G. THOMAS HILL ENERGY CENTER

The Thomas Hill Energy Center Power Division (Thomas Hill) is a coal-fired electric generating facility located in Randolph County, Missouri. Based on the air program's technical review of this facility, current conditions support a recommendation of attainment for all of Randolph County.

G.1 Monitoring and Modeling Data

There are no ambient SO_2 monitors near Thomas Hill that can be relied upon to characterize the air quality around the source. Instead, the air program performed extensive air dispersion modeling to characterize air quality for the area. The air program modeled Thomas Hill using the most recent three years of actual emissions data and concurrent representative meteorological data to approximate a monitored design value for the area. The following paragraphs summarize the modeling analysis performed specific to Thomas Hill, and the modeling protocol in Appendix H contains more detail on general modeling procedures.

Emissions Data for Model Input

The most recent three years (2013-2015) of hourly emissions (CEMS) data was obtained through EPA's Clean Air Markets Division program database (CAMD) and the downloaded SO_2 hourly mass emissions data was formatted for direct input into AERMOD. Thomas Hill provided hourly recorded varying stack release parameters including exit temperature and exit flow rate that were evaluated and paired with the CAMD retrieved CEMS emissions. Further emissions information including interactive source evaluation is included in Section G.2.

Meteorological Data for Model Input

An air program staff meteorologist performed a technical evaluation to determine which surface and upper air stations are most representative of Thomas Hill. Thomas Hill has no on-site or nearby collected surface or upper air meteorological data. Offsite NWS data is evaluated for representativeness in the following discussion. In general, meteorological stations within 200 km of the facility of interest are preferred as their prevailing weather conditions would be most similar to the facility. However, locations more than 200 km from the facility of interest can be considered when surface conditions of nearby meteorological stations are not deemed representative.

For upper air data, the Topeka, KS National Weather Service upper air station is closest to Thomas Hill at 263 km and best represents the vertical atmospheric characteristics of the region.

For surface data, the Kirksville (61 km), Chillicothe (86 km), and Columbia (89 km) weather reporting stations are the closest to the Thomas Hill facility. Eleven other surface weather stations are within 200 km of Thomas Hill. Explicit criteria for each of the respective stations are compared below.

> Kirksville: The surface roughness values differ more in winter and spring (63% and 55%) than in summer and fall (5% and 7%) between Thomas Hill and Kirksville. There is strong agreement in summer and fall because land cover is similar when the higher roughness values at Kirksville (14% forest and 8% developed) coincide with the higher roughness values due to seasonal tree canopy (40% forest) at Thomas Hill. Surface roughness values are very similar in winter and spring when the dominant short ground cover (planted/cultivated at 69%) at Kirksville matches well to the short roughness values (26% barren, 20% water) at Thomas Hill. The albedos agree within 6%. The Bowen ratios differ by 20% to 35% for dry conditions, but agree within 20% for average and wet conditions.

Chillicothe: The surface roughness values differ by 60-70% in winter and spring, and 31% in summer and fall. Chillicothe land cover is over 80% herbaceous planted or cultivated land. This is much more cultivated land than Thomas Hill at 7%, and the majority 40% forest cover at Thomas Hill finds no corresponding cover with high roughness values at Chillicothe. Albedo values agree within 6%. Bowen ratios differ by 6 to 38% for all seasons and precipitation schemes, with the best agreement under average precipitation conditions.

Columbia: The surface roughness values differ by 75 to 80% between Thomas Hill and Columbia in winter and spring, and show better agreement in summer and fall at 20-25% difference. The land cover at Columbia is 82% planted/cultivated, with very little tall cover (under 10%). Thomas Hill has 40% forest land with taller cover resulting in higher roughness values than Columbia. Albedo values are a match across all seasons, with less than 1% difference. Bowen ratios differ by 20 to 35% for dry conditions, 10%-20% for average conditions, and 5% to 15% for wet conditions.

The remaining eleven weather stations within 200 km of Thomas Hill offer no improvement to the comparison of combined surface roughness, albedo, or Bowen ratios than the three closest surface weather stations. Kirksville shows the strongest agreement with Thomas Hill with respect to surface roughness and Bowen ratio, though Columbia is the best match to Thomas Hill albedo. Kirksville offers the closest surface roughness values because it is the airport that has at least 20% taller surface cover to correspond to the taller forested areas near Thomas Hill. Kirksville is also the strongest match for Bowen ratio overall, with Columbia being a close second. Though Columbia is the closest match for albedo, the distance of Columbia from Thomas Hill, plus the strongest disagreement with surface roughness values rule it out as a representative location. Albedo agreement within 10% is generally acceptable for use in meteorological modeling as it is not the strongest influence on dispersion characteristics compared to the other variables. The Kirksville surface NWS site data is preferable to represent the meteorological conditions at Thomas Hill due to its proximity and surface characteristics.

The recommended representative meteorological stations used in this modeling analysis are shown in Table 1.

Table 1 – Thomas Hill Energy Center Meteorological Datasets

Facility of Interest	Surface Data Location	Upper Air Location
Thomas Hill Energy Center	Kirksville, MO	Topeka, KS

The same tiered grid spacing as detailed in the modeling protocol was used for Thomas Hill, except the last tier was extended to encompass all of Randolph County. This resulted in the domain and receptor grid extending to 50 km from the facility.

The regional background concentration was established at 9 ppb for rural areas. This was based on an analysis of the East St. Louis monitor in Illinois. The modeling protocol in Appendix H further details this analysis. The background was added to model predicted concentrations to account for natural sources and sources not included in the modeling inventory. The maximum modeled concentration for the area is 136.6 $\mu g/m^3$ or 52 ppb. This demonstrates the area is currently in compliance with the 1-hour SO_2 standard of 75 ppb. A map including plotted output concentrations is shown in Figure 1.

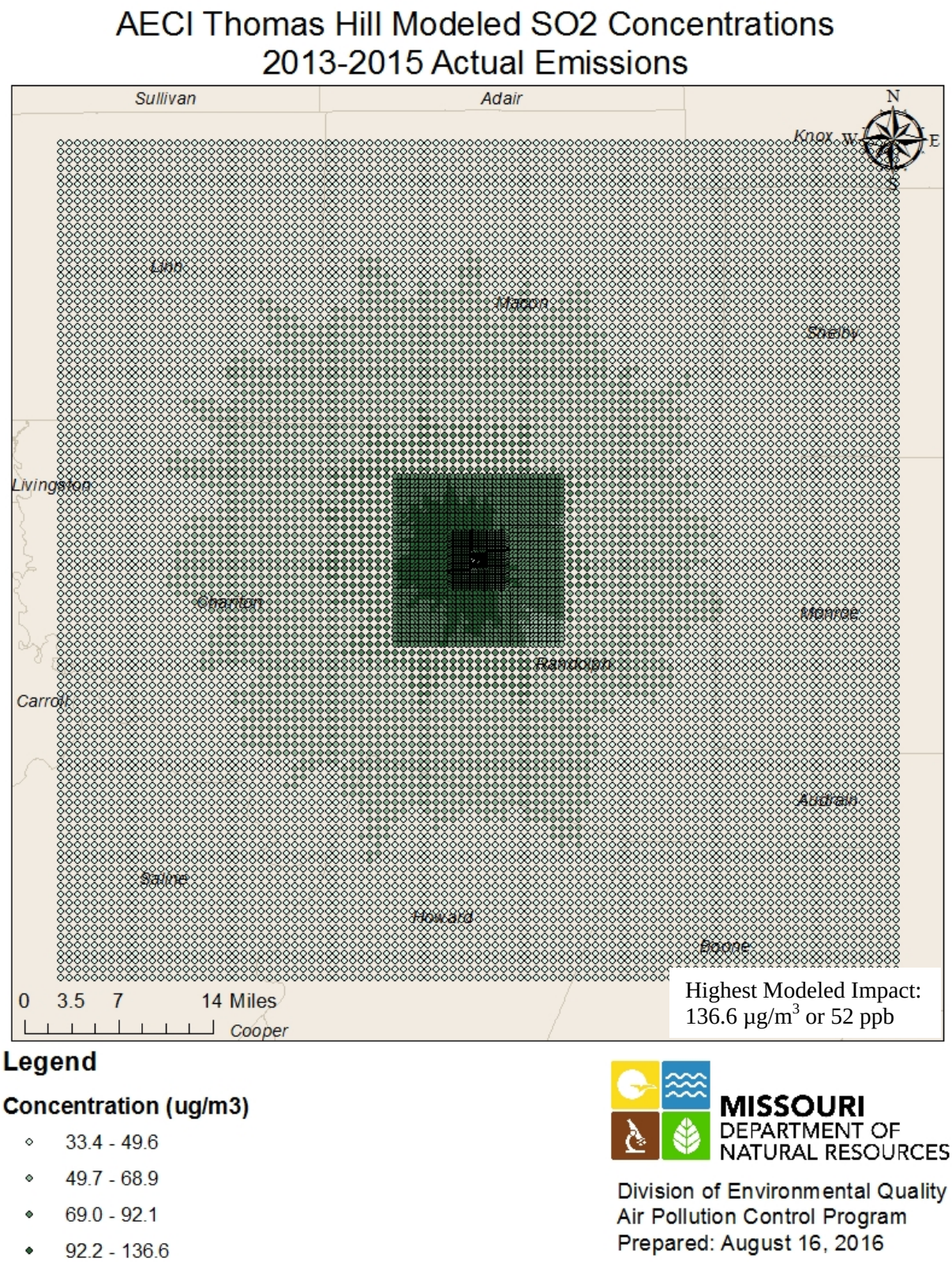

Figure 1 – AECI Thomas Hill Modeled SO_2 Concentrations

G.2 Emissions Data

The emissions sources surrounding Thomas Hill were evaluated to determine an interactive source inventory for the dispersion modeling analysis. There is one interactive source located in the 20 km buffer of the Thomas Hill plant. Figure 2 displays a map of Randolph and surrounding counties along with all permitted SO_2 sources within 50 km of Thomas Hill that were evaluated for inclusion in the modeling inventory. Table 2 lists all sources included on the map along with their 2013-2015 actual emissions.

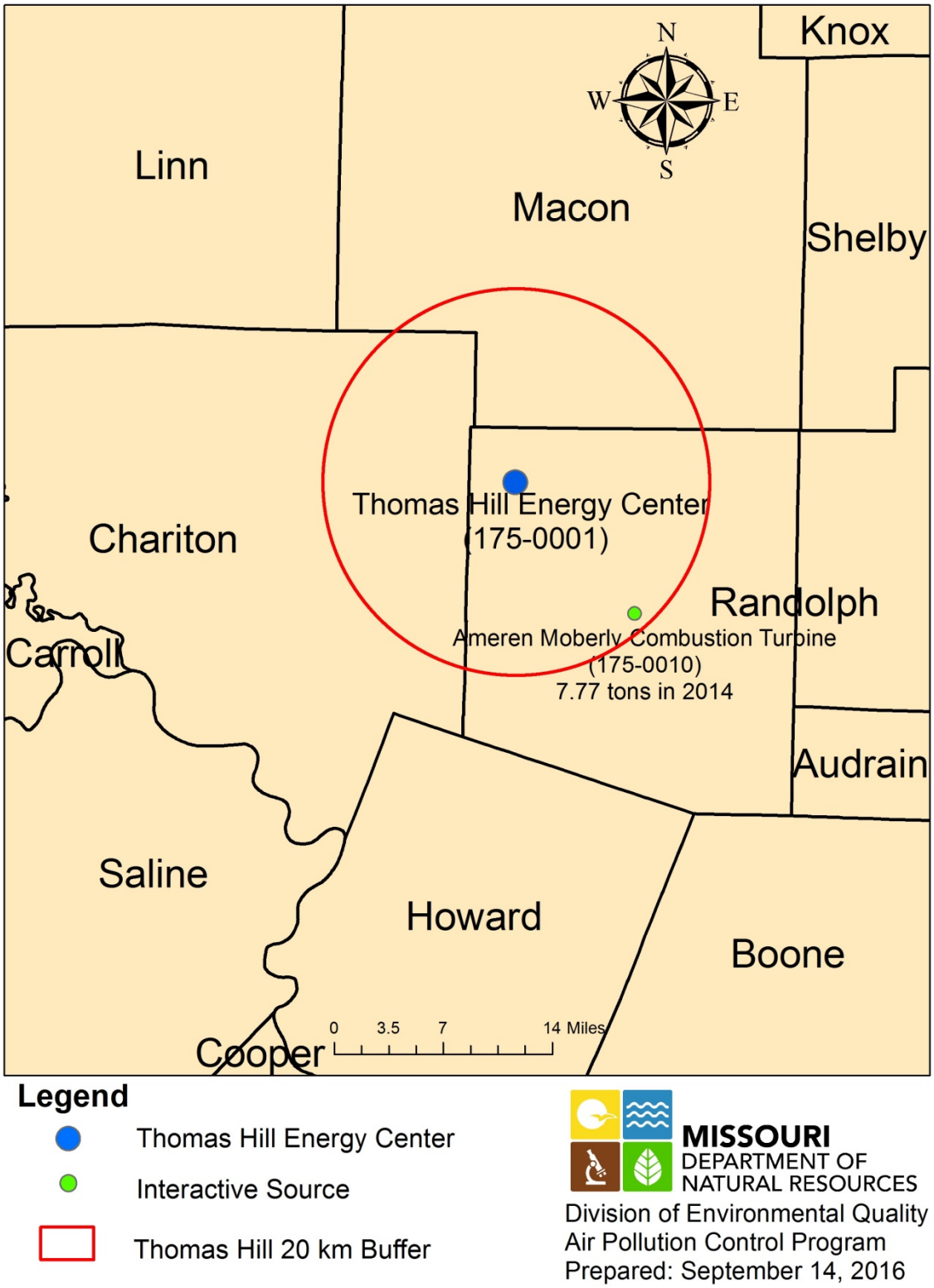

Figure 2 – AECI Thomas Hill with Nearby Interactive Source

Table 2 – AECI Thomas Hill and Interactive Source 2013-2015 SO_2 Emissions

Source Name	2013 SO_2 Emissions (TPY)	2014 SO_2 Emissions (TPY)	2015 SO_2 Emissions (TPY)	Distance to the facility (km)
AECI Thomas Hill Energy Center (175-0001)	14,284.8	16,575.1989	15,731.1008	0
Ameren Missouri-Moberly Combustion Turbine (175-0010)	2.626	7.7674	0.0016	18.8

G.2.1 Evaluation of Sources to Model

All sources included on the map in Figure 2 were evaluated for possible inclusion in the modeling inventory. Ameren Missouri's Moberly combustion turbine (175-0010) was identified as the only source within 50 km that emitted more than one ton per year of SO_2 in 2014. Therefore this source was included in the interactive source inventory. The following bullets describe each of the sources listed in Table 2 along with a discussion about how each source was characterized in the modeling analysis:

- AECI Thomas Hill – Thomas Hill includes three coal-fired boilers that generate electricity that is supplied to the grid. The plant is owned by Associated Electric Cooperative Incorporated (AECI). The air program used actual SO_2 emissions data from the continuous emission monitoring system (CEMS) located at this facility. The modeled years include the most recent three years (2013 – 2015). The air program also utilized variable release parameters as provided by the facility. The use of CEMS data in the model for this facility allows the model to act as a surrogate for monitoring data, which EPA guidance deems appropriate when developing boundary designation recommendations.

- Ameren Missouri-Moberly Combustion Turbine – This source is located within 20 km of Thomas Hill (19.3 km southeast of Thomas Hill). This facility consists of one remotely operated, unmanned simple cycle combustion turbine for electric power generation, a 340,000 gallon distillate fuel oil storage tank and three (3) small interconnected lube oil tanks with a capacity of approximately 2,750 gallons. The design rating of the turbine is 891 Million British thermal units per hour (mmBtu/hr) and it is fueled solely by No.2 fuel oil. The plant's total SO_2 emissions were 7.67 tons in 2014, which was the highest of the last 3 years. The source was included in the modeling analysis with using 2014 reported emissions. The single emission release point has a stack release and was modeled with parameters as reported to MoEIS.

Beyond these two included sources, 12 other sources within 50 km of Thomas Hill were excluded from the model analysis due to SO_2 emission levels below 1 ton in 2014. These 12 sources cumulatively emitted less than 2.7 tons in 2014 and averaged only 0.22 tons per source. Possible impacts from these sources are accounted for through the use of a regional background concentration.

Table 3 details unit and emission release parameter information for the boilers at Thomas Hill, and Table 4 shows an excerpt from the hourly emissions file.

Table 3 – Thomas Hill Emission Release Parameters

Facility I.D.	Facility Name	Site Name	Emission Point I.D.	Model ID	Description	Release Type
175-0001	Thomas Hill Energy Center Power Division	Thomas Hill	1	MB1	Boiler #1	POINT
175-0001	Thomas Hill Energy Center Power Division	Thomas Hill	2	MB2	Boiler #2	POINT
175-0001	Thomas Hill Energy Center Power Division	Thomas Hill	3	MB3	Boiler #3	POINT

Easting *Meters*	**Northing** *Meters*	**Base Elevation** *Meters*	**Actual Stack Height** *Meters*	**Stack Temperature** *Kelvin (From MoEIS)*	**Stack Exit Velocity** *Meters/Second (From MoEIS)*	**Stack Diameter** *Meters*
531199.28	4378125.47	230.73	137.16	Used hourly temperatures in lieu of static values (see Table 4)	Used hourly velocity values in lieu of static values (see Table 4)	5.29
531163.08	4378161.28	230.73	135.91	Used hourly temperatures in lieu of static values (see Table 4)	Used hourly velocity values in lieu of static values (see Table 4)	5.29
530983.64	4378224.00	230.73	141.52	Used hourly temperatures in lieu of static values (see Table 4)	Used hourly velocity values in lieu of static values (see Table 4)	9.93

Table 4 – Excerpt from 2013-2015 Combined Hourly CEMS Emission File for Thomas Hill

	Year	Month	Day	Hour	Unit ID	SO_2 Emission Rate (g/s)	Temp (K)	Velocity (m/s)
SO HOUREMIS	13	1	1	1	MB1	78.395	405.706	8.653
SO HOUREMIS	13	1	1	1	MB2	133.557	419.317	12.467
SO HOUREMIS	13	1	1	1	MB3	352.049	392.094	9.157
SO HOUREMIS	13	1	1	2	MB1	78.673	403.539	8.595
SO HOUREMIS	13	1	1	2	MB2	128.391	416.65	11.991
SO HOUREMIS	13	1	1	2	MB3	348.105	392.483	9.152
SO HOUREMIS	13	1	1	3	MB1	77.98	402.706	8.595
SO HOUREMIS	13	1	1	3	MB2	128.883	416.15	12.11

SO HOUREMIS	13	1	1	3	MB3	344.048	393.261	9.261
SO HOUREMIS	13	1	1	4	MB1	79.781	402.928	8.645
SO HOUREMIS	13	1	1	4	MB2	131.843	416.206	12.128
SO HOUREMIS	13	1	1	4	MB3	347.979	394.039	9.32

G.3 Meteorology and Topography

Meteorology and topography are interrelated as significant topographical features often cause localized meteorological effects. Due to this related nature, these two factors were evaluated together. Topography and surrounding land features can have a significant impact on the wind patterns and thus the dispersion of air pollutants from emission sources. There are no significant terrain features in the area around Thomas Hill that would greatly impact dispersion, such as mountain ranges. The surrounding terrain and meteorological effects were represented in Thomas Hill's modeling analysis to best simulate monitoring of the area's ambient air quality. Since no significant terrain or meteorological features exist around Thomas Hill, topography and meteorology were not used to set the recommended attainment area boundary.

G.4 Jurisdictional Boundaries

Attainment area boundaries are typically defined by easily identifiable features such as county, municipal, or township boundaries. Large, immovable features such as rivers or highways can also be used. In this case, since Thomas Hill's modeled impact attains the standard, the main considerations are that the boundary include Thomas Hill and be easily identifiable.

All permitted SO_2 emitting sources located within Randolph County were evaluated in this analysis, and the receptor grid for this modeling analysis was increased to include the entire county. As discussed previously, the modeling evaluation performed for Thomas Hill resulted in no modeled violations of the 2010 1-hour SO_2 NAAQS. Therefore, the county boundary is considered representative of the recommended attainment area. The recommended attainment boundary for Thomas Hill consists of the county lines for Randolph County. Figure 3 displays a map with the recommended boundary.

Northern Boundary: County Line dividing Randolph and Macon Counties
Eastern Boundary: County Line dividing Randolph from Monroe and Audrain Counties
Southern Boundary: County Line dividing Randolph from Boone and Howard Counties
Western Boundary: County Line dividing Randolph and Chariton Counties

Figure 3 – AECI Thomas Hill Recommended 2010 1-hour SO_2 NAAQS Attainment Area