A New Database Program for creating Area Source Inventories

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ABSTRACT

The process of creating air pollution emission inventories can be both time consuming and expensive, imposing a trade-off between the quality and the quantity of an inventory. Preparers usually spend inordinate amounts of time managing rather then checking the accuracy of inventories that can easily exceed several tens of thousands of records. The Ohio Environmental Protection Agency (Ohio EPA) has developed a Microsoft Access Database program, called the Area Source Calculator, to help facilitate the creation of extensive and quality inventories.

The Area Source Calculator has three major functions; importing, calculating, and exporting. The import functionality allows the addition of activity, emission factor, and control data into the database. This information can then be used to calculate area source emissions for each pollutant by Source Classification Code (SCC) per county. These emissions can then be exported to the U.S. Environmental Protection Agency's (EPA) Nation Emission Inventory (NEI) Input Format (NIF) V3.0, Great Lakes Commission Regional Air Pollutant Inventory Development System (RAPIDS) V2.4.1 or Microsoft Excel.

Additional functionality has been included to help facilitate inventory accuracy and ease of use. Activity, Emission Factor, Control, and Emissions data can be copied between inventory years. Corrections can be made to the Area Source emissions based on known Point Source releases. The Area Source Calculator even includes basic quality assurance checks to help ensure the quality and integrity of the data.

The Area Source Calculator is designed to help Ohio EPA produce Area Source emission inventories in a minimal amount of time. Therefore, emphasis of creating emission inventories will be on establishing accurate data instead of managing information.

INTRODUCTION

The Area Source Calculator (ASC) is a Microsoft Access Database tool developed to help facilitate the creation of the Area Source emission inventory for the State of Ohio. The main focus was to prepare the inventory for submission to the United States Environmental Protection Agency (U.S. EPA) for the 2005 National Emission Inventory (NEI). The Area Source Calculator can also be used to inventory both Criteria and Hazardous Air Pollutants to submit to interested regional, state, and local agencies.

MOTIVATION

Previously, the Ohio Environmental Protection Agency (Ohio EPA) prepared its Area Source inventory via a series of Microsoft Office Excel spreadsheets. This process proved both manually intensive and time consuming. The quality and quantity of the inventory suffered as more time was spent on managing the existing data rather then ensuring the accuracy of the emissions. This would only worsen as more SCCs and pollutants are included in the inventory.

There are numerous existing programs offered by either public or private organizations to help simplify and accelerate inventory development. However, many of these programs take a broad approach to creating inventories trying to account for as many exceptions as possible. This can lead to complicated programs that have large learning curves or are too expensive to justify for basic inventory purposes.

The remedy was to develop a new inventory program that was limited in scope, specifically designed for the purpose of creating an Area Source inventory for submission to the NEI. Microsoft Access was chosen as the easiest platform to automate this process since it is both flexible and widely used. Since trying to account for all possible situations would overcomplicate the program, only one method of emission estimation was chosen. This would significantly reduce although not eliminate the number of manual calculations needed to produce an Area Source inventory.

The goal of the Area Source Calculator was threefold.

- To automate some of the inventory creation tasks based on a standard estimation method
- Generate export files in NIF, RAPIDS and Excel
- Provide a platform to experiment with alternative methods of inventory creation.

The third goal is significant. Many national, regional, and state environmental agencies are in the process of revising or creating programs to help facilitate the collection of information for inventorying purposes. Programs such as the Area Source Calculator can be used to test ideas on a smaller scale to determine if they are feasible and useful. This will help prevent the development of programs or the addition of features that add little to no value for inventory creation.

METHODOLOGY

The Area Source Calculator is limited to producing Area Source emission inventories for submission to the NEI V3.0 based on a single emission estimation method. The emissions would be categorized by four parameters.

- Pollutant
- SCC
- County
- Inventory Year

Emissions can be incorporated into the Area Source Calculator's inventory in two ways. The emissions can be imported directly from some method or source outside of the calculator or it can be estimated via Equation (1) inside the calculator.

Equation (1) $CEM = A \times EF \times (1 - CE \times RP \times RE)$

where

CEM = Controlled Emission Value
A = Activity
EF = Emission Factor
CE = Control Efficiency
RP = Rule Penetration
RE = Rule Effectiveness

Few Area Source emission sources have defined control devices or regulatory rules so the Control Efficiencies, Rule Penetrations, and Rule Effectiveness can often be neglected. This simplifies Equation (1) drastically to Equation (2).

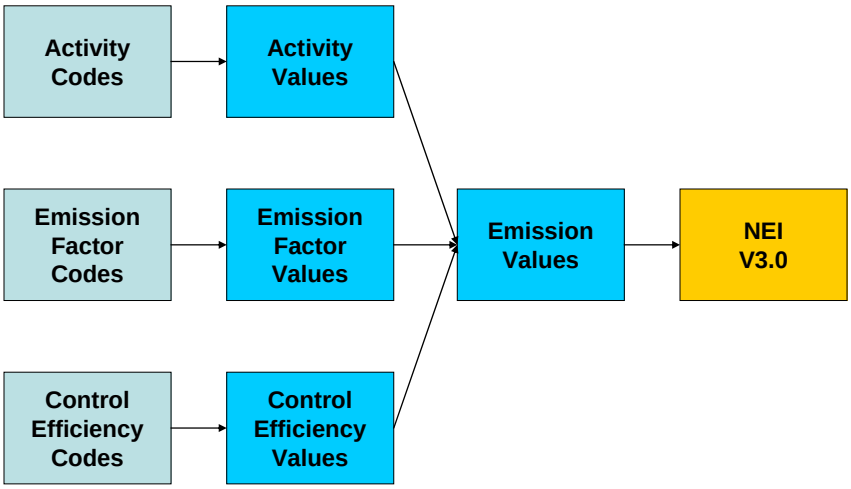
Equation (2) $UEM = A \times EF$

where

UEM = Uncontrolled Emission Value
A = Activity
EF = Emission Factor

Equation (2) is a simple yet effective method to estimate the emissions from Area Sources. By restricting the Area Source Calculator's emission estimation to Equations (1) and (2), the program requirements are less intensive than other methods such as speciation and mass balance techniques. This allows for a more simplified database structure, shown in Figure 1.

Figure 1. Area Source Calculator Flow Chart



For most Area Sources, only the Activity and Emission Factor is needed to get an estimate of the emissions. Some activities are readily available from State and Federal agencies while other activities are more difficult to obtain and require extensive research and creative thinking. Some examples are census population and employment estimates, vehicle miles traveled, pesticides applied, wood combustion, etc. Emission Factors come primarily from the Factor Information Retrieval (FIRE) Data System maintained by the U.S. EPA, EPA's NEI documentation, and Trade Associations.

FUNCTIONS

The Area Source Calculator has three levels of functionality, primary, secondary and tertiary. The primary functions are the critical parts of inventory creation. These include importation of data, calculation of emissions, and exportation of the inventory. The secondary functions include ancillary processes that help reinforce the primary functions. These include querying the inventory records and individual data modifications. The final and least critical functions are the tertiary functions. These provide extra services that help improve the quality or functionality of the inventory. These include quality assurance and checks, correction for possible point source inventory double counting, and producing complete back ups of inventory years. This hierarchy is summarized below.

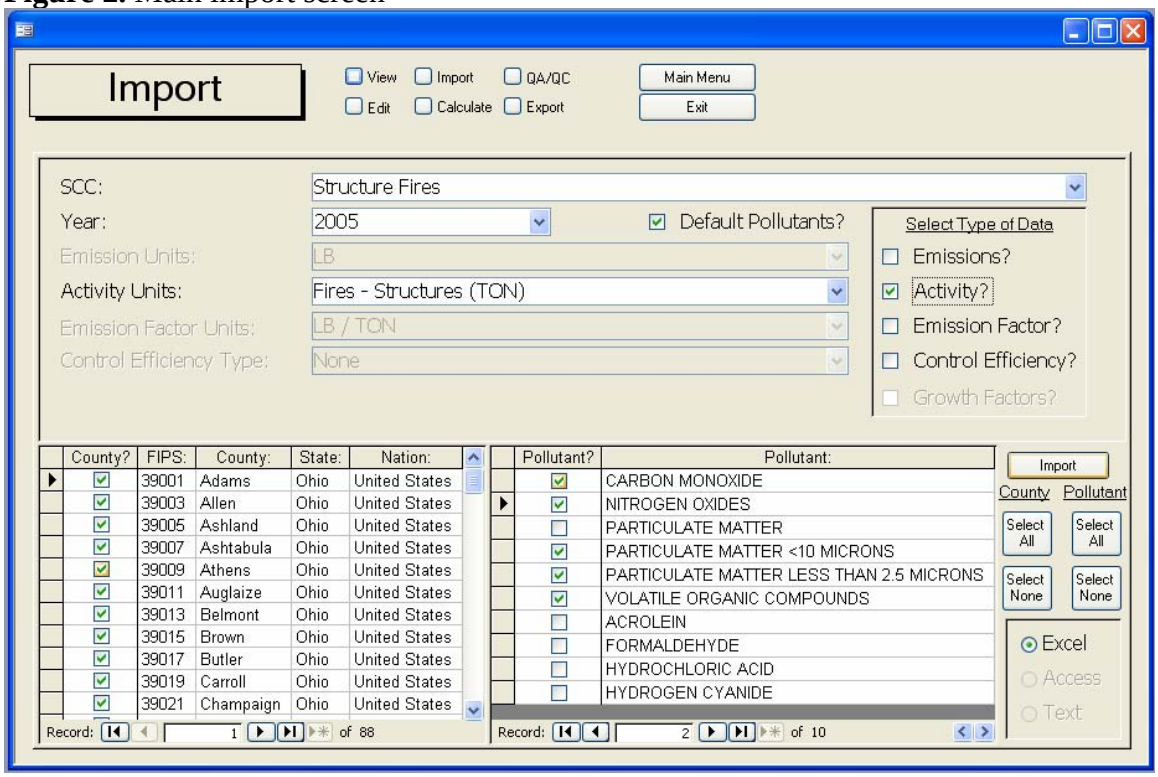
- Primary
    a. Import
    b. Calculate
    c. Export
- Secondary
    a. View
    b. Edit
- Tertiary
    a. QA/QC
    b. Point Source Correction
    c. Back Up

PRIMARY

Import

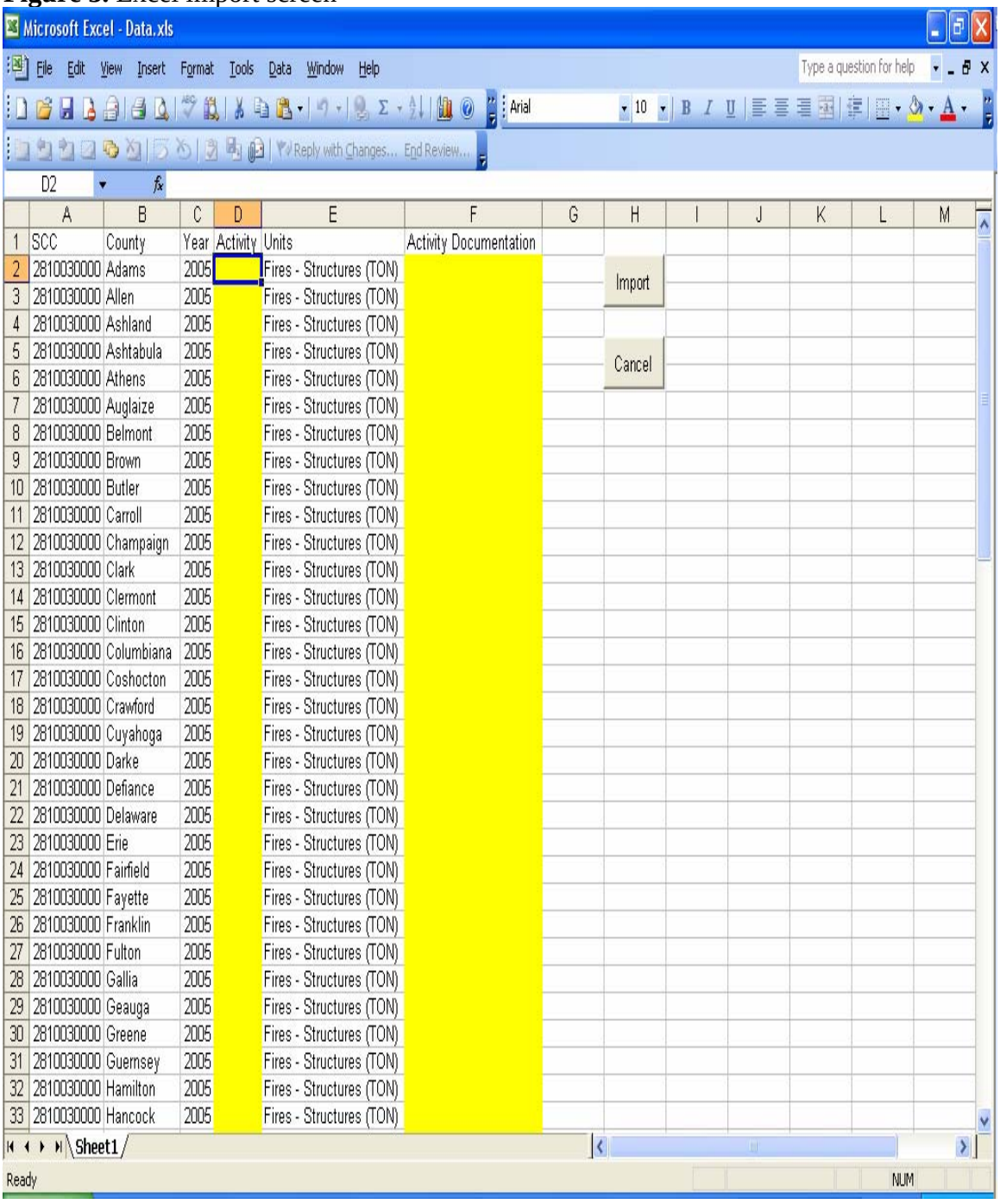
The import function of the Area Source Calculator allows the user to import four types of information; Emissions, Activities, Emission Factors, or Control Efficiencies. Once the user selects the SCC of the desired data and Inventory Year they are provided with a default list of units and pollutants. The user can either accept these defaults or customize their selections. A screen shot of this form is shown in Figure 2.

Figure 2. Main import screen



To provide easy transfer of information from Ohio EPA's existing spreadsheets, data is imported via a Microsoft Excel Spreadsheet that is shown in Figure 3. All the relevant selections the user made in the previous screen are represented in the Excel spreadsheet. All that is required is value for the type of data selected and any corresponding documentation.

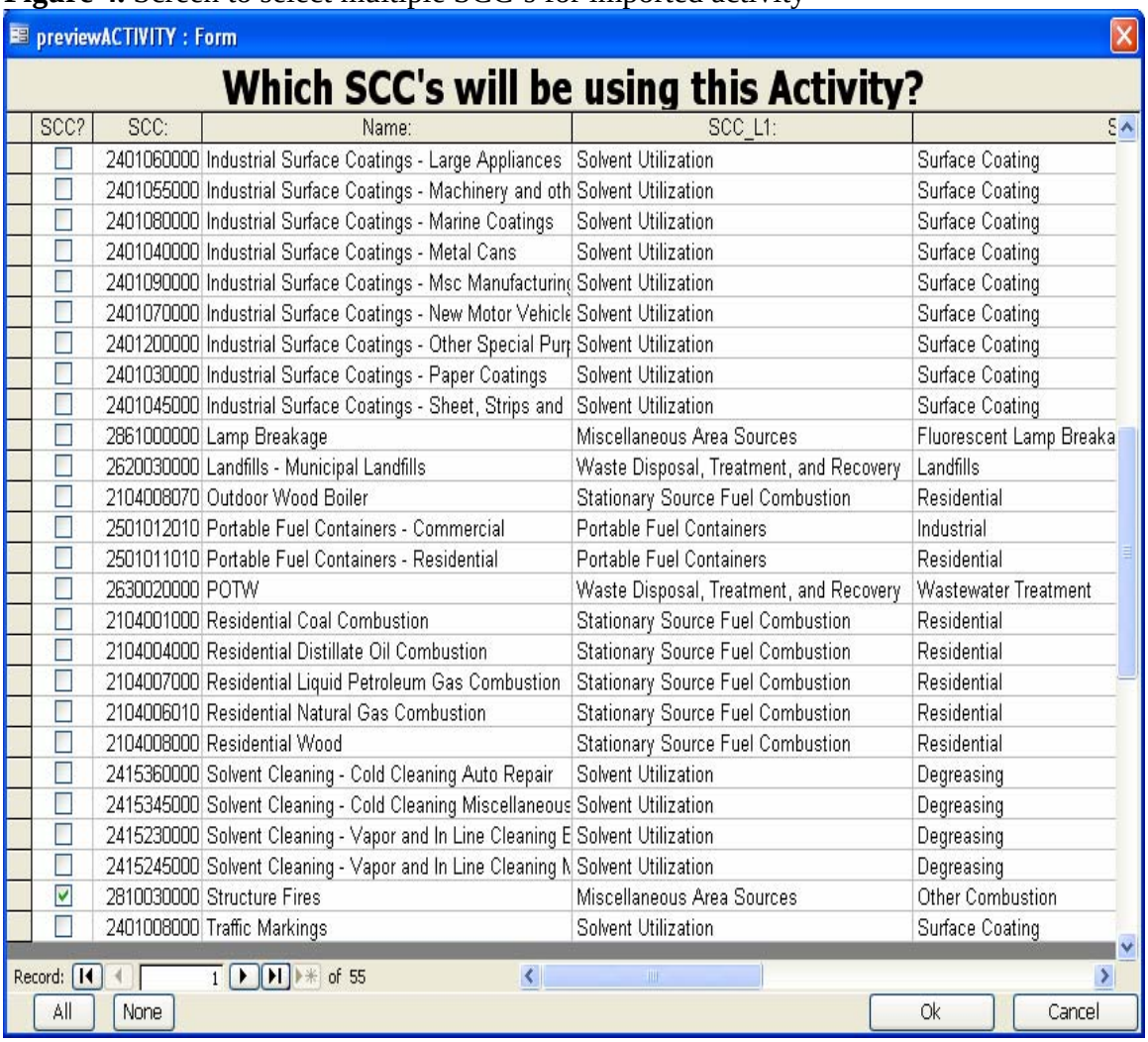
Figure 3. Excel import screen



	A	B	C	D	E	F
1	SCC	County	Year	Activity	Units	Activity Documentation
2	2810030000	Adams	2005		Fires - Structures (TON)	
3	2810030000	Allen	2005		Fires - Structures (TON)	
4	2810030000	Ashland	2005		Fires - Structures (TON)	
5	2810030000	Ashtabula	2005		Fires - Structures (TON)	
6	2810030000	Athens	2005		Fires - Structures (TON)	
7	2810030000	Auglaize	2005		Fires - Structures (TON)	
8	2810030000	Belmont	2005		Fires - Structures (TON)	
9	2810030000	Brown	2005		Fires - Structures (TON)	
10	2810030000	Butler	2005		Fires - Structures (TON)	
11	2810030000	Carroll	2005		Fires - Structures (TON)	
12	2810030000	Champaign	2005		Fires - Structures (TON)	
13	2810030000	Clark	2005		Fires - Structures (TON)	
14	2810030000	Clermont	2005		Fires - Structures (TON)	
15	2810030000	Clinton	2005		Fires - Structures (TON)	
16	2810030000	Columbiana	2005		Fires - Structures (TON)	
17	2810030000	Coshocton	2005		Fires - Structures (TON)	
18	2810030000	Crawford	2005		Fires - Structures (TON)	
19	2810030000	Cuyahoga	2005		Fires - Structures (TON)	
20	2810030000	Darke	2005		Fires - Structures (TON)	
21	2810030000	Defiance	2005		Fires - Structures (TON)	
22	2810030000	Delaware	2005		Fires - Structures (TON)	
23	2810030000	Erie	2005		Fires - Structures (TON)	
24	2810030000	Fairfield	2005		Fires - Structures (TON)	
25	2810030000	Fayette	2005		Fires - Structures (TON)	
26	2810030000	Franklin	2005		Fires - Structures (TON)	
27	2810030000	Fulton	2005		Fires - Structures (TON)	
28	2810030000	Gallia	2005		Fires - Structures (TON)	
29	2810030000	Geauga	2005		Fires - Structures (TON)	
30	2810030000	Greene	2005		Fires - Structures (TON)	
31	2810030000	Guernsey	2005		Fires - Structures (TON)	
32	2810030000	Hamilton	2005		Fires - Structures (TON)	
33	2810030000	Hancock	2005		Fires - Structures (TON)	

If the user selects ‘Import’ the data is immediately imported into the corresponding Access database table. In the case of importing Activities, an additional screen is introduced. Since several SCCs may use the same values and type of activity, it is advantageous to allow this data to be shared by several SCCs. Figure 4 shows how this is accomplished in the Area Source Calculator by allowing the user to specify which SCCs are related to the imported activity. This saves time by allowing a shared activity to be imported only once.

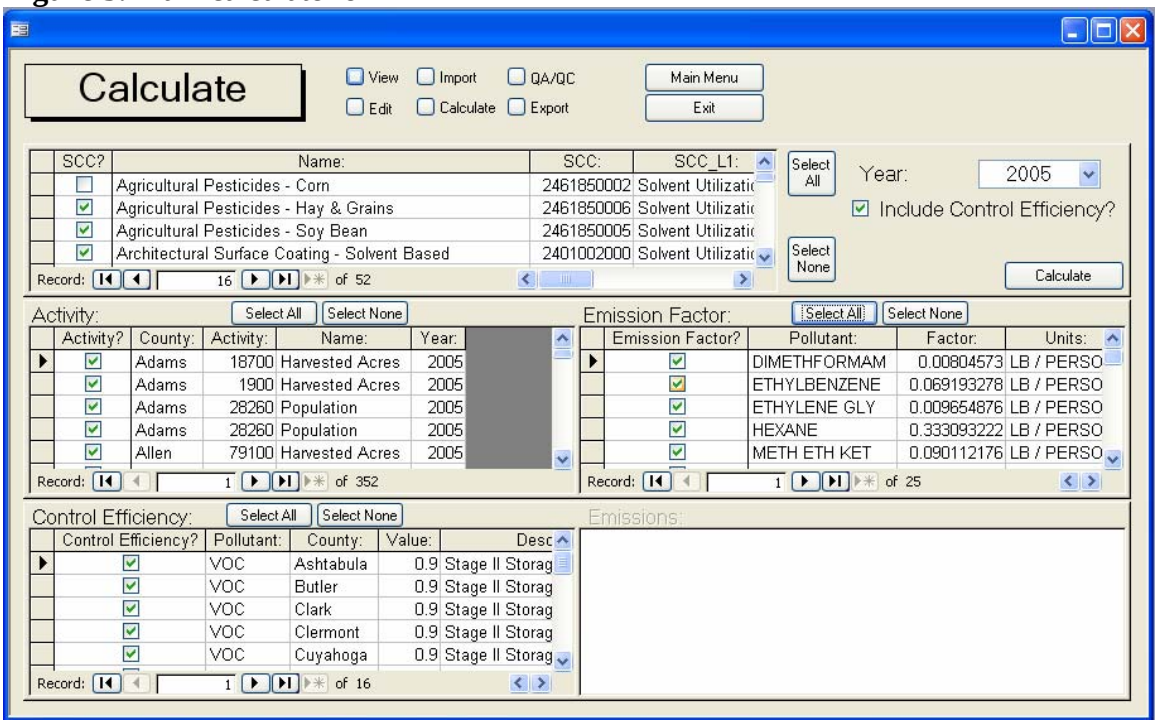
Figure 4. Screen to select multiple SCC’s for imported activity



Calculate

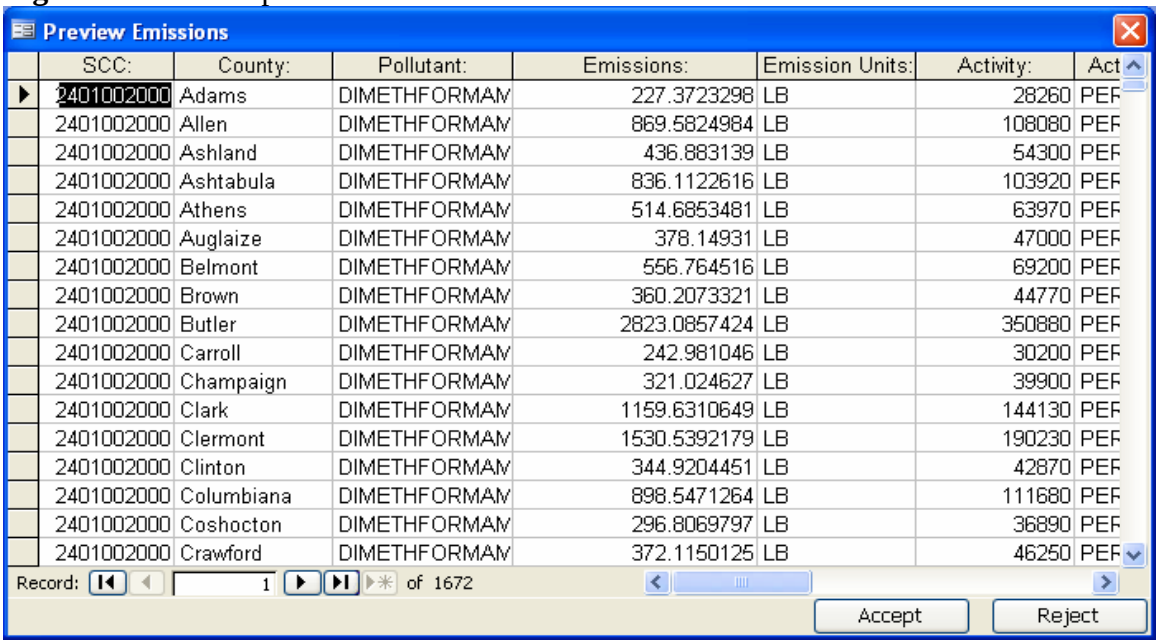
The estimation of emissions using Equations (1) and (2) occur on the 'Calculate' form shown in Figure 5. Once an inventory year and SCCs are chosen, only the related Activities, Emission Factors, and Control Efficiencies are displayed. The user can then specify which values they wish to use to estimate the emissions. To help simplify the estimates, the usage of control efficiencies can be universally deactivated.

Figure 5. Main calculate form



Once calculated, the estimated emissions can be previewed before it is accepted into the database. Figure 6 shows an example of this preview screen.

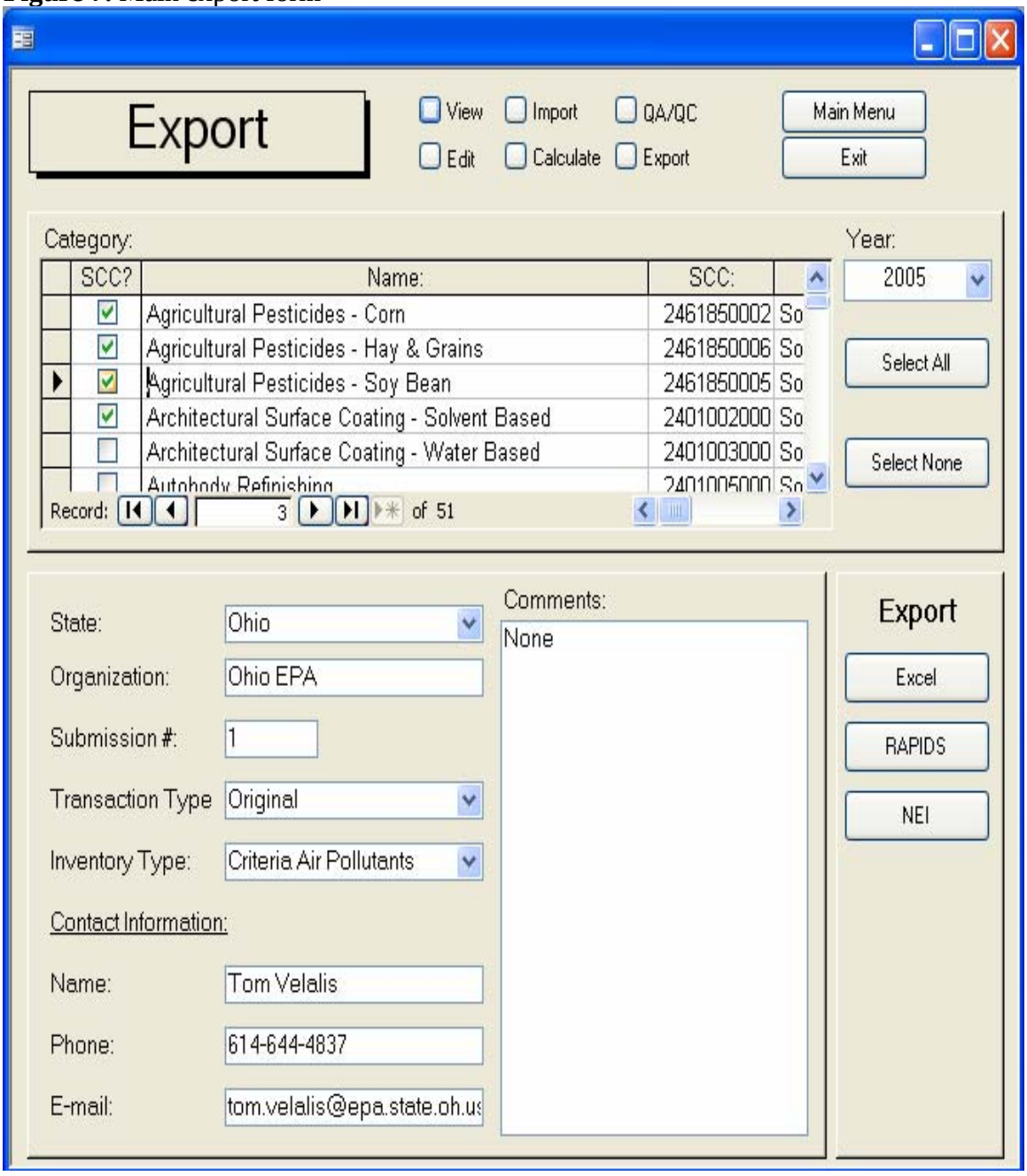
Figure 6. Emission preview screen



Export

Once an emission inventory has been created within the Area Source Calculator, the information can be exported to the common NIF V3.0 format, Great Lakes Regional RAPIDS V2.4.1 format, or Microsoft Excel. To export the inventory, the user specifies the inventory year and desired SCCs. The user can also select whether to export only Criteria Air Pollutants, only Hazardous Air Pollutants, or both. This form allows the user to tailor the exported data to the interested agency or individual. This export form is shown in Figure 7.

Figure 7. Main export form

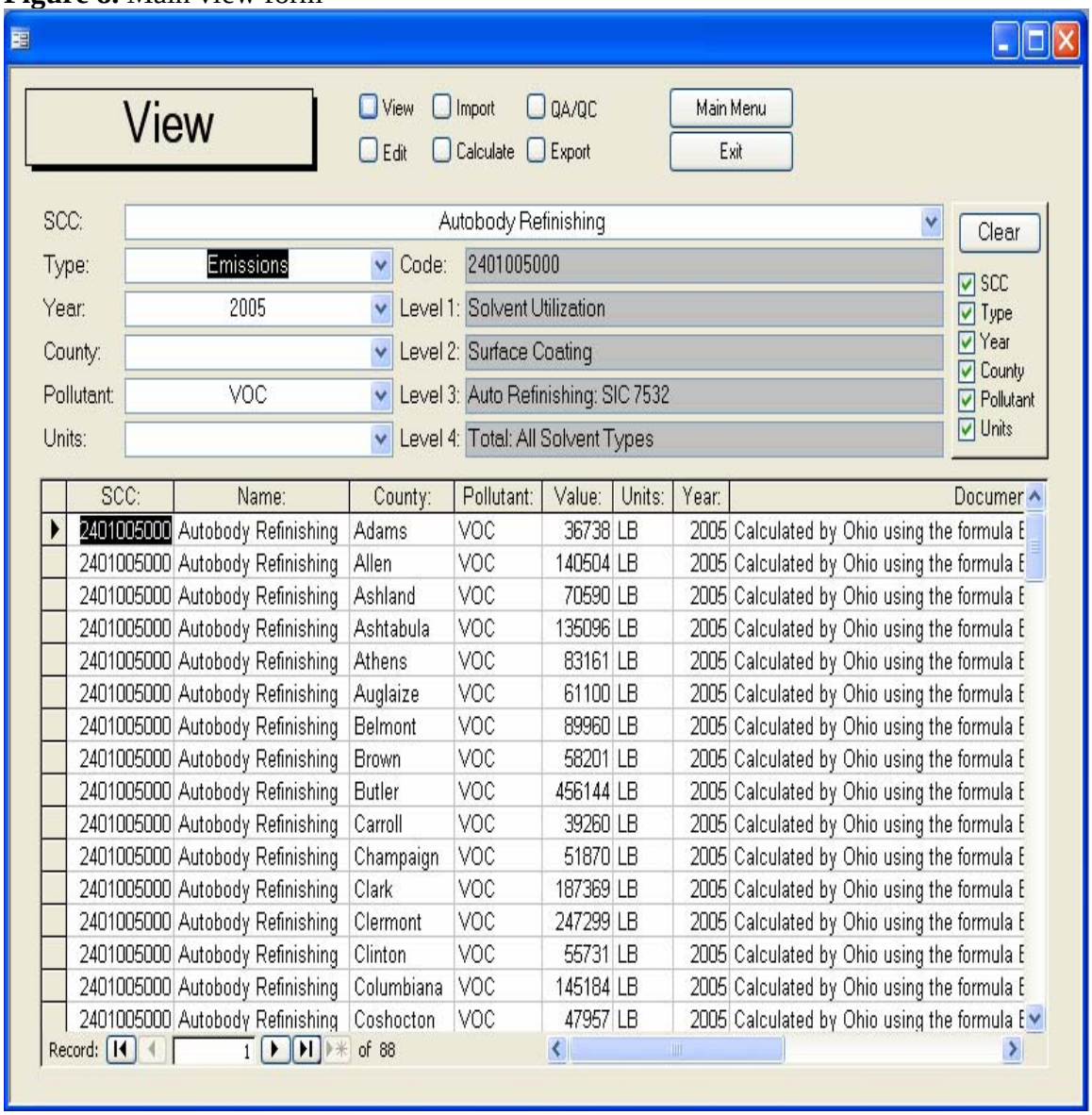


SECONDARY

View

To help facilitate manual inventory quality assurance, a comprehensive viewing form is included in the Area Source Calculator. This “View” form allows the user to query the inventory based on SCC, Data Type, Inventory Year, County, Pollutant, and Units. This allows for easy examination of data based on the SCC and type of data queried. This form is shown in Figure 8.

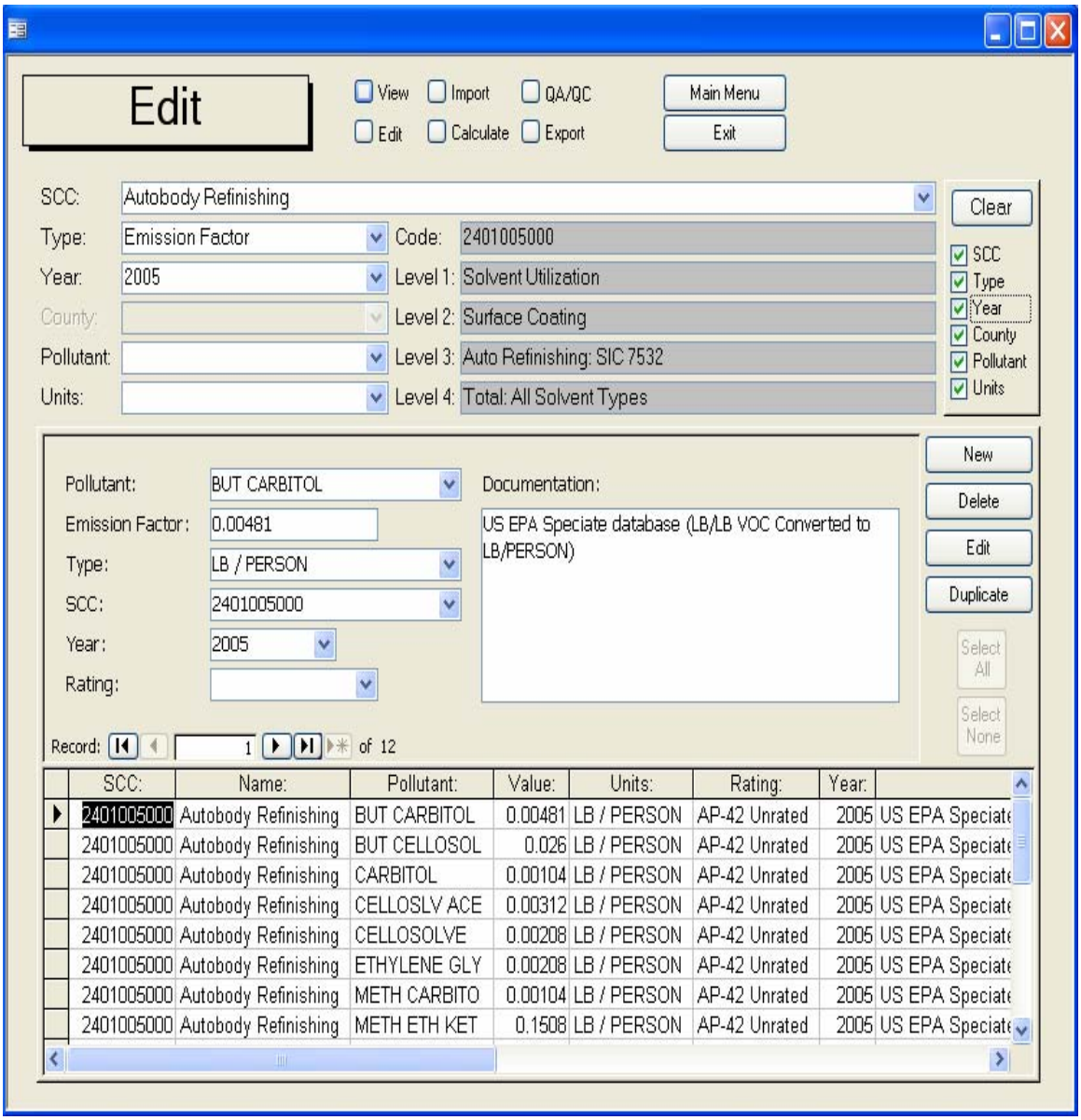
Figure 8. Main view form



Edit

To compliment the querying capabilities of the 'View' form, an additional form was incorporated to give more individual control of the database to the user. This 'Edit' form, shown in Figure 9, allows for easy manipulation of single records in the database. The user can add, modify, or subtract individual records in the database. This form also allows the user to duplicate records between inventory years. This is especially useful for Emission Factors, which may rarely change between inventory years.

Figure 9. Main edit form



TERTIARY

QA/QC

The Quality Assurance and Check form in the Area Source Calculator is used primarily for basic inspection of the integrity of the inventory data. To minimize overlap with other QA/QC programs, such as the NIF 3.1 Basic Format and Content Checker, the Area Source Calculator's QA/QC is extremely basic. It performs searches for duplicate records, empty records, negative activities, and negative emissions. Although these QA/QC functions could be expanded within the Area Source Calculator, most are best dealt with by U.S.EPA's QA/QC software.

Point Source Correction

Producing Area Source inventories independently of Point Source inventories can lead to double counting of emissions. To minimize this problem and produce a more accurate Area Source inventory, the Area Source Calculator includes a method to subtract the Point Source emissions from their corresponding Area Source SCCs. This is accomplished via a table that relates the Point Source SCCs to the Area Source SCCs where the Area Source Calculator deducts the facility reported emissions from the Area Source emissions

Back Up

The Area Source Calculator also can back up the records for a specific inventory year. This produces a new Microsoft Access Database file outside of the program that contains all the records and relevant information of a specific inventory year. This is intended to help archive inventory data when the database size approaches the 1 GB limit built into Microsoft Access Databases.

CONCLUSIONS

The Area Source Calculator takes a different approach to emission inventory creation than many other programs. It focuses on a simple method to produce Area Source emission inventories rather then trying to broadly account for all possible situations. This helps produce Area Source inventories in a fast and efficient manner. Finally, the calculator allows the users to devote more time in collecting activity data and deciding on the appropriateness of the emission factors rather than allocating resources to processing records. The advantages and disadvantaged of the calculator are summarized below.

Advantages

- Automation of repetitive tasks
- Easier management of data
- Simple estimation method
- Compatible with NIF V3.0
- Allows for low-risk experimentation in alternative inventory methods

Disadvantages

- Confined only to Area Source Inventories
- Does not eliminate all manual calculations
- May not be applicable to all inventoried SCCs
- Limited to Microsoft Office's 1 GB database size
- Not a web application

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KEY WORDS
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Emission Estimation
Database
Area Source
Nonpoint