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Project Summary

State Acid Rain Research and Screening System Version 1.0 User's Manual

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This project summary describes Version 1.0 of EPA's STate Acid Rain Research and Screening System (STARRSS). The system was developed to assist utility regulatory commissions in reviewing utility acid rain compliance plans.

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

The acid rain provisions included in Title IV of the 1990 Clean Air Act Amendments (CAAA) mandate that many electric utilities substantially curtail their sulfur dioxide (SO_2) emissions by 1995—with even more stringent environmental limits taking effect in the year 2000. These affected utilities must file compliance plans with EPA and state public utility commissions to indicate how they intend to reduce their SO_2 emissions to allowable levels. As they review these compliance plans, state regulators will play a critical role in determining the success of the CAAA. Whether they are asked to formally preapprove compliance plans or not, commissions will have considerable influence over utilities' compliance decisions. Therefore, in determining what constitutes a "good" compliance plan, commissions will have to address the following questions:

- Is the utility's preferred plan the least-cost solution?
- How risky is the utility's preferred plan?
- What other compliance strategies should the utility be considering?
- Should the utility be a buyer or a seller in the SO_2 allowance market—and to what extent?

STARRSS is an integrated information/modelling system that is designed to assist state regulatory commissions and utilities in answering these questions.

A Compliance Planning Model

Funded by EPA's Air and Energy Engineering Research Laboratory (in Research Triangle Park, NC), STARRSS is a screening tool that allows analysts to compare the cost-effectiveness of a wide variety of acid rain compliance options, including:

- Scrubbing
- Repowering
- Fuel switching/blending
- Cofiring
- Combustion technologies (e.g., sorbent injection)
- Emissions allowance purchases
- Conservation
- New, cleaner resources
- Improved boiler efficiency
- Emissions dispatch

Designed to run quickly on a personal computer (an IBM PC AT or IBM-compatible PC with an 80286 processor or better), STARRSS focuses on the comprehensive analysis of many compliance strategies. As a decision support tool, STARRSS uses a multiple-scenario, risk-assessment approach. The model uses three user-specified forecasts (high, medium, and low forecasted values) for most input data items (e.g., price forecasts, technology costs, and performance). Through

a Monte Carlo process, STARRSS then simulates hundreds of different scenarios for a particular compliance strategy, selecting one of these three values during each scenario (based on user-specified probabilities). Therefore, a strategy is exposed to the uncertainties of future events (e.g., varying allowance prices, fuel prices, construction costs, generating unit operating characteristics). These multiple simulations yield a *distribution* of cost estimates that represent the range of possible costs for a compliance strategy.

Working with this distribution, the user can see the level of economic or business risk that is inherent in a particular compliance strategy. Just because a strategy has a low expected cost (as measured by the average of the cost distribution) does not necessarily make it a desirable plan.

For example, a STARRSS analysis of Strategy A may have an expected value of $2 billion, plus or minus $0.5 billion. In other words, considering potential fluctuations in the fuel and allowance markets and other parameters, Strategy A is likely to cost between $1.5 and $2.5 billion. Strategy B has a cost of $2.1 billion, plus or minus $0.1 billion. If one simply chose the optimal strategy based on a comparison of the plans' expected value for compliance costs, then one would pick Strategy A as the better plan. However, Strategy B is less *risky*, because it has less variance in its total costs. A utility or state commission may want to choose Strategy B, realizing that the likely economic exposure is capped at $2.2 billion, whereas there may be a substantial probability that Strategy A could cost as much as $2.5 billion.

In terms of a graphical explanation, Figure 1 shows the cost distributions for two hypothetical compliance strategies. While the Fuel Switch strategy has an expected (i.e., average) cost that is less than for the Scrub BigCoal 1 strategy, it also has greater cost volatility. Comparisons such as these allow the user to identify the cost-versus-risk trade-offs that often arise in the course of compliance strategy development.

Two examples of the many input and reporting screens in STARRSS follow. Figure 2 shows one of the input screens in which the user specifies the following operational information for each of a utility's affected units: unit capacity, heat rate, and baseline heat consumption (the average annual fuel consumption for 1985-1987, which is used in the CAAA as a baseline for calculating allowance allocations and bonus allowances). In addition, the user specifies the number of Phase I and Phase II allowances in a unit's basic allocation. The Calculated SO_2 Emissions field is a calculated estimate of the unit's current SO_2 emissions and is based on information specified on this and other screens.

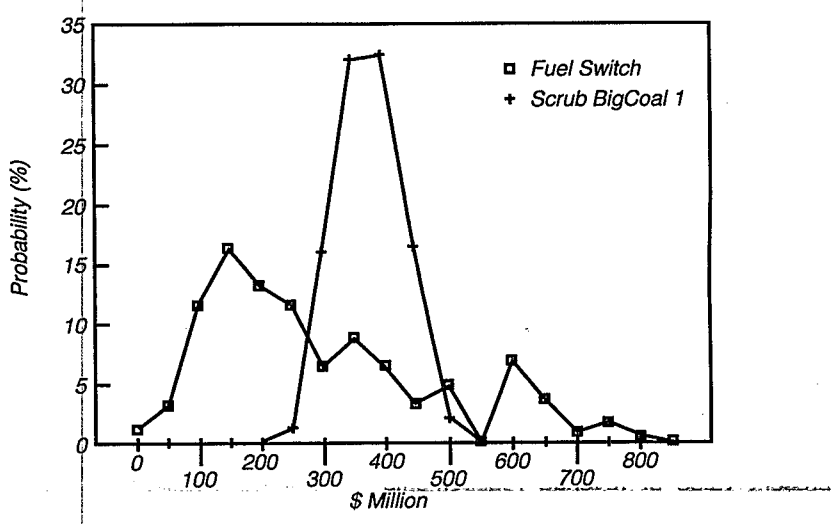

Figure 1. *Comparison of total cost distributions for two compliance strategies.*

Affected Units --- Screen 1 of 1

Database Name: SULFUR POWER & LIGHT

Unit Name	Capacity (MW)	Heat Rate	Baseline Heat (TBTUs)	Calculated SO2 Emis. (tons)	Allowances Phasel	Allowances PhaseII
BIGCOAL 1	650.0	10000	26.700	75293	36500	14000
BIGCOAL 2	650.0	10000	27.300	84761	37000	14500
MEDCOAL 1	350.0	10500	32.320	44656	44000	17500
MEDCOAL 2	350.0	10600	32.800	46244	44500	18000
MEDCOAL 3	350.0	10400	32.860	44424	45000	18000
MEDCOAL 4	350.0	10400	32.260	7984	0	17500
SMALLOIL 1	50.0	13800	0.370	77	0	200
SMALLOIL 2	50.0	13600	0.640	115	0	330
SMALLOIL 3	80.0	13500	1.040	171	0	600

Enter Text

F1 Help | ESC Menu

Figure 2. *Display/edit affected units screen.*

To facilitate the process of database development and refinement, databases have been developed to model all of the major utilities affected under the CAAA. These databases contain publicly available information for all of the above generating unit characteristics and allowance allocations. Relevant databases will be included with each STARRSS delivery to serve as a starting point for further database development. State commissions will receive databases for all utilities within their jurisdictions, including multi-state holding companies and power pools.

For any affected unit, the user can specify that the unit is a candidate for a limitless range of compliance activities (e.g., fuel switching, cofiring, repowering). For any compliance option, the user can dictate any of the following applicable entries:

- New fuel or fuel blend
- SO_2 removal efficiency of a technology
- Capital costs

- Increased non-fuel variable operating and maintenance (O&M) costs
- Increased fixed O&M costs
- Increased non-operating costs
- Capacity derations (or capacity increases)
- Boiler efficiency improvements or losses
- In-service year and option life

Except for the first and last items, these data inputs can be entered as triple forecasts (high, medium, and low), as discussed earlier. STARRSS will determine the cost-effectiveness of different compliance strategies by analyzing each plan's present value of revenue requirements over a user-specified time period. Instead of just calculating a single cost for a plan, STARRSS will run hundreds of scenarios using different combinations of each data item's triple forecasts in order to develop a full range of costs. This multiple-scenario analysis is important considering that compliance costs are strongly dependent on future market conditions, which are inherently uncertain. STARRSS will analyze the interaction of different combinations of options with the allowance market, bulk power market, and utility energy conservation efforts.

STARRSS can be run in one of two operating modes: evaluation or optimization. In an evaluation run, the user specifies one or more compliance strategies to be evaluated and compared. In an optimization run, the user lets STARRSS develop its own compliance strategies. However, no single strategy can be declared optimal since exact future costs and performance are uncertain. Therefore, the STARRSS optimization approach involves the selection of a *set* of top plans from a list of potentially billions of compliance strategies. The number of plans in this set is determined by the user. STARRSS then evaluates these top plans under a range of economic and operational uncertainties (e.g., changing fuel prices, allowance prices, generating unit operations).

That STARRSS ranks the plans based on the expected value of compliance costs does not imply that the least-cost plan is best. The risks that STARRSS quantifies (i.e., the cost ranges) also must be taken into consideration in determining the best strategy. The level of risk that a utility is willing to bear is a major factor in the decision to adopt an emissions reduction option. Therefore, STARRSS' No. 1 plan may not be the appropriate choice if the strategy's risks are too great.

Figure 3 is an example of a STARRSS output report. The Compliance Strategies Detail Report shows the expected value of the costs and SO_2 emissions reduction impacts for the compliance options in all of the top strategies. The first column of numbers displays the total present value costs over the life of each option. The second column reports the average annual emissions reduction impact (or bonus allowance allocation) that is attributable to each compliance option. The final column is a measure of each option's $/ton cost (on a levelized basis; therefore, it is not merely the first column's numbers divided by the second).

Other reports show the range (and statistical standard deviation) of the costs and impacts of compliance options and overall strategies. These statistics allow the user to assess the relative economic and performance risks among different compliance options and strategies. STARRSS also includes graphical reporting features similar to those shown in Figure 1 that displays the cost profiles and allowance trading activity of selected compliance strategies.

Conclusion

STARRSS is an acid rain compliance planning modelling system that provides decision-makers with a means of comparing the range of outcomes for a variety of utility compliance strategies. The central objective of the STARRSS system is not to identify the *best* compliance strategy for decision-makers, but to provide a decision-support screening tool that will help organizations identify good strategies (i.e., low cost, combined with acceptable levels of risk) that deserve further detailed analysis.

Compliance Strategies Detail Report

SULFUR POWER & LIGHT — Target Reduction 79809 Tons
Evaluated 7/30/1992 at 14:15; Phase I run with 250 iterations

Strategies	Total Cost ($M)	Impact (tons)	Average $/ton
1: SCRUB BIGCOAL 1 & 2			
BIGCOAL 1 WETFGD1	315	63136	477
bonus allowances	—	6695	—
BIGCOAL 2 WETFGD1	315	63136	477
bonus allowances	—	6695	—
Link BCOAL 1&2 GROUPFGD1	(44)	—	—
Base Conservation	—	266	—
bonus allowances	—	45	—
Allowance purchases (sales)	(211)	(60165)	375
Totals for strategy 1 :	376	79809	495

* = Allowance transactions meet or exceed user-specified limits

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Figure 3. *Compliance strategies detail report screen.*

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The complete report, entitled "State Acid Rain Research and Screening System Version 1.0 User's Manual," (Order No. PB94- 152550; Cost: $36.50, subject to change) will be available only from:
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