Technical Memorandum: AirControlNET (ACN) Software Redesign: Assessment of Functionality and Limitations

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1 BACKGROUND

The AirControlNET (ACN) software tool was first released in 1999 and provides the ability for the EPA to model the emission reductions and costs associated with control strategies applied to sources of air pollution. Subsequently, AirControlNET has been upgraded several times but new requirements to interface with recently developed tools and databases have made the current computing platform insufficient to meet today's needs. Therefore, at this time it is appropriate to redesign the AirControlNET software to improve its effectiveness and functionality to support current and upcoming needs.

The purpose of this work assignment is to redesign the AirControlNET software so that it can meet current and future needs for modeling the emission reductions and costs associated with emissions reductions while also interfacing with new tools and databases currently under development. This work assignment consists of four tasks: (1) develop a work plan, (2) assess current performance of AirControlNET and prepare recommendations for improvements, (3) finalize recommendations for the redesign of AirControlNET, and (4) create a new version of AirControlNET. This document is part of the Task 2 assessment.

2 GENERAL

Task 2 of this work assignment involves the review of a current version (4.0) of AirControlNET and preparation of a report assessing the strengths and weaknesses of the approach used in the current version to model the impacts of control measures. The EPA WAM has provided a recent version of AirControlNET to the Review Team, along with a memo describing a review of AirControlNET that was previously developed by Abt Associates. . The Review Team consisted of Cynthia Loomis and Gregory Stella of Alpine Geophysics, and Alison Eyth of the UNC-CH Carolina Environmental Program. The review in this document started with the existing memo and in particular determines the appropriateness of the FoxPro application environment with respect to current and future needs of the EPA's Innovative Strategies and Economics Group (ISEG). These needs include interfacing with the Phoenix Framework, ASAP, and the Emissions Modeling Framework (EMF), along with application for BART analyses and the 8-hour ozone implementation rule, and being able to access the tool without using the graphical user interface. In this report, we make recommendations for improving the AirControlNET approach, including recommending a software platform. Some preliminary thoughts on alternative application environments are discussed.

3 DOCUMENTED PURPOSE AND FUNCTIONALITY

In the AirControlNET Documentation and Development Reports and User's Guide, AirControlNET is identified as a control technology analysis tool developed by E.H. Pechan & Associates, Inc. (Pechan) to support the U.S. Environmental Protection Agency (EPA) in its analyses of air pollution policies and regulations. The tool provides data on emission sources,

potential pollution control measures and emission reductions, and the costs of implementing those controls.

The documentation notes that AirControlNET can be used by a wide range of people including policy analysts, engineers, economists, and others interested in evaluating the effectiveness and costs of air pollution control strategies. This tool allows the user to search and review available control measures available for a specific emissions inventory and to obtain information regarding pollutant emission reductions and associated costs for use in regulatory and policy evaluations or modeling efforts. It also allows the user to export these data for use in further analysis and for input to the REMSAD-ST air quality modeling tool. It therefore reduces the time and effort typically associated with obtaining such information and makes available the information used by EPA/OAQPS for its regulatory analyses. Furthermore, it provides the opportunity for the users to share their knowledge and expertise by reviewing the data contained within AirControlNET and providing new or updated information.

The core of AirControlNET is a relational database system in which control technologies have been pre-applied to sources within EPA emissions inventories. The system contains a resulting database of control measure applicability, efficiency, and cost information for reducing the emissions contributing to ambient concentrations of ozone, PM-10, PM-2.5, SO2, NOx, as well as visibility impairment (regional haze) from point, area, and mobile sources. PM-10 and PM-2.5 as included in AirControlNET represent primary emissions of PM. The control measure data file in AirControlNET includes not only the technology's control efficiency, and calculated emission reductions for that source, but also estimates the costs (annual and capital) for application of each control measure.

AirControlNET relies on the control efficiency, throughput, fuel use, and emission factor data provided in the input inventory to perform cost related analysis for many of the technologies. But AirControlNET also requires information about individual control measures to allow for incremental application of controls. This information is obtained by examining the technical and economic data available in the input inventory and on the control measure data.

3.1 Modules within AirControlNET

There are three modules currently available in the reviewed version of AirControlNET.

1) Control Scenarios Module (CSM) that allows the user to select specific control measures from the database by pollutant, source, and geographic area to create an emissions reduction scenario with pre-computed emissions reductions and associated costs. The user can then export this scenario into spreadsheet format for further analysis or into an input script for air quality modeling within REMSAD-ST.

2) Least-Cost Module (LCM) that allows the user to obtain an emissions reduction scenario by source and geographic area consisting of the set of control measures that achieves a stated pollutant-specific emission reduction target (in tons or percentage) with the least amount of total annual costs.

3) Script Builder Module (SBM) that allows the user to develop "control factor files" based on percent reductions by pollutant, source, and geographic area to create an emissions reduction scenario for input into the REMSAD-ST air quality model.

AirControlNET also includes exporting and reporting features that allow the user to export emissions and cost data resulting from queries into text files, maps, charts, spreadsheets, or pre-formatted reporting tables.

3.2 Tools within AirControlNET

AirControlNET provides a set of tools which are designed to allow the user the flexibility of selecting the baseline and user modified emissions data for emission reduction and cost evaluation of control strategies.

1) The Data Set Tool allows the user to Add, Remove, Edit descriptions, and Select existing AirControlNET data sets. Once a desired data set has been loaded into AirControlNET, it will be used in the Control Scenario Module, Least Cost Module, and Reporting Module.

2) The Sensitivity Control Set Tool is used to create and maintain sensitivity control sets that contain the parameters that allow for modified AirControlNET control measures. The parameters that can be modified are control measure efficiency, interest rates, labor rates, energy costs, and equipment lifetimes. Sensitivity Control Sets are used in conjunction with base data sets to create modified data sets and the currently selected control set is used to execute "on the fly" sensitivity calculations in the Control Scenario Module.

3) The Mobile Measures Tool is used to create new mobile source control measures that can subsequently be used in AirControlNET analyses. New mobile measures are developed from user provided changes to motor vehicle activity (i.e., VMT) and emissions by vehicle class and year as illustrated in the example below. Newly created data sets can subsequently be used in the Control Scenarios, Least Cost, and Reporting Modules. They can also be combined with other existing data sets.

4 CURRENT CAPABILITY OF AirControlNET

As noted earlier in this document, AirControlNET was originally designed with the purpose to provide information to OAQPS policy staff for evaluating the resulting ozone and particulate matter precursor emissions and effectiveness and costs of air pollution control strategies necessary to determine reduction strategies and nonattainment areas within the national U.S. domain. These results were intended to allow users the ability to review potential control strategies as applied regionally, State- or county-wide, or by MSA. Additionally, the GIS-based results allow policy staff to determine future nonattainment area configuration based on residual emissions and source type distribution. The tool as configured, allows users to search and review available control measures and to obtain information regarding pollutant emission reductions and associated costs for use in regulatory and policy evaluations or modeling efforts *based on preconfigured base year and projection year emission inventories*.

4.1 AirControlNET Modules

4.1.1 Control Scenarios Module

The Control Scenarios Module provides the capability to query a database in a detailed fashion and create a control scenario as part of a control strategies and costing analysis. The interface for this module provides the user with a query-based tool to evaluate the emission reductions and costs associated with implementing the chosen control measure(s) to the pre-computed database. This module facilitates such queries through pre-set filters that allow the user to define criteria for selection of control measures and create a data set that may consist of a wide range of pollution control measures at various costs, applicability, and control efficiencies.

4.1.1.1 Exporting Data from a Control Scenario

By selecting Export under File from the interface toolbar menu, the user can export the following types of data files reflecting the control scenario for use in subsequent analysis:

1) Measure File. Users can export the current scenario displayed in the Database Grid to a range of file formats, namely Dbase, Excel spreadsheet, or text file.

2) REMSAD-ST Script File. Users can export the emission reductions information into a control factors file, or input script, for the REMSAD-ST air quality model.

4.1.1.2 Reporting Data from a Control Scenario

By selecting Report under File from the interface toolbar menu, the user can report the following types of pre-formatted templates reflecting the control scenario for use in subsequent analysis and/or presentation:

1) Emissions Summary. Users can produce an emissions summary report using state, county, MSA, pollutant, sector, NAICS, cost per ton, and max control filters. The report includes number of records, measure name, affected source, emissions before control, incremental reductions, emissions after control, percent reduction and cumulative emissions data.

2) Cost Summary. Users can produce a cost summary report using state, county, MSA, pollutant, sector, NAICS, cost per ton, and max control filters. The report includes number of records, measure name, affected source, total cost, cost per ton and cumulative cost data.

4.1.2 Least-Cost Module

The Least-Cost Module provides the capability to create the least-cost set of control measures that achieves a specified emission reduction target as part of a control strategies and costing analysis. The interface for this module provides a query-based tool to determine the set of control measures that will meet the emissions reduction target as specified in terms of absolute tons or as a percentage. This module facilitates such queries through pre-set filters that allow the user to define criteria for selection of control measures and then create the resulting data set.

4.1.2.1 Exporting Data from a Least-Cost Control Scenario

By selecting Export under File from the interface toolbar menu, the user can export the following types of data files reflecting the control scenario for use in subsequent analysis:

1) Measure File. Users can export the current scenario displayed in the Database Grid to a range of file formats, namely Dbase, Excel spreadsheet, or text file.

2) REMSAD-ST Script File. Export the emission reductions information into a control factors file, or input script, for the REMSAD-ST air quality model.

3) Control Cost File. Users can export the total annual costs of their control strategy into a spreadsheet file for use in economic impact models (e.g., ISEG's EMPAX-CGE model).

4.1.2.2 Reporting Data from a Least-Cost Control Scenario

By selecting Report under File from the interface toolbar menu, the user can report the following types of pre-formatted templates reflecting the least-cost scenario for use in subsequent analysis and/or presentation:

1) Emissions Summary. Users can produce an emissions summary report using state, county, MSA, pollutant, sector, NAICS, cost per ton, and max control filters. The report includes number of records, measure name, affected source, emissions before control, incremental reductions, emissions after control, percent reduction and cumulative emissions data.

2) Cost Summary. Users can produce a cost summary report using state, county, MSA, pollutant, sector, NAICS, cost per ton, and max control filters. The report includes number of records, measure name, affected source, total cost, cost per ton and cumulative cost data.

4.1.3 REMSAD-ST Script Builder

The REMSAD-ST Script Builder Module provides the capability to develop emission control scenarios for execution in the REMSAD-ST air quality model. The interface for this module provides a quick and easy way to build text files reflecting emission reduction strategies that can be exported as a REMSAD-ST input script. The emission reductions are defined by pollutant control factors. This module facilitates the script development process through pre-set filters that allow the user to define criteria for application of the specified pollutant reductions and then create the resulting input script for REMSAD-ST.

4.1.3.1 Export results into REMSAD-ST script

Once the user's individual selections completely define their overall control strategy scenario, then the user can export the contents shown in the Display Grid into a REMSAD-ST Script directly by using the Export Script user command button. This will export the control scenario information for each row entry with its checkbox selected into a control factors file, or input script, for the REMSAD-ST air quality model. The user can also export this information into a file by selecting Export under File from the interface toolbar menu.

4.2 Mapping Tool

AirControlNET's Mapping Tool allows the creation of maps that shade States, counties, and MSAs based on pollutant emission reductions and costs. The tool allows the user to set the map's title, notes, font size, and static layers. There are also controls to set the dynamic layer shading ranges and colors. Each dynamic map feature, a state, county, or MSA, has ten dynamic shading ranges, one for each pollutant. The color shades and ranges can be automatically or manually set. The automatic ranges are determined by either an equal interval or Jenks Natural Breaks algorithm and the number of intervals is set interactively by the user. The range colors can be set manually by clicking on the color to be changed and then using the color selector. Various toolbars allow the customization of the map and provide easy zoom functionality for closer review of AirControlNET results.

4.3 Graphing Tool

When a Least Cost Module query returns results, there are two graphs that can be displayed: "Cost per Ton vs Incremental Tons Reduced" and "Cost vs Incremental Tons Reduced."

4.3.1 Graph of $ / ton vs. Cumulative Incremental Reduction

The Least Cost Module within AirControlNET selects the sets of optimum controls to achieve the reductions based on the selections supplied by the user. The graph of $/ton vs. cumulative incremental reduction is created using the output of the Least Cost Module. In this graph, $ / ton for each control is plotted against cumulative incremental reduction from the controls. This type of graph is useful for control implementation cost analysis since this graph can be used to evaluate the most cost effective controls and also observe sudden change in the slope of the graph, i.e., the sudden increase in cost effectiveness of control measures.

4.3.2 Graph of Cumulative Control Costs vs. Cumulative Incremental Reduction

As in the previous graph, the AirControlNET Least Cost Module is used to select the set of optimum controls to achieve the reductions as defined by the user. The graph of cumulative total annual cost vs. cumulative incremental reduction is created using the output of Least Cost Module. This type of graph would be used to view the total control cost needed to achieve the specified emissions reduction.

4.4 Data Set Tool

AirControlNET allows the user the flexibility of selecting pre-configured baseline and user modified emissions data for emission reduction and cost evaluation of control strategies. The Data Set Tool allows the user to Add, Remove, Edit descriptions, and Select existing AirControlNET data sets. Once the desired data set has been loaded into AirControlNET, it will be used in the Control Scenario Module, Least Cost Module, and Reporting Module.

4.5 Sensitivity Control Set Tool

The Sensitivity Control Set Tool is used to create and maintain sensitivity control sets which contain the parameters that allow for modified AirControlNET control measures. The parameters that can be modified are control measure efficiency, interest rates, labor rates, energy costs, and

equipment lifetimes. Sensitivity Control Sets are used in conjunction with base data sets to create modified data sets and the currently selected control set is used to execute "on the fly" sensitivity calculations in the Control Scenario Module.

4.6 Mobile Measures Tool

The Mobile Module Tool is used to create new mobile source control measures that can subsequently be used in AirControlNET analyses. New mobile measures are developed from user provided changes to motor vehicle activity (i.e., VMT) and emissions by vehicle class and year. Newly created data sets can subsequently be used in the Control Scenarios, Least Cost, and Reporting Modules.

4.7 Summary of Existing Capability as Designed

It is the opinion of the Review Team that AirControlNET is a valuable tool from which beneficial emissions control scenario data can be extracted and used for the original purpose in which the tool was designed and for the inventories and control technologies pre-loaded into the model.

5 LIMITATIONS OF AirControlNET

Based on the input and evaluation of AirControlNET by EPA, EPA contractors, and the Review Team, a number of limitations have been identified in the tool and are presented here. For each limitation identified in this section, a complimentary recommended modification is presented in the next section. We have restricted the discussion in this section to limitations within the existing capacity of the AirControlNET tool as reviewed.

5.1 Ability to Add New Emission Inventory Inputs

The largest limitation in the reviewed version of AirControlNET is the inability to input new emission inventories and run each module interactively with these data. As currently configured, AirControlNET can not accept emissions inventory files directly and it is not currently possible for someone (outside of the original design contractor using pre-processing software) to easily configure an emissions inventory for direct use in AirControlNET. This immediately makes the software inadequate for anyone attempting to design a control analysis with emissions other than the pre-computed data provided with the tool.

The AirControlNET database is currently configured as a single table containing emission sources and associated potential control technology application and control cost information. This database cannot easily be separated in the component parts (emissions and control measure) to allow the user easy review of the individual elements.

5.2 Ability to Add New Control Measure and Control Cost Options

Similar to the limitation identified above, the inability of a user to add new control measures or control cost information also prevents AirControlNET from being an interactive tool and again limits the users' analyses to the available emissions or control measure data. Should revisions or

additional control measures or technologies become available, AirControlNET does not have the ability (with the exception of the mobile sector) to improve upon existing measures or costs.

5.3 Ability to Review and Modify Existing Control Measure Data

As noted above, the AirControlNET database contains the pre-application of emission source data and control measure combinations. This combination of data into a single file prevents the database review of individual control measures prior to the strategy's application and thereby limits the user's ability to make modifications to parameters associated with each measure or technology (control efficiency, control cost, or source category application).

However, through the Sensitivity Control Set Tool, the user can modify limited parameters of specific control measures already included in the AirControlNET control measures database. These modified parameters can then be used to run an alternate control strategy using the other modules and tools available in the model. As identified in AirControlNET documentation and verified through application of the Review Team, the parameters that can be modified are control measure efficiency, interest rates, labor rates, energy costs, and equipment lifetimes. These changes are required to be handled individually for each control measure and large changes over multiple source categories or control strategies would prove to be time consuming and cumbersome.

5.3.1 Ability to Review and Modify Control Measure Grouping

AirControlNET uses groups of like source categories (PODs) to assign control measures. These groupings, although indirectly available in the AirControlNET Documentation Report by reviewing affected SCCs for each control measure, are not available for review or modification within the exiting tool's database framework. This limitation prevents the user from making improvements or modifications to source category groupings based on recent control measure or technology studies or application analyses.

5.3.2 Ability to Review and Modify Control Measure Cost Calculations

Many of the control measures or technologies within the AirControlNET framework contain a set of default cost effectiveness values (cost of control per ton pollutant reduced) or control cost equation to estimate the capital and operating and maintenance (O&M) costs associated with application of the measure or technology. Much like the inability to modify the control efficiency of individual control measures, the current version of AirControlNET prevents the user from updating control cost variables.

5.3.3 Ability to Review and Modify Control Measure Cost Equations

Review of the AirControlNET Documentation Report indicates that certain control measures or technologies have very specific variable requirements for estimating capital and O&M costs of control application. It is unclear at this time what occurs when these variables are not available in the emissions data sets and how default cost effectiveness values are used as replacements.

Additionally, there appear to be a number of control cost equations used within the AirControlNET tool. The ability of the user to modify these equations based on updated information is not an option currently available in the reviewed framework.

5.4 Software Platform

The software platform currently used for AirControlNET (Microsoft Visual FoxPro) introduces substantial limitations to the application. Visual FoxPro is a rapid application development environment, which is designed to quickly put together an application. But typically the rapid application development approach involves compromises in usability, features, and/or execution speed. In the case of AirControlNET, it appears that there were some constraints regarding the controls available for use in the graphical user interface (GUI), as only a small portion of features typically used in GUIs today appear in AirControlNET.

The Visual FoxPro database system is an open file-based DBF system that does not have the security, reliability, replication, and many other features of a full relational database engine. In addition, the maximum size of Visual FoxPro file is 2 GB, and there are no plans to extend this limit. This is a substantial limitation given the size of typical emission inventories today. The only true database server that Visual FoxPro is designed to interface with is Microsoft's SQL Server. This database is not commonly used at EPA or in the environmental community, which tends to lean towards open source databases (e.g., MySQL, PostgreSQL), or in EPA's enterprise environment: Oracle. Thus, AirControlNET's reliance on Visual FoxPro severely limits its ability to interface with other applications and databases. In addition, Visual FoxPro could not be effectively using on a high performance server because it is designed to run on a Windows desktop computer.

6 RECOMMENDED MODIFICATIONS

The following section provides Review Team recommendations on AirControlNET modifications to address the limitations identified in the previous section. Suggested changes related to the features available in AirControlNET and the structure of the data it uses are discussed in this section, while alternative software platforms are discussed in Section 8.

6.1 Ability to Add New Emission Inventory Inputs

A key component in making AirControlNET a useful interactive tool is the ability to import alternate emission inventories and apply control measures from the available control measures database to design a control strategy for review. Both base year and future year emissions (with or without additional control) should be importable into the AirControlNET model using a standardized set of input formats and should remain a separate file from the control measure application until the control strategy module is run.

The Review Team's discussions with EPA staff most likely to use a revised AirControlNET identifies that appropriate inventory formats for inclusion in an import tool should at a minimum include the latest published National Emission Inventory (NEI) Input Format (NIF), version 3.0 or complimentary NEI Output Format (NOF) as published in February 2005, and the SMOKE Inventory Data Analyzer (IDA) format. These formats are most commonly used by EPA modeling and policy analysis staff and are likely to be the formats in which current emission inventories are available. An additional format which should be closely considered is the one-record-per-line (ORL) format which is currently used in SMOKE to input toxic emission

inventories. An additional benefit of supporting alternate emission inventory inputs is that the tool will have more use to RPOs, states and localities outside of EPA as they will not have the ability to input their own inventories. This will greatly expand the potential user base of the new version.

In addition to the source identification codes and emissions associated with each input inventory, it should be a requirement of the import function to have pollutant specific control efficiency and control device codes populating the input emission files. In the absence of these data, it will be difficult, if not impossible, to make sound judgments of existing control effectiveness or devices and what incremental measures or technologies may be available for application.

The introduction of the ORL format identifies another limitation with the current version of AirControlNET; that being the analysis of control measures related to only ozone and particulate matter precursor emissions (with the exception of mercury emissions). With the movement to one atmosphere modeling, the integration of toxic emissions into the overall development of control strategies has become more important. Although there still is limited information on the technologies available to reduce toxic emissions, these pollutants should be considered in the redesign.

6.2 Ability to Add New Control Measure and Control Cost Options

AirControlNET users may want to introduce new control technology or control measure information currently unavailable in the existing AirControlNET controls database. In these cases, the existing version of the model does not allow the import of the data for use in any control strategy analysis. To provide the maximum flexibility to the user in this aspect, AirControlNET needs the ability to import or create new control measure and control cost options for emission sources or source types within the emissions inventory.

These data may include the full suite of parameters currently available in AirControlNET's control measures definition file or a subset if the user is willing to forgo some of the functionality of the AirControlNET output. An example may be a user including relevant control efficiency and rule effectiveness and penetration rates, but no associated control cost information, thereby making the strategy unusable in a least cost analysis.

A noted application issue within the existing framework of AirControlNET is the potential of the model to apply more than one control technology or measure to a single source when more than one segment (SCC) is present in the input inventory. As an example, a dual-fired industrial boiler may burn both oil and gas during separate times of the year. Based on the coding practices of the emissions inventory, this boiler could be represented by two separate SCCs, each with emissions and each appropriately associated with the boiler. Should a control strategy analysis be conducted using AirControlNET which requires control on both oil and gas fired boilers, this unit may be subject to separate control devices on each of the fuel segments. The emissions reduction associated with the double count would not be unreasonable as technologies for oil and gas boilers are comparable. However, the costs associated with the application of both of the technologies would be overestimated for this single piece of equipment.

To circumvent this issue, during the application phase of the control measure assignment, a single primary fuel or segment may need to be assigned to prevent this double application of control.

6.3 Ability to Review and Modify Control Measure Grouping

AirControlNET includes control measure and applicability information that is organized and linked by Cost POD. A Cost POD is a group of source types, as defined by SCCs, which have similar emission characteristics, control techniques, and control costs. Each Cost POD may have one or several control strategies (which consist of control options, efficiency, and cost information). All of the emission reduction and control cost calculations are performed at the Cost POD level. The Cost POD is used to link the control applicability information through the POD/SCC Crosswalk.

The user should have the ability to review and modify the groups of source categories which get assigned to each Cost POD. The existing PODs may have been established using outdated documentation and engineering judgment as to which source types are to be associated with each control measure or technology. The ability to revise the Cost PODs to meet the user's desired application allows the incorporation of state-of-knowledge application of control technology and measures to specific source types and categories.

6.4 Ability to Review and Modify Control Measure Cost Calculations and Equations

Many of the control measures or technologies within the AirControlNET framework contain a set of default cost effectiveness values (cost of control per ton pollutant reduced) or control cost equation to estimate the capital and operating and maintenance (O&M) costs associated with application of the measure or technology. Much like the inability to modify the control efficiency of individual control measures, the current version of AirControlNET prevents the user from updating control cost variables. While updating or adding new control strategy or control measure data, the user should have the ability to modify or add new control cost data relative to the new strategy or technology. Any new data should include default cost effectiveness values in case the required parameters for the comprehensive control cost equation are not available in the input inventory.

An important item to keep in mind is the fact that AirControlNET relies on these control cost equations for many of its control cost estimates of capital and O&M costs. In some of these cases, these equations are tailored to specific source types and require very detailed input information in order to effectively calculate costs. Should AirControlNET be modified to allow user input of control technology or measures and associated control costs, these equations should be identified to the user in advance so that they may be able to assign appropriate variables to new control measures.

There should also be generic control cost equations which allow for the implementation of control costs using standard engineering economic scalars when detailed information is not required.

6.5 Least Cost Analysis

The current version of the least cost module takes as input a user defined desired percent reduction of controllable emissions. To facilitate interaction with the Response Surface Model (RSM) and for other types of analyses, the ability to express the desired percent reduction in terms of total emissions needs to be present. In addition, while the current version can output graphs that are cost as a function of emissions reduction, users would also like to get this information in a tabular format and expressed by a parameterized equation so that it can be input to other software programs. Also, if there is a maximum level of control that can be achieved given the available control technologies, this result should be made clear to the user so that time is not wasted trying to achieve additional controls.

Flexibility in specifying the geographic region for a least cost analysis, and other options such as being able to apply uniform levels of control over each county (as required by ASAP and the RSM) have also been requested. Another type of improved flexibility would be to limit the types of controls considered as part of a least cost analysis. For example, the user may want to consider new and innovative controls in the analysis, or alternatively may want to restrict the analysis to use only the "tried and true" control technologies. The result could vary greatly given the technologies that are included in the least cost computation.

6.6 Interaction with Other Models, Frameworks, and Databases

When AirControlNET was originally developed, it was designed primarily as a standalone tool. In recent years, it has become increasingly important for EPA's tools to work together as they are each a piece in an increasingly complex puzzle. For example, the redesigned AirControlNET needs to be able to work provide input data to SMOKE and the RSM. It needs to use the outputs from EGAS, and reduction targets derived from the RSM or other policy development scenarios. It needs to work with frameworks such as the EMF, Phoenix as part of ASAP, and MIMS so that it can be executed iteratively and behind-the-scenes. This requirement drives the needs for a command line style interface. It also needs to interface with EMPAX and BenMAP, and with independently developed databases, including the NEI database and the control programs database. Thus, in the coming years, to realize its full potential and usefulness, AirControlNET has to work together with many other pieces of software and databases.

6.7 Output Capabilities

Some of the issues with using the current version are the form of the output products. It would be desirable to have emissions reductions in terms of total absolute and percent emissions reduced by sector and/or category. It would reduce EPA staff time required for analyses by outputting results in such a way that typical applications (e.g., air quality/emissions modeling, regulatory impact analyses, etc.) require little or no post processing. In general, the types of output products desired are tables, graphs / plots, and maps. The details of the specific output products most needed will be specified at design time.

6.8 Database Structure

As discussed in Abt Associates' review of AirControlNET, "the emissions inventories and control measures databases (along with the crosswalks used to relate them) are combined offline

into one massive database, rather than remaining separate and being combined online as needed". By changing the structure of the database into a more "normalized" form that stores the control measures, emission sources, and relationships between them in separate tables, it will allow for much more flexibility in considering the control measures and inventories independently. If the data is separated, it is easier to limit the parts the inventory and types of control measures to only those needed for specific analyses. This will also reduce the size of the database. Note that this approach may not lead to increased speed in all cases (e.g., national applications), as the "joining" of the different types of information will need to be done at the time of analysis. But, this is a normal operation for databases to perform. It should lead to substantial performance improvements for analyses on sub-national scales, as the subsets of the inventory will greatly reduce the number of sources to be considered during the analysis while providing greater flexibility to the user's ability to modify each table.

6.9 Augmented Inventory Data

Some information related to the inventory is needed by AirControlNET but is not currently available in the inventory. This information includes whether a source is low-level or elevated, and the output capacity (e.g., MW or BTU) of electric generating units and non-utility boilers. It would be useful if the inventories in AirControlNET can be augmented with this type of information although preferred to have this information included with the input inventories.

7 DESIRED FUNCTIONALITY

This section provides a summary of the required features of the revised AirControlNET that are needed to support applications that are expected over the next several years. Many of these items were provided by the EPA Team at the kickoff meeting for this project. The functions are grouped into High, Medium, and Low priorities as specified by EPA. Many of these features are identified in Section 6 as a result of the Review Team's review of AirControlNET, but are confirmed by the EPA's own assessment of the limitations of AirControlNET, which resulted in this work assignment. Additional discussion related to these features and how they will be addressed in the new version of AirControlNET will be provided in later Tasks of this work assignment.

7.1 High Priority Features

1. Software platform that supports compatibility with EPA's Phoenix framework and Air Strategy Assessment Program (ASAP) software. This includes including linking with the Response Surface Model (RSM), BenMap, SMOKE, and Air Quality Models (e.g. CMAQ).
2. Effective database server to manage input databases (e.g., emissions inventories, controls and their costs).
3. Interface with EPA's new control programs database.
4. Least cost analyses on flexibly specified geographic regions with the option to apply uniform levels of control over each county (as required by ASAP and the RSM).

5. Output of emissions reductions in terms of total absolute and percent emissions reduced by sector and/or category.
6. Output results in such a way that typical applications (e.g., air quality/emissions modeling, regulatory impact analyses, etc) require little or no post processing.
7. Compatibility with the Emissions Modeling Framework (EMF), including generation of control related inputs to SMOKE.
8. Compatibility with National Emissions Inventory (NEI) database format.
9. Compatibility and interaction (via the EMF) with EGAS, which generates growth factors that could be used in AirControlNET to project emissions to future years.
10. Improved approach to co-control so that double counting of reductions is avoided when multiple control measures are applied.
11. Ability to operate AirControlNET via the command-line so that the graphical user interface does not need to be invoked in order to get outputs.
12. Option to include local control measures in strategy development (including associated emission reductions and costs).
13. Improved approach for matching controls with sources, including options such as including an identifier showing under which programs/rules the controls can be applied.
14. Improved approach for identifying and accounting for existing controls on sources, what the baseline emissions would be prior to any controls, and what the impact would be of new controls that are being applied in a future year control scenario.
15. Improved approach for identifying emission reductions of multiple pollutants resulting from a single control measure ("co-control").
16. Ability to select broad control strategies that may employ multiple control measures and sources at several levels.
17. Viewing emissions data, available controls, and related costs – both detailed data and summaries in tabular, graphical, and map formats.
18. Addition and use of an identifier showing sources that can trade in various trading programs.
19. Breakdown of labor vs. capital costs of controls.
20. Tracking of metadata and an audit trail.
21. Many/most of the user options currently in AirControlNET.
22. For the least cost module, an option to set an emissions reduction target across all sources by overall percent reduction (e.g., total NOx emissions reduction of 35%), as opposed to only reduction of controllable emissions.
23. Easy generation of cost curves and underlying data in form of table and/or parameters defining the curves.

24. Tracking and output of uncertainty information using approaches such as Monte Carlo Analysis, including performing uncertainty analysis with software packages such as Crystal Ball.
25. Flexibility in setting geographic boundaries for an analysis (e.g., to help determine the optimal size of the non-attainment area).
26. Enhanced functionality for stationary nonpoint (a.k.a. area) sources
27. Enhanced onroad and nonroad mobile functionality
28. Easy access to control measure and source information at any time (i.e., users should be able to click on a control measure or source and link to information regarding it)
29. Ability to aggregate costs by NAICS.
30. Improved format, content, and scope for providing complete and clear documentation, including options for providing part or all of the documentation within AirControlNET (e.g., as part of a help function, a click-on attribute by cell, or some of both).

7.2 Medium Priority Features

1. Support for HAPs & climate change information (emission reduction, control measure, costs, etc.
2. Standard format and functionality to support inputting emissions data sets by EPA and state/local/tribal users, including upcoming changes to the structure of EPA's NEI database (NEI has been the primary data set on which AirControlNET has operated to date)
3. Improved approach to incorporation of new data sets (e.g., emissions, controls, costs) that requires little or no preprocessing
4. Capability to work with sources at the gridded level (e.g., as needed for ASAP)
5. Viewing output capacity, such as MW or Btu, generated for electric generating units (EGUs)" and non-utility boilers
6. Identification of low-level vs. elevated emissions and/or sources
7. Tracking and output of sensitivity information (e.g., identify sensitivity of the results based on typical variation of the various input parameter values)
8. Accounting for impacts of trading programs and emerging emission reduction technologies, with a method for conveying to the user the confidence level of the control information
9. Better communications between AirControlNET and EMPAX (e.g., crosswalk of SCCs to NAICS codes for all sources, including transportation sources)

7.3 Low Priority Features

1. Capability for identifying and working with sources on tribal lands

2. Indication of the demand for the various measures - In any sort of time to comply rule, capacity constraints are a consideration, such as with the simulations regarding CAIR, NAAQS, etc. Having the ability to sort and sum the types of devices and their sizes (e.g. SCRs for 400 boilers that are between 15 and 25 MW), will provide output that can be used together with information on the supply side to address some of these issues
3. Ability to better reflect changes in energy and materials demand (to help address questions regarding capacity constraints on the energy side as well as the materials demand side, and to address price shocks, such as during the period of NAAQS implementation for things like steel and oil)
4. Ability to identify cost impacts on small entities and businesses
5. Ability to identify cost impacts on municipal entities (for which "unfunded mandates" may be of concern)

8 RECOMMENDED SOFTWARE PLATFORM

Part of the purpose of this document is to discuss software platforms that are alternatives to Microsoft Visual FoxPro. Microsoft Access has been suggested by EPA as one possible alternative application platform. Microsoft Access does have the advantage of being more widely available and known by more users than Visual FoxPro. However, it suffers from many of the same constraints as Visual FoxPro in that it is designed to run only in a desktop environment and does not have the power of a true database server and therefore would not meet the requirements of a redesigned AirControlNET.

A software platform that overcomes the limitations of the current Visual FoxPro implementation is Java. In addition to having a full-featured GUI library, software written in Java can communicate with a variety of database servers in a standard way using the Java Database Connectivity (JDBC). By using Java and JDBC, the new AirControlNET has the potential to communicate with databases stored in MySQL, PostgreSQL, SQL Server, Oracle, or other relational database servers. This is useful because the ASAP platform is currently using MySQL as its database server, and the EMF is currently using PostgreSQL as its database server. Note that MySQL and PostgreSQL both run successfully on Windows desktop machines for small to medium size databases, but they can also support large databases when run on larger Linux and Unix servers. Other advantages of Java include portability across Windows, Linux, and other Unix operating systems, and a wide variety of available open source libraries that can be used to speed application development.

Another advantage of choosing Java is that the EMF, EmisView (http://emisview.sourceforge.net), the MIMS Framework, and ASAP are all developed using Java. This will allow for existing code to be shared with AirControlNET, such as the code for importing emission inventories in NIF, ORL, and IDA formats that is currently being used by the EMF and EmisView. In addition, a table-based application that supports sorting, filtering, plotting, and some statistics is already available as part of the MIMS Analysis Engine and is also used by EmisView. This tool has many features that could be useful for AirControlNET including the ability to view data that is the result of a query issued against a database server. It

is also likely that the new AirControlNET could take advantage of portions of the EMF quality assurance and data versioning subsystems.

It is useful to mention that EmisView has many similar features that are required in the new AirControlNET, such as the following:

- Users can load in their own emission inventories from a variety of inventory formats (e.g., NIF, ORL, IDA).
- Users can define subsets of these inventories based on geographic information, SCC codes, source size and other criteria.
- Outputs are produced in the form of configurable plots and tables.
- Analyses can be configured during one session and then saved and rerun at later dates.
- It needs to function as both a desktop tool, and to interface with data stored in the EMF for quality assurance purposes.
- A batch interface is required for running analyses and generating plots and tables without using the GUI.

During the design phase, it would be worthwhile to examine the integration of the features needed by AirControlNET into EmisView itself. If this was done, some additional GUI screens and features would need to be added to EmisView, but many of the existing features could be preserved and taken advantage of by AirControlNET. A less coupled approach would be to use some of the source code and concepts from EmisView but to build AirControlNET as a new standalone application, which would still save resources over starting from scratch.

In conclusion, Java is a preferred platform for developing the new AirControlNET for the following reasons:

- The graphical user interface library supports all needed functionality.
- The ability of AirControlNET to interface with other applications and databases running on a variety of database servers will be enhanced.
- Code that has already been developed for EmisView and the EMF could be reused.
- Open source tools and libraries (e.g. for math functions or optimization) can be used to speed development.
- The developed software could run on Windows, Linux, or other operating systems that support Java and the selected database server(s).
- Object-oriented software developed in Java is typically faster to extend and easier to maintain than software developed with other types of languages.

This recommendation will be discussed at the brainstorming meeting. The specifics of how the new AirControlNET will look and behave will be developed as part of the design process that will begin in January 2006.

9 SUMMARY

This document presents a review of a current version (4.0) of AirControlNET by assessing the strengths and weaknesses of the approach used in this version to model the impacts of control measures. This review also focuses on the appropriateness of the FoxPro application environment with respect to current and future needs of the EPA's Innovative Strategies and Economics Group (ISEG). Some preliminary thoughts on alternative application environments are also discussed.

This document is also designed to spur discussion at a follow on brainstorming meeting. The Review Team will conduct a meeting with EPA staff, including ISEG, members of the emissions, modeling, and analysis division (EMAD) such as those on the National Emission Inventory (NEI) team, and modelers from the Office of Research and Development. The purpose of this meeting will be to review the Review Team's assessment and recommendations and to brainstorm regarding additional ideas for improving AirControlNET. As part of this meeting, the Review Team will:

- Present a summary of the current approach, strengths, and weaknesses of AirControlNET;
- Present a summary of the current approach used in AirControlNET to assign existing control and new control measures to emission sources (e.g., organize controls by SCC, assume current controls are accurate in the NEI, etc.);
- Present a summary of the Team's recommendations for improving performance of the AirControlNET;
- Facilitate the brainstorming by the meeting participants for additional ideas to improve the performance of AirControlNET; and
- Facilitate prioritization of topic areas for the AirControlNET redesign to help focus the initial design and development effort.