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Computer runs from the "Integrated Planning Model" (IPM).

EVALUATION OF ROUTINE MAINTENANCE MODEL SCENARIO FOR POWER PLANTS

Purpose: This analysis uses model scenarios to evaluate the impact that the changes to the routine maintenance provisions of NSR are likely have on emissions from the power generation sector.

Methodology: In order to evaluate the impact of the routine maintenance provisions, EPA considered a scenario under which NSR regulations remained in place and a range of scenarios that could occur if NSR did not exist. The first scenario is intended to represent the existing program, which the EPA has found impedes or results in cancellation of projects that maintain and improve reliability, availability, and efficiency at existing power plants.[1] The second range of scenarios represents companies receive flexibility under the NSR program that removes many of these impediments . As part of this analysis, EPA reviewed three key variables: change in SO_2 emissions, change in NO_x emissions and change in cost.

In the future, when a final rule is issued on treatment of routine maintenance under NSR, there will already be in place final rules governing the use of plantwide applicability limits (PALs), and Clean Units. Some sources with in the electric utility generation industry may take advantage of these changes. However, any such decision will be based on case specific information related to their past operating levels, current levels of control and company's specific strategies for complying with NSR. Therefore, we can not make estimates on how many sources may take advantage of PALs and Clean Units. To the extent they are used within the industry, they will dampen the effects shown in this analysis (i.e., estimated decreases and increases will not be as large.

This analysis was performed using the Integrated Planning Model (IPM). IPM is a linear programming model that EPA uses to analyze the effect of various environmental policies on the power sector. It provides forecasts of least-cost capacity expansion, electricity dispatch and emission control strategies for meeting energy demand and environmental, transmission, dispatch and reliability constraints. EPA has used it to analyze many environmental policies including the Phase II Acid Rain Nitrogen Oxide regulations and the Nitrogen Oxide SIP Call. Analysis can be performed varying multiple constraints such as availability of various types of power plants (e.g. coal-fired, nuclear, gas-fired combined cycle units), heat rates of various types of power plants, environmental constraints (e.g. caps on emissions, emission rate limitations). More detail regarding IPM can be found in the document titled "Documentation of EPA Modeling Application (V.2.1) Using the Integrated Planning Model, which can be found at: http://www.epa.gov/airmarkets/epa-ipm/index.html.

Assumptions: The first scenario, referred to as the NSR base cases approximates utility behavior under the current program, where the EPA has found that companies perform limited maintenance on coal plants because of concerns about NSR. In this scenario, it was assumed that

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[1]This finding is described in detail in EPA's June 13, 2002 New Source Review Report to the President.

the performance of coal units would deteriorate, resulting in higher heat rates and lower capacities. EPA did not assume that reduced maintenance resulted in a change in maximum potential unit availability. This is because over the last 20 years, availability of coal-fired plants has increased even as the plants have aged. This is due in large part to improved maintenance practices. For instance tests to inspect boiler tubes have been continually improving (see "Preventing Boiler Tube Failures with EMAT's", S.P. Clark et al, "EPRI International Conference on Boiler Tube Failures and HRSG Tube Failures and Inspects", November 6-8, 2001). These improved preventive maintenance practices allow companies to replace components during regularly scheduled outages before they fail rather than causing unscheduled outages after they fail. The second range of scenarios, referred to as increased maintenance cases #1 - #5 , looks at a range of scenario for what might happen in the utility sector if companies were provided with increased flexibility under NSR to perform maintenance. This would result in lower heat rates, higher capacities and/or higher unit availabilities for these units. Finally EPA looked at one case (standard base case) in which heat rate, capacity and unit availability did not change.

Table 1: Key modeling assumptions in routine maintenance analysis

	Winter Availability	Summer Availability	Heat Rate Change	Capacity Change
NSR Base-case	81.6%	89.8%	+0.1% per year	-0.1% per year
Increased Maintenance Case #1	85.0%	92.0%	-0.1% per year	+0.1% per year
Increased Maintenance Case #2	81.6%	89.8%	-0.1% per year	+0.1% per year
Increased Maintenance Case #3	85.0%	92.0%	-1.6% in year 2005 and beyond	+1.6% in year 2005 and beyond
Increased Maintenance Case #4	85.0%	92.0%	-3.2% in year 2005 and beyond	+3.2% in year 2005 and beyond
Increased Maintenance #5	81.6%	89.8%	-1.6% in year 2005 and beyond	+1.6% in year 2005 and beyond
Standard Base Case	81.6%	89.8%	No change	No change

It is important to note several limitations to this analysis. First this analysis only considered emission regulations that are currently in effect (e.g. the NOx SIP Call and the Title IV Acid Rain Provisions). Future environmental regulations such as emission reduction requirements necessary to meet the fine particulate matter standards or emission reductions under multi-pollutant regulations could significantly change this analysis. Second, the analysis assumed the operating and maintenance costs of coal-fired units was the same for units performing limited maintenance and for units performing increased maintenance.. Since the most significant cost associated with running an existing power plant is the cost of fuel, this impact is probably fairly small.

Results:

Changes in SO2 Emissions, NOx emissions and cost are summarized in tables 2, 3 and 4 below.

Table 2: Changes in SO2 emissions in scenarios considered in routine maintenance analysis.

	2005 SO2 Emissions (tons)	2010 SO2 Emissions (tons)	2015 SO2 Emissions (tons)	2020 SO2 Emissions (tons)
NSR Base-case	10,168,230	9,713,684	9,101,622	9,103,275
Increased Maintenance Case #1	10,135,120	9,739,029	9,104,121	9,102,688
Increased Maintenance Case #2	10,186,660	9,701,112	9,099,363	9,099,271
Increased Maintenance Case #3	10,075,060	9,773,242	9,104,836	9,103,779
Increased Maintenance Case #4	10,009,250	9,813,664	9,105,429	9,104,396
Increased Maintenance #5	10,079,510	9,764,971	9,099,923	9,100,361
Standard Base Case	10,168,520	9,712,499	9,100,264	9,100,680

As shown in table 2, there is very little change in SO2 emissions over the entire time period studied under the two scenarios. This is because SO2 emissions are already capped nationally under the Title IV Acid Rain Provisions. Therefore if a unit decreases its emissions to make room under its PAL, it could instead sell excess allowances to another unit. However because emissions can also be shifted temporally by banking emission allowances to be used in a future year there can be significant changes in emissions for a specific year. While temporal distribution of emissions did not change much over time in the NSR cases considered, there was more temporal distribution of emissions in the increased maintenance scenarios considered.

Table 3: Changes in NOx emissions in scenarios considered under routine maintenance scenarios.

	2005 NOx Emissions (tons)	2010 NOx Emissions (tons)	2015 NOx Emissions (tons)	2020 NOx Emissions (tons)
NSR Base-case	**4,279,362**	**4,285,400**	**4,338,461**	**4,375,486**
Increased Maintenance Case #1	**4,340,166**	**4,362,948**	**4,442,881**	**4,471,499**
Increased Maintenance Case #2	**4,276,550**	**4,283,081**	**4,327,979**	**4,362,859**
Increased Maintenance Case #3	**4,307,796**	**4,350,737**	**4,423,141**	**4,472,706**
Increased Maintenance Case #4	**4,276,172**	**4,334,671**	**4,412,340**	**4,460,041**
Increased Maintenance #5	**4,259,170**	**4,271,294**	**4,324,992**	**4,363,930**
Standard Base Case	**4,277,407**	**4,285,423**	**4,332,209**	**4,360,044**

Increasing capacity (under the increased maintenance cases) leads to increases in NOx emissions. When comparing increased maintenance cases #1 and #2 (which had the same increases in efficiency, but different changes in maximum availability, NOx emissions increase by an average of almost 92,000 tons per year over the time period analyzed.

It appears that changing heat rates and capacities has the opposite affect on emissions.. NOx emissions actually decrease when flexibility under NSR allows power generation companies to improve efficiency by performing increased maintenance if maximum availability of these units does not change at the same time. For instance if one compares two scenarios with the same maximum capacities: NSR Base-case , increased maintenance case #2 and the standard base case, average emissions are about 7000 tons per year higher over the time period analyzed in NSR Base-case where heat rates are higher and capacities are lower. Looking at increased maintenance cases #3 and #4 shows the same trend. In these two cases maximum availability remains constant, but heat rates are lower and capacities are higher in increased maintenance case #4. These lower heat rates and higher capacities lead to emissions that are on average nearly 18000 tons per year less in increased maintenance case #4 than in increased maintenance case #5.

Another point to note is that EPA also looked at the speed in which the improvements to the units were made. For example by 2020, the heat rate decrease and the capacity increase was the same in both increased maintenance case #2 and increased maintenance case #5 were the same. However in case #5, those changes happened in one step in 2005, in case #2, the changes happened gradually. When the changes occurred all at emissions were lower in the early years. In the later years, when the total magnitude of the changes was more similar in both cases, the NOx emissions were also more similar.

This analysis suggests that the affect that changing the requirements of NSR with regards to routine maintenance will have on emissions is dependent upon the affect that it will have on maximum unit availabilities. If the routine maintenance changes increase efficiency and plant capacity without increasing maximum unit availability, this analysis suggests that the changes could decrease emissions. The amount of that emission decrease would depend both on how much heat rate decreased and capacity increased and how quickly these changes occurred. The greater the heat rate decrease and capacity increase and the more quickly the changes occurred, the greater the emission reductions. If on the other hand, the new provisions increase maximum unit availabilities this analysis suggests that the changes could increase emissions.

Changes in cost are summarized in table 4 below. Note that this analysis does not consider changes in maintenance costs, it only assumes changes in fuel costs and changes in capital costs associated with new generating units and new emission control equipment. Therefore it probably understates the cost of the increased maintenance scenarios and understates the cost of the NSR Base-case.

Table 4: Total cost of scenarios considered (in 1999 dollars)

	2005 Total Cost (million 1999 dollars)	2010 Total Cost (million 1999 dollars)	2015 Total Cost (million 1999 dollars)	2020 Cost (million 1999 dollars)
NSR Base-case	76,187	80,934	88,921	95,819
Increased Maintenance Case #1	75,432	79,819	87,306	92,817
Increased Maintenance Case #2	76,088	80,290	87,861	93,781
Increased Maintenance Case #3	74,422	79,309	86,715	92,788
Increased Maintenance Case #4	73,740	78,250	85,898	91,932
Increased Maintenance #5	75,164	79,782	87,600	93,784
Standard Base Case	76,149	80,572	88,404	94,588

For more detailed results, see the attached I'M run summaries. The runs are listed in table 5 below.

Table 5: I'M Runs used in this analysis

Scenario	I'M Run #
NSR Base-case	NSR-13
Increased Maintenance Case #1	NSR-8
Increased Maintenance Case #2	NSR-11
Increased Maintenance Case #3	NSR-14
Increased Maintenance Case #4	NSR-15
Increased Maintenance #5	NSR-16
Standard Base Case	IPM2000s100d

Coal Use Tbtu

	2005 Coal Use	2010 Coal Use	2015 Coal Use	2020 Coal Use
NSR Base-case	21128	21511	21843	22136
Increased Maintenance Case #1	21478	22094	22499	22805
Increased Maintenance Case #2	21,132	21,523	21,846	22,130
Increased Maintenance Case #3	21,286	22,037	22,418	22,788
Increased Maintenance Case #4	21,137	21,926	22,392	22,740
Increased Maintenance #5	20,964	21,488	21,827	22,130
Standard Base Case	21,128	21,524	21,844	22,132

Natural Gas Use Tbtu

	2005 Natural Gas Use	2010 Natural Gas Use	2015 Natural Gas Use	2020 Natural Gas Use
NSR Base-case	6048	7460	9042	10454
Increased Maintenance Case #1	5743	6934	8269	9573
Increased Maintenance Case #2	6013	7346	8714	10002
Increased Maintenance Case #3	5635	6825	8269	9594
Increased Maintenance Case #4	5472	6704	8072	9404
Increased Maintenance #5	5905	7214	8649	10002
Standard Base Case	6035	7437	8894	10233