Missouri Department of Natural Resources

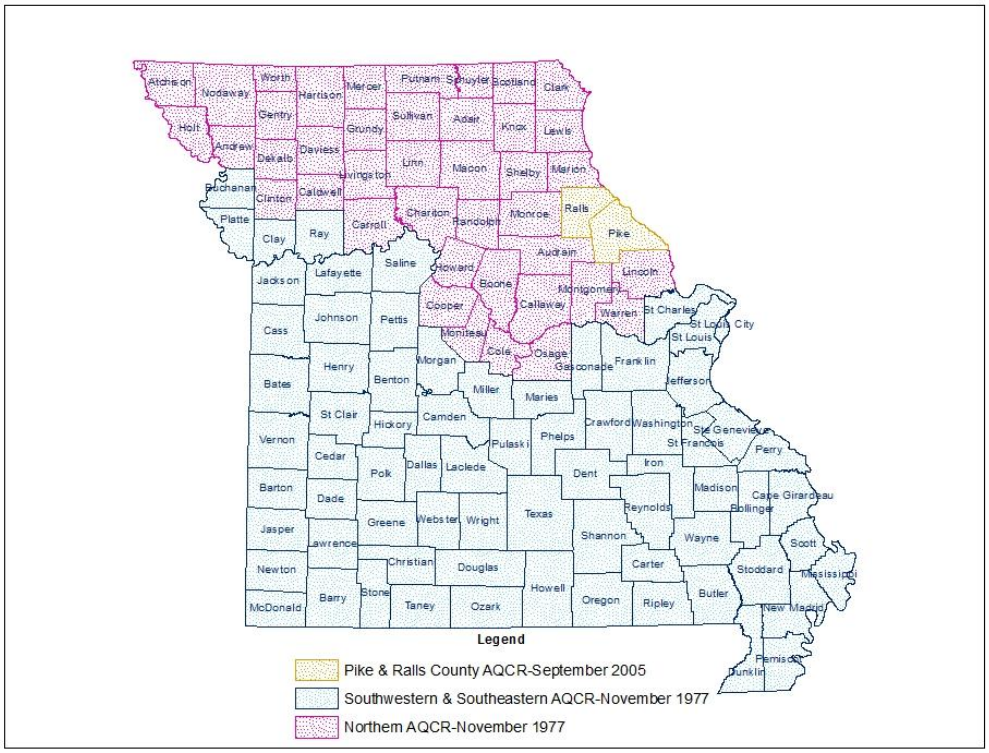
Increment Standards-Sulfur Dioxide

Sulfur dioxide (SO_2) forms in the atmosphere as a result of the combustion of fossil fuels, other combustion processes, ore extraction and diesel engines. SO_2 also contributes to the secondary formation of fine particulate matter in the form of sulfates. The scope of this document is limited to a discussion on demonstrating compliance with the increment standards. For a general discussion on increment, please refer to the document entitled "Increment Standards."

The 1977 Clean Air Amendments set the major source baseline date for SO_2 as January of 1975 with a trigger date of August 1977. Assuming a trigger date of August 1977, the minor source baseline date has been triggered for all of the of the air quality control regions (AQCRs) within the State of Missouri, refer to Figure 1. The minor source baseline dates that denote where increment is being consumed are based upon the following timeframes:

- November 1977-Southeastern & Southwestern AQCRs,
- November 1977-Northern AQCR, and
- September 2005-Pike and Ralls Counties AQCR.

Figure 1
SO_2 Minor Source Baseline Dates



Compliance with the 3-hour and 24-hour Class II increment standards for SO_2 is based upon the second highest concentration that is predicted to occur at each receptor within the modeling domain. The short

term standards can be exceeded once per year. Conversely, the annual increment standard for SO_2 cannot be exceeded and is based upon the maximum annual concentration that is predicted to occur at each receptor within the modeling domain, refer to Table 1.

Table 1
Class II Increment Standard-SO_2

Pollutant	Averaging Time	Increment	Comment
		($\mu g/m^3$)	
SO_2	3-Hour	512	Not to be exceeded more than once per year
SO_2	24-Hour	91	Not to be exceeded more than once per year
SO_2	Annual	20	Not to be exceeded

If the predicted impact due to the proposed source and interactive sources is below the Class II increment standards for the 3-hour, 24-hour and annual averaging periods, compliance has been demonstrated and no further analysis for the SO_2 increment standards will be necessary.

If, on the other hand, violations of the SO_2 increment standards are predicted to occur at one or more receptors, the applicant will be required to determine if the proposed project or modification has a significant ambient impact. If the source can demonstrate that it does not have a significant impact on a violating receptor(s), measured in time and space, a permit can be issued without further review of the standard. If the source cannot demonstrate less than significant impacts, the facility must consider emission limits, the installation of controls or other measures in order to reduce its ambient impact at violating receptors.

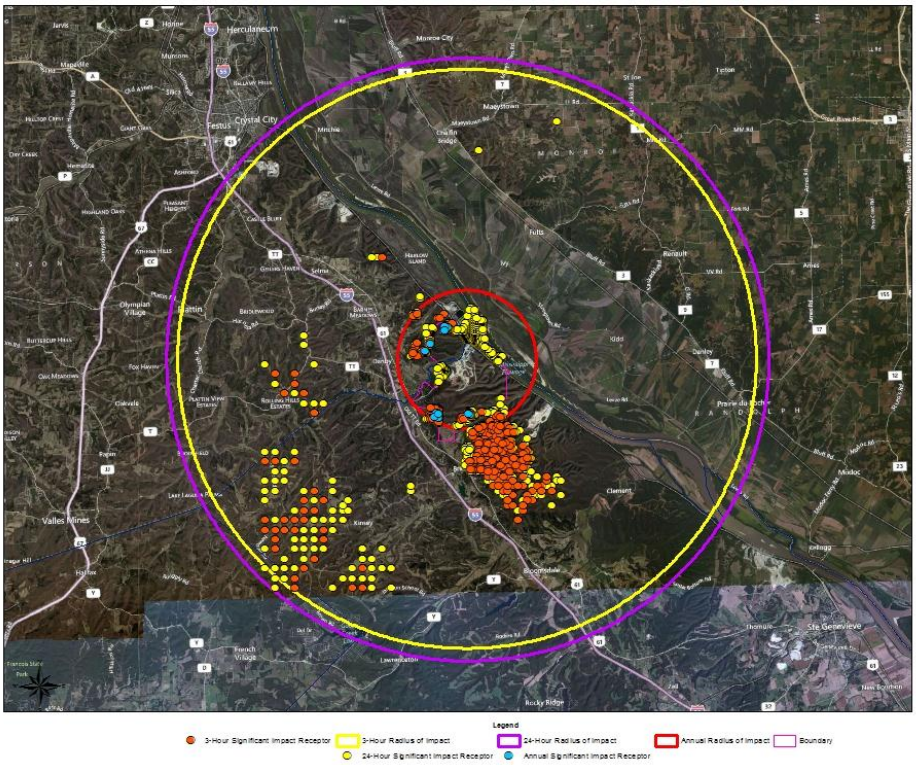
The following paragraphs provide a hypothetical example of a Class II increment evaluation for SO_2. The data describes a basic situation and is not meant to address all modeling scenarios and/or issues that might arise during the review process.

Example Increment Demonstration

Facility A is proposing to install a coal-fired boiler at a greenfield site. Based upon the emissions from the worst case operating load, the preliminary impact analysis (project emissions only), indicates that Facility A's radius of impact extends 15.6-kilometers beyond the center of the proposed facility, refer to Figure 2.

Increment Standards-Sulfur Dioxide

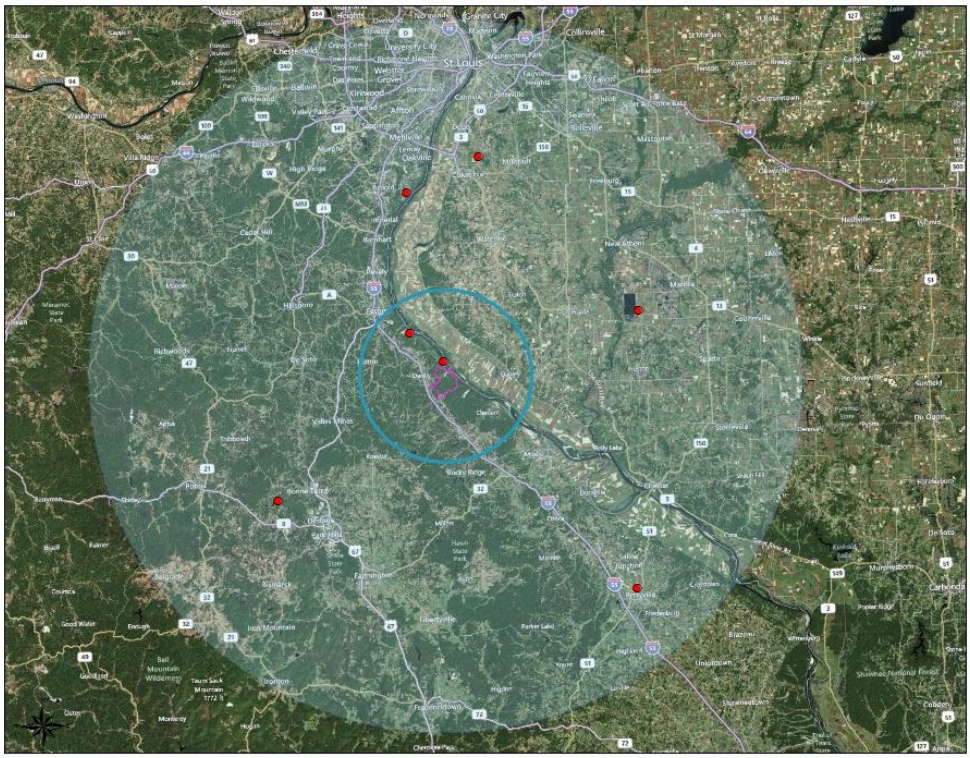
Figure 2
SO_2 Significant Impact Determination
3-Hour, 24-Hour and Annual Significant Impact Comparison



Because the ambient impact due to the proposed construction exceeds the 3-hour, 24-hour and annual significant impact thresholds of 25.0, 5.0 and 1.0 $\mu g/m^3$, a full impact analysis is required and must include an evaluation of compliance with the increment standards.

As noted in the introduction, increment compliance is based upon the impact due to the combination of the emissions from the proposed source and existing "interactive" sources. In order to determine the impact due to the proposed source and interactive sources, the emissions from Facility A and existing SO_2 sources must be explicitly modeled and compared to the increment standard. The radius of impact due to the proposed project determined what sources were explicitly modeled for compliance purposes. The air quality analysis must consider any emission source that could consume increment within the significant impact area of the facility under consideration, refer to Figure 3.

Figure 3
SO_2 Prevention of Significant Deterioration Domain
Interactive Source Inventory Development



Emission rates and release parameters for each source within the inventory were input into the air quality model. The combined ambient impact due to the modeled sources were calculated and output on a receptor by receptor basis for use in the compliance demonstration. Table 2 contains the model outputs for a sampling of receptors that were evaluated for this example.

Table 2
SO_2 Increment Compliance Determination

3-Hour Averaging Period
(Increment = 512.0 μg/m³)

Easting	Northing	Elevation	Hill	2003	2004	2005	2006	2007	2nd High	Increment
(Meters)	*(Meters)*	*(Meters)*	*(Meters)*	*(μg/m³)*	*(μg/m³)*	*(μg/m³)*	*(μg/m³)*	*(μg/m³)*	*(μg/m³)*	*(μg/m³)*
				(H2H)	*(H2H)*	*(H2H)*	*(H2H)*	*(H2H)*	*(H2H)*	*(H2H)*
733000	4230500	115.12	219.05	273.565	234.9758	293.6315	200.0028	379.5032	379.5032	512
731000	4227500	148.27	163.98	128.7416	189.2691	367.0073	206.4564	336.5694	367.0073	512
734000	4230500	119.47	215.52	340.5528	320.7333	272.4852	292.4935	347.2039	347.2039	512
731000	4229000	138.48	191.08	250.5889	221.3721	344.8047	286.7255	301.7097	344.8047	512
731500	4229500	136.87	208.49	268.192	283.1724	328.9346	296.4578	304.991	328.9346	512
734000	4227500	138.89	209.92	315.3038	229.922	267.4879	180.1948	229.3696	315.3038	512
733500	4228500	169.76	250.63	271.2274	228.1864	300.3058	194.9318	236.0701	300.3058	512

Increment Standards-Sulfur Dioxide

24-Hour Averaging Period (Increment = 91.0 μg/m³)										
Easting	Northing	Elevation	Hill	2003	2004	2005	2006	2007	2nd High	Increment
(Meters)	(Meters)	(Meters)	(Meters)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
				(H2H)	(H2H)	(H2H)	(H2H)	(H2H)	(H2H)	(H2H)
734000	4229500	114.4	250.63	65.96769	82.418	89.48804	78.59625	79.48997	99.48804	91
732500	4229000	148.56	208.98	22.61656	56.92957	66.55613	50.60294	48.12312	66.55613	91
734000	4230000	114.29	250.63	55.70069	53.29164	62.25663	52.94081	61.28596	62.25663	91
731000	4230000	149.75	257.81	11.86281	25.90944	42.67803	25.00151	23.00302	42.67803	91
732500	4228500	139.64	213.81	38.69583	25.00575	39.11903	24.88653	42.61016	42.61016	91
733000	4229000	125.3	250.63	39.30284	26.35946	40.738	39.02798	40.42813	40.738	91
734500	4229500	114.29	250.63	38.75287	31.05034	31.56057	34.05512	38.87486	38.87486	91
Annual Averaging Period (Increment =20.0 μg/m³)										
Easting	Northing	Elevation	Hill	2003	2004	2005	2006	2007	Max	Increment
(Meters)	(Meters)	(Meters)	(Meters)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)	(μg/m³)
				(H1H)	(H1H)	(H1H)	(H1H)	(H1H)	(H1H)	(H1H)
734000	4229500	114.4	250.63	34.24681	32.43425	39.47034	39.25916	39.93748	39.93748	20
732500	4229000	148.56	208.98	16.80981	22.00936	34.00489	38.19441	34.33718	38.19441	20
734000	4230000	114.29	250.63	14.71435	15.95657	20.57337	23.42038	21.08007	23.42038	20
731000	4230000	149.75	257.81	18.82925	19.7536	19.90769	19.76249	18.0528	19.90769	20
732500	4228500	139.64	213.81	10.78788	10.58429	13.52972	17.82663	16.706	17.82663	20
733000	4229000	125.3	250.63	13.5898	13.89461	14.23526	15.51951	16.86345	16.86345	20
734500	4229500	114.29	250.63	8.38742	9.13993	13.75075	12.69059	11.45436	13.75075	20

The first four columns contain information regarding the location of the receptor under review, followed by the predicted concentration from the dispersion model for each year under consideration. To determine compliance with the 3-hour and 24-hour increment standards, the second highest concentration for each year was determined on a receptor by receptor basis. The maximum, second high value that was predicted across the five year period was compared to the increment standards of 512 and 91.0 μg/m^3 for the 3-hour and 24-hour periods, respectively. According to Table 2, compliance with the 3-hour increment standard has been demonstrated and no further review for this averaging period is necessary. On a 24-hour basis, one violation was predicted.

For the annual averaging period, the maximum concentration for the five year period was obtained and compared to the increment standard. Based upon the results contained within Table 2, the top three annual concentrations exceeded the increment standard of 20.0 μg/m^3. Because increment violations are predicted to occur for the 24-hour and annual standards, the applicant must determine if Facility A has a significant impact on a violating receptor, refer to Table 3.

Table 3 SO_2 Increment Violations vs. Significant Impact					
24-Hour Increment (91.0 μg/m³) vs. Significance (5.0 μg/m³)					
Easting	Northing	Elevation	Hill	Increment	Significant Impact Concentration
(Meters)	(Meters)	(Meters)	(Meters)	(μg/m³)	(μg/m³)
				(H2H)	(H1H)
734000	4229500	114.4	250.63	99.48804	5.268

Increment Standards-Sulfur Dioxide

Annual Increment (20.0 μg/m^3) vs. Significance (1.0 μg/m^3)					
Easting	**Northing**	**Elevation**	**Hill**	**Increment**	**Significant Impact Concentration**
(Meters)	***(Meters)***	***(Meters)***	***(Meters)***	***(μg/m^3)***	***(μg/m^3)***
				(H1H)	***(H1H)***
734000	4229500	114.4	250.63	39.93748	0.9823
732500	4229000	148.56	208.98	38.19441	0.2571
734000	4230000	114.29	250.63	23.42038	0.9980

For the 24-hour averaging period, Facility A had a significant impact on a violating receptor; as such, it must be determined if the significant impact occurs at the same time as the violation. In order to demonstrate that a significant impact does not occur at the same time as a violation, the applicant must determine the maximum concentration for each 24-hour period in the year due to the proposed project (significance analysis) and due to all sources (increment analysis). Table 4 contains sample output from a time of day evaluation.

Table 4 **SO_2 Time of Day Evaluation**						
Easting	**Northing**	**Elevation**	**Hill**	**First High Modeled Increment Concentration**	**Significant Impact Concentration**	**Date**
(Meters)	***(Meters)***	***(Meters)***	***(Meters)***	***(μg/m^3)***	***(μg/m^3)***	***(YYMMDDHH)***
734000	4229500	114.4	250.63	116.3262	3.48776	06010124
734000	4229500	114.4	250.63	96.7377	3.8282	06010224
734000	4229500	114.4	250.63	52.4177	0.0128	06010324
734000	4229500	114.4	250.63	45.3639	0.01158	06010424
734000	4229500	114.4	250.63	50.74915	0.23682	06010524
734000	4229500	114.4	250.63	20.66827	0.21572	06010624
734000	4229500	114.4	250.63	63.24251	0.01054	06010724
734000	4229500	114.4	250.63	73.64282	0.01025	06010824
734000	4229500	114.4	250.63	15.25698	0.01135	06010924
734000	4229500	114.4	250.63	0.24835	0.01104	06011024
734000	4229500	114.4	250.63	6.52604	0.01549	06011124
734000	4229500	114.4	250.63	58.53074	0.01519	06011224

Based upon the time of day evaluation, Facility A did not have a significant impact at the same time that a violation occurred; as such, no further analysis is necessary and increment compliance for Facility A has been demonstrated.