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THE AIR COMPLIANCE ADVISOR

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FACILITIES ENGINEERING
Utilities
THE AIR COMPLIANCE ADVISOR

1. Purpose. The purpose of this report is to describe the capabilities, potential uses, and benefits of the Air Compliance Advisor (ACA) software package.

2. Applicability. This PWTB applies to all U.S. Army facilities engineering activities.

3. References.

a. U.S. Environmental Protection Agency (USEPA), *Air Compliance Advisor User Guide – Version 7.1*, US EPA Office of Air Quality Planning and Standards (OAQPS), Innovative Strategies and Economics Group (ISEG), Copyright 2000

b. Fenlason, R.W., "New software helps with compliance strategies," *Public Works Digest*, June 1997.

c. USEPA, *OAQPS Control Cost Manual*, Fifth Edition, EPA 453/B-96-001, Office of Air Quality Planning Standards, February 1996.

d. Vatavuk, W.M., *Estimating Costs of Air Pollution Contro*l, Lewis Publishers, Michigan, 1990.

e. Maloney, D.M., M.R. Kemme, M.F. Rhodes, and F.L. Wasmer, "Decision Support System Developing Air Pollution Compliance Strategies at DOD Facilities," Paper 96-TP15B.03, Proceedings of the Air and Waste Management 89th Annual Meeting & Exhibition, Nashville Tennessee, June 23-28, 1996.

f. Air and Waste Management Association, *Air Pollution Engineering Manual*, Van Nostrand Reinbold, New York, 1992.

4. Discussion.

a. The day-to-day mission at Army installations requires the operation of a wide variety of air pollution sources. Environmental Coordinators (ECs) at Army facilities are tasked with maintaining compliance with both applicable air pollution regulations and permits governing the operation of these air pollution sources. The development of a cost-effective air pollution compliance management program must consider a large number of related issues. These issues include source characterization; emission reduction techniques (e.g., the application of control devices, and the modification of source operations); regulatory requirements at the federal, state, and local levels; and permit conditions. Development of an optimized management program can be a daunting task for the EC because of the complexity of the problem and the large number of solution approaches.

b. The Air Compliance Advisor (ACA) was developed to help EC's with their difficult duty of achieving and maintaining air pollution compliance. The ACA provides the following features and benefits:

- Large built-in database of information about chemical properties, air pollution sources, and air pollution control technology,
- MS Windows® Explorer type of user interface that allows intuitive access to all built-in and user generated information,
- Guidance to users when there is missing, incorrect, or inconsistent information,
- Ability for users to enter data in virtually any dimensionally correct units,
- Useful analyses for emission estimation and application of air pollution control technology,
- Consistent application of cost-effective control and mitigation techniques,
- Improved compliance with air pollution regulations,
- Reduction in man-hours for developing and implementing air compliance management programs, and
- Improved (knowledgeable) communication between ECs and regulators, contractors, and vendors.

c. Appendix A to this PWTB provides more detailed description of the capabilities, potential uses, and benefits of the ACA.

5. Points of Contact. Questions and/or comments regarding this subject that cannot be resolved at the installation level should be directed to: US Army Corps of Engineers, CEMP-RI, 441 G Street, NW, Washington, DC, 20314-1000; or: US Army Engineering Research and Development Center, Construction Engineering Research Laboratory, at 1 (800) USA-CERL, for Mr. Michael Kemme (email m-kemme@cecer.army.mil).

FOR THE COMMANDER:

DWIGHT A. BERANEK, P.E.
Chief, Engineering and Construction Division
Directorate of Civil Works

Appendix A

The Air Compliance Advisor

1. Background.

a. The day-to-day mission at Army installations requires the operation of a wide variety of air pollution sources. Environmental Coordinators (ECs) at Army facilities are tasked with maintaining compliance with both applicable air pollution regulations and permits governing the operation of these air pollution sources. The regulations stemming from the passage of Title I (Attainment and Non-attainment), Title III (Hazardous Air Pollutants), and Title V (Permits) of the 1990 Clean Air Act Amendments (CAA-90) further complicate the task of maintaining regulatory compliance. Installations are often required to modify source operations, control pollutant emissions, monitor pollutant emissions, and/or significantly increase record keeping.

b. The development of a cost-effective air pollution compliance management program must consider a large number of related issues. These issues include source characterization; emission reduction techniques (e.g., the application of control devices, and the modification of source operations); regulatory requirements at the federal, state, and local levels; and permit conditions. Development of an optimized management program can be a daunting task for the EC because of the complexity of the problem and the large number of solution approaches.

c. The Air Compliance Advisor (ACA) was developed to help EC's with their difficult duty of achieving and maintaining air pollution compliance. The ACA is a database and decision support tool with the following characteristics:

- Representation of typical air pollution source data,
- Large database of chemical air pollutants and air pollution control devices,
- Solutions to "standard" air pollution problems (e.g., calculate facility-wide actual and potential emissions, size control devices, and estimate their costs),
- Minimal data requirements for quick analyses and a complete data structure for more exact analyses,

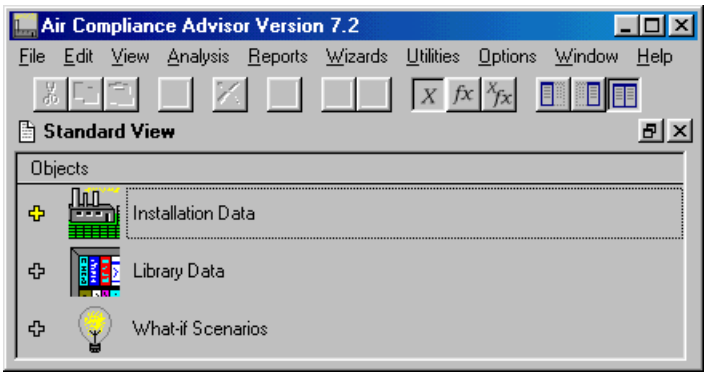
- Capability for the EC to play "what-if" games with the data to evaluate multiple compliance options,
- Guidance for locating missing data during analysis runs,
- Ability to enter values with a wide range of dimensionally correct units,
- “Wizards” to step users through complex operations, and
- Extendibility of the ACA’s data and functions to allow the end-user to represent unusual air pollution data and solve non-standard problems.

d. The ACA was developed through a partnership of the following organizations:

- U.S. Army Construction Engineering Research Laboratories (USACERL),
- U.S. Army Corps of Engineers Directorate of Military Programs (CEMP),
- Argonne National Laboratories (ANL),
- U.S. Air Force Research Laboratory (AFRL),
- The EPA’s Clean Air Technology Center (CATC),
- The Strategic Environmental Research and Development Program (SERDP).

e. The ACA has a long development history. Concept development and early prototype development work was performed by a consortium of researchers from CERL, ANL, AFRL, and CATC. Further development, resulting in a production version of the ACA, was accomplished through funding and guidance provided by CEMP and SERDP. Over the last several years, CATC has made a commitment to maintain and distribute the ACA. The ACA and its user manual are available for downloading from the CATC web site http://www.epa.gov/ttn/catc/products.html - software. This site will be updated as new versions of the ACA become available.

2. Description of the ACA



a. The ACA software package contains data structures and analysis tools designed to help ECs manage their air pollution sources. The design of the ACA assumes that the typical end-user has some environmental/technical background with at least a moderate level of computer experience, yet the design allows the more advanced end-user virtually unlimited power and extendibility. The ACA is composed of data structures stored in "objects" and information related to an object is a "property" of the object. Objects are arranged in a hierarchy and more or less of an object's structure can be viewed by expanding or collapsing objects much in the same way that file folders can be viewed in Microsoft (MS) Windows® Explorer. The three primary data structures of the ACA are the **Installation Data** object, the **Library Data** object, and the **What-If Scenarios** object. These three object types along with a description of the ACA's analytical capability can be found below. Greater detail about the ACA can be found in its users guide.

b. The **Installation Data** object is used to store data related to a DOD installation. This normally includes general information about the installation (attainment status, local energy and labor costs, ACA installation-level program settings) and air pollution source data. The ACA contains a large number of predefined source types for users to select and add to the ACA's installation source list. An air pollution source object contains slots to hold data that is specific for that source. All source objects also contain slots for operational data such as the source's operating schedule and pollutant stream parameters (temperature, pressure, flow rate). The ACA allows entry of both actual and potential operational data to help with Title V Federal Operating Permit Program issues. This feature allows separate calculations of potential to emit (PTE) and actual emissions. This is useful since PTE determines the applicability of the Title V Operating Permit program and is a key factor in writing permit applications. Figure A1 shows an example of an installation containing several source types and some of the specific data slots associated with the **Waste Water Plant** source object.

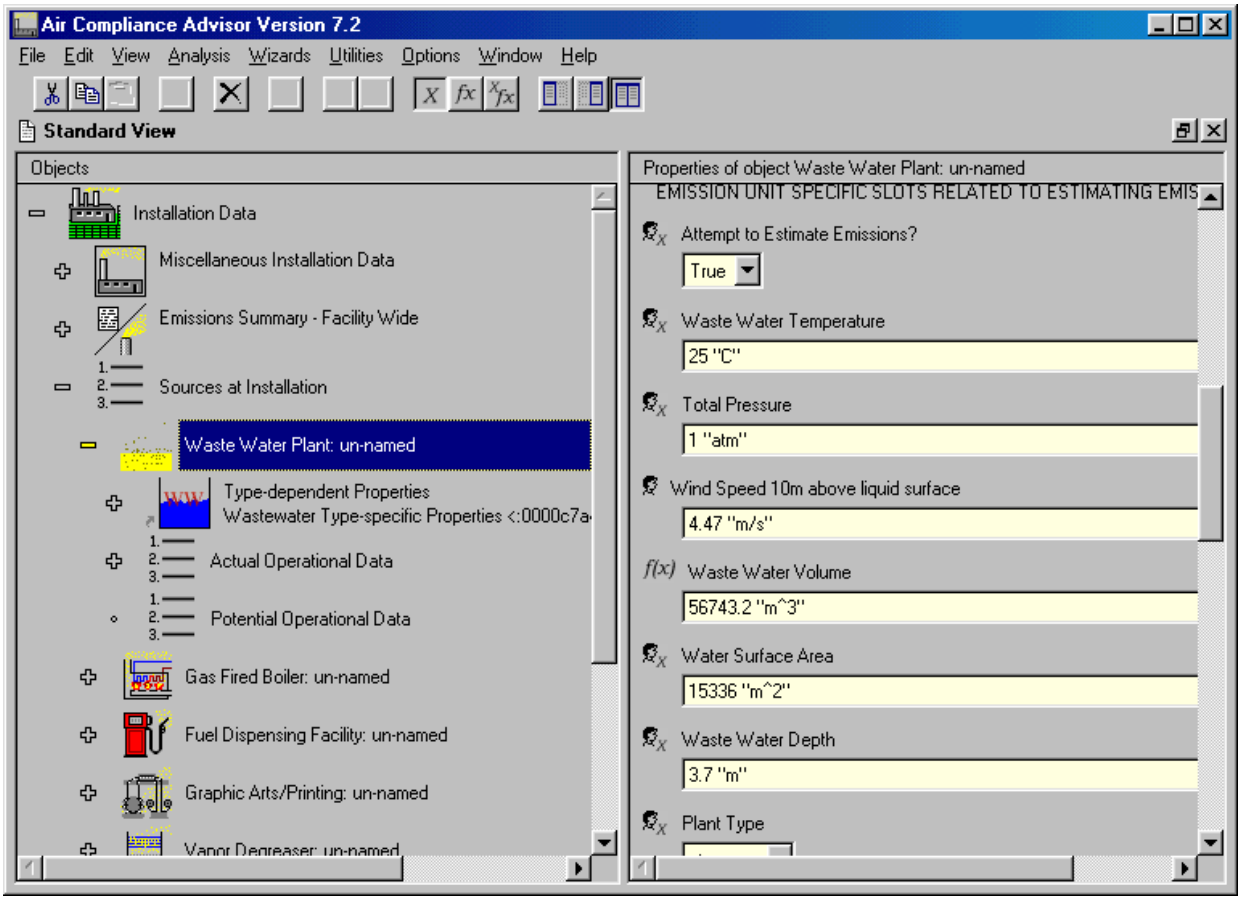


Figure A1. Example of installation data in the ACA

c. The **Library Data** object contains data built-in to the ACA and data objects that allow users to add their own library data. This is similar in concept to spell checking features of word processors that come with a pre-existing dictionary of words but also allow users to add their own words to user dictionaries. The **Library Data** object includes separate libraries for chemicals, materials, reports, control devices, federal regulations, pollution prevention options, suggestions, and miscellaneous data. The libraries for federal regulations, pollution prevention options, and suggestions are associated with prototype analyses for determining applicable federal regulations, pollution prevention options, and suggestions. Details of these libraries and prototype analyses can be found in the ACA's user guide. Further description of the other five libraries can be found below.

(1) The **Chemicals Library** object contains a large amount of built-in information regarding chemicals found in air pollution streams. The **Chemicals Library** contains chemical properties for all of the hazardous air pollutants (HAPs) listed in Title III of the Clean Air Act Amendments of 1990, as well as the chemical properties of the criteria pollutants. The ACA uses the chemical properties found in this library during analyses for estimating emission rates and determining applicable control technologies. These chemicals are used to define the contents of air pollution streams and materials. Figure A2 shows the start of the list of chemicals in the library and some of the data slots for acetaldehyde.

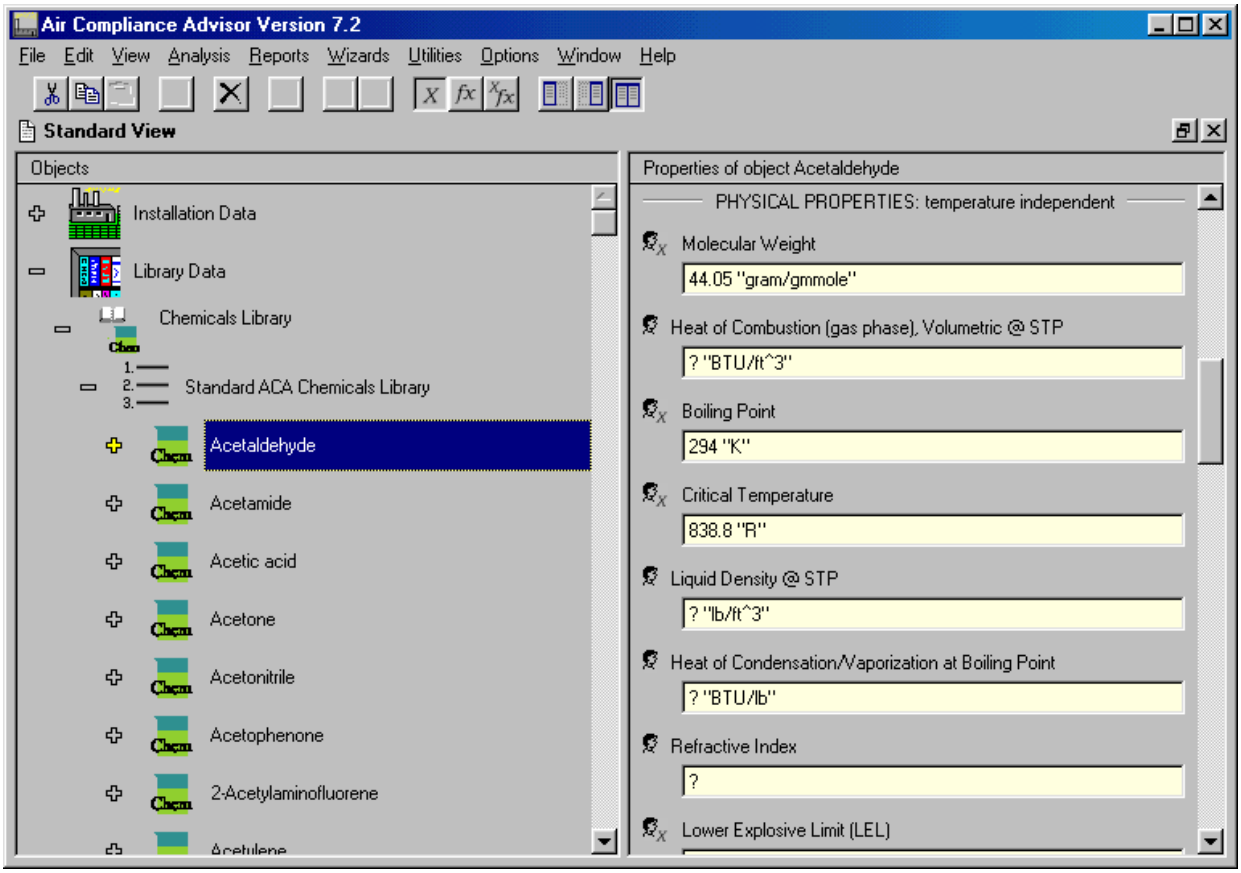


Figure A2. Example of **Chemicals Library** data in the ACA

(2) The **Materials Library** object contains information about materials that are part of processes generating air pollution. The two most common types of materials are coatings such as paints and varnish and wastewater containing volatile air pollutants. The material data is used to define the material usage of air pollution sources. When defining certain sources such as painting operations or wastewater treatment, the user is required to select one of these materials

(3) The **Control Devices Library** object contains most of the air pollution control devices found in the US EPA's *OAQPS Control Cost Manual* and a few other control devices specified elsewhere. These control devices include carbon adsorbers, condensers, electrostatic precipitators, baghouses, flares, thermal incinerators, wet scrubbers, and catalytic incinerators. Control device objects contain a sophisticated data structure that allows the ACA to determine the applicability and costs of control devices. All the user must normally specify is the parameters of the air pollutant stream and the desired control efficiency. Figure A3 shows the beginning of the **Control Devices Library** and a few of the slots associated with the **fixed bed Catalytic Incinerator** control device object.

(4) The **Reports Library** object is a relatively new feature of the ACA. This library contains ACA reports and allows the user to create special purpose reports from within the ACA.

(5) The **Miscellaneous Objects Library** object provides a place to store any commonly used ACA data object for future reference. An object is normally stored here so that it can be copied as needed. This eliminates the need to recreate the object each time it is required.

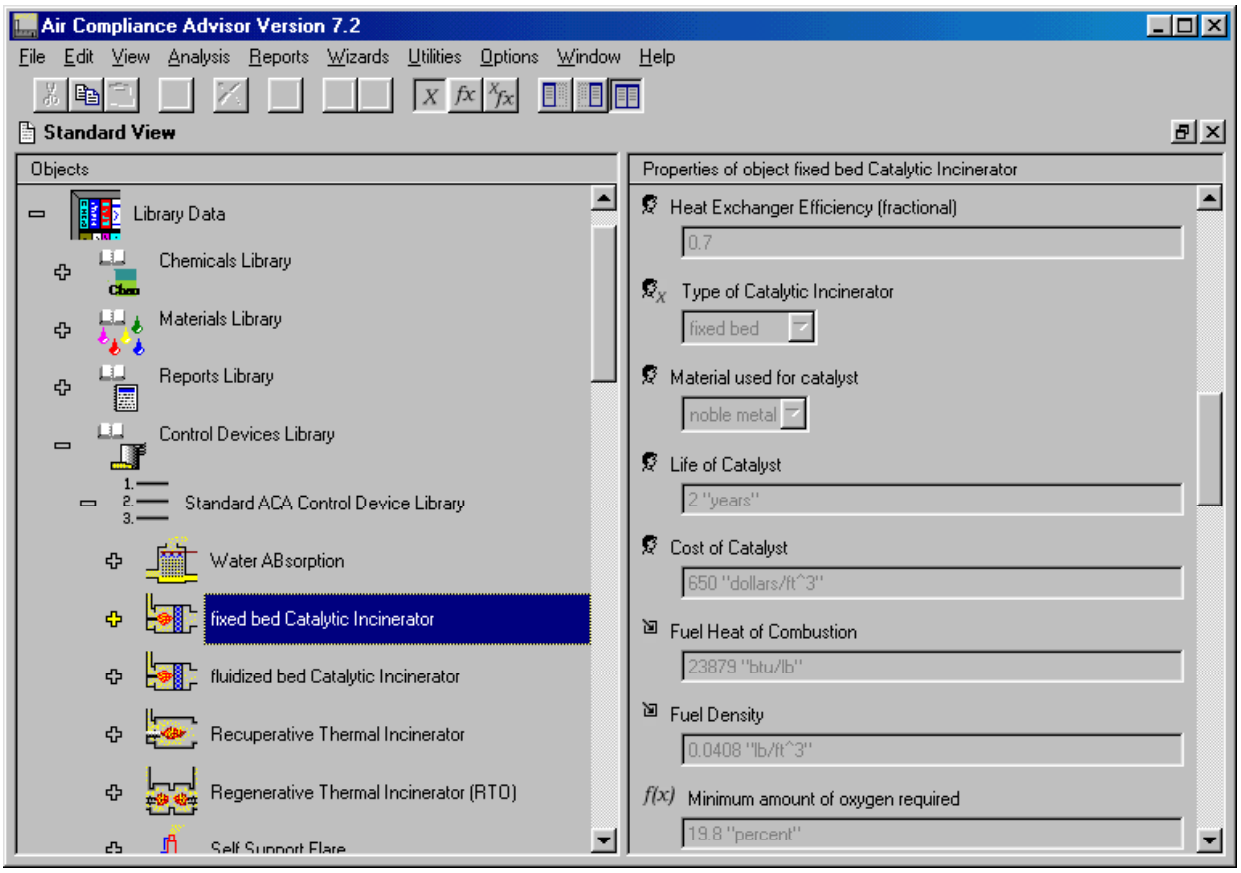


Figure A3. Example of **Control Devices Library** data in the ACA

d. The ACA contains useful analytical capabilities for ECs. Some general analytical capabilities of the ACA include (1) automatic unit conversion, (2) minimal data entry requirements, and (3) user-extendibility of analyses. While numerous calculations in the ACA are made "behind the scenes" (much like a spreadsheet automatically re-calculates in the background), there are several other specific analyses available within the ACA program. These include (1) calculations of potential and actual emissions, (2) control device cost estimates and applicability grading, and (3) prototype analyses. Running ACA analyses will create reports and add analysis results to the appropriate ACA objects. After analysis results are added to objects, users can change any information related to these results and instantly see the effects on the results. In this way, users can rapidly perform what-if type analyses by changing parameters of interest and viewing the results.

(1) The ACA's emission estimating analyses include estimating emissions from individual air pollution sources and summarizing raw and stack emissions for the entire installation. In general, source, operational, and material-specific data are required to make emissions estimates in the ACA. The ACA uses internal algorithms based on standard emission

estimation techniques to calculate emissions. Most emission estimates are calculated using the US EPA's AP-42 emission estimation guidance. If a user does not enter all the information required for emission estimation, the ACA will identify the name of the required data entry slot and its location. Figure A4 shows an example summary report the ACA generates when the **Summarize Emissions from Stack** analysis is selected.

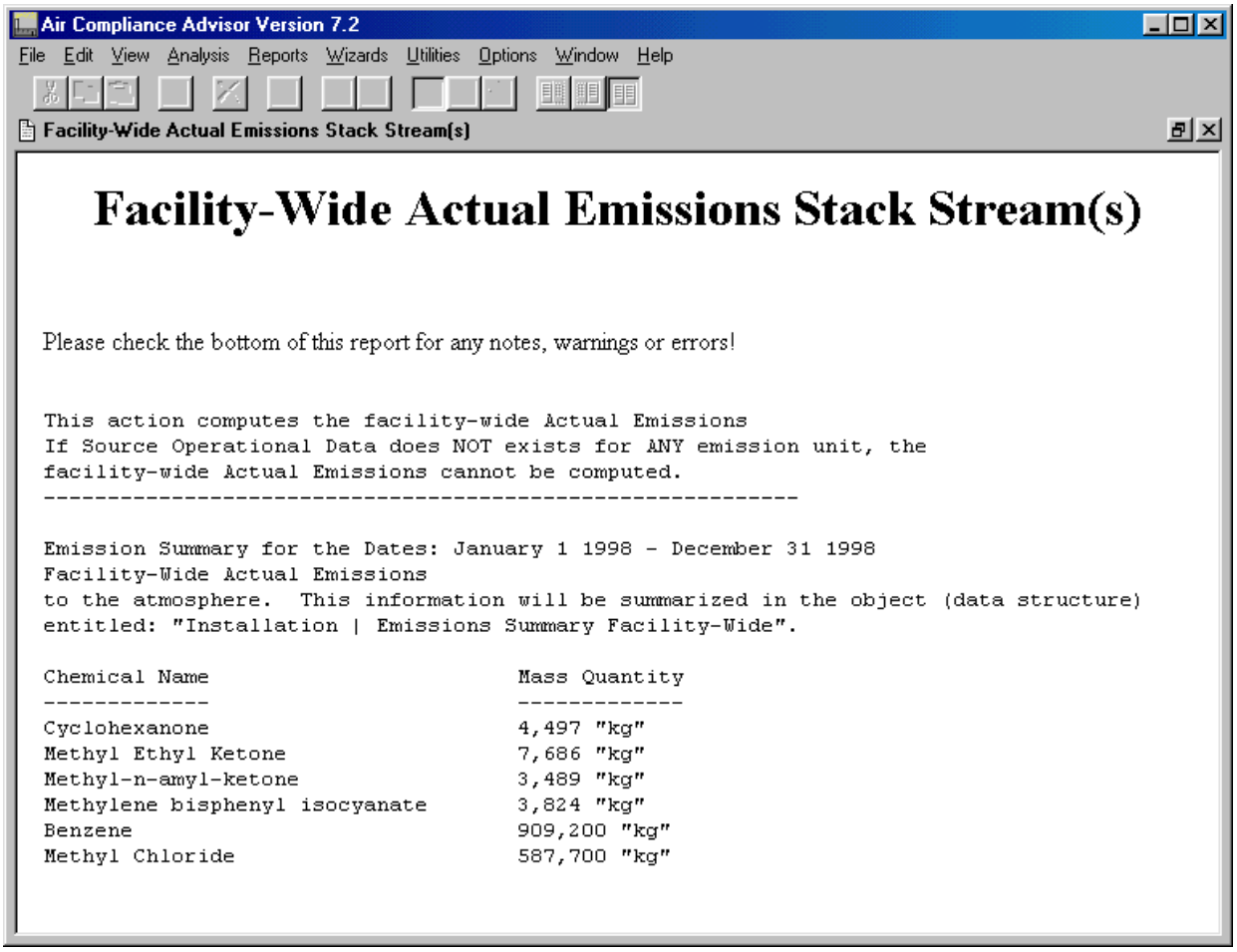


Figure A4 Example of emission summary report

(2) The ACA can provide a large amount of economic information about control technology for a specified air pollution stream through its **Apply Control Technologies** analysis. Algorithms were developed and implemented for all of the control devices found in the **Control Device Library**. For each control device, extensive research resulted in the development of algorithms for both the sizing and costing of the device. The **What-if Scenario** object is used to enter required information. The analysis of an applicable control device considers both air pollution source-specific parameters (e.g., hours of operation, pollution stream temperature, pollution concentrations, pollution chemical characteristics, and particle size distributions), control device specific parameters (e.g., achievable reduction efficiencies, cost estimation data, operation and maintenance requirements, and applicability constraints), and installation specific economic data (e.g., cost of labor, utilities, and cost indices). The control technology objects contain models based primarily upon guidance provided in the US EPA's

OAQPS Control Cost Manual, William M. Vatavuk's *Estimating Costs of Air Pollution Control*, Louis Theodore and Anthony J. Buonicore's *Air Pollution Control Equipment Volumes I & II*, and the Air & Waste Management's *Air Pollution Engineering Manual*. Figure A5 shows a small excerpt of a report generated from the **Apply Control Technologies** analysis.

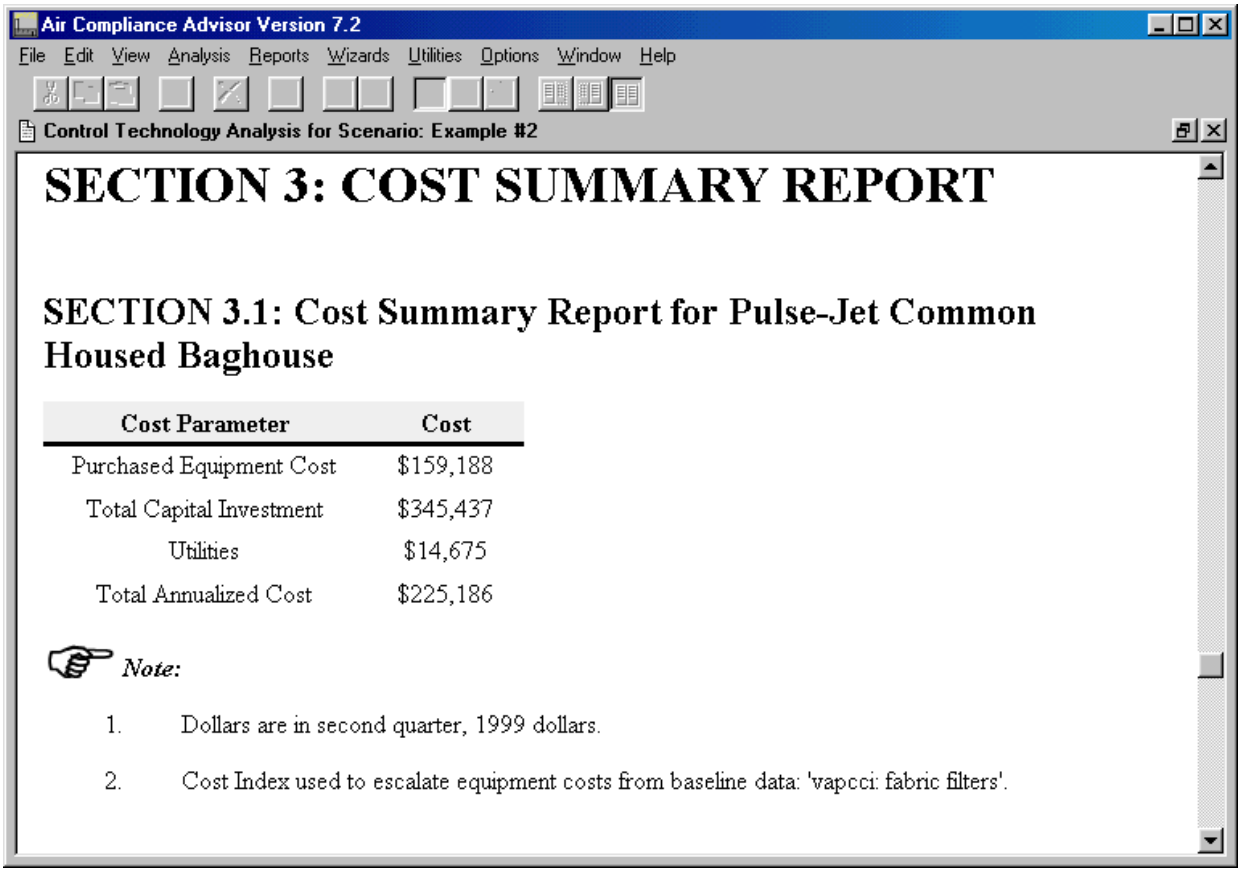


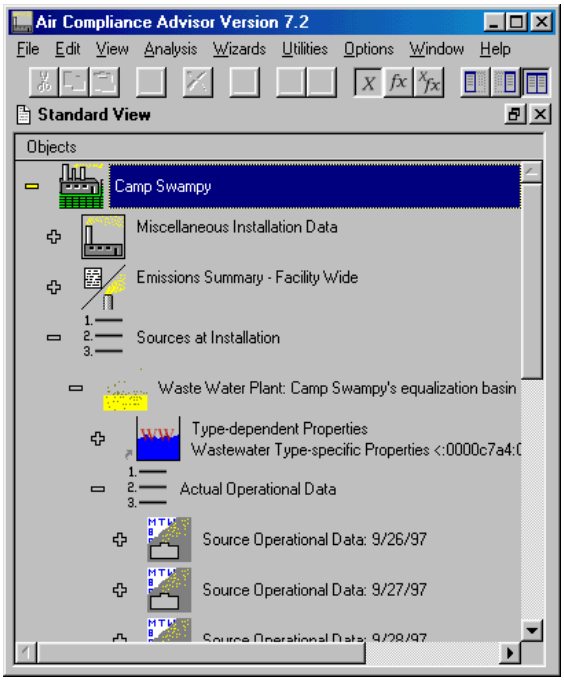
Figure A5. Example of summary economic information from **Apply Control Technology** analysis.

(3) The ACA also contains prototype analyses for determining applicable regulations, pollution prevention opportunities, and suggestions. These analysis options are labeled as being prototype because there are limitations on their use. However, user may find the results of these analyses very useful in many situations.

e. The ACA has minimal requirements for its operation. The ACA software requires the following computer components to run properly:

- IBM PC or compatible computer
- 486 (or later) type processor
- VGA monitor
- Mouse (or other pointing device) supported by MS Windows®
- MS Windows 95® or later MS Windows® operating system
- 12 MB of RAM (minimum)
- 12 MB free hard drive space (minimum)
- Screen area: 800x600 pixels (or greater)

3. Examples of DOD Studies



a. During development, testing of the ACA included studies of air pollution sources at three DOD installations. A description of this work is presented below to provide examples of applying the ACA at Army installations. The names of these installations will not be used in this technical bulletin to protect potentially sensitive information. Two of the examples deal with quality assurance checks on emission estimates while the other example explores emission control strategies for a painting facility.

(1) In the first example, the ACA was used to examine emission inventory estimates provided by a contractor for an installation's Title V application. The idea here was to enter the process information provided by the contractor's emission inventory report into the ACA, estimate emissions with the ACA, and then compare ACA and contractor results. When discrepancies were discovered, an attempt was made to determine the reason for the difference. When feasible, the process of adding air pollution source information into the ACA was simplified by combining the process parameters from many small sources of the same types to produce a representative larger source that was used to estimate the sum of the emissions. If difference between the contractor's and the ACA's emission estimates appeared, then individual source emissions were investigated.

(a) This quality assurance check produced some interesting results. The ACA helped uncover 21 separate discrepancies. Many of these were minor but potentially confusing issues such as the use of the wrong units. There were also instances where the ACA and contractor results disagreed and it was later determined that the ACA was correct. Most of these were isolated to individual sources within a larger source group. Therefore, most of the errors did not make large differences in the emission summation for the source category as a whole. One very notable exception to this occurred for the calculation of potential VOC emissions from underground storage tanks. In this case, the contractor reported potential emissions of 1,627 tons/year when the correct value should have been 0.0750 tons/year. It should be noted that the ACA did verify that the majority of the contractor's emission estimates were accurate. Even if this had been the case for every emission estimate, the ACA would have been a useful tool in verifying the results.

(2) In the second example, the ACA was used to check the estimates of VOC emissions from an industrial wastewater treatment plant's equalization basin. The estimates were provided to the installation by student contractor personnel. The specific volatile compounds of concern included acetone, ethanol, and ethyl ether. Although acetone is no longer defined by the EPA as a VOC, its emissions were estimated to compare with emission estimates made in the past. The

students calculated emission estimates for the three chemicals for 45 consecutive days running from late September through early November. They used the U.S. EPA's Wastewater Treatment Compound Property Processor and Air Emissions Estimator (WATER8) computer model to calculate the emission estimates.

(a) The ACA was used to verify the emission estimates of the first ten days. In the ACA, a wastewater plant source type was added to the installation source list and then data about the equalization basin and each of the ten operating days was entered. The required information for the equalization basin includes mechanical aeration properties, the wind speed across the basin surface, and the geometry of the basin. Information for each of the ten days was added to separate operational data sets. Each operational data set described the operational time and the material input into the equalization basin. To help in this process, ten separate materials that described the wastewater composition on each of the ten days were created and added to the **User-Defined Materials Library**. The material input for each operational data set was then defined by selecting these materials and entering the flow rate of the wastewater. After the equalization basin source was completely described, the ACAs **Estimate Emission Rates** analysis was run. The analysis generated a report showing the emissions of the three chemicals for each of the days described in the operational data sets. In addition, the WATER8 model was used to verify both sets of results.

(b) The results from this analysis showed that only one mistake was made in the original emission estimates. This work was also a good quality assurance test for the ACA's ability to estimate emissions from wastewater sources. In every case, the ACA's emission estimation results agreed with the results generated from the WATER8 model. The complicated emission estimation algorithms for wastewater treatment emissions were programmed into the ACA based on the U.S. EPA's WATER8 model documentation.

(3) In the final example, the ACA was used to examine control strategies for emissions from a large paint booth and to compare these results with a contractor's feasibility study. The paint booth was designed to use split-flow recirculation where a portion of the air passing across the paint booth is recirculated while the remainder of the air is sent to an air pollution control device.

(a) Input data for the ACA were taken directly from the feasibility study. The ACA study considered worst and typical case operational scenarios at both 90% and 75% recirculation. The input data included a definition of the air pollutant stream (chemical composition, temperature, pressure, etc.), local economic information (energy costs, labor costs, value of recovered solvent, etc.), the desired control efficiency, and the hours of operation.

(b) The ACA output showed that four control devices were applicable to this air pollutant stream. These control technologies included thermal recuperative incineration, thermal regenerative incineration, catalytic incineration, and carbon adsorption. Table A1 shows an example of summary cost information results provided by the ACA. The ACA also provided very detailed cost breakdowns for each of these control technologies. The ACA recommended carbon adsorption as the most economic control option. Further work with the ACA indicated that a single bed system would be more cost effective than either a two or a three-bed system.

Table A1 Summary control device costs for worst-case scenario, 90% recirculation

	Thermal Recuperative Incineration	Thermal Regenerative Incineration	Catalytic Incineration	Carbon Adsorption w/vapor recv.
Purchased Equip. Cost	$389,000	$835,500	$1,065,000	$462,000
Total capital investment	$626,000	$1,344,000	$1,714,000	$744,000
Annual Utilities Cost	$52,200	$9,300	$31,300	$1,600
Annualized Cost[1]	$170,000	$258,000	$366,000	$144,000

1 Annualized cost includes capital recovery (i.e., the amortization of the initial capital investment)

(c) The ACA also produced qualitative results of interests. One general warning was related to the presence of isocyanates in the waste gas stream. These compounds and their byproducts are very toxic and extra care must be taken to reduce the risk posed by these chemicals to installation personnel and the public. Other warnings included a potential problem with particulate matter in the gas, the potential poisoning of catalysts from particulates and heavy metal emissions, and the difficulty of desorbing high molecular compounds found in the waste gas stream.

(d) In this example, users would benefit from the ACA's ability to generate issue that can be discussed with the contractor performing the feasibility study. Some of the issues raised by the ACA are shown below:

- The ACA ranked recuperative thermal oxidation very highly while the feasibility study did not. Since this technology has a proven track record, why wasn't it considered more carefully?

- The ACA considered many cost elements (i.e., auxiliary equipment, handling, insulation, painting, indirect installation costs, operating labor, and indirect annual costs) that did not appear in the feasibility study. Were these cost factors considered and if not are they considered relevant?

- The ACA provided a warning about isocyanates that was not mentioned in the feasibility study. Would the toxicity of these compounds and their byproducts influence the selection of a control device?

- The ACA shows relatively large cost differences between the worst case and the typical case scenarios for the same control technology. Shouldn't these cost differences be considered when sizing and deciding between control technologies?

(e) The ability of the ACA to pose these types of questions is one of its greatest strengths. The ACA provides a tool for EC to check the accuracy and completeness of information provided by regulators and contractors.

4. Conclusions

The ACA is a tool that will assist ECs in the management of their air pollution compliance programs. The ACA provides the following features and benefits:

- Acceptance, support, and ownership of the ACA by the U.S.EPA,
- Large built-in database of information about chemical properties, air pollution sources, and air pollution control technology,
- MS Windows® Explorer type of user interface that allows intuitive access to all built-in and user generated information,
- Guidance to users when there is missing, incorrect, or inconsistent information,
- Ability for users to enter data in virtually any dimensionally correct units,
- Useful analyses for emission estimation and application of air pollution control technology,
- Consistent application of cost-effective control and mitigation techniques,
- Improved compliance with air pollution regulations,
- Reduction in man-hours for developing and implementing air compliance management programs, and
- Improved (knowledgeable) communication between ECs and regulators, contractors, and vendors.

As was mentioned in the Introduction, the ACA and its user manual can be downloaded from the U.S. EPA's CATC web site http://www.epa.gov/ttn/catc/products.html - software (cost free). This tool will continue to improve and evolve through EPA sponsored changes and users should check the EPA web site for new versions. Questions and comments about the ACA can be directed to the POCs listed in Paragraph 5 of this Technical Bulletin.

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