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Project Summary

Comparison of the 1985 NAPAP Emissions Inventory with the 1985 EPA Trends Estimate for Industrial SO_2 Sources

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Section 406 of the 1990 Clean Air Act Amendments (CAAA) requires that the Administrator of the Environmental Protection Agency (EPA) transmit a report to Congress containing a national inventory of annual sulfur dioxide (SO_2) emissions from industrial sources, as well as emission projections for the next 20 years, not later than 1995. The requirement stems from the 5.6 million ton emissions cap on SO_2 from industrial sources that is contained in Title IV of the CAAA and based on estimated 1985 emissions from the National Acid Precipitation Assessment Program (NAPAP). This report presents analyses of 1985 industrial SO_2 emissions from two available data sources: the NAPAP inventory and the EPA Trends report. These analyses conclude that the two data sources estimate comparable emissions in the aggregate, but estimates for specific categories and for processes within those categories vary widely. The Trends method is limited to source categories that emit 10,000 tonnes per year of SO_2. In general, the Trends method overestimates emissions from these source categories due primarily to the absence of SO_2 control efficiency assumptions. Overestimation of emissions in the Trends data set is offset by the inclusion of additional source categories in the NAPAP inventory with the final aggregate estimates within less than 10% of each other. (NOTE: Trends methodology is being changed for 1993, using the 1985 NAPAP emissions inventory as a base.)

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Section 406 of the 1990 Clean Air Act Amendments (CAAA) requires that the Administrator of the Environmental Protection Agency (EPA) transmit a report to Congress containing "a national inventory of annual sulfur dioxide emissions from industrial sources not later than January 1, 1995 for all years for which data are available, as well as the likely trend in SO_2 emissions over the following twenty year period (1995 to 2015)." The CAAA also establishes an emissions cap of 5.6 million tons per year from industrial sources; this annual cap is equivalent to the 1985 industrial SO_2 estimate from the National Acid Precipitation Assessment Program (NAPAP) inventory. To provide the analysis mandated by Congress, the 1985 baseline data must first be examined to identify strengths and weaknesses in the available emission and supporting data. The purpose of the overall study was to understand the similarity and differences between existing data sets and determine which data are suitable to serve as a baseline for the SO_2 emission projections. This paper presents the initial analysis of two major sources of industrial data currently available: the 1985 NAPAP emission inventory and the 1985 national emis-

sion estimates, referred to as the Trends emission estimates.

Overview of the Data Sets

The 1985 NAPAP emission inventory effort supported acid deposition research, including atmospheric modeling, through comprehensive, detailed source emission estimates provided by local and state agencies. It is a bottom-up inventory and a 1985 snapshot. The SO_2 emission data for significant (>100 tons per year) sources were systematically quality assured, with greater effort expended on larger sources. The inventory included a unique confirmation step, allowing individual plants emitting at least 2500 tons per year to review their emission estimates prior to finalization.

Prior to 1993, EPA prepared an annual emissions Trends report representing both current and historic emissions (1940 to present). Industrial emission estimates were derived from national, published activity data and standard, process-level emission factors; historic estimates were altered based on the most recent activity data and emission factors to better represent the most current understanding of emission processes. For the industrial sector, activity data were obtained primarily from the Department of Energy, Energy Information Administration; the Department of the Interior, Bureau of Mines; and the Department of Commerce, Bureau of Census. It is essentially a top-down approach designed to follow category emissions through time and not a true inventory. It presents a consistently derived national emission estimate at the emission category level (*e.g.*, industrial oil combustion) rather than the source (*e.g.*, boiler) level.

Due to findings discussed here, as well as other factors, the Trends methodology has been revised as of 1993. References to Trends in this paper will no longer be valid for years 1985 and beyond, effective with the 1993 edition of the Trends report. The reader is cautioned that comments herein on the Trends report are valid only for editions prior to 1993.

Methodology

The 1985 NAPAP and Trends industrial emission estimates were directly compared. The 1985 NAPAP-published emission estimates as well as the annual U.S. point source file were used as the basis for the analysis. The 1992 report *National Air Pollutant Emission Estimates, 1900-1991*, and the background procedures (*Procedures Document for the Development of National, Regional and Preliminary Air Pollutant Emissions Trends Report*) formed the basis of the analysis of the published Trends estimates. (Note that the Trends estimates are updated annually; the Trends procedures themselves have also been revised in 1993. This analysis uses the Trends procedures used through 1992, but does not include the new Trends procedures that will be reflected in the forthcoming 1993 report.) This study of industrial SO_2 emissions verified emission estimates and activity (*i.e.*, throughput) where possible based on the original source materials.

The comparison of NAPAP and Trends analyzed the derivation of individual industrial category estimates. Such analyses were complicated by several factors:

- NAPAP is comprehensive and includes all reported industrial emission categories; Trends is limited to categories thought to emit at least 10,000 tonness SO_2 (uncontrolled) annually.

- NAPAP is source and plant specific; Trends is national and category specific. No opportunity exists to match individual data values between the inventories; in fact, category definitions differ between the two inventories.

- The 1985 NAPAP inventory is a single-year inventory and is not updated; Trends adjusts historical emission estimates based on the most current information.

Results of the Comparison

This research led to a highly detailed view of the two sets of emission estimates on a category basis, principally relying on emission and activity (throughput) data. The authors attempted to reproduce the 1985 Trends emissions estimates and noted any irregularities between the calculated and published data. The analyses proved complex, especially when disaggregating data to create comparable categories between NAPAP and Trends data sets, and raised a number of questions.

Table 1 summarizes the differences between the NAPAP and Trends estimates. Overall, the two 1985 estimates (NAPAP and Trends) compare favorably: NAPAP estimates 5.6 million tons SO_2 (as reflected in the CAAA), and Trends estimates 6.0 million tons. However, Table 1 shows distinct variability in the category-level estimates between the two data sets. The major industrial SO_2 emission producing categories, industrial combustion, non-ferrous metals, iron and steel, petroleum refineries, oil and natural gas production, pulp and paper, and cement manufacturing are discussed in detail in the report.

Summary

As these two data sets are reviewed and compared, the genesis and purpose of each methodology must be considered. The 1985 NAPAP inventory was a comprehensive emissions inventory designed to reflect actual conditions in 1985, with great emphasis on the gathering and quality assurance of the emission estimate at the plant and process level. It was assembled mainly at the state and local level by professionals familiar with the individual sources and with significant review by the major sources. The Trends methodology was designed to provide a longitudinal view of the direction and probable magnitude of emission changes. It was assembled from standard emission factors and national activity data in most cases and was not intended to reflect actual conditions for individual plants or source types at any given time. A *de minimus* level of 10,000 tonnes SO_2 (uncontrolled) was established for inclusion of a source category, so Trends is not intended to be comprehensive. The Trends methodology reviewed and presented here is currently in transition; subsequent Trends reports will reflect a fundamental shift in the estimation approach.

The two 1985 estimates, Trends and NAPAP, provide reasonable agreement, within less than 10%, when viewed as an aggregate industrial SO_2 estimate. There is greater divergence when the data sets are compared at the category and subcategory levels. Because the data sets were developed from different data sources and with different purposes, disagreement at disaggregated category levels primarily reflects the inherent differences in the methodologies.

The overall agreement appears to be due to a balance between Trends overestimates where subcategories overlap between Trends and NAPAP and the inclusion of more categories and more individual emission points in NAPAP. The systematic Trends overestimate, relative to the NAPAP inventory, is due in part to the absence of SO_2 control efficiency estimates in the methodologies. SO_2 control technologies have been applied to most of the large industrial SO_2 categories through the promulgation of New Source Performance Standards (NSPS), issuance of operating permits, and New Source

Table 1. *Magnitude Differences Between 1985 Trends and NAPAP SO_2 Emission Estimates*

Source Category [a]	Trends (tons)	NAPAP (tons)	Delta (tons)	Delta (percent)
Coal [b]	1,840,000	1,721,000	119,000	6.9
Oil [c]	540,000	713,000	-173,000	-24.3
Natural Gas [d]	0	33,000	-33,000	-100.0
Wood	10,000	42,000	-32,000	-76.2
Miscellaneous Fuel	80,000	14,000	66,000	471.4
Other Fuel Combustion Emissions				
Reported through NAPAP		74,000	-74,000	-100.0
1° Copper	650,000	655,000	-5,000	-0.8
1° Lead and Zinc	240,000	106,000	134,000	126.4
2° Lead	30,000	21,000	9,000	42.9
1° Aluminum	70,000	58,000	12,000	20.7
Other Primary and Secondary				
Metals Emissions Reported through NAPAP		42,000	-42,000	-100.0
Iron and Steel	360,000	204,000	156,000	76.5
Iron and Steel Foundries		16,000	-16,000	-100.0
Oil and Natural Gas Production	160,000	332,00	-172,000	-51.8
Pulp and Paper	250,000	130,000	120,000	92.3
Cement	620,000	291,000	329,000	113.1
Glass	30,000	23,000	7,000	30.4
Lime	30,000	32,000	-2,000	-6.3
Sulfuric Acid	210,000	217,000	-7,000	-3.2
Carbon Black	10,000	28,000	-18,000	-64.3
Petroleum Refineries	830,000	640,000	190,000	29.7
Other Industrial Process Emissions				
Reported through NAPAP		220,000	-220,000	-100.0
Total	5,960,000	5,612,000	348,000	6.2

[a] Except where noted, the emissions for a source category represent process level emissions only and do not include emissions from the combustion of fuel.
[b] Excludes bitumnous coal and lignite consumed at cement and lime manufacturing facilities.
[c] Excludes both distillate and residual oil consumed at cement plants and petroleum refineries and residual oil consumed at iron and steel mills.
[d] Excludes natural gas consumed in cement manufacturing, petroleum refining, the iron and steel industry, glass manufacture, and at crude petroleum and natural gas production facilities

Review Permits. The strengths and weaknesses revealed in this review are presented below.

NAPAP Data Set

- The 1985 NAPAP inventory still represents the most comprehensive and accurate emissions estimates for 1985 because of its rigorous quality assurance of emissions and bottom-up nature. The inventory accounts for individual source operating characteristics, controls and emission factors.
- Activity data in the 1985 NAPAP inventory were not subject to the same standard of quality assurance or completeness. Some data were unreported due to confidentiality restrictions, and activity data for small sources (*i.e.*, <100 tons per year) passed only the grossest quality assurance checks. There are known reporting problems among miscellaneous fuels and other categories. The accuracy and representativeness of activity data in the NAPAP inventory are best evaluated source by source; category-level summaries are unreliable without adjustments.
- It is still possible to locate questionable data values in the 1985 NAPAP emission inventory when examined on a source by source basis, especially for smaller emitters.

Trends Data Set

- Some industrial emission categories, notably iron and steel foundries, are missing from the Trends method. As such, the inventory is not comprehensive, although few major gaps were found under close scrutiny.
- As a top-down approach, broad assumptions of emission factors and controls are used across a category. Frequently, estimates make no adjustment for controls. Accommodating individual source operating characteristics, including emission factors, is impossible.
- The underlying industrial activity data are largely reliable and probably far superior to the corresponding NAPAP estimates at the category level. Any method for 1995 and beyond should take advantage of these independent data sources.
- Based on the Trends documentation, the actual Trends execution contains minor to moderate errors in calcula-

tion of activity and emissions. Trends could also benefit from recently revised standard emission factors and updated sources of activity data.

Conclusion

The 1985 NAPAP SO_2 emission estimates remain the most reliable emission estimate baseline because that was one of the intentions of the inventory effort. Reliable emission projections of the 1985 data, especially to 1995 and beyond, are difficult because the activity data in the NAPAP inventory are incomplete due, in part, to confidentiality and other restrictions. Because it is a 1985 inventory, emission factors and activity data do not reflect current or future operations for these source categories.

The Trends methodology reflected in this review is poorly suited to provide a baseline estimate for industrial emissions, fundamentally due to its design and primary objectives. Its strengths lie in the identification and use of the underlying industrial activity data which would provide a firm foundation for year-to-year projection of specific industrial activities and their baseline emissions.

Results using the new Trends method could not be reviewed in the scope of this research. Due to findings discussed here, as well as other factors, the Trends methodology has been revised as of 1993. References to Trends in this paper will no longer be valid for years 1985 and beyond, effective with the 1993 edition of the Trends report. The reader is cautioned that comments herein on the Trends report are valid only for editions prior to 1993.

Several additional sources of data that may provide more recent data and fill data gaps for an analysis of industrial SO_2 emissions were identified: Information Collection Requests obtained in support of the Maximum Achievable Control Technology (MACT) standards developed under Title III of the CAAA, SO_2 state implementation plan (SIP) inventories, and ozone/carbon monoxide SIP inventories. Of these, the MACT data are the most promising because many of the significant industrial SO_2 source categories are under MACT development; the data collected from the sources have been targeted for and will therefore be accessible from the Aerometric Information Retrieval System; and major sources, production data, and control equipment information can be identified from the data collected.

Finally, the 1985 NAPAP data were analyzed to determine whether individual source tracking would be a feasible option to improve the reliability of the emission estimates and the projections through time. Such an option would improve and update the baseline estimate and provide current information on processes and control equipment. It could also be used with the industrial activity data available from a variety of sources to project the remainder of the inventory. Figure 1 shows that relatively few sources (about 130) account for approximately 50% of the total industrial SO_2 emissions. To capture 80% of the SO_2 emissions, approximately 500 sources would need to be inventoried.

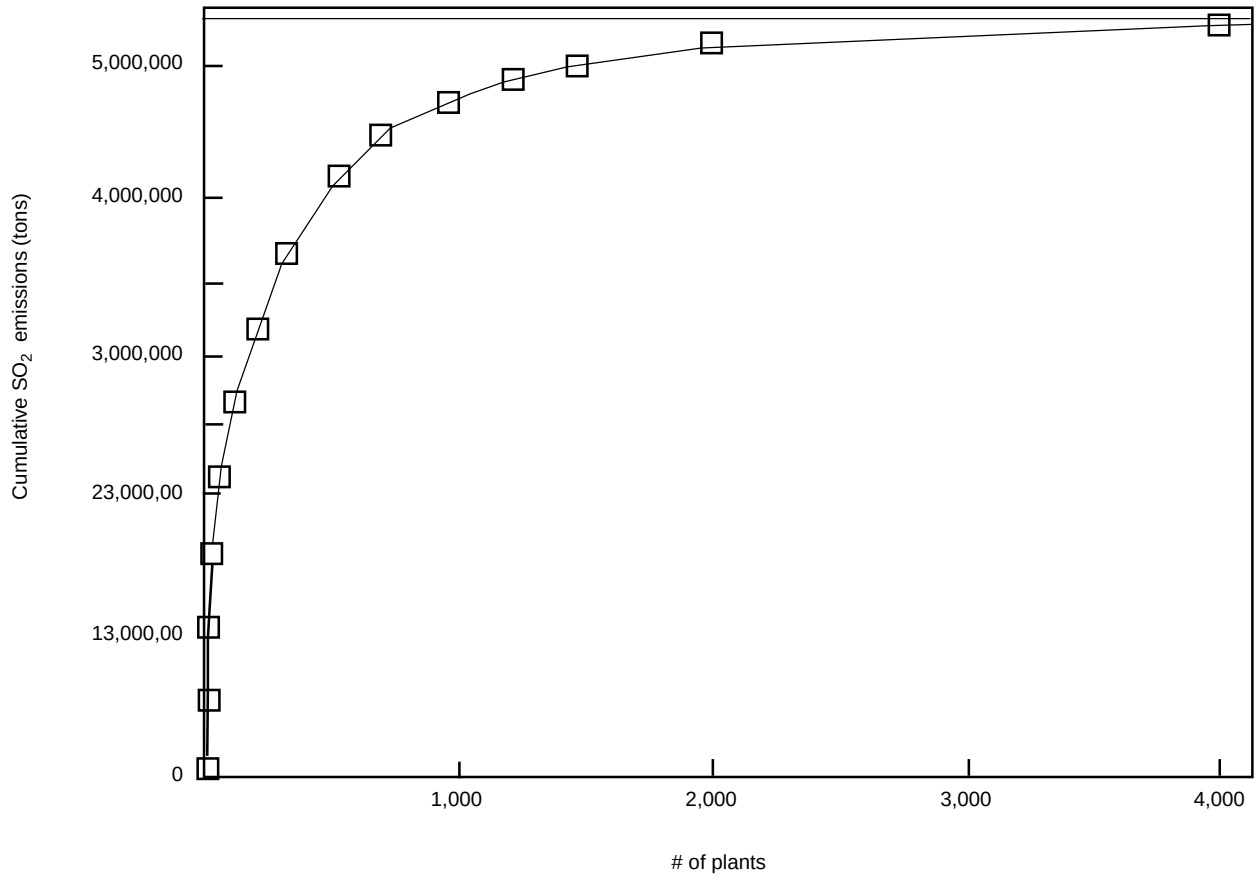

***Figure 1**. Cumulative sulfur dioxide emissions in the 1985 NAPAP inventory versus number of plants.*

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The complete report, entitled "Comparison of the 1985 NAPAP Emissions Inventory with the 1985 EPA Trends Estimate for Industrial SO_2 Sources," (Order No. PB94-152220/AS; Cost: $36.50, subject to change) will be available only from:
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