How A State Agency Accounts For Underestimating Base-Year Point Source Emissions: An Alternative To Existing EPA Guidance

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Abstract:

When calculating emissions from point sources, inventory preparers multiply activity values by the highest quality emission factors available. If control devices are used to reduce emissions the emission estimate is reduced by the control efficiency. In reviewing the results of modeling of inventory data during the late 1980s and early 1990s EPA observed that to get atmospheric models to work properly they had to increase the emissions inputs. This implied that inventory preparers were underestimating emissions. EPA reasoned that the most likely cause was the assumption by inventory preparers that control devices operate at their rated efficiency all the time. Real world experience shows that control devices malfunction and sometimes go down, which would boost actual emissions significantly above traditionally calculated emissions estimates. To address the problem EPA developed guidance that was intended to correct the underestimates.

Existing EPA guidance requires that to account for control device malfunctions and down times inventory preparers should assume that control devices work at rated efficiency only 80% of the time. For processes controlled by high efficiency devices, such as baghouses, assuming that process were operating uncontrolled 20% of the time resulted in greatly increasing estimates. Worse, the guidance was written ambiguously and was interpreted in several ways. This resulted in inconsistent application between the EPA Regions and even within the same Region. Neither EPA nor State and Local Agencies were satisfied with the guidance.

Over the past 5 – 7 years there have been various attempts correct the deficiencies in the guidance (which primarily affected 1-hour ozone non-attainment areas) before

designation of non-attainment for the new 8-hour ozone and regional haze standards. The Point Sources Committee of the Emission Inventory Improvement Program (EIIP) developed a document to assist inventory preparers in accounting for control device malfunction and downtime. The STAPPA/ALAPCO Emissions & Modeling Committee discussed the issue several years ago and drafted a letter to EPA which requested them to revisit their guidance and suggested using the EIIP control device chapter as an alternative to the guidance.

Air program staff of the South Carolina Department of Health and Environmental Control agreed that emission calculations probably underestimate controlled actual emissions. However, it was also thought that the guidance indiscriminately and improperly inflated estimates. The approach taken by SC was simple and direct. Facility staff responsible for reporting emissions inventory data are requested in the Department's point source emissions inventory questionnaire to estimate the percentage of annual operation when control devices do not operate at design efficiency and to estimate the amount of efficiency reduction.

Introduction:

Existing guidance from EPA to account for excess emissions from processes due to control device malfunctions or downtime, known as Rule Effectiveness (RE), has required that emissions calculations for processes that have control devices must assume that the control devices are only 80% effective and that the rated control efficiency must be adjusted by that correction factor. Depending on the control efficiency, applying this guidance can greatly over-estimate actual emissions. Primary concern has focused on base year inventories for point sources. There is much less disagreement about applying Rule Effectiveness to future year point source inventories or to area source inventories. There have been various efforts over the years to take a more realistic approach to quantify those excess emissions. South Carolina has modified its point source emissions inventory questionnaire to request control device malfunction and down time. This has been accepted by the regulated community.

Background*:*

Prior to 1987 it was assumed that regulations affecting point sources were 100% effective and consequently control device efficiencies reported in emission inventories were accurate. Experience proved that emissions inventories developed during that time significantly underestimated emissions in both the base year and in projections based on the base year. To avoid these underestimates, EPA developed a guidance document titled *"Guidelines For Estimating And Applying Rule Effectiveness For Ozone/Co State Implementation Plan Base Year Inventories."*[1] This guidance described procedures to estimate the effectiveness of regulations in bringing about the reductions required by regulations.

During subsequent years at annual emissions inventory conferences, inconsistency and inequity "war stories" were exchanged between state and local attendees. Indeed, EPA staff recognized that the existing guidance was inadequate and a paper titled "Clearing Up the Rule Effectiveness Confusion"[2] was drafted and shared with state and local agencies to promote discussion. Various papers regarding the problems associated with the implementation of Rule Effectiveness have been presented at annual emissions inventory conferences.[3] The EIIP Point Sources Committee developed a Technical Paper which discussed the proper use of Rule Effectiveness[4] and which was also based on a presentation at a previous emissions inventory conference. The Point Sources Committee of the EIIP also prepared a document, Volume II: Chapter 12, "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates,*"[5] to allow inventory preparers address EPA's concerns about under-estimating point source emissions.

EPA developed new guidance for preparing ozone and PM inventories in 1999 but it offered no improvements to RE guidance.[6] Finally, in June 2000 STAPPA/ALAPCO's Emissions and Modeling Committee prepared a letter to EPA which addressed the concerns about RE and requested that the existing guidance be updated.[7] The letter offered the EIIP control device malfunction chapter as a basis for new guidance development.

Specifically, What is Wrong with EPA's Current Rule Effectiveness Guidance:

There is little question that failure to take point source control device malfunction or down-time into account will lead to potentially significant under-estimates of controlled emissions. There is also an argument to be made for using the current guidance for projection inventories. It is prudent to plan for the worst case. The problem lies with using RE guidance for base-year point source inventories. The top-down assumption of 20% uncontrolled emissions greatly over-compensates for under-estimations made in the 1980s. Conscientious inventory preparers are aware of the problem and, using a bottom-up approach try to account for excess emissions.

Some effects of this over-compensation are shown using Examples from EIIP's Volume II: Chapter 12, "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates"*[8] shown below:

"A general formula for calculating increases in annual emissions due to malfunctioning control devices is:

"$I = {}_{ta} x (C_{En} - C_{Ea}) / (100\% - C_{En})$

where:

I	=	Increase in annual emissions due to a malfunctioning control device (%)
C_{En}	=	Normal control efficiency (%)
C_{Ea}	=	Malfunction control efficiency (%) [note: use the actual control efficiency. Do not express as a percent of the normal control efficiency.]
$_{Ta}$	=	Operating time under malfunction conditions (% of total hours)"

"The three examples in this appendix use the above formula to calculate annual emission increases for three hypothetical examples. In each example, we assume a specific malfunction efficiency (e.g., assume that a malfunctioning fabric filter operates at 97.5 percent efficiency) and show the annual emission increases that would result under different combinations of design efficiencies and percentage malfunction time."

"**EXAMPLE F-1: VERY HIGH DESIGN EFFICIENCY AND SLIGHT DECREASES IN ACTUAL EFFICIENCY RESULT IN SIGNIFICANT ANNUAL EMISSION INCREASES**

Consider a hypothetical ESP that operates under 97.5 percent efficiency during a minor malfunction. Table F-1 shows the emission increases that would occur if the device operated under malfunction conditions from 1 to 10 percent of the time, and if the ESP was otherwise expected to operate at design efficiencies between 98 and 99.5 percent. For example, if the control device design efficiency is 99.5 percent, and the control device operates under malfunction conditions (at 97.5 percent efficiency) for 5 percent of the time, the increased emissions due to the malfunction would add 20 percent to the expected annual emission. The data in Table F-1 are presented graphically in Figure F-1. As you can see in the example of Table F-1 *(Table 1. this paper)*, small decreases in the control percentage can result in large percentage increases in actual emissions if the design efficiency is high."

Table 1. Percentage Increase Over Expected Annual Emissions for an ESP Operating at 97.5% Efficiency During Malfunction (Adapted from Volume II: Chapter 12, "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates*"[9]

Design Efficiency	Percentage Downtime at 97.5% Control									
	1.00%	**2.00%**	**3.00%**	**4.00%**	**5.00%**	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**
99.50%	4.00%	8.00%	12.00%	16.00%	20.00%	24.00%	28.00%	32.00%	36.00%	40.00%
99.00%	1.50%	3.00%	4.50%	6.00%	7.50%	9.00%	10.50%	12.00%	13.50%	15.00%
98.50%	0.67%	1.33%	2.00%	2.67%	3.33%	4.00%	4.67%	5.33%	6.00%	6.67%
98.00%	0.25%	0.50%	0.75%	1.00%	1.25%	1.50%	1.75%	2.00%	2.25%	2.50%

Chapter 12's Table F-1 *(Table 1. this paper)* reflects a slight drop in control efficiency. Table 2. below was generated using the same formulas and shows the effects of a control device not operating at all for a high efficiency device.

Table 2. Percentage Increase Over Expected Annual Emissions for an ESP Operating at 0.0% Efficiency During Malfunction

Design Efficiency	Percentage Downtime at 0.0% Control									
	1.00%	**2.00%**	**3.00%**	**4.00%**	**5.00%**	**6.00%**	**7.00%**	**8.00%**	**9.00%**	**10.00%**
99.50%	199.00%	398.00%	597.00%	796.00%	995.00%	1194.00%	1393.00%	1592.00%	1791.00%	1990.00%
99.00%	99.00%	198.00%	297.00%	396.00%	495.00%	594.00%	693.00%	792.00%	891.00%	990.00%
98.50%	65.67%	131.33%	197.00%	262.67%	328.33%	394.00%	459.67%	525.33%	591.00%	656.67%
98.00%	49.00%	98.00%	147.00%	196.00%	245.00%	294.00%	343.00%	392.00%	441.00%	490.00%

Emission Inventory Guidance for Implementation of Ozone and Particulate Matter states "The RE value is applied to adjust the control efficiency and is not applied to the emission estimate directly. For example, 80% RE means the control effectiveness is actually 80% of the estimated control efficiency. It does not mean that actual emissions are 20% greater than estimated."[10] Therefore, using the formula above and applying Rule Effectiveness in accordance with EPA guidance to the 99.5% control efficiency of the electrostatic precipitator in the example, the person calculating emissions must use 79.6% as the control efficiency.

$$(99.5\%)*(80.0\%) = 79.6\%$$

If a facility has uncontrolled emissions of 200 tons per year and has an electrostatic precipitator with design efficiency of 99.5% then its actual emissions would be 1 ton per year.

Table 3. Impact of Applying RE to an Electrostatic Precipitator According to Guidance to a Facility With Uncontrolled Emissions of 200 Tons Per Year

Design Efficiency	Uncontrolled Emissions (Tons per Year)	Emissions Using Design Efficiency (Tons per Year)	Control Efficiency after RE	Emissions after RE (Tons per Year)
99.50%	200	1.0	79.60%	40.8
99.00%	200	2.0	79.20%	41.6
98.50%	200	3.0	78.80%	42.4
98.00%	200	4.0	78.40%	43.2
95.00%	200	10.0	76.00%	48.0
90.00%	200	20.0	72.00%	56.0
80.00%	200	40.0	64.00%	72.0

Using EPA RE guidance on a facility with uncontrolled emissions of 200 tons per year and with a 99.5% design efficiency electrostatic precipitator (Table 3.) raises emissions

from 1.0 ton per year to 40.8 tons per year. A facility that maintains its equipment well would have good grounds contesting paying permit fees based on RE guidance.

Table 4. Impact of Applying RE to an Electrostatic Precipitator According to Guidance to a Facility With Uncontrolled Emissions of 500 Tons Per Year

Design Efficiency	Uncontrolled Emissions (Tons per Year)	Emissions Using Design Efficiency (Tons per Year)	Control Efficiency after RE	Emissions after RE (Tons per Year)
99.50%	500	2.5	79.60%	102.0
99.00%	500	5.0	79.20%	104.0
98.50%	500	7.5	78.80%	106.0
98.00%	500	10.0	78.40%	108.0
95.00%	500	25.0	76.00%	120.0
90.00%	500	50.0	72.00%	140.0
80.00%	500	100.0	64.00%	180.0

Furthermore, if the same facility has 500 tons per year before controls their emissions would be increased from 2.5 tons per year to 102.0 tons per year. Not only would the facility be required to pay 40 time more in permit fees, it would also be in violation of if it had a federally enforceable permit to limit its emissions to less than 100 tons per year.

Clearly actual emissions should not be calculated using uncorrected design efficiency. Just as clearly, however, assuming control effectiveness is only 80% of the estimated control efficiency can be inappropriate. This is especially true if better information is available to more accurately account for control device malfunction and downtime.

South Carolina's Approach to Rule Effectiveness:

Emissions inventory staff at the SC Department of Health & Environmental Control (SC DHEC), Bureau of Air Quality (BAQ) have not had to deal with the problems associated with Rule Effectiveness discussed above because the state has been in attainment with NAAQS. However, with the new 8 hour ozone and PM fine standards, SC will be in non-attainment. Therefore, over the years SC emissions inventory staff have actively participated in national efforts summarized above to correct the existing guidance. Although progress has been made, the guidance still has not been corrected.

SC emissions inventory staff have initiated procedures to collect data necessary to more accurately calculate Rule Effectiveness. Before discussing the SC approach to RE, however, a brief overview of SC emission inventory procedures is in order.

SC emissions inventory staff currently mail point source emissions inventory questionnaires[11] and Document Certification forms to Title V and Synthetic Minor sources. The questionnaire consists of instructions, a facility general information page,

process activity rate pages, control device, and stack pages. Using activity rates provided by sources, Department staff calculate actual emissions using the best methods available as documented in the EIIP's Preferred and Alternative Methods document series.[12] In many other state and local programs emissions calculations are performed by facility staff and then mailed to the delegated agency. There the data may be quality-assured and then keyed in.

SC emissions inventory staff believe that control device variability should be addressed on a facility by facility basis (bottom-up) and not by an across-the-board one size fits all correction factor (top-down). To improve the accuracy of the point source inventory, the questionnaire explicitly asks for control equipment downtime, malfunction or upsets. Facilities are asked to indicate on the Control Device page the percent of the annual process rate during which the control device operated at lower overall efficiency or did not operate at all.

SC emissions inventory staff then use the malfunction/downtime information to multiply the activity rate times the percent of time the process operated with full control, with partial control, or with no control. Then staff create two or more processes as necessary within the database. One process will have full controls while the other(s) will reflect less or no controls. Then the partial activity rates are multiplied by the highest quality emission factors to get emissions under each control scenario. Excess emissions are fully and accurately accounted for.

Title V and synthetic minor permits require excess emissions reporting for all affected sources. Department staff have reviewed excess emissions reports but have found little of value to help quantify excess emissions resulting from control device problems. However, facility staff who compile inventory data and who also send in excess emission reports are better suited than anyone to have a sense of the impact on the control device efficiency. Certainly far better than the arbitrary 80% assumption.

In addition to reporting the percent malfunction/downtime values, SC DHEC also requests facility inventory preparers to have a Document Certification Form signed by the facility Responsible Official. One of the signatures is specifically to certify that they have taken Rule Effectiveness issues into account in the data sent to us.

Summary and Conclusions:

Rule Effectiveness guidance was developed prior to the implementation of Title V permit regulation. Title V imposes much more stringent record-keeping and reporting requirements on Title V facilities and facilities which take federally enforceable permit limits to avoid Title V. Strictly following RE guidance can result in greatly inflating permit fees and can even place facilities with well-maintained equipment in violation of their permits if their production increases.

STAPPA/ALAPCO has recommended to EPA that its RE guidance be updated to allow agencies to more accurately calculate emissions using newer EIIP guidance. The EIIP Point Sources Committee document "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates*" serves as an excellent basis for more accurately estimating emissions by taking into account control device variability. It can also serve as a basis for future guidance document development by EPA.

SC DHEC staff have incorporated the EIIP guidance into its procedures and have expanded upon it by requesting specific information about what percent of the annual operating activity occurred at less than design efficiency. SC DHEC also requests that facility inventory data preparers estimate the control efficiency during any malfunctions or downtime. SC DHEC also includes a Document Certification form that the facility's Responsible Official must sign to verify that good faith efforts have been made to make these estimates.

Federally enforceable permits require recording and reporting excess emissions to the delegated air agency. Facility staff are required to have excess emissions records available. So no additional burden has been placed on the regulated community. Moreover, facility staff are (or should be) familiar with their processes and equipment. They are in the best position to make sound estimates regarding effects of control device malfunction and downtime. More sound anyway, than an arbitrary 80% across the board top down correction. Furthermore, accepting control device malfunction/downtime estimates from facility staff is an extension of the trust we extend when we request facilities to complete the other information collected on emission inventory questionnaires. With EIIP guidance and requiring the facility's Responsible Official to certify that the information supplied is accurate SC DHEC staff feel that our base year emission estimates are much more sound than they would be using EPA's existing guidance.

References:

[1] Guidelines For Estimating And Applying Rule Effectiveness For Ozone/Co State Implementation Plan Base Year Inventories, US Environmental Protection Agency, Research Triangle Park, NC EPA-152/R-92-010; pp 1-5.

[2] Bromberg, Steve, "Clearing Up the Rule Effectiveness Confusion," EIIP Volume II: Chapter 12, "How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates," Appendix A, July, 2000.

3 Hochhauser, Martin; Betterton, Robert "The Effect of Air Pollutant & Control Device Characteristics on Emission Rates," Presented at the 11th International Emission Inventory Conference "Emission Inventories - Partnering for the Future," Atlanta, GA, April 15-18, 2002.

[4] Mangat, Toch. "Emissions Inventories and the Proper Use of Rule Effectiveness," EIIP Volume II: Chapter 12, "How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates," Appendix B, July, 2000.

[5] The Point Sources Committee, Volume II: Chapter 12, "How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates," July, 2000.

[6] Emission Inventory Guidance for Implementation of Ozone and Particulate Matter <http://www.epa.gov/ttn/chief/eidocs/eidocfnl.pdf> - National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations and associated memos. U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1999.

[7] Williams, Herb; Westman, Roger. "*STAPPA and ALAPCO Comments on EPA' s Rule Effectiveness Policy*" <http://www.4cleanair.org/members/committee/modeling/REREDraft4rev.PDF>(June 12, 2000)

[8] EIIP Point Sources Committee. Volume II: Chapter 12, "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates,*" Appendix F, pp 12.F-1 – 12F-2. July, 2000

[9] EIIP Point Sources Committee. Volume II: Chapter 12, "*How to Incorporate the Effects of Air Pollution Control Device Efficiencies and Malfunctions into Emission Inventory Estimates,*" Appendix F, pp 12.F-2. July, 2000

[10] Emission Inventory Guidance for Implementation of Ozone and Particulate Matter <http://www.epa.gov/ttn/chief/eidocs/eidocfnl.pdf> - National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations and associated memos. U.S. Environmental Protection Agency, Research Triangle Park, NC, April 1999. p3

[11] http://www.scdhec.net/eqc/baq/html/emissions_inventory.html

[12] http://www.epa.gov/ttn/chief/eiip/techreport/volume02/index.html