#### Given/Assume

#### Combustion

	Enter Value	
C1 =	167	Coal burn, tons/hr
HV =	11,313	Btu/lb
S1 =	0.63	Coal sulfur weighted average, %

K2 =	0.875	0.95	for bituminous coals
		0.875	for subbituminous coals
			= 0.55 to 0.85 for lignite, based on the Na content
		1.0	for oil

#### F1 = 0.0019 Fuel Impact Factor from F1 table

F2 (AH) =	1.00	Technology Impact Factor from F2 tables	If not applicable, enter "1".
F2 (PM) =	1	Technology Impact Factor from F2 tables	If not applicable, enter "1".
F2 (FGD) =	0.01	Technology Impact Factor from F2 tables	If not applicable, enter "1".

#### For SCR

S2 =	0.03	SCR catalyst SO2 oxidation rate (specified as a decimal, typically from 0.001- 0.03)					
fsops =	0.9647	portion of time that SCR is in use					
F2 (AH) =	1.00	Technology Impact Factor from F2 tables	If not applicable, enter "1".				
F2 (PM) =	1	Technology Impact Factor from F2 tables	If not applicable, enter "1".				
F2 (FGD) =	0.01	Technology Impact Factor from F2 tables	If not applicable, enter "1".				

F3SCR =	1	Technology Imp	act Factors for SCR	
		Coal Type	F3SCR	
		PRB	0.17	
		Other Coals	1	(no data available)

fsreagent = SNH3 =

0.95 0.75 fraction of operation with reagent injection NH3 slip from SCR/SNCR, ppmv at 6% O2, wet

Equation 4-1	EMComb = K · F	1 • E2							
K =	3063	Ib H2SO4/ton SO2							
F1 =	0.0019	Fuel Impact Factor from F1 table							
Equation 4-3	? = K1 • K2 • C1 • S1								
C1 =	167	Coal burn, tons/hr							
S1 =	0.63	Coal sulfur weighted average, %							
K1 =	Molecular weight 0.02	and units conversion constant SO2/%S							
K2 =	Sulfur conversio	n to SO <sub>2</sub>							
	0.875	0.95 for bituminous coals							
		0.875 for subbituminous coals							
		= 0.55 to 0.85 for lignite, based on the Na content							
		1.0 for oil							
E2 =	K1	• K2 • C1 • S1							
E2 =	0.02	* 0.875 * 167 * 0.63							
E2 =	2	SO2 mass rate, tons/hr							
EMComb =	к	* F1 * F2							
EMComb =	3063	* 0.0019 * 2							
EMComb =	10.74	total H2SO4 manufactured from combustion, lbs/hr							
Sulfuric Acid	Released from Co	mbustion (ERComb)							
Equation 4-3 E	ERComb = EMCor	nb • F2 (all that apply)							
ERComb =	EMComb	• F2 (AH) • F2 (PM) • F2 (FGD)							
ERComb =	11	* 1 * 1 * 0.01							
ERComb =	0.11	total H2SO4 released from combustion, lbs/hr							
Sulfuric Acid	Manufacture by S	CR (EMSCR)							
EMSCR = K · S	S2 • fsops • E2• F3	<b>JSCR</b> = Total H2SO4 manufactured from SCR, lbs per hour							
K =	3063	Ib H2SO4/ton SO2							
S2 =	0.03	SCR catalyst SO2 oxidation rate (specified as a decimal, typically from 0.001- 0.03)							
fsops =	0.9647	for continuous operation							
E2 =	2	SO2 produced, tons per hour							
F3SCR =	1	Technology Impact Factor, for SCR Table 4-2							
EMSCR =	K	• S2 • fsops • E2 • F3SCR							
EMSCR =	3063	* 0.03 * 0.9647 * 2 * 1							
EMSCR =	163.66	= Total H2SO4 manufactured from SCR, lbs per hour							

 Equation 4-11a: Manufacture

 TSAM = EMComb + EMSCR/SNCR +

 TSAM =

 TSAM =

 11 +

 T64

 TSAM =

 174.40

 Total H2SO4 manufactured, lbs per hour

#### Sulfuric Acid Released from SCR and SNCR

Equation 4-5 ERS	CR = [EMSCR	r – (Ks • B • fsreagent • SNH3)] • F2x
ERSCR = Total H2	SO4 released	from SCR, lbs per hour
EMSCR = Total H2	2SO4 manufact	tured from SCR, lbs per hour
Ks =	3799	Conversion factor
HV =	11,313	Btu/lb
B =	3.79E-03	Coal burn in TBtu/hr
fsreagent =	0.95	fraction of SCR operation with reagent injection
SNH3 =	0.75	NH3 slip from SCR/SNCR, ppmv at 6% O2, wet
		SCR averages 0.75 ppmv over catalyst guarantee period
		SNCR averages 5 ppmv
		Note: actual NH3 slip data should be used if available
F2x =		Technology Impact Factors, all that apply
ERSCR =		[ EMSCR – ( Ks • B • fsreagent • SNH3 )] • F2 (AH) • F2 (PM) • F2 (FGD)
ERSCR =		( 164 - ( 3799 * 3.79E-03 * 0.95 * 0.75 ))* 1 * 1 * 0.01
ERSCR =		( 164 – ( 1.03E+01 ))* 0.01
ERSCR =		153 * 0.01
ERSCR =	1.53	Total H2SO4 released from SCR, lbs per hour

Equation 4-11b: Release

TSAR = ERComb + ERSCR/SNCR + ERFGC								
TSAR =	ERComb	+	ERSCR/SNCR	+	ERFGC			
TSAR =	0.11	+	1.53	+				
TSAR =	1.64	Тс	otal H2SO4 releas	ed,	lbs per hour			

Table 4-1			
Summary of Fuel Impac	t Factors (F1) for Stea	am Generating Units	
Fuel	Equipment	F1	Comment
			32 data points; SO2 =
Eastern Bituminous (all)	Dry Bottom Boiler	0.0000011163*SO2+0.0064877	S1*KF1/HV
			SO2 = Boiler SO2 concentration (ppmvd, 3% O2, dry) derived from fuel sulfur content (%)
			S1 = Coal sulfur weighted average, % dry = 0.63
			KF1 = 10,003,602
			HV = Coal heating value, Btu/lb, dry = 11,313
			SO2 = 0.63 * 10,003,602 / 11313 = 557 ppmvd
		0.00/1095/1	
Med-High S Eastern			
Bituminous (>2.5%)	Cyclone	0.016	One data point.
W. Bituminous	Dry Bottom Boiler	0.00111	One data point.
W. Bituminous	Cyclone	0.0022	One data point.
Subbituminous/PRB	All Boilers	0.0019	Average of 8 units
Lignite	Dry Bottom Boiler	0.0044	Two data points.
Lignite	Cyclone	0.00112	One data point.
Petroleum coke	Boiler	0.04	One data point.
Natural gas	Boiler	0.01	
#2 Fuel oil	Boiler	0.01	
#6 Fuel oil	Boiler	0.025	
Used oil	Boiler	0.0175	
Natural gas	CT	See Table 6-1	
#2 Fuel oil	CT	See Table 6-1	
Natural gas	CC	0.0555	
#2 Fuel oil	CC	0.0555	New category in 2007.
Other Alternative Fuels	Any	0.04	
Other Alternative Fuels.			Use Coal F1. in
co-fired w/coal. >75%			absence of any
heat throughput	NA		applicable data.
0 1			

#### Table 4-3 Summary of F2 Factors for Air Heater Removal of Sulfuric Acid **Boiler Type** Fuel Low S Eastern Bit

PRB

All Boilers All Boilers All Boilers

# F2 Med-High S Eastern Bit (S >2.5%)

# Comment

0.50 Average of measurements at 7 units. 0.85 Based on two data points. 0.36 Based on two data points.

#### Table 3-2

#### Summary of F2 Factors for Particulate Control Devices (ESP, Baghouse) Equipment Type Coal Type F2 Factor Comment or Observation Cold-side ESP Low S Eastern Bit 0.63 Average of measurements at 4 units. Cold-side ESP 0.77 Average of measurements at 3 units. High S Eastern Bit (>2.5%) Subbituminous (PRB) Cold-side ESP 0.72 Based on one measurement at one unit. 0.63 Based on one measurement at one unit. Hot-side ESP All Wet ESP All 0.12 Average of measurements at 2 units. Baghouse Subbituminous coal 0.10 Two data points.

### Table 3-3

#### Summary of F2 Factors for Wet, Dry FGD Equipment and Additives

FGD Type	Coal Type	F2 Factor	Comment or Observation
Wet: Spray Tower	E. Bituminous	0.47	Seven data points.
Wet: Spray Tower	PRB or Lignite	0.40	Two data points.
Wet: Venturi Tower	All coals	0.73	Four data points.
Dry FGD and baghouse	All coals	0.01	Two data points.
Mg-Ox mixed w/fuel oil	All fuel	0.50	One data point.
Mg-Ox into furnace	All fuel	0.25	One data point.

# Table 4-2F3scR Technology Impact Factors for SCRCoal TypeF3scRPRB0.17Other Coals1 (no data available)

## Equation 4-1 EMComb = K • F1 • E2

where,

EMComb= total H2SO4 manufactured from combustion, lbs/yr

K = Molecular weight and units conversion constant, equal to 3,063.

This value is derived as follows:  $98.07/64.04 \cdot 2000 = 3,063$ .

Here, 98.07 is the molecular weight of H2SO4; 64.04 is the molecular weight of SO2; conversion from tons per year to pounds per year requires multiplying by 2000.

F1 = Fuel Impact Factor

E2 = Sulfur dioxide (SO2) emissions, either: (1) recorded by a continuous emissions monitor, tons/yr, or (2) calculated from coal burn data, tons/yr.

When any source uses FGD equipment or another technology to control SO2 emissions, either the fuel basis **must** be used for the manufacturing and release calculations, or CEMS data can be used but only when the CEMS precedes the FGD or SO2 control equipment

As an alternative to using CEMS data, the following relationship based on coal burn data can be used to estimate the rate of SO2 emissions:

# Equation 4-2b E2 = $K1 \cdot K2 \cdot C1 \cdot S1$

where,

E2 = SO2 mass rate, tons/yr

C1 = Coal burn, tons/yr

S1 = Coal sulfur weighted average, %

K1 = Molecular weight and units conversion constant, equal to 0.02. This value is derived from  $(64.04)/(100 \cdot$ 

32.06) = 0.02. Here, 64.04 is the molecular weight of SO2; 32.06 is the molecular weight of S; and conversion of % S to a fraction requires multi

K2 = Sulfur conversion to SO2, implicit from EPA AP-42 (EPA, 1995b)

= 0.95 for bituminous coals

= 0.875 for subbituminous coals

- = 0.55 to 0.85 for lignite, based on the Na content
- = 1.0 for oil

# Sulfuric Acid Released from Combustion (ERComb)

For units that do not employ SCR or SNCR NOx control or FGC, the sulfuric acid released is the product of the amount manufactured and the Technology Impact Factors (F2) for all downstream equipment (the air heater, the particulate control device, the FGD,

## Equation 4-3 ERComb = EMComb • F2 (all that apply)

## Sulfuric Acid Manufacture by SCR (EMSCR)

The following relationship estimates the total H2SO4 manufactured from an SCR equipped utility boiler or steam generator:

### Equation 4-4 EMSCR = K • S2 • fsops • E2• F3SCR

where,

EMSCR = Total H2SO4 manufactured from SCR, lbs per year

K = Conversion factor = 3063

S2 = SCR catalyst SO2 oxidation rate (specified as a decimal, typically from 0.001-

0.03)

fsops = Operating factor of SCR system, or the fraction of coal burn when the flue gas is directed through the SCR, whether NH3 reagent is injected to derive NOx reduction or not. This value should reflect the hours the SCR reactor processed flue gas, whi

E2 = SO2 produced, tons per year

F3SCR = Technology Impact Factor, for SCR

An F3SCR factor for PRB coals is shown in Table 4-2. This factor is derived from measurements at two PRBfired units. SO3 emitted from these units was lower than specified in the catalyst guarantee, which was based on laboratory test data. At present, the

Table 4-2 F3SCR Technology Impact Factors for SCR Coal Type PRB Other Coals

F3SCR 0.17 1 (no data available)

### Sulfuric Acid Released from SCR and SNCR

The sulfuric acid released from SCR or SNCR is determined by subtracting from the sulfuric acid manufactured the amount removed by the residual ammonia, or ammonia slip. For SCR, the sulfuric acid released (ERSCR) is estimated with the following relations

Equation 4-5 ERSCR = [EMSCR – (Ks • B • fsreagent • SNH3)] • F2x

where,

ERSCR = Total H2SO4 released from SCR, lbs per year EMSCR = Total H2SO4 manufactured from SCR. lbs per year

Ks = Conversion factor = 3799

B = Coal burn in TBtu/yr

fsreagent = fraction of SCR operation with reagent injection, when residual NH3 is produced that will remove SO3. The value of fsreagent will be similar to, but slightly less than, the value of fsops, defined for Equation 4-4. SNH3 = NH3 slip from SCR/SNCR, ppmv at 6% O2, wet:

• SCR averages 0.75 ppmv over catalyst guarantee period

SNCR averages 5 ppmv

• Note: actual NH3 slip data should be used if available

F2x = Technology Impact Factors, all that apply

The conversion factor Ks, equal to 3799, considers all relevant constants to yield the result in pounds per year of sulfuric acid. The derivation of this constant, for the case where residual NH3 is reported in terms of 6% oxygen and "wet" flue gas at 8.1

The coal burn rate in TBtu/yr is obtained from coal use records, such as those reported to EIA in Form 767. The operating factor of the SCR describes the portion of the coal burn that reflects the period of SCR operation, based on whether the unit operate

Accordingly, total sulfuric acid manufacture (TSAM) and release (TSAR) is estimated for agenerating unit equipped with SCR and flue gas conditioning by the following equations:

Equation 4-11a: Manufacture TSAM = EMComb + EMSCR/SNCR + EMFGC Equation 4-11b: Release TSAR = ERComb + ERSCR/SNCR + ERFGC

Equation 4	EMComb	= K • F1 • E2	2						
K =	3063	Ib H2SO4/t	on SO2 t Footor fr	om Et toblo					
FI=	0.0019	Fuel impac	I Factor Ir	om Fi lable					
Equation 4 C1 = S1 = K1 =	E2 = K1 • 1 186.853 0.45 Molecular 0.02	K2 • C1 • S1 Coal burn, Coal sulfur weight and u SO2/%S	tons/hr weighted units conv	average, % ersion consta	ant				
K2 =	Sulfur conversion to SO2								
	0.875 0.95 for bituminous coals 0.875 for subbituminous coals = 0.55 to 0.85 for lignite, based on the Na content 1 for oil								
E2 =	K1	•	K2	•	C1	•	S1		
E2 = E2 =	0.02 1.471467	SO2 mass	0.87 rate, tons	5 * /hr	186.853	×		0.45	
EMComb =	K	*	F1	*	E2				
EMComb =	= 3063	*	0.001	9 *	1.471467				
EMComb =	8.563499	total H2SO	4 manufa	ctured from c	combustion,	lbs/hr			
Sulfuric Ac Equation 4 ERComb = ERComb = ERComb =	id Release -3 ERComb = EMComb = 8.563499 = 4.500975	d from Comb = EMComb * total H2SO	oustion (E o • F2 (all F2 (AH) 4 released	RComb) that apply) • 1 * d from combi	F2 (PM) 0.72 ustion, Ibs/h	• * r	F2 (F	GD) 0.73	
Sulfuric Ac EMSCR = K =	tid Manufac K • S2 • fsc 3063	ture by SCR ps • E2• F33	(EMSCR SCR on SO2	) = Total H2	SO4 manuf	actured fror	m SCF	, lbs per hour	
S2 = fsops =	0.03	SCR cataly no SCR in	st SO2 ox	idation rate ( ase	specified as	s a decimal	, typica	ally from 0.001- (	0.03)
E2 = E3SCB =	1.47	Technology	/ Impact F	per nour actor, for SC	R		Table	4-2	
EMSCR =	ĸ	•	S2	•	fsops	•	E2	•	F3SCR
EMSCR =	3063	*	0.0	3 *	0	*		1.47 *	
EMSCR =	0	= Total H28	SO4 manu	ifactured from	n SCR, lbs	per hour			
Equation 4 TSAM = E	-11a: Manu MComb + E	facture MSCR/SNC	R +						
TSAM =	EMComb	+	EMSCR/S	-16 -	EMFGC				
TSAM =	8 563499	+ = Total H29	SO4 man	u Ifactured lbs	per hour				

Sulfuric A	cid Released from S	CR and SNCR							
Equation -	4-5 ERSCR = [EMS0	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR =	Total H2SO4 releas	ed from SCR, lbs per l	hour						
EMSCR =	Total H2SO4 manu	factured from SCR, lbs	s per hour						
Ks =	3799 Conver	sion factor							
HV =	11458 Btu/lb								
B =	0.004282 Coal bu	ırn in TBtu/hr							
fsreagent	= 0 fraction	of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	omv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	SNCF	R averages 5 ppmv							
	Note:	actual NH3 slip data s	hould be used if availa	able					
F2x =	Techno	logy Impact Factors, a	ll that apply						
ERSCR =	: [	EMSCR -(	Ks •	В •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	: (	0 - (	3799 *	0.004282 *	0 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	: (	0 - (		0		))*	0.01		
ERSCR =	:	0				*	0.01		
ERSCR =	<ul> <li>0 Total H</li> </ul>	2SO4 released from S	CR, lbs per hour						
Equation	4-11b: Release								
TSAR = E	RComb + ERSCR/S	SNCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	4.500975 +	0 +							
TSAR =	4.500975 Total H	2SO4 released, lbs p	er hour						

Equation 4	EMComb = K • F1 •	E2								
K =	3063 lb H2SC	04/ton SO2	1-							
FI =	0.0019 Fuel Imp	Dact Factor from FI tabl	e							
Equation 4 C1 = S1 = K1 =	E2 = K1 • K2 • C1 • 167.456 Coal bu 0.63 Coal sul Molecular weight ar 0.02 SO2/%	S1 rn, tons/hr fur weighted average, % nd units conversion cons S	% stant							
K2 =	K2 = Sulfur conversion to SO2 0.875 0.95 for bituminous coals									
$\begin{array}{c} 0.875 \\ 0.875 \\ 0.875 \\ \text{for subbituminous coals} \\ = 0.55 \\ \text{to } 0.85 \\ \text{for lignite, based on the Na content} \\ 1 \\ \text{for oil} \end{array}$										
E2 =	K1 •	K2 •	C1 •	S1						
E2 = E2 =	0.02 * 1.846202 SO2 ma	0.875 * ss rate, tons/hr	167.456 *	0.63						
EMComb	=K *	F1 *	E2							
EMComb	= 3063 *	0.0019 *	1.846202							
EMComb	= 10.74434 total H2	SO4 manufactured from	n combustion, lbs/hr							
Sulfuric Ad Equation 4	cid Released from Co I-3 ERComb = EMCo	ombustion (ERComb) omb • F2 (all that apply)	F2 (DM)							
FRComb	= 10.74434 *	Γ2 (AΠ) • 1 *	F∠(FIM) ▼ 1 *	0.01						
ERComb	= 0.107443 total H2	SO4 released from co	mbustion, lbs/hr							
			,							
Sulfuric Ac EMSCR = K =	cid Manufacture by S K • S2 • fsops • E2• 3063 lb H2SC	CR (EMSCR) F3SCR = Total H 04/ton SO2	12SO4 manufactured fr	om SCR, lbs per hour						
S2 =	0.03 SCR ca	talyst SO2 oxidation rate	e (specified as a decima	al, typically from 0.001	- 0.03)					
fsops =	0.9647 for conti	nuous operation								
E2 =	1.846202 SO2 pro	duced, tons per hour	CP	Table 4.2						
FMSCR =	K •	S2 •	fsons •	F2 •	E3SCB					
EMSCR =	3063 *	0.03 *	0.9647 *	1.846202 *	1					
EMSCR =	163.659 = Total I	H2SO4 manufactured fr	om SCR, lbs per hour							
Equation 4 TSAM = E	I-11a: Manufacture MComb + EMSCR/S	NCR +								
TSAM =	EMComb +	EMSCR/SI+	EMFGC							
TSAM =	10./4434 + 174.4033 = Total I	163.659 H2SO4 manufactured 1	bs per hour							
-										

Sulfuric Acid	Released from So	CR and SNCR							
Equation 4-5	ERSCR = [EMSC	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR = To	tal H2SO4 releas	ed from SCR, lbs per	hour						
EMSCR = To	tal H2SO4 manuf	actured from SCR, lbs	s per hour						
Ks =	3799 Convers	sion factor							
HV =	11313 Btu/lb								
B = (	0.003789 Coal bu	rn in TBtu/hr							
fsreagent =	0.95 fraction	of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	omv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	<ul> <li>SNCR</li> </ul>	averages 5 ppmv							
	Note: a	actual NH3 slip data s	hould be used if availa	ıble					
F2x =	Techno	logy Impact Factors, a	ll that apply						
ERSCR =	[	EMSCR -(	Ks •	в •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	(	163.659 – (	3799 *	0.003789 *	0.95 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	(	163.659 – (		10.25564		))*	0.01		
ERSCR =		153.4033				*	0.01		
ERSCR =	1.534033 Total H2	2SO4 released from S	CR, lbs per hour						
Equation 4-1	1b: Release								
TSAR = ERC	omb + ERSCR/S	NCR + ERFGC							
TSAR = E	RComb +	ERSCR/SN+	ERFGC						
TSAB = (	0.107443 +	1.534033 +							

TSAR = 0.107443 + 1.534033 + TSAR = 1.641477 Total H2SO4 released, lbs per hour

Equation 4	EMComb =	= K • F1 • E2	2							
K =	3063	lb H2SO4/t	on SO2							
⊢1 =	0.0019	Fuel Impac	t Factor fro	m F1 table						
Equation 4 C1 = S1 = K1 =	E2 = K1 • I 186.747 0.45 Molecular 0.02	K2 • C1 • S1 Coal burn, Coal sulfur weight and u SO2/%S	tons/hr weighted a units conve	average, % rsion consta	ant					
K2 =	K2 = Sulfur conversion to SO2									
	0.875 0.95 for bituminous coals									
	0.875 for subbituminous coals									
	= 0.55 to 0.85 for lignite, based on the Na content									
50	1/1		1	for oil	~1		01			
E2 =	KI 0.00	•	K2 0.075	•	100 747	•	51	0.45		
E2 =	1 470622	SO2 mass	0.875	or an	186.747			0.45		
L2 =	1.470033	302 mass	rale, 10115/1	11						
EMComb =	EMComb = K * F1 * E2									
EMComb -	9 5596/1	total H2SO	0.0019 4 manufac	turod from c	ombustion	) lbc/br				
ENICOIND	0.000041		4 manulau		ombustion	, 105/11				
Sulfuric Ac Equation 4 ERComb = ERComb =	id Released -3 ERComb EMComb 8.558641	d from Comb = EMComb *	oustion (EF • F2 (all th F2 (AH) 1	Comb) hat apply) *	F2 (PM) 0.72	• •	F2 (F	GD) 0.73		
ERComb =	4.498422	total H2SO	4 released	from combi	ustion, Ibs/h	٦r				
Sulfuric Ac EMSCR = K = S2 = fsops = F2 =	id Manufac K • S2 • fso 3063 0.03 0.03 1 470633	ture by SCR ps • E2• F33 lb H2SO4/t SCR cataly no SCR in l SO2 produ	(EMSCR) SCR on SO2 st SO2 oxi baseline ca ced, tons n	= Total H2 dation rate ( ase er hour	SO4 manut	factured fror	n SCF , typica	R, lbs per hour Ally from 0.001-	0.03)	
E3SCB =	1.170000	Technology	/ Impact Fa	actor, for SC	R		Table	4-2		
EMSCR =	K	•	S2	•	fsops	•	E2	•	F3SCR	
EMSCR =	3063	*	0.03	*	. c	) *	1.47	0633 *		
EMSCR =	0	= Total H2S	SO4 manuf	actured fror	n SCR, lbs	per hour				
Equation 4 TSAM = EI TSAM = TSAM = TSAM =	-11a: Manu MComb + E EMComb 8.558641 8.558641	facture MSCR/SNC + + = Total H2S	CR + EMSCR/S 0 SO4 manuf	r+ factured, lbs	EMFGC					

Sulfuric A	cid Released from S	SCR and SNCR							
Equation 4	4-5 ERSCR = [EMS	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR =	Total H2SO4 release	sed from SCR, lbs per l	nour						
EMSCR =	Total H2SO4 manu	afactured from SCR, lbs	s per hour						
Ks =	3799 Conver	rsion factor							
HV =	11410 Btu/lb								
B =	0.004262 Coal bi	urn in TBtu/hr							
fsreagent	= 0 fraction	n of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sl	ip from SCR/SNCR, pp	mv at 6% O2, wet						
	• SCR	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	<ul> <li>SNCF</li> </ul>	R averages 5 ppmv							
	Note:	actual NH3 slip data sl	nould be used if availa	able					
F2x =	Techno	ology Impact Factors, a	ll that apply						
ERSCR =	: [	EMSCR – (	Ks •	в •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	: (	0 – (	3799 *	0.004262 *	0 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	: (	0 – (		0		))*	0.01		
ERSCR =		0				*	0.01		
ERSCR =	0 Total H	12SO4 released from S	CR, lbs per hour						
Equation 4	4-11b: Release								
TSAR = E	RComb + ERSCR/S	SNCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	4.498422 +	0 +							
TSAR =	4.498422 Total H	12SO4 released, lbs p	er hour						

Equation 4	4 EMComb = K • I	F1 • E2								
K =	3063 lb H2	SO4/ton SO2								
F1 =	0.0019 Fuel	Impact Factor from F1 tat	ole							
Equation 4 C1 = S1 = K1 =	4 E2 = K1 • K2 • C 163.736 Coal 0.59 Coal Molecular weigh 0.02 SO2 Sulfur conversio	1 • S1 burn, tons/hr sulfur weighted average, t and units conversion cor %S n to SO2	% istant							
0.875 0.95 for bituminous coals 0.875 for subbituminous coals = 0.55 to 0.85 for lignite, based on the Na content 1 for oil										
E2 = E2 = E2 =	K1 • 0.02 * 1.690574 SO2	K2 • 0.875 * mass rate, tons/hr	C1 • 163.736 *	S1 0.59						
EMComb EMComb EMComb	EMComb = K * F1 * E2 EMComb = 3063 * 0.0019 * 1.690574 EMComb = 9.838635 total H2SO4 manufactured from combustion, lbs/hr									
Sulfuric A Equation 4 ERComb ERComb	cid Released from 4-3 ERComb = EM = EMComb • = 9.838635 * = 0.098386 total	Combustion (ERComb) /Comb • F2 (all that apply F2 (AH) • 1 * H2SO4 released from c	•) F2 (PM) ● 1 * ombustion, lbs/hr	F2 (FGD) 0.01						
Sulfuric A EMSCR = K = S2 = fsops = E2 = F3SCR = EMSCR = EMSCR = EMSCR =	cid Manufacture b K • S2 • fsops • E 3063 lb H2 0.03 SCR 0.988 for c 1.690574 SO2 1 Tech K • 3063 * 153.4827 = To	y SCR (EMSCR) 20 F3SCR = Total 2004/ton SO2 catalyst SO2 oxidation ra produced, tons per hour nology Impact Factor, for S2 • 0.03 * tal H2SO4 manufactured f	H2SO4 manufactured te (specified as a deci SCR fsops 0.988 * from SCR, lbs per hou	from SCR, lbs per hour mal, typically from 0.00 <sup>-</sup> Table 4-2 E2 • 1.690574 * r	1- 0.03) F3SCR 1					
Equation 4 TSAM = E TSAM = TSAM = TSAM =	Equation 4-11a: Manufacture TSAM = EMComb + EMSCR/SNCR + TSAM = EMComb + EMSCR/SI + EMFGC TSAM = 9.838635 + 153.4827 TSAM = 163.3213 = Total H2SO4 manufactured, lbs per hour									

Sulfuric A	cid Released f	rom SCR and SNCR							
Equation	4-5 ERSCR =	[EMSCR – (Ks • B • fsreag	gent • SNH3)] • F2x						
ERSCR =	Total H2SO4	released from SCR, lbs pe	er hour						
EMSCR =	= Total H2SO4	manufactured from SCR,	lbs per hour						
Ks =	3799 C	Conversion factor							
HV =	11523 E	itu/lb							
B =	0.003773 0	oal burn in TBtu/hr							
fsreagent	= 0.97 fr	action of SCR operation w	ith reagent injection						
SNH3 =	0.75 N	IH3 slip from SCR/SNCR,	ppmv at 6% O2, wet						
	•	SCR averages 0.75 ppmv	over catalyst guarantee	period					
	•	SNCR averages 5 ppmv							
	•	Note: actual NH3 slip data	a should be used if availa	able					
F2x =	Т	echnology Impact Factors	, all that apply						
ERSCR =	- [	EMSCR -(	Ks •	в •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	= (	153.4827 – (	3799 *	0.003773 *	0.97 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	= (	153.4827 – (		10.42898		))*	0.01		
ERSCR =	-	143.0537				*	0.01		
ERSCR =	= 1.430537 T	otal H2SO4 released from	SCR, lbs per hour						
Equation	4-11b: Release	e							
TSAR = E	ERComb + ER	SCR/SNCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	0.098386 +	1.430537 +							
TSAR =	1.528924 T	otal H2SO4 released, lbs	s per hour						

Equation 4	EMComb =	= K • F1 • E2							
r = F1 =	0.0019	Fuel Impact	t Factor fro	om F1 table					
Equation 4 C1 = S1 = K1 = K2 =	Equation 4 E2 = K1 • K2 • C1 • S1 C1 = 199:105 S1 = 0.45 Coal sulfur weighted average, % K1 = Molecular weight and units conversion constant 0.02 SO2/%S K2 = Sulfur conversion to SO2 0.875 0.95 for bituminous coals 0.875 for subbituminous coals = 0.55 to 0.85 for lignite based on the Na content								
	= 0.55 to 0.85 for lignite, based on the Na content								
E2 = E2 = E2 =	K1 0.02 1.567952	• * SO2 mass i	K2 0.875 rate, tons/	• 5 * hr	C1 199.105	• *	S1	0.45	
EMComb = EMComb = EMComb =	EMComb = K * F1 * E2 EMComb = 3063 * 0.0019 * 1.567952 EMComb = 9.12501 total H2SO4 manufactured from combustion, lbs/hr								
Sulfuric Ac Equation 4 ERComb = ERComb = ERComb =	id Released -3 ERComb = EMComb = 9.12501 = 0.365	d from Comb = EMComb * total H2SO4	oustion (EF • F2 (all t F2 (AH) 1 4 released	RComb) hat apply) • I * I from combi	F2 (PM) 0.1 ustion, lbs/h	• * r	F2 (F	GD) 0.4	
Sulfuric Ac EMSCR = K = S2 =	tid Manufac K • S2 • fso 3063 0.03	ture by SCR ps • E2• F3S lb H2SO4/to SCR cataly	(EMSCR) SCR on SO2 st SO2 oxi	= Total H2	SO4 manuf	actured fron s a decimal,	n SCR , typica	, lbs per hour Illy from 0.001- (	0.03)
tsops = E2 = F3SCR = EMSCR = EMSCR = EMSCR =	Image: Start Start       Image: Start Start Start Start       Image: Start								
Equation 4 TSAM = E TSAM = TSAM = TSAM =	-11a: Manu MComb + E EMComb 9.12501 9.12501	facture MSCR/SNC + = = Total H2S	R + EMSCR/S ( 604 manu	il + ) factured, lbs	EMFGC				

Sulfuric A	cid Released from S	CR and SNCR							
Equation 4	4-5 ERSCR = [EMSC	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR =	Total H2SO4 releas	ed from SCR, lbs per l	nour						
EMSCR =	Total H2SO4 manu	factured from SCR, lbs	s per hour						
Ks =	3799 Conver	sion factor							
HV =	11453 Btu/lb								
B =	0.004561 Coal bu	ırn in TBtu/hr							
fsreagent	= 0 fraction	of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	mv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	<ul> <li>SNCF</li> </ul>	R averages 5 ppmv							
	Note:	actual NH3 slip data s	hould be used if availa	able					
F2x =	Techno	logy Impact Factors, a	ll that apply						
ERSCR =	[	EMSCR -(	Ks •	в •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	(	0 - (	3799 *	0.004561 *	0 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	(	0 - (		0		))*	0.01		
ERSCR =		0				*	0.01		
ERSCR =	0 Total H	2SO4 released from S	CR, lbs per hour						
Equation 4	4-11b: Release								
TSAR = E	RComb + ERSCR/S	NCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	0.365 +	0 +							

TSAR =	0.365 +	0 +
TSAR =	0.365 Total H2	2SO4 released, lbs per hour

Equation 4	EMComb	= K • F1 • E2	2						
K =	3063	b H2SO4/t	on SO2 t Eastar fr	om E1 tabla					
F I =	0.0019	ruei iiipac	I Facior In						
Equation 4 C1 = S1 = K1 =	E2 = K1 • 199 0.56 Molecular 0.02	K2 • C1 • S1 Coal burn, Coal sulfur weight and u SO2/%S	tons/hr weighted inits conve	average, % ersion consta	ant				
K2 = Sulfur conversion to SO2									
0.875 0.95 for bituminous coals 0.875 for subbituminous coals = 0.55 to 0.85 for lignite, based on the Na content 1 for oil									
E2 =	K1	•	K2	•	C1	•	S1	0.50	
E2 =	1 0502	. * . • • • • • • • • • • • • • • • • • • •	0.873	5 * /br		199 *		0.56	
C2 =	1.9502	502 mass	rate, tons/	11					
EMComb = EMComb = EMComb =	EMComb = K * F1 * E2 EMComb = 3063 * 0.0019 * 1.9502 EMComb = 11.34958 total H2SO4 manufactured from combustion, lbs/hr								
Sulfuric Ac Equation 4 ERComb =	cid Release I-3 ERComb = EMComb	d from Comb o = EMComb	oustion (El o • F2 (all 1 F2 (AH)	RComb) that apply) •	F2 (PI	VI) •	F2 (F	GD)	
ERComb =	= 11.34958	*	· í ·	1 *		0.72 *		0.73	
ERComb =	= 5.965339	total H2SO	4 released	from combi	ustion,	lbs/hr			
Sulfuric Ac EMSCR = K =	cid Manufac K • S2 • fsc 3063	ture by SCR ops • E2• F38 Ib H2SO4/t	(EMSCR) SCR on SO2	) = Total H2	SO4 m	anufactured	from SCF	R, Ibs per hour	0.03)
fsops =	0.03	no SCR in l	paseline c	ase	specin		nai, typica		0.03)
E2 =	1.9502	SO2 produ	ced, tons p	per hour					
F3SCR =	1	Technology	Impact F	actor, for SC	R		Table	9 4-2	
EMSCR =	K	•	S2	•	fsops	•	E2	•	F3SCR
EMSCR =	3063	– Total H29	0.0 0.0 manu	3 Ifactured from	n SCR	U Ibs per hour	. I.	.9502	
	0	- 10(011)20			10011				
Equation 4	-11a: Manu MComb + F	Ifacture	B.						
TSAM =	EMComb	+	EMSCR/S	+ 16	EMFG	C			
TSAM =	SAM = 11.34958 + 0								
TSAM =	SAM = 11.34958 = Total H2SO4 manufactured, lbs per hour								

Sulfuric A	cid Released from So	CR and SNCR							
Equation 4	4-5 ERSCR = [EMSC	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR =	Total H2SO4 release	ed from SCR, lbs per	hour						
EMSCR =	Total H2SO4 manuf	factured from SCR, lbs	s per hour						
Ks =	3799 Convers	sion factor							
HV =	11564 Btu/lb								
B =	0.004602 Coal bu	ırn in TBtu/hr							
fsreagent	= 0 fraction	of SCR operation with	n reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	omv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	SNCR	l averages 5 ppmv							
	Note:	actual NH3 slip data s	hould be used if availa	ıble					
F2x =	Techno	logy Impact Factors, a	II that apply						
ERSCR =	[	EMSCR – (	Ks •	в •	fsreagent •	SNH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	(	0 - (	3799 *	0.004602 *	0 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	(	0 - (		0		))*	0.01		
ERSCR =		0				*	0.01		
ERSCR =	0 Total H	2SO4 released from S	CR, lbs per hour						
Equation 4	4-11b: Release								
TSAR = E	RComb + ERSCR/S	NCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	5.965339 +	0 +							
TSAR =	5.965339 Total H	2SO4 released, lbs p	er hour						

Equation 4	EMComb	= K • F1 •	E2							
K =	3063	3 lb H2SO4	1/ton SO2	from E1 table						
F1 =	0.0013		aci Facioi	TUTTE	;					
Equation 4 C1 = S1 =	E2 = K1 • 164.883 0.0	K2 • C1 • S Coal burn Coal sulf	S1 n, tons/hr ur weighte	d average, %						
KI =	0.02	2 SO2/%S		IVERSION CONS	lani					
K2 =	K2 =       Sulfur conversion to SO2         0.875       0.95 for bituminous coals         0.875 for subbituminous coals         =       0.55 to 0.85 for lignite, based on the Na content         1 for oil									
F2 =	K1	•	К2	•	C1	•	S1			
E2 = E2 = E2 =	0.02 1.731272	2 * 2 SO2 mas	0.8 s rate, tor	75 * s/hr	164.88	3 *	01	0.6		
EMComb EMComb EMComb	EMComb = K * F1 * E2 EMComb = 3063 * 0.0019 * 1.731272 EMComb = 10.07548 total H2SO4 manufactured from combustion, lbs/hr									
Sulfuric Ac Equation 4 ERComb =	cid Release 1-3 ERCom = EMComb	d from Cor b = EMCor	mbustion ( mb • F2 (a F2 (AH)	ERComb) Il that apply)	F2 (PM)	•	F2 (FG	aD)		
ERComb =	= 10.07548	3 *	. ,	1 *		1 *	_ ` (	D.O1		
ERComb	= 0.10075	5 total H28	SO4 releas	sed from cor	nbustion, I	bs/hr				
Sulfuric Ac EMSCR = K = S2 = fsops =	cid Manufac K • S2 • fs 3063 0.03 0.97	cture by SC ops • E2• F 3 Ib H2SO4 3 SCR cata for contin	CR (EMSC 3SCR 4/ton SO2 alyst SO2	R) = Total H oxidation rate ration	2SO4 manu (specified a	factured fro as a decima	m SCR, I, typical	lbs per hour ly from 0.001-	0.03)	
E2 =	1.731272	2 SO2 proc	luced, ton	s per hour						
F3SCR =		Technolo	gy Impact	Factor, for S	CR		Table 4	4-2		
EMSCR = EMSCR =	K 3063	• 3 *	S2 0.	.03 *	fsops 0.97	• 7 *	E2 1.731	• 272 *	F3SCR	1
EMSCR =	155.427	5 = Total H	2SO4 ma	nufactured fro	om SCR, lbs	per hour				
Equation 4 TSAM = E	1-11a: Man MComb + 1	ufacture EMSCR/SI	NCR +							
I SAM = TSAM =	EMComb	+ 3 +	EMSCF 155.42	8/Sl + 175	EMFGC					
I SAIVI =	SAM = 165.503 = Total H2SO4 manufactured, lbs per hour									

Sulfuric A	cid Released	from SCR and SNCR									
Equation -	4-5 ERSCR =	[EMSCR - (Ks · B · fs	reagent • SNH3)] • F	2x							
ERSCR =	Total H2SO4	released from SCR, lb	s per hour								
EMSCR =	= Total H2SO4	manufactured from So	CR, lbs per hour								
Ks =	3799 (	Conversion factor									
HV =	12011 E	Btu/lb									
B =	0.003961	Coal burn in TBtu/hr									
fsreagent	= 0.96 f	raction of SCR operation	on with reagent injec	tion							
SNH3 =	0.75 N	NH3 slip from SCR/SN	CR, ppmv at 6% O2	wet							
	•	SCR averages 0.75 p	pmv over catalyst gu	arantee perio	ıd						
	•	SNCR averages 5 ppr	mv								
	•	Note: actual NH3 slip	data should be used	if available							
F2x =	T	echnology Impact Fac	tors, all that apply								
ERSCR =	• [	EMSCR -	-( Ks	•	в •	<ul> <li>fsreage</li> </ul>	ent • S	NH3 )]•	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	- (	155.4275 -	-( 379	9 *	0.003961 *	* 0	.96 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	- (	155.4275 -	- (		10.83395			))*	0.01		
ERSCR =		144.5936						*	0.01		
ERSCR =	= 1.445936 T	otal H2SO4 released	from SCR, lbs per ho	our							
<b>F</b>		_									
Equation	4-11D: Releas										
ISAR = E	ERComb + ER	SCR/SNCR + ERFGC									
ISAR =	ERComb +	- ERSCR/SN-	+ ERFGC								
ISAR =	0.100755 +	1.445936	+ .	-							
TSAR =	1.546691 1	otal H2SO4 released	, lbs per hour								

Equation 4	EMComb	= K • F1 • I	E2								
K = F1 _	3063	3 ID H2SO4	l/ton SO2	rom E1 tablo							
11=	0.0013		act i actor ii								
Equation 4 C1 = S1 = K1 =	E2 = K1 • 198.598 0.56 Molecular 0.02	K2 • C1 • S Coal burr Coal sulfi weight and SO2/%S	61 a, tons/hr ur weighted d units conv	average, % ersion const	ant						
K2 =	Sulfur con	version to	SO2								
$\begin{array}{c} 0.875 \\ 0.875 \\ 0.875 \\ 0.875 \\ 0.875 \\ 0.875 \\ 0.875 \\ 0.875 \\ 0.85 \\ 0$											
E2 =	K1	•	K2	•	C1	•	S1				
E2 = E2 =	0.02 1.94626	2 * 6 SO2 mas	0.87 s rate, tons	'5 * /hr	198.59	8 *		0.56			
EMComb = EMComb = EMComb =	=K = 3063 = 11.32665	* 3 * 5 total H2S	F1 0.001 O4 manufa	* 9 * ctured from (	E2 1.9462 combustio	26 n, Ibs/hr					
Sulfuric Ac Equation 4 ERComb = ERComb = ERComb =	cid Release I-3 ERCom = EMComb = 11.32665 = 8.155185	d from Cor b = EMCor 5 * 9 total H2S	nbustion (E nb • F2 (all F2 (AH) O4 release	RComb) that apply) • 1 * d from comb	F2 (PM) 0.7 ustion, Ibs	• /2 * /hr	F2 (F	GD) 1			
Sulfuric Ac EMSCR = K = S2 = fsops = F2 =	cid Manufad K • S2 • fso 3063 0.03 ( 1 94626	cture by SC ops • E2• F 3 lb H2SO4 3 SCR cata 1 no SO2 c 3 SO2 proc	R (EMSCR 3SCR //ton SO2 /lyst SO2 oz ontrol at Hu	) = Total H2 kidation rate untington 2 b per hour	SO4 man (specified aseline ca	ufactured fro as a decima se	m SCR I, typica	, lbs per hour ally from 0.001-	· 0.03)		
F3SCR = EMSCR = EMSCR = EMSCR =	K 3063	1 Technolo • 3 * ) = Total H	gy Impact F S2 0.0 2SO4 mani	actor, for SC • 3 * ufactured from	CR fsops m SCR. lb	• 0 * s per hour	Table E2 1.9	4-2 • 4626 *	F3SCR	1	
Equation 4 TSAM = E	I-11a: Manı MComb + I EMComb	ufacture EMSCR/SN		SN +	EMEGO						
TSAM = TSAM =	11.32665	5 + 5 = Total H	2SO4 mani	0 Jfactured, Ibs	s per hour						

Sulfuric Ad	cid Released from S	CR and SNCR							
Equation 4	4-5 ERSCR = [EMSC	CR – (Ks • B • fsreager	nt • SNH3)] • F2x						
ERSCR =	Total H2SO4 releas	ed from SCR, lbs per l	hour						
EMSCR =	Total H2SO4 manuf	factured from SCR, lbs	s per hour						
Ks =	3799 Conver	sion factor							
HV =	11560 Btu/lb								
B =	0.004592 Coal bu	ırn in TBtu/hr							
fsreagent	= 0 fraction	of SCR operation with	n reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	omv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv o	ver catalyst guarantee	e period					
	SNCF	R averages 5 ppmv							
	Note:	actual NH3 slip data s	hould be used if availa	able					
F2x =	Techno	logy Impact Factors, a	all that apply						
ERSCR =	[	EMSCR – (	Ks •	в •	fsreagent •	SNH3 )] •	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	(	0 - (	3799 *	0.004592 *	0 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	(	0 - (		0		))*	0.01		
ERSCR =		0				*	0.01		
ERSCR =	0 Total H	2SO4 released from S	CR, lbs per hour						
Equation 4	4-11b: Release								
TSAR = E	RComb + ERSCR/S	NCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	8.155189 +	0 +							
TSAR =	8.155189 Total H	2SO4 released, lbs p	er hour						

Equation 4	EMComb		2							
κ = F1 =	0.0019	) Fuel Impa	ton SO2	m F1 table						
Equation 4 C1 = S1 = K1 = K2 =	E2 = K1 • 173.942 0.6 Molecular 0.02 Sulfur con 0.875	K2 • C1 • S Coal burn, Coal sulfur weight and SO2/%S version to S	1 tons/hr r weighted a units conver 5O2 0.95 0.875	verage, % sion consta for bitumin for subbitu = 0.55 to 0	ant ous coals minous coa .85 for ligni	als ite, based o	n the Na	a content		
50			1	for oil	<u>.</u>		<i></i>			
E2 = E2 = E2 =	K1 0.02 1.826391	• * SO2 mass	K2 0.875 rate, tons/h	• * r	173.942	•	51	0.6		
EMComb EMComb EMComb	= K = 3063 = 10.62905	* 5 total H2SC	F1 0.0019 04 manufact	* * ured from c	E2 1.826391 ombustion	, lbs/hr				
Sulfuric Ac Equation 4 ERComb = ERComb =	cid Release I-3 ERComl = EMComb = 10.62905	d from Com o = EMCom •	bustion (ER b • F2 (all th F2 (AH) 1	Comb) at apply) • *	F2 (PM) 1	•	F2 (FG	GD) 0.01		
ERComb	= 0.10629	total H2S	04 released	from com	bustion, Ib	os/hr				
Sulfuric Ac EMSCR = K = S2 = fsops = E2 -	cid Manufac K • S2 • fsc 3063 0.03 0.964 1.826391	ture by SCF ops • E2• F3 b lb H2SO4/ SCR catal for continu	R (EMSCR) SCR ton SO2 yst SO2 oxic ous operatio	= Total H2 dation rate ( on	SO4 manul	factured from	m SCR, I, typical	lbs per hour ly from 0.001-	0.03)	
F3SCR = EMSCR = EMSCR = EMSCR =	1.020391 1 K 3063 161.7853	Technolog • • • • • •	y Impact Fa S2 0.03 SO4 manufa	et flour ctor, for SC • * actured fror	R fsops 0.964 n SCR, lbs	• • per hour	Table 4 E2 1.826	4-2 • 391 *	F3SCR	1
Equation 4 TSAM = E TSAM = TSAM = TSAM =	I-11a: Manu MComb + E EMComb 10.62905 172.4143	ufacture EMSCR/SNG + 5 + 8 = Total H2	CR + EMSCR/SI 161.7853 SO4 manufa	+ actured, lbs	EMFGC per hour					

Sulfuric A	cid Released from S	CR and SNCR							
Equation	4-5 ERSCR = [EMS0	CR – (Ks • B • fsreager	t • SNH3)] • F2x						
ERSCR =	Total H2SO4 releas	ed from SCR, lbs per l	nour						
EMSCR =	Total H2SO4 manu	factured from SCR, lbs	per hour						
Ks =	3799 Conver	sion factor							
HV =	11995 Btu/lb								
B =	0.004173 Coal bu	urn in TBtu/hr							
fsreagent	= 0.95 fraction	of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	mv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	ver catalyst guarantee	period					
	SNCF	R averages 5 ppmv							
	Note:	actual NH3 slip data s	hould be used if availa	ıble					
F2x =	Techno	ology Impact Factors, a	ll that apply						
ERSCR =	: [	EMSCR – (	Ks •	в •	fsreagent •	SNH3 )] •	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	: (	161.7853 – (	3799 *	0.004173 *	0.95 *	0.75 ))*	1 *	1 *	0.01
ERSCR =	: (	161.7853 – (		11.29507		))*	0.01		
ERSCR =	:	150.4902				*	0.01		
ERSCR =	1.504902 Total H	2SO4 released from S	CR, lbs per hour						
Equation	4-11b: Release								
TSAR = E	ERComb + ERSCR/S	NCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	0.10629 +	1.504902 +							
TSAR =	1.611193 Total H	2804 released, lbs p	er hour						

Equation 4	EMComb	= K • F1 • E	2						
K =	306	3 ID H2SO4/1	ton SO2	: r from E1 tr	blo				
	0.001	e ruei impac	I Facio		able				
Equation 4 C1 = S1 = K1 =	E2 = K1 • 27.600 0.70 Molecular 0.02	K2 • C1 • S1 Coal burn, Coal sulfur weight and SO2/%S	tons/hr weighte units co	ed average nversion co	, % onstant				
K2 =	Sulfur cor	version to S	O2						
	0.875	5	C	).95 for bitu	uminous c	oals			
			0.	875 for sub	obitumino	us coals			
				= 0.55	to 0.85 fo	or lignite, bas	ed on the Na	content	
				1 for oil					
E2 =	K1	•	K2	•	C1	•	S1		
E2 =	0.02	2 *	0.	875 *	2	27.606 *	0.	76	
E2 =	0.36716	6 SO2 mass	rate, to	ns/hr					
EMComb	K	*	<b>E1</b>	*	Eo				
EMComb -	- 306'	2 *	0.0	010 *	L2 0	36716			
EMComb	2 1267	S total U280	0.0 M monu	ufactured fr	u. om oombi	uction lbc/br			
ENICOIND	2.1307		4 manu	naciureu m					
Sulfuric Ac Equation 4 ERComb = ERComb = ERComb =	id Release -3 ERCom = EMComb = 2.13676 = 1.538467	d from Com b = EMCom 6 * 7 total H2SC	bustion b • F2 (a F2 (AH 04 releas	(ERComb) all that appl ) • 1 * sed from co	ly) F2 ( ombustior	PM) • 0.72 * n, lbs/hr	F2 (FGI	)) 1	
Sulfuric Ac EMSCR =	id Manufad K • S2 • fso 2065	cture by SCF ops • E2• F3	R (EMSC SCR	CR) = Tota	I H2SO4	manufacture	d from SCR, I	os per hour	
S2 -	0.00	SCR cataly	/st SO2	oxidation r	ate (snec	ified as a dec	rimal typically	$from 0.00^{-1}$	1-0.03)
$f_{sons} =$	0.00	1 no SO2 co	ntrol ins	talled at C	arbon 1		siniai, typioaily	10111 0.00	0.00)
F2 =	0.36716	5 SO2 produ	iced, tor	ns per hour					
F3SCR =		1 Technolog	v Impac	t Factor, fo	r SCR		Table 4-	-2	
EMSCR =	К	•	S2	•	fsop	s•	E2	•	F3SCR
EMSCR =	3063	3 *	с с	).03 *		0 *	0.367	16 *	
EMSCR =	(	) = Total H2	SO4 ma	nufactured	I from SC	R, lbs per ho	ur		
Equation 4 TSAM = El TSAM = TSAM = TSAM =	-11a: Man MComb + I EMComb 2.1367( 2.1367)	ufacture EMSCR/SNC + 5 + 5 = Total H2	CR + EMSCI SO4 ma	R/SN+ 0 anufactured	EMF	GC			

Sulfuric Ad	cid Released f	rom SCR and SNC	R											
Equation 4	4-5 ERSCR =	[EMSCR – (Ks • B	<ul> <li>fsreagent</li> </ul>	• SNH3)] • F	2x									
ERSCR =	Total H2SO4	released from SCR	, lbs per h	our										
EMSCR =	Total H2SO4	manufactured from	SCR, lbs	per hour										
Ks =	3799 C	Conversion factor												
HV =	12125 E	stu/lb												
B =	0.000669	oal burn in TBtu/hr												
fsreagent	= 0 fi	action of SCR oper	ration with	reagent injec	tion									
SNH3 =	0.75 N	IH3 slip from SCR/S	SNCR, ppr	nv at 6% O2	wet									
	•	SCR averages 0.7	5 ppmv ov	er catalyst gu	arantee	period								
	•	SNCR averages 5	ppmv											
	•	Note: actual NH3 s	lip data sh	ould be used	if availa	able								
F2x =	Т	echnology Impact I	Factors, al	l that apply										
ERSCR =	[	EMSCR	- (	Ks	•	В	•	fsreagent	• SN	JH3 )]•	F2 (AH)	•	F2 (PM) •	F2 (FGD)
ERSCR =	(		0 – (	379	9 *	0.0006	69 *	0	*	0.75 ))*		1 *	1 *	1
ERSCR =	(		0 – (				0			))*		1		
ERSCR =			0							*		1		
ERSCR =	0 T	otal H2SO4 release	ed from SC	CR, lbs per he	our									
Equation 4	4-11b: Release	e												
TSAR = E	RComb + ERS	SCR/SNCR + ERFC	GC											
TSAR =	ERComb +	ERSCR/	SN+	ERFGC										
TSAR =	1.538467 +		0 +											
TSAR =	1.538467 T	otal H2SO4 releas	ed, lbs pe	er hour										

Equation 4	EMComb	= K • F1 •	E2									
к = F1 =	0.001	3 10 H2SO4 9 Fuel Imp	i/ton SO2 act Factor f	rom F1 table								
Equation 4 C1 = S1 = K1 =	E2 = K1 • 42.222 0.73 Molecular 0.02	K2 • C1 • S Coal burr Coal sulfu weight and SO2/%S	S1 n, tons/hr ur weighted d units conv	average, % version const	ant							
112 -	0.87	5	0.9 0.87	95 for bitumir 75 for subbitu = 0.55 to 1 1 for oil	nous umino 0.85	coals ous co for ligr	als nite, based	on the	Na contei	nt		
E2 = E2 = E2 =	K1 0.02 0.554250	• 2 * 6 SO2 mas	K2 0.87 s rate, tons	• 75 * s/hr	C1	42.22	• 9 *	S1	0.75			
EMComb = EMComb = EMComb =	= K = 3063 = 3.22560	* 3 * 1 total H2S	F1 0.001 O4 manufa	* 19 * actured from	E2 0. comb	55425 pustior	6 ı, Ibs/hr					
Sulfuric Ac Equation 4 ERComb = ERComb = ERComb =	cid Release I-3 ERCom = EMComb = 3.22560 = 2.32243	ed from Cor b = EMCor • 1 * 3 total H2S	nbustion (E nb • F2 (all F2 (AH) O4 release	RComb) that apply) • 1 * d from comb	F2 oustio	(PM) 0.7 n, lbs/	• 2 * hr	F2 (f	-GD) 1			
Sulfuric Ac EMSCR = K = S2 = fsops = E2 -	cid Manufad K • S2 • fs 306 0.03	cture by SC ops • E2• F 3 lb H2SO4 3 SCR cata 1 no SO2 c	CR (EMSCF 3SCR I/ton SO2 alyst SO2 o controls inst	R) = Total H2 xidation rate called at Carb	2SO4 (spe oon 2	i manu	factured fro	om SCI al, typic	R, Ibs per ally from	hour 0.001- 0.4	03)	
F3SCR = EMSCR = EMSCR = EMSCR =	K 306	1 Technolo • 3 * 0 = Total H	gy Impact I S2 0.( 2SO4 man	Factor, for So • • • • • • • • • • • • •	CR fso m SC	ps CR, Ibs	• 0 * s per hour	Tabl E2 0.5	e 4-2 • 54256 *	ļ	F3SCR	1
Equation 4 TSAM = E TSAM = TSAM = TSAM =	I-11a: Man MComb + EMComb 3.22560 3.22560	ufacture EMSCR/SN + 1 + 1 = Total H	ICR + EMSCR/ 2SO4 man	St+ 0 ufactured, lb	EM s per	FGC						

Sulfuric A	cid Released from S	CR and SNCR							
Equation 4	4-5 ERSCR = [EMSC	CR – (Ks • B • fsreagen	t • SNH3)] • F2x						
ERSCR =	Total H2SO4 releas	ed from SCR, lbs per h	iour						
EMSCR =	<ul> <li>Total H2SO4 manuf</li> </ul>	actured from SCR, lbs	per hour						
Ks =	3799 Conver	sion factor							
HV =	12128 Btu/lb								
B =	0.001024 Coal bu	rn in TBtu/hr							
fsreagent	= 0 fraction	of SCR operation with	reagent injection						
SNH3 =	0.75 NH3 sli	p from SCR/SNCR, pp	mv at 6% O2, wet						
	• SCR a	averages 0.75 ppmv ov	er catalyst guarantee	period					
	SNCF	averages 5 ppmv							
	Note:	actual NH3 slip data sł	nould be used if availa	able					
F2x =	Techno	logy Impact Factors, al	ll that apply						
ERSCR =	. [	EMSCR – (	Ks •	в •	fsreagent •	SNH3 )] •	F2 (AH) •	F2 (PM) •	F2 (FGD)
ERSCR =	. (	0 – (	3799 *	0.001024 *	0 *	0.75 ))*	1 *	1 *	1
ERSCR =	. (	0 — (		0		))*	1		
ERSCR =		0				*	1		
ERSCR =	0 Total H	2SO4 released from So	CR, lbs per hour						
Equation 4	4-11b: Release								
TSAR = E	RComb + ERSCR/S	NCR + ERFGC							
TSAR =	ERComb +	ERSCR/SN+	ERFGC						
TSAR =	2.322433 +	0 +							
TSAR =	2.322433 Total H	2SO4 released, lbs pe	er hour						

The following are the special assumptions, knowns and other items of interest involved in the calculations expressed in the previous tabs:

1. The spreadsheet calculations were made according to the version of the spreadsheet sent to UDAQ by EPA. This appears to correspond to a version of the EPRI document from 2012. However, it does not match the document 1023790 downloaded from EPA's website. This can be verified by referencing the equation numbers referred to within the 1023790 document and those listed on the "Explain" tab. The equation reference numbers tend to differ slightly, although the content of the equation itself is identical.

2. In several places throughout this methodology specific values needed to be supplied which were unavailable at the time of calculation. These values were typically site specific values or estimations of SCR performance (SCR oxidation rate) based on available coal data which could only be obtained through testing. The plants in question - Hunter Units 1, 2, and 3; Huntington 1 and 2; and Carbon Units 1 and 2 - burn a blend of Western sub-bituminous and bituminous (primarily sub-bituminous), low sulfur, low alkaline, coal which is unlike any other fuel type tested or estimated through the EPRI estimation methodology. The closest analogue would be PRB coal, which is higher in both alkalinity and heating value, and was tested primarily in Eastern plants which had switched over from higher sulfur coal to PRB. Although this allowed for some reasonable estimation in the assigning of the various factors - in other cases, some experimentation with the equations was called for.

3. As no power plant burning Utah coal currently operates with an SCR system installed, determining an appropriate SCR oxidation value to use required an analysis of the equation. Eventually, it was determined that using the highest oxidation value of 3% (yielding an S2 factor of 0.03) resulted in the highest possible sulfate value, and the most realistic release totals.

4. The FGD system at Hunter 3 is an upgraded wet scrubber followed by a particulate filter baghouse. Although the total control for this system in terms of SO2 emission is similar to the dry lime injection/baghouse systems currently installed at Hunter Units 1 and 2 and Huntington 1 and 2, the EPRI technology factors (F2) for this system are not precisely defined. Rather than using a single F2 factor of 0.01 as was the case for the Post-Control scenarios for the BART units, a hybrid F2 factor of 0.1 \* 0.4 was generated by using the F2(PM) and F2(FGD) factors as found on the "F2" tab. This yielded a resulting F2 factor of 0.04 which is quite similar, and agrees well with observed SO2 emissions from Unit 3.

5. The BART units (Hunter 1 and 2 and Huntington 1 and 2) were previously equipped with cold side ESPs for particulate control, and (with the exception of Huntington 2) first generation wet scrubbers for control of SO2 emissions. Huntington Unit 2 was uncontrolled for SO2 in the baseline case. Therefore, the technology factors chosen were F2(PM) = 0.72 and F2(FGD) = 0.73, Huntington 2's F2(FGD) was set at 1.

6. Following the installation of Modeling Scenario 1 controls (LNB/OFA + FGD/Baghouse) these technology factors were updated. As the installation of the Dry FGD system includes the effect of the baghouse, no particulate control mechanism needs to be included. Although not specifically discussed in the EPRI document under particulate control. UDAQ believes that the effect of "double counting" the impact of particulate control upon H2SO4 release would be excessive. Although the purpose of FGD systems is to remove acid gas emissions; no system is perfectly efficient, and the technology factor assigned to FGD/baghouse systems is already quite good. Therefore for all BART Post scenarios, F2(PM) was set at 1, while F2(FGD) was set at 0.01 as per Table 4-5.

7. Baseline emissions were based on 2003 emission inventory values. This year contained the most up-to-date record of coal burn data, hours of operation coal sulfur weight percentage, and emission inventory data available from the baseline period (2001-2003). Post-control emissions were based on the 2012 and 2013 emission year inventories. Coal sulfur contents rose slightly between 2003 and 2013, although sulfate emissions generally dropped.

8. Carbon Units 1 and 2 are based solely on emissions from 2012/2013. As the effect of shutting down the Carbon Plant is based on removing actual emissions. Those emissions must be calculated using the definition of actual emissions - most commonly this is defined as the emissions from the two-year period immediately preceding the change. Without inventory data currently available from the 2014 reporting year, the two-year period immediately preceding this action would be the 2012-2013 inventory periods.

9. Although each tab shows a section where the "effect" of SCR/SNCR is apparently included, a quick review of the baseline tabs will reveal that this is reduced to zero (0) by setting Fsops = 0. Similarly, the effect of ammonia slip is also reduced to zero (0) in the baseline tabs as Fsreagent has also been set to 0.

10. The GivenAssume tab was used as an input tab, and is not to be used as a representation of the values for all individual calculation tabs. Rather each individual calculation tab (such as "Hunter 1 Baseline") should be viewed independently of the others. These tabs were generated by plugging the appropriate values into the "GivenAssume" tab and then copying/pasting the values directly from the "Calculate" tab once generated. This way the work could be replicated by inserting the same input values. The appropriate values have been highlighted on each tab. Red highlights serve as inputs, these items can be found on both the "Baseline" and "Post" tabs. Purple highlights on the "Post" tabs designate the ERcomb values which is also the release value for each plant under Modeling Scenario 1 (LNB/OFA +FGD/Baghouse) but prior to the installation of SCR. Finally Green highlights designate the final release values for each plant for that particular tab. For the Baseline tabs, this is the total amount. For the Post tabs, this value represents the effect of SCR - in addition to the Scenario 1 controls already present.