Everything That Emission Factors/Emission Inventories Could Be

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ABSTRACT

One of the primary purposes of emission inventories is to provide inputs for air quality dispersion models. Over time these models, especially photochemical models, have become more demanding of emission inventories. Standard emission inventories do not provide the data necessary for models. Many models have preprocessors, programs that attempt to make up for the shortcomings of the emission inventories. This paper describes many of the elements of an emission inventory and discusses possible enhancements to improve the data used for modeling analyses.

INTRODUCTION

Air quality models demand emission inventory data typically not found in general inventories. Whether this is spatial or temporal allocation or speciation, assumptions usually must be made to prepare the inventory for model inputs. Much of this work is done by preprocessors, programs that attempt to provide information not found in the emission inventories.

Many of the data elements contained in emission inventories are discussed and improvements suggested. This paper is the opinion of the author. However, it is based on over 30 years of experience with emission inventories and dispersion models.

DATA ELEMENTS

This section describes many of the data elements that make up an emission inventory. Shortcomings are discussed and possible solutions offered.

Emission Factors

One size does not fit all. The development of an emission factor should depend upon the ultimate use of the emission factor. For example, if a state wished to determine the statewide total emissions for a specific source category, use of an average emission factor (i.e. a factor based on the average of all stack tests) is reasonable. However, if the emission factor is intended to establish an emission limit for an individual source, use of an average value is not reasonable. Use of the average means that there would be a fifty per cent chance that the source is exceeding the emission limit. When modeling studies

are carried out we need to know the emission rate for each stack as accurately as possible, use of average values is not appropriate.

Where possible, emission factors should be based upon unit specific source tests or data from continuous emission monitors (CEMs). Development of a data base that stores stack test results or summarized CEM data would allow individuals to make more informed determinations about the development of emission factors for a specific case.

It has always been assumed that emission rates vary linearly with throughput. We determine emission factors on a pound per ton or pounds per million cubic feet basis. However, is this always true? Some sources may operate more efficiently at higher loads, thus reducing the pound per ton values as the operation approaches capacity. Other sources may behave just the opposite. Where stack test data or CEM data is available, we should determine whether this assumption is universally true. Since air quality modeling is typically conducted with sources operating at capacity, it is important to accurately characterize emission rates at this level of operation.

Location

In today's world, with the widespread use of handheld global positioning systems (GPS), there is no reason that the locations of individual stacks at major sources should be inaccurately reflected in an emission inventory. However, I often find sources that are off by kilometers, sometimes tens of kilometers. Handheld GPS instruments cannot provide the accuracy needed to define the locations of individual stacks, but can be used to verify that they are close. Accurate definition must rely on scaled plot plans or digital representation using CADD software. An effort should be made to verify the location of stacks at major sources and to indicate in the inventory that the location has been verified.

Stack Parameters

Stack parameters, such as exit gas temperatures and air flow volume or exit gas velocity can vary with throughput level. However, most emission inventories allow storage of only one set of values. An exception is the Ohio EPA, which allows storage of maximum and minimum values for stack parameters. For combustion sources, this can be very important and certainly can impact modeled concentrations. Careful pairing of the appropriate emission rates and stack parameters is necessary to determine what a true worst-case condition actually is. Too often it is assumed that operation at maximum capacity is worst case. For non-combustion sources it would be useful to know whether air flow volume is controlled by a constant volume fan or varies with production level. The inventory should have an indicator that establishes this for each major source.

Hourly Emission Rates

For each major process it would be useful to know the typical operating schedule: what hour of the day it starts and stops, what days of the week it operates and how many weeks a year it operates. Preprocessors make this determination based on source type and the

information may be accurate in the aggregate. However, for an individual source or process the data can be highly inaccurate.

Reactivity

All VOCs (volatile organic compounds) are not equal. However, only a VOC total is maintained in most emission inventories. Preprocessors assign reactivity by industry profile. This process involves two sets of errors. First, it averages all sources in a category and applies an industry average to all sources in that category. Second, the profiles are typically based on historical surveys and are therefore out of date. Our company does a lot of work with foundries. Based on this work we have seen a large shift in the binders used by foundries. Over time the binders have become less reactive or toxic and are often used in less quantities per amount of product. However, it is unlikely that this information has found its way into the industry profiles used by most preprocessors. While it will be a large task, storage of actual VOC composition would improve modeling efforts for ozone and toxics.

Increment-Consuming Sources

Part of my job involves permitting of new sources or modifications at existing sources. This often includes Prevention of Significant Deterioration (PSD) analyses. A PSD analysis often involves dispersion modeling of other increment-consuming sources, usually within 50 kilometers of a new source. Where does an applicant or their consultant go to obtain this information? Too often the states point to a large stack of permit files and say good luck. A few states, such as Indiana, have made an attempt to produce such an inventory and make it available via the internet. While there are some problems with the Indiana database, it is a great start, usually not found in many other states. One concern in Indiana is the time it takes to get permits issued and such a database is a terrific benefit to applicants. If other states would adopt similar procedures it would help eliminate errors often made by applicants who are under severe time constraints. Since states have the ultimate responsibility to track increment consumption, having an accurate database would benefit everyone.

Allowable Emission Rates

Some modeling analyses need allowable emission rates, not actual emission rates. Where does someone get these emission rates; usually not from emission inventories. Allowable emission rates are often expressed in varying ways and it is important to understand the underlying state regulation that establishes the permit limit. For example, a source may have an emission limit expressed in pounds per hour. If the source is operating at half of rated capacity is it allowed the full pound per hour limit or only half of it? The answer can depend on the regulation. Many limits are expressed as pounds per ton or pounds per million BTU (British Thermal Units). In these cases, the allowable emission rate varies with the throughput. Some people want to use potential emission rates as allowable emission rates, yet they are different. If a source has a high allowable emission limit, but the potential emission rate cannot approach this limit, should the allowable be set to the

potential emission rate? The response often depends on whom you ask. Emission inventories need to include information that easily allows modelers to determine allowable emissions, if necessary at varying levels.

Plant Boundaries

Modeling studies often need information on the plant boundaries of other facilities. This information is rarely available. Screening modeling analyses, carried out to determine what other sources to include in refined modeling, often show modeled problems that are caused by placing receptors on plant property. At least for major sources, plant boundaries should be available as part of the emission inventory.

Building Dimensions

Permitting modeling analyses need to look at downwash, especially where stacks are short compared to nearby buildings. The Ohio EPA has some information available in a database for many sources. Other states should obtain and make this information readily available.

Terrain Elevations

Digital elevation models (DEMs) are typically used to estimate the terrain heights for receptors and building or stack locations. The files used to make these estimates may be based upon information that is 20 to 30 years old. If significant earthmoving/grading activities have occurred in the vicinity of a facility, it may be necessary to verify elevations, especially if the source has, or will have, short stacks.

Quality Assurance with Feedback

Emission inventories need to have quality assurance programs developed that will flag missing or suspect data. Too often emission inventories are missing UTM coordinates, stack heights, stack diameters, exit gas temperatures, or air flow estimates. All of these values are needed for modeling. Many times there are values in the inventory that are questionable. Using the diameter and air flow values in the Indiana emission inventory I have calculated exit velocities well below one meter per second and many times over 100 meters per second. Both extremes are questionable.

Sometimes these values are flagged by modeling preprocessor software and corrections are made to the modeling files. However, no corrections are made to the original emission inventory. When the next modeler comes along, the errors are still in the inventory. A system needs to be initiated that provides feedback to the inventory keepers to fix the problems found by preprocessors. Eventually many errors could be eliminated.

SUMMARY

If we were put on the witness stand and asked to state the status of emission inventories that form the basis of modeling input for regulation development and permitting, what would we say? If we stated that we were unsure about the exact location of stacks, the actual and allowable emission rates, stack parameters, the reactivity of the emissions, how emissions vary with time, whether the emissions consume PSD increment or not, where plant boundaries are located or what building dimensions might be, do we honestly feel that we would get a favorable judgment from an impartial jury? I don't think so. We can do better and need to get the process started now.