MEMORANDUM

TO: Docket

FROM: EPA, Clean Air Markets Division

SUBJECT: Analysis of the Marginal Cost of SO_2 and NOx Reductions

DATE: January 28, 2004

Figures VI-1 and VI-2 in the Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone depict marginal cost curves that graph the marginal cost of the last ton of emission reductions needed to achieve various emission caps. Figure VI-1 includes marginal costs of SO_2 reductions for caps from 10 million tons down to 1.5 million tons. Figure VI-2 includes marginal costs of NOx reductions for caps from 5 million tons down to 0.75 million tons. This memo provides detail explaining how these curves were developed.

The curves were developed using the Technology Retrofit and Updating Model (TRUM). TRUM is a model that selects investment options and dispatches generation to meet electricity demand. For simplicity this model was developed as a steady-state, single-region spreadsheet model supported by Visual Basic for Applications (VBA) code. The model consists of a set of about six hundred "sample" generating units with varying characteristics. The mix of generation types and sizes was chosen to mirror, in general terms, the nationwide mix of capacities. The starting point for developing these sample generating units was the configuration of the Integrated Planning Model (IPM)[1] used by EPA. Therefore, it relies on the same underlying data. Each unit is assumed to choose emission control retrofits, fuels, and generation levels so as to maximize its own net profit in response to fuel prices, emission allowance prices, and prices of electricity for various demand segments. Most of the assumptions used in TRUM for retrofit costs and removal efficiencies, fuel prices, and costs for new units are also based on IPM inputs or outputs to the extent possible in a simplified model.

Prices of fuels can be adjusted in the model in response to demand; price of electricity by demand segment is set in the model so as to meet demand; and allowance prices can be adjusted to cause the industry to meet given emission caps. The model allows each unit to make choices that maximize its net profit, taking prices and the actions of other units as unchanging parameters. Because the choices made by the sample units will, in fact, have various effects on prices (and thus on the decisions made by other units) the model is run interactively until the interacting choices made by the units converge to a stable solution.

[1]IPM is a more sophisticated model of the power sector developed by ICF that EPA uses for much of its analysis of the power sector.

In order to make the model run quickly, it was not designed to recognize the distinctions among electricity demand regions and the transmission constraints that can keep them separate. Thus, only one price of electricity is determined for each demand segment for the entire set of sample plants. EPA and ICF have tested TRUM against, the IPM and have found TRUM to be sufficiently accurate to analyze many environmental policies at a "macro-level."

In order to develop the marginal cost curve for SO_2, the model was run interactively to determine the marginal cost of SO_2 reductions at various SO_2 emission levels. Because the NOx level can affect decisions about dispatch and fuel use, which can in turn impact the marginal cost of SO_2 reductions, the model was run holding Nox emissions at a cap level of 2.3 million tons. This cap was chosen because it was within the range of policy options for NOx being considered, therefore it reasonably approximated the affects that NOx regulations would have on dispatch and fuel choice. Because decisions made to control SO_2 (e.g. dispatch, fuel switching) can also affect NOx emissions, a constant NOx emissions cap does not represent a constant marginal cost for NOx reductions across the entire curve. The first point on the curve, at ten million tons of SO_2 emitted, results in a marginal cost for SO_2 of about $500 per ton. The marginal NOx curve was developed the same way, holding SO_2 emissions constant at just over 5 million tons. Similar to the way that the NOx cap was chosen for the SO_2 analysis, this cap was chosen to reasonably approximate dispatch and fuel choices that could be expected due to SO_2 regulation. The first point of the NOx curve, at five million tons of Nox emitted, results in a marginal costs for NOx of $500 per ton. Figure VI-1 and Figure VI-2 are included below. Just as the marginal cost of SO_2 control to meet a constant cap of 5.26 million tons changes as the NOx cap is changed, the marginal cost of NOx to meet a constant cap of 2.3 million tons also changes as the SO_2 cap varies. All costs are in 1999$.

Figure VI-1

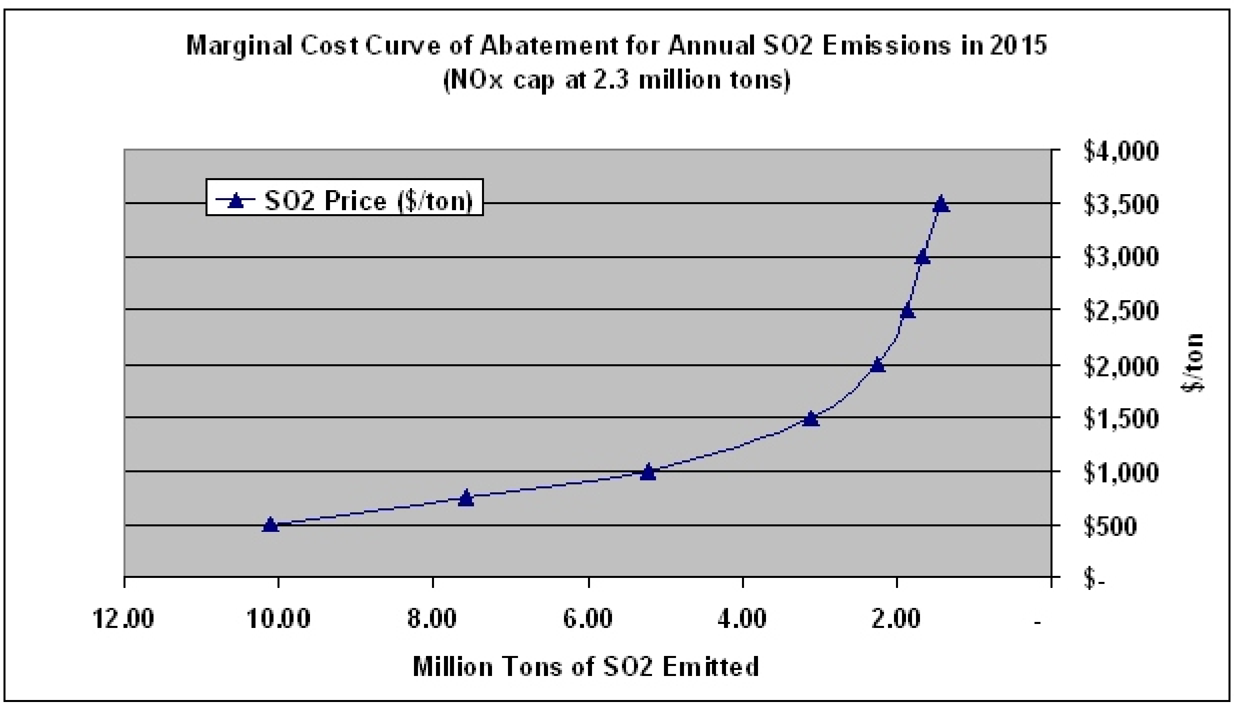
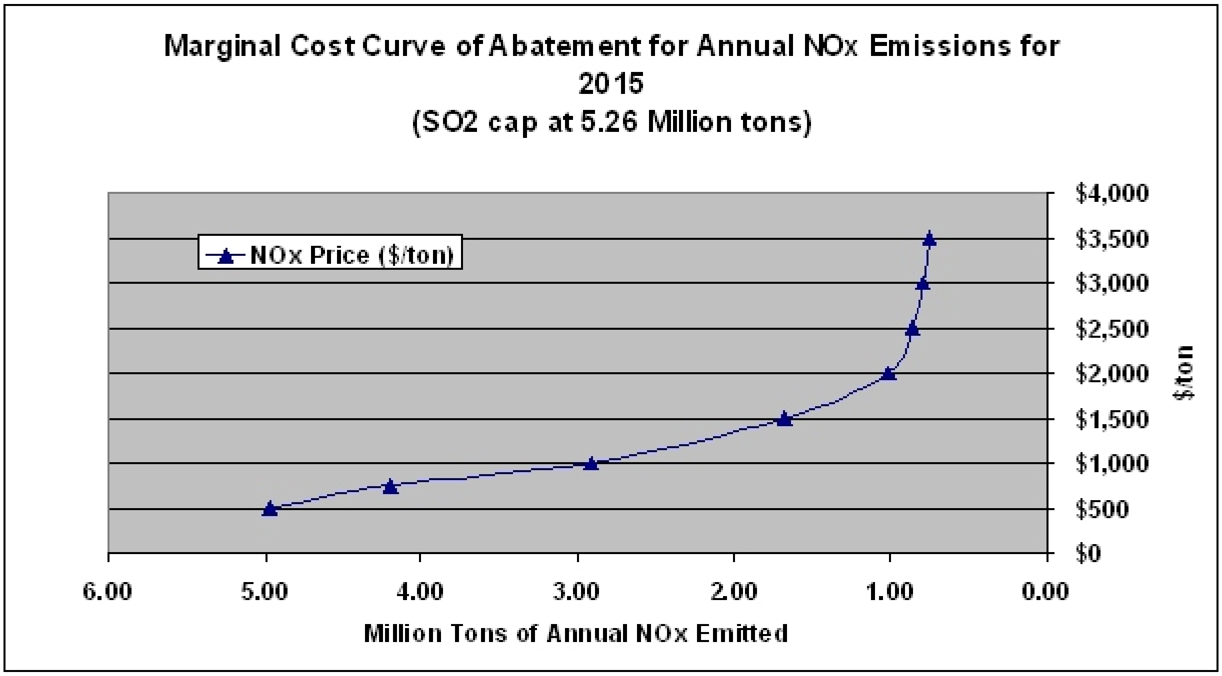


Figure VI-2



Marginal Cost Curve of Abatement for Annual NOx Emissions for 2015
(SO2 cap at 5.26 Million tons)
NOx Price ($/ton)
$4,000
$3,500
$3,000
$2,500
$2,000
$1,500
$1,000
$500
$0
$/ton
6.00
5.00
4.00
3.00
2.00
1.00
0.00
Million Tons of Annual NOx Emitted