_{2.5} minus PM₁₀ and PM_{2.5}, respectively. Line 6 presents the sub-regional contribution, and Line 7 shows the regional contributions.

The most current emission inventory (lb/day) for PM₁₀, NO_x, total organic compounds (TOG) and SO_x for the Fresno-Madera area is provided in Table 4.

Values from Tables 3 and 4 were used to calculate the inter-pollutant trading ratio for Fresno County. The methods employed for these calculations are addressed in the next section.

Table 1 Monthly and Annual Average CMB results at the Fresno Drummond site for February to December 2000 plus the January 2001 Episode (all concentrations are in $\mu\text{g}/\text{m}^3$)

Fresno Drummond Monthly							Burning		Motor Vehicle		Tire/Brake		Sulfate		Nitrate		Geological	
SITE ID	DATE	CONC	UONC	PCMASS	RSQ	CHISQ	Mass	Unc	Mass	Unc	Mass	Unc	Mass	Unc	Mass	Unc	Mass	Unc
FSD	1/1/01	186	9.4	87.9	1.0	1.1	40.1	11.3	18.5	9.6	2.5	1.5	5.0	0.7	62.4	5.1	35.1	6.8
FSD	Feb	27.0	2.1	97.3	1.0	0.7	5.7	2.5	3.1	1.8	0.3	0.4	1.1	0.2	7.7	0.8	8.3	2.1
FSD	Mar	23.9	2.1	116.0	1.0	0.7	4.6	2.4	3.1	1.8	0.1	0.4	1.8	0.2	8.2	0.9	9.9	2.3
FSD	Apr	24.8	2.2	112.1	1.0	0.6	3.4	2.7	2.4	1.6	0.2	0.5	2.4	0.2	5.0	0.5	14.4	3.0
FSD	May**	20.0	2.1	99.5	1.0	0.6	0.345	0.329	2.1	1.4			2.327	0.226	2.4774	0.3211	12.6	1.7055
FSD	Jun*	34.1	2.5	105.8	1.0	1.0	1.9	0.4	3.8	2.3	0.0	0.6	4.2	0.4	3.6	0.4	22.5	3.8
FSD	Jul*	26.4	2.3	100.6	1.0	0.6	1.0	0.4	1.5	1.3			1.7	0.2	2.7	0.3	19.6	2.2
FSD	Aug*	38.2	2.5	90.2	0.9	2.7	3.8	0.7	0.9	1.5	1.4	0.9	2.0	0.3	3.3	0.4	23.1	4.3
FSD	Sep*	56.7	3.3	92.8	1.0	0.9	1.5	0.6	3.4	2.5	0.9	1.0	2.6	0.4	3.6	0.4	40.6	6.0
FSD	Oct*	50.7	3.4	93.5	1.0	0.5	1.8	0.4	4.5	2.6			2.2	0.3	8.4	0.8	30.6	3.3
FSD	Nov	40.5	2.6	95.7	1.0	0.4	11.9	3.3	4.5	2.7	0.4	0.4	2.1	0.2	13.1	1.2	6.8	1.8
FSD	Dec	65.8	3.9	89.7	1.0	0.8	13.7	4.3	7.3	3.8	0.8	0.6	3.2	0.3	23.4	2.0	10.6	2.6

Min	20.0	2.1	87.9	0.9	0.4	0.3	0.3	0.3	0.9	1.3	0.0	0.4	1.1	0.2	2.5	0.3	6.8	1.7
Avg	49.5	3.2	98.4	1.0	0.9	7.5	2.4	4.6	2.8	0.7	0.7	2.6	0.3	12.0	1.1	19.5	3.3	
Max	186.0	9.4	116.0	1.0	2.7	40.1	11.3	18.5	9.6	2.5	1.5	5.0	0.7	62.4	5.1	40.6	6.8	

Note:

CONC: concentration

UONC: Uncertainty of concentration

PCMASS: Percent of mass

RSQ: R square

CHISQ: Chi square

Mass: concentration based on mass

UNC: Uncertainty of concentration based on mass

Table 2 Annual Average CMB results and Design Value for the Counties Noncompliant with the Standards (50) in San Joaquin Valley Unified Air Pollution Control District (All concentrations in $\mu\text{g}/\text{m}^3$)

SITE ID	CONC	UCONC	PCMASS	Design Value *	Sum of species	Burning		Motor Vehicle		Tire/Brake		Sulfate		Nitrate		Geological		Geological Profile	Un-assigned
						Mass	UNC	Mass	UNC	Mass	UNC	Mass	UNC	Mass	UNC	Mass	UNC		
BGS	57.7	3.6	98.5	57.0	55.6	6.3	2.3	3.6	2.4	1.1	1.2	3.0	0.3	14.9	1.3	26.7	5.8	FDKERANN	1.4
FSD	49.5	3.2	98.4	50.0	46.9	7.5	2.4	4.6	2.8	0.7	0.7	2.6	0.3	12.0	1.1	19.5	3.3	DFSDANN	3.1
HAN	51.5	3.3	104.1	53.0	52.9	6.6	2.0	4.0	2.3	0.5	0.7	3.0	0.3	15.7	1.4	23.2	4.2	FDHANANN	0.1
VCS	52.5	3.3	99.6	54.0	51.8	6.7	2.5	4.0	2.5	0.5	1.0	3.1	0.3	15.9	1.5	21.7	3.8	FDVCSANN	2.2

Note:

* All Design Values are equal to or exceed the California 24-Hour Standard ($50 \mu\text{g}/\text{m}^3$)

BGS: Bakersfield Golden State for Kern County

FSD: Fresno Drummond for Fresno County

HAN: Hanford for Kings County

VCS: Visalia Church Street for Tulare County

Unassigned: Mass based concentration that CMB model did not assign to attribute.

Table 3
SJVAPCD N2 Annual Rollback Analysis (Concentrations on Lines 1 through 7 are in $\mu\text{g}/\text{m}^3$)

Fresno - Drummond, Annual, Design value = 50 $\mu\text{g}/\text{m}^3$	General Note	Geologic and Construction	Mobile Exhaust	Tire and Brake Wear	Organic Carbon	Vegetative Burning	Ammonium Nitrate including associated water	Ammonium Sulfate	Marine	Unassigned
Line1 Source Contribution from Analysis	From CMB monthly analysis Feb 2000 to Dec 2000, adding January 2001 episode for chemistry equivalent to annual design value	From CMB	From CMB	From CMB	Estimated portion of mass included in Vegetative Burning =30%	From CMB minus estimated Organic Carbon from other sources	From CMB	From CMB	From CMB, if present	Unaccounted mass from CMB, if any.
LINE 1	50.00	19.50	4.60	0.70	2.25	5.25	12.00	2.60	0.00	3.1
Line2 Natural and Transport Contribution, see "Background" sheet	Portion not included in rollback analysis, removed prior to rollback as not subject to local control, added back to projected future concentrations	See background sheet for numerical estimate and episode adjustment. Removed prior to rollback as not subject to local control, added back to projected future concentrations	0, no natural background, transport estimated at 0	0, no natural background, transport estimated at 0	See background sheet for numerical estimate and episode adjustment. Removed prior to rollback as not subject to local control, added back to projected future concentrations. Includes biogenic emissions. = 20%	See background sheet for numerical estimate and episode adjustment. Removed prior to rollback as not subject to local control, added back to projected future concentrations. Includes wildfires and biogenic. =20% + 10%	See background sheet for numerical estimate and episode adjustment. Removed prior to rollback as not subject to local control, added back to projected future concentrations	See background sheet for numerical estimate and episode adjustment. Removed prior to rollback as not subject to local control, added back to projected future concentrations	100% because marine salts are a natural emission	0, background estimate at maximum, no additional background estimate for unexplained mass
LINE 2	8.25	4.0	0.0	0.0	0.7	1.6	1.0	1.0		
Line 3 Net for Rollback	Net for Rollback, default percentages adjustable for episode characteristics, applicable to all columns except						Net for non-linear rollback, default percentages adjustable for episode characteristics		Removed entirely from rollback, added back to result	

Fresno - Drummond, Annual, Design value = 50 µg/m3	General Note	Geologic and Construction	Mobile Exhaust	Tire and Brake Wear	Organic Carbon	Vegetative Burning	Ammonium Nitrate including associated water	Ammonium Sulfate	Marine	Unassigned
	as indicated.									
LINE 3	41.75	15.5	4.6	0.7	1.6	3.7	11.0	1.6	0.0	3.1
Line4 Local Contribution PM2.5-PM10 Area of Influence	Source contribution from smallest area of influence, representative of large particle primary source area, includes all PM size emissions in the area - Rolled back against local area of influence emission estimates	70%PM10 50%PM2.5 of net	70%PM10 50%PM2.5 of net	70%PM10 50%PM2.5 of net	70%PM10 50%PM2.5 of net	70%PM10 50%PM2.5 of net	70%PM10 50%PM2.5 of net, non-linear rollback	70%PM10 50%PM2.5 of net		70%PM10 50%PM2.5 of net
LINE 4	24.74	10.9	2.3	0.5	0.8	1.8	5.5	0.8		2.2
Line5 Local Contribution Area of Influence of PM2.5	Rolled back against local PM2.5 area of influence emission estimates - episode specific adjustments based on meteorology and episode duration	15%PM10 30%PM2.5	15%PM10 30%PM2.5	15%PM10 30%PM2.5	15%PM10 30%PM2.5	15%PM10 30%PM2.5	15%PM10 30%PM2.5 non-linear rollback	15%PM10 30%PM2.5		15%PM10 30%PM2.5
LINE 5	9.63	2.3	1.4	0.1	0.47	1.1	3.3	0.5		0.5
Line6 Sub regional Contribution	Rolled back against specified County(ies) emission estimates - episode specific	10%PM10 15%PM2.5	10%PM10 15%PM2.5	10%PM10 15%PM2.5	10%PM10 15%PM2.5	10%PM10 15%PM2.5	10%PM10 15%PM2.5 non-linear rollback	10%PM10 15%PM2.5		10%PM10 15%PM2.5

Fresno - Drummond, Annual, Design value = 50 µg/m3	General Note	Geologic and Construction	Mobile Exhaust	Tire and Brake Wear	Organic Carbon	Vegetative Burning	Ammonium Nitrate including associated water	Ammonium Sulfate	Marine	Unassigned
	adjustments based on meteorology and episode duration									
LINE 6 Line7 Regional Contribution	5.30 Rolled back against Valley-wide emission estimates - episode specific adjustments based on meteorology and episode duration	1.6 5%PM10 5%PM2.5	0.7 5%PM10 5%PM2.5	0.1 5%PM10 5%PM2.5	0.24 5%PM10 5%PM2.5	0.6 5%PM10 5%PM2.5	1.65 5%PM10 5%PM2.5 non-linear rollback	0.24 5%PM10 5%PM2.5		0.3 5%PM10 5%PM2.5
LINE 7 Associated Emissions Categories	2.09 Based upon appropriate seasonal or annual inventory	0.8 PM10 paved roads+ PM10 unpaved roads+ PM10 off road mobile+ PM10 farm operations+ PM10 construction+ PM10 windblown	0.2 PM10, TOG & CO onroad mobile+ PM10, TOG & CO 860 offroad equipment PM10, TOG & CO 870 farm equipment CO presumed to add minimal mass	0.0 Tire and brake wear as predicted by EMFAC2002	0.08 Total TOG minus motor vehicle, OC may also include a small portion of otherwise unassigned elemental carbon PM10 & CO Area, Stationary CO presumed to add minimal mass	0.2 PM10 & CO residential burning PM10 & CO waste burning and disposal PM10 cooking PM10 & CO fires CO presumed to add minimal mass	0.55 Total E.I. NOx (+ bacterial soil NOx estimate removed as natural background)	0.08 Total SOx		0.2 Total PM10

Table 4 Emission Inventory for Year 1999 through Current Year (valid for this project)- All emissions in tons per day

Emissions Inventory	Area of Influence	Geologic and Construction	Mobile Exhaust	Tire and Brake Wear	Organic Carbon	Vegetative Burning	Ammonium Nitrate including associated water	Ammonium Sulfate	Marine	Unassigned
PM10	Fresno	74.4504	4.1236	0.511	5.6266	10.4843				39.92145356
NOx	Fresno						174.7763			
TOG	Fresno		58.2653		396.7168					
SOx	Fresno							9.0772		

3.0 Interpollutant Trading Ratio

The SJVAPCD (Sweet, 2005) provided the interpollutant trading calculation method, which is presented in Tables 5, 6, and 7. Summing 'organic carbon' and 'vegetation burning' from Line 1 in Table 3 gave the value of 'Vegetative Burning Total' in Table 5. 'Industry Component' and 'Regional Background' were calculated as 30% and 20% of the 'Vegetative Burning Total', respectively. The value for 'Regional Background' was subtracted from the 'Industry Component' to obtain the 'Industry minus Background' value. The value for 'County Contribution' was estimated to be 50% of the value of 'Industry minus Background'. The value for 'Organic Carbon PM₁₀ Inventory-Fresno County' was obtained from the emission inventory shown in Table 4. The value for 'County Contribution' divided by the value of 'Organic Carbon PM₁₀ Inventory' gave the 'County Impact' in units of $\mu\text{g}/\text{m}^3$ per ton.

The values of 'Ammonium Sulfate' and 'Regional Background' in Table 6 were obtained from the values of 'Ammonium Sulfate' in Lines 1 and 2 in Table 4, respectively. The value of 'Ammonium Sulfate' was reduced by the value of 'Regional Background' to obtain the entry labeled 'Ammonium Sulfate minus Background'. The value for 'County Contribution' was also determined as 50% of the value of 'Ammonia Sulfate minus Background'. The value of 'SO_x Inventory-Fresno County' was obtained from the emission inventory shown in Table 4. The value of 'County Contribution' divided by the value of 'SO_x Inventory' gave the 'County Impact' in units of $\mu\text{g}/\text{m}^3$ per ton.

The inter-pollutant trading ratio of SO₂ to PM₁₀ was calculated as the ratio of the 'County Impact' of PM₁₀ to the 'County Impact' of SO_x. The ratio is 1.8 (tons of SO₂ to equal the effect of 1 ton of PM₁₀ reduction). Likewise, the interpollutant trading ratio of NO₂ to PM₁₀ was calculated in Table 7 as a ratio of the 'County Impact' of PM₁₀ to the 'County Impact' of NO_x. The resulting ratio is 3.0 (tons of NO₂ to equal the effect of reducing 1 ton of PM₁₀).

Table 5 PM₁₀ County Impact

PM ₁₀	Note	Units	Estimate	Uncertainty
"Vegetative Burning" Total	1	µg/m ³	7.50	2.43
Industry Component (30%)	2	µg/m ³	2.25	
Regional Background (20%)	3	µg/m ³	0.45	
Industry minus Background		µg/m ³	1.80	
County Contribution	4	µg/m ³	0.90	
Organic Carbon PM ₁₀ Inventory - Fresno County	5	ton/day	5.63	
County Impact		µg/m ³ per ton	0.16	0.21

Table 6 SO_x County Impact and Inter-pollutant trading ratio of SO_x and PM₁₀

Sulfate	Note	Units	Estimate	Uncertainty
Ammonia Sulfate	6	µg/m ³	2.60	0.29
Regional Background	7	µg/m ³	1.00	
Ammonium Sulfate minus Background		µg/m ³	1.60	
County Contribution	8	µg/m ³	0.80	
SO _x Inventory - Fresno County	9	ton/day	9.08	
County Impact		µg/m ³ per ton	0.09	0.10
Tons of SO_x to Equal Effect of 1 ton PM₁₀ Reduction	10		1.8	2.2

Table 7 NO_x County Impact and Inter-pollutant trading ratio of NO_x and PM₁₀

Nitrate	Note	Units	Estimate	Uncertainty
Ammonium Nitrate	11	µg/m ³	12.00	0.29
Regional Background	12	µg/m ³	1.00	
Ammonium Nitrate minus Background		µg/m ³	11.00	
County Contribution	13	µg/m ³	5.50	
NO _x Inventory - Fresno	14	ton/day	174.7763	
County Impact		µg/m ³ per ton	0.03	0.03
Tons of NO_x to Equal Effect of 1 ton PM₁₀ Reduction	15		3.0	4.0

Note:

1. Per SJVUAPCD and CARB, PM₁₀ emissions from stationary industrial combustion sources are included in the Vegetative Burning category from Chemical Mass Balance modeling performed for the SJVUAPCD 2003 PM₁₀ Attainment Plan (Fresno-Drummond monitoring station).
2. Per SJVUAPCD, 30% of this category is attributed to stationary industrial combustion sources.
3. Per SJVUAPCD, regional background is estimated to be 20% of net concentration after previous adjustment to Vegetative Burning category.
4. Contribution from sources within Fresno County is estimated to be 50% of net concentration after previous adjustments to Vegetative Burning category.
5. Organic carbon PM₁₀ inventory for Fresno County that contributes to this monitoring location; from SIP inventory with updates and adjustments based on Central California Ozone Study (CCOS) study.

6. Ammonium sulfate category from Chemical Mass Balance modeling performed for the SJVUAPCD 2003 PM₁₀ Attainment Plan (Fresno-Drummond monitoring station).
7. Per SJVUAPCD, regional background of ammonium sulfate is estimated to be 1 mg/m³.
8. Contribution from sources within Fresno is estimated to be 50% of net concentration after previous adjustment to Vegetative Burning category.
9. SO_x inventory for Fresno that contributes to this monitoring location; from SIP inventory with updates and adjustments based on CCOS study.
10. PM₁₀ County Impact divided by Ammonium Sulfate County Impact.
11. Ammonium nitrate category from Chemical Mass Balance modeling performed for the SJVUAPCD 2003 PM₁₀ Attainment Plan (Fresno - Drummond monitoring station).
12. Per SJVUAPCD, regional background of ammonium nitrate is estimated to be 1 mg/m³.
13. Contribution from sources within Fresno County is estimated to be 50% of net concentration after previous adjustment to Vegetative Burning category.
14. NO_x inventory for Fresno County that contributes to this monitoring location; from SIP inventory with updates and adjustments based on Central California Ozone Study (CCOS) study.
15. PM₁₀ County Impact divided by Ammonium Nitrate County Impact.

4.0 Reference

- 1) EPA-CMB8.2 Users Manual, December, 2004
- 2) San Joaquin Valley Air Pollution Control District State Implementation Plan PM10 Modeling Protocol (SJVAPCD, 2005)
- 3) Attachment 6 and calculation method obtained from SJVAPCD (James Sweet, james.sweet@valleyair.org, 559-230-5810)