Needs for Conformity Between Test Methods for Health, Ambient and Emission Assessments (Factors); Some Shortfalls and Uncertainties

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Abstract

The air quality management process relies upon many standards. These standards upon result in determinations of levels that cause harm to humans and other receptors by test methods that are developed and utilized for the specific situation. Such methods may even be developed for special and unique applications that may not be replicated in other situations. Pollutants in ambient air are assessed using standards and methods developed under a separate set of circumstances that are very specific to conditions that exist in the ambient air. Still another set of methods/standards are used in sampling of emissions. In the development of a State Implementation Plan (SIP), the result of these different evaluation methods (which more often for emissions are reduced to the form of emission factors) are routinely incorporated into models operating with still different procedures and standards. The results of such efforts then are transformed into emission limits that may not fully conform to define the same exact pollutant that the original efforts to define the problem utilized and thus the 'prescription' to mitigate that problem may not be fulfilled.

This paper will discuss some typical and different interpretations in use across the spectrum of various levels of such measurement methods or standards. Errors, or misdirection, in analyses caused by such differences may sometimes be small but are likely of undetermined quantity. Incongruities and uncertainties may even vary by pollutant. For example, health based measurements in some cases are based upon a specific ion only, while in other cases the ambient measurement may quantify the mass of a complete compound in some cases and the ion in others. Policies and laws relating to emissions may then be stated in the form of the mass of the ion, or as the mass of the entire substance. In some cases such standards and the underlying testing requirements are completely ambiguous. The intent of this paper is to point out some such differences and to make suggestions and recommendations to sensitize users and those conducting testing such that the results are most useful. The importance of documentation and clarity will be a major point stressed. A major intent of the paper is to provide some guidance to the emission testing community that will enhance the use of the data produced for a somewhat secondary application of emission factor development.

Introduction

Much a attention, time and effort in the last two decades or so have gone into estimation and interpretation of uncertainties associated with emission estimates, risk assessments, modeling results and various other facets of the air quality management system. Such information is critical to a proper understanding of various results, though the precision and accuracy of methods used for such assessments themselves are also open to discussion and doubt. Until there are ‘hard’ data (such as from continuous emission monitoring) for every application, estimate or use, doubt will always, be a prevalent and deserved component of the process. Therefore an unquenched thirst for the various elusive truths should be continually encouraged and maintained. Every possible real world practical approach and every statistical approach should be pursued to provide the best sense possible as to how far the data available may have strayed from the ‘ground truth’ of reality. Though the emission inventory “will never be right, it is never wrong,” because it is often the best or only information available upon which to base assessments and emission control strategies.

Emission inventories have long been recognized as a cornerstone of air quality management.[1,2] Emission inventories are required in order to establish the sources, determine their relative ‘insults’ on the ambient air quality and to develop mitigation strategies for the reduction and management of these emissions, among other things. The emission inventory, though a basic and fundamental component of the process, is often overlooked.[3] Without a clear realization of the importance, the strengths and limitations of this tool, it is difficult to make intelligent decisions on the overall air quality strategies to be employed. Fundamental flaws in the organization of thought and approaches come together in the emission inventory and it can often become the lowest common denominator of communication. This is key to its importance and its use as a tool for analysis of the larger picture.

On several past occasions, this author has identified incongruities that can result in inaccuracies or other interjections of error. Some of those items are reviewed below, but the main focus of this paper is the measurement methods and methods of reporting test results that are used for emission factors. Measurements and standards are often defined by the methods established or specified to measure status against those standards because different measurement and analysis methods may not measure exactly the same thing and may even use different physical principles to accomplish the measurements. Thus the purpose of this paper is to stimulate new thought in the area of evaluating and assuring that ‘ambient’ data taken for health studies, ambient data taken for determination of genuine outdoor ambient levels and emission data taken for emission inventories/air quality simulation modeling are indeed targeting for the same pollutant, or at least close enough as to not introduce significant errors into the overall ‘air quality management systems model.’

Health effects studies often utilize personal monitors, specialized versions of ambient samplers or a unique laboratory method that was devised to fit the particular need. Though such methods may be based on sound science and exacting engineering specifications, it would likely be the rare case where that method would produce exactly the same result as another method. There seems always to be some physical law of nature that will be slightly different from one measurement system to another that makes the interchangeability of such methods and their resulting data be less than exact.

When sampling the ambient air, methods have been developed and adopted that also are repeatable and are designed to collect the theoretical particle, compound or substance, but actual measurement statistics and analyses may provide some subtle or distinct differences between instruments/methods and especially differences from the measures used in health studies and the emissions in a smoke stack.

"Exact"Emissions Concept

The Clean Air Act (CAA)[4], with its various amendments through 1990, has produced more and more programs that demand more and more "exactness" in quantification of emissions. The basic emission inventory of the 1970-era represented the knowingly "gross" emissions in a jurisdiction in an effort to define the relative impact of facilities, one to another. This provided a basis and rational to develop program(s) and efforts that would address and precipitate reductions in the appropriate groupings of facilities, for the correct pollutants and with an approximate fairness of application of the "pain" and economics of the resulting emission controls. As air quality management has evolved and become more refined, modeling has become extremely important and critical to the precision and "dependability" of the results. The 1990 Amendments to the CAA brought new levels of "expectation" for additional uses such as assessment of emission fees, emission trading programs and other such applications. Such efforts, the author believes, have been implemented without serious analysis and consideration of uncertainties and variabilities that are inherent.

Whether one is the payer of the payee of emission fees and trading transactions, it is critical that the "currency rate" and value be constant and reliable. One would not likely take a European vacation without knowing what the currency and exchange rates were and that they were expected to remain stable. One would not wish to have to renegotiate them on each occasion that one wished to make a purchase. This would soon lead to economic chaos and personal bankruptcy, or windfall wealth, depending on which side of these negotiations one could consistently maintain. Many papers have addressed the emission factor analogy to this situation. If one begins to look into the nature and precision of emission factors, they will soon discover that many factors are, by nature, very accurate and not in need of improvement or error analysis. However, many (and I contend that it is a majority) emission factors have a great deal of inherent variability[5].

Since the emission factor development and subsequent calculation of emissions does not have the luxury of even the odd questions having the correct answer "in the back of the book," one does not know what 'truth' is. In rare situations where there have been parametric tests funded, such as the multi-million dollar Canadian studies[6] on dioxin emissions from municipal incinerators in the 1980's, it becomes obvious to most even-casual observers that there are many variables that can make a difference in the generation and estimation of emissions. Factors such as design, maintenance, temperatures, control device selection and design, fuels, synergistic combinations of minor constituents of fuels, etc. can cause two fold and even 10-fold or more variation in emissions measured. Even measured data are often suspect and subject to errors[7] and concerns regarding validity, so how can emission estimates using average conditions as applied to another facility be any less of concern? The test method and procedures and the manner the data are reported are definitely important to the interpretation and use of the data.

There are about 250 major source categories in AP-42[8], and each source category averages about 3 major processes. There are about 50 or so source categories that are not amenable to parametric testing. Thus, one could reasonably estimate that about $ 6 Billion would be needed to test these facilities parametrically! This is a little less than the annual budget for all of the U.S. EPA! It is not likely that such monies will be allocated to complete such a level of testing and to develop the needed better emission factors and bring us to the ideal level of emission factor accuracy and precision. Even these levels would not necessarily answer all the questions and needs and especially could not guarantee that the test methods used would provide precisely the same output as would compare with health and ambient data.

Pollutants

Under the current legislation, there are basically two types of pollutants, "criteria," and "Hazardous." Criteria pollutants are so called because the associated National Ambient Air Quality Standards (NAAQS) are based on health effects criteria. Hazardous Air Pollutants (HAPs) are specifically listed pollutants in the Clean Air Act of 1990. Currently, there are 188 HAPs, but this number can increase or decrease through a regulation-specified listing/demisting process. Both criteria pollutants and HAPs are defined in legislation, however, there are many ambiguities in the definitions and test methods which can, and do, lead to incongruities that should be examined. Some of these come about because of the multiplicity of the parts of the Act that come to a common application point, the state agency and industry that may be under the active component of multiple regulations. A few examples of these are reviewed below.

Particulate Matter

Particulate matter (PM) may well provide the best example of potential incongruities or the confusion that this paper is attempting to address. PM was defined as total particulate or total suspended particulate (TSP) in the original NAAQS and was further defined by the test method; the high volume air sampler. The original sampler was little more than a vacuum cleaner in a box, sucking air through a filter. Due to the design of the box's lid and orientation of the box with respect to its lid, it was not a precise differentiator of particle size. Many regulators, if not scientists, have historically accepted approximately 30 micrometers particle size as the largest that would likely be picked up on the filter. However, rigorous studies have provided numbers ranging to 50 or even 100 micrometers as a cut-off under various wind conditions and orientations. However, no hi volume samplers were used in the laboratories and many of the health studies completed that were used in the development of the criteria documents and NAAQS for the pollutant defined. In parallel with this ambient uncertainty, the process was further complicated by the fact that it was impractical, if not impossible, to put a high volume air sampler into a stack and orient it in such a way to provide any meaningful relationship to what was being measured in the ambient air. Thus, the technical community came up with other ways to try to quantify the emissions from an emission source or stack. The method that gained the most acceptance was what became known as Method 5[9].

Method 5 provided (and still does) a standardized method to measure "total particulate matter" (not to be confused with Total Suspended Particulate) from stacks. It minimizes the impact of non-isokinetic factors on particles collected; it is reproducible; it is fairly inexpensive and straightforward and provides a means of quantifying what is going up the stack. However, it does not remove particles that are larger than 100, or 50, or 30 micrometers from the stream and measurement results include all particle sizes. Much of the smaller particulate matter will pass through the filter and some particles will be volatile and condense in the "back half" of the train instead of the front half filter.

With the advent of PM-10, and now PM-fine PM2.5), the differences in the application of the NSPS and NAAQS portions of the law are even further evident. To show compliance with the NSPS, one must still use the prescribed Method 5 without any differentiation of particle size. This does not mean that Method 5 is not appropriate for this purpose, as the underlying purpose of Method 5 in NSPS is to assure that equipment is working to the degree required, not to quantify the emissions on a scale that will relate to some subsequent concentration in the ambient air. This is not to imply that improving the ambient concentration of particulate matter of any size is not an underlying purpose and goal of NSPS, but that it is not connected in a quantifiable manner. What it does do is make it difficult to collect data that are useful in developing emission factors which show a one to one (or like to like) relationship from the source to the ambient sampler.

Ozone and Volatile Organic Matter (VOC)

Although there is a NAAQS for ozone, the emissions of volatile organic compounds (VOCs) and oxides of nitrogen are pollutants that must be controlled as precursors. Thus the test methods for VOC and NOx are not even apples and apples. VOC's are measured by methods[10] designed to define the lowest emission level that is desired from a gas stream. The methods to measure VOC's basically rely on flame ionization detectors and are responsive to methane in the air or that "created" by the method. The method does not accurately produce mass measurements[11] but responds differently to various carbon bonds and compounds to different degrees. In addition, these methods hardly respond to oxygenates and some other compounds at all. Therefore, we again find that a method that serves well for the purpose of assessing the performance of a piece of control equipment does not relate to quantifying (by calculation or estimation) the compound by compound emissions that come from the stack and serve in a one to one relationship between the emission control situation as related to ambient impacts.

The definition of VOC's as published in the Federal Register[12] excludes several compounds such as methane, ethane and others. Therefore these emissions are to be excluded from the emission inventories that facilities submit to an agency and which are then used to run photochemical simulation models. However, when the modelers prepare the data base for modeling, they speciate the inventory and then "reinject" estimates for these missing compounds, which are then recognized by the model and used in the photochemical simulations. Though they are not considered very reactive, they do have a role in the results and have a discernable impact somewhere down wind.

Hazardous Air Pollutants

Most HAPS are also particulate matter or VOC's, and occasionally both. The list of HAPs in the Act includes several "families" of compounds, such as for several heavy metals (This does not necessarily imply that heavy metal should be included as a family activity.). A computer search on a few of these will turn up several such families that include 150 to 250 compounds that are in common usage and included in the definition of the HAPs. It is no small undertaking to even identify what the specific compounds are that should be included in HAPs. Glycol ethers, for example, are in the Act along with a lengthy footnote which is fairly complex, except to a trained organic chemist, and even that footnote contains an error which has not been officially corrected (Being it is in the law, only Congress can make the technical correction

In many instances, it is difficult to determine what the chemical on the list actually is and how it should be reported. For example, several compounds on the list could be reported in terms of the basic component (such as HCl) or it could be reported on the basis of a hydrated aerosol (hydrochloric acid). Many times, one can make good assumptions, or the actual information may be hidden away somewhere in a federal regulation/Register, but the typical non-regulator may not have a clue as to what is being requested nor where to start looking for it unless he/she is told very directly. Even this may not make sense to the person in the context of daily work. Radio nuclides is another example of a HAP that is on the list, but there is no clue as to what the units of measure for reporting this pollutant should be.

Many compounds are potentially injurious to health but not on the list of 188. North Carolina's program, for example adds a few of these. This in no way makes a complete list. Even internal to the HAP list there is a specification of 2,3,7,8 tetrachlorodibenzo para dioxin (2,3,7,8 TCDD), but exclusion of the other isomers which are also of concern. At the same time, the sister furan compounds are listed as an entire family, not by individual isomer. This is just a sample of the incongruities involved in the HAP list which at some moments in time will need to be addressed by Congress.

In addition, Congress did not do a good job of defining chemicals or substances and groups that always make sense. Congress, in their wisdom and power, established a list of 189 (now 188) pollutants that they felt should be addressed; not forsaking all others, but effectively taking the focus away from others. If a specific isomer is stated in the CAA list, facilities reporting emissions will not likely be inclined to voluntarily report more. Differences such as this may often seem minor, but in the real world can cause many practical problems to implement and enforce.

Another pollutant-oriented issue that makes it difficult to be compliant with all inventory guidance relates to criteria pollutants. "VOC" is defined[13], for regulatory purposes, to exclude a number of specific compounds, including methane, ethane, acetone and other compounds with low photochemical reactivity. This effectively excludes them from record-keeping requirements at the facility level and the states do not generally ask for reporting of these compounds separately. However, when inventory input to photochemical models is generated, the fact that most or all of these compounds eventually have some reactivity somewhere, sometime, down stream, is recognized. This is then reflected in the reintroduction of large quantities of these compounds to the modeling inventory, based on speciation profiles or other secondary information. Consequently, the modeling is then done with a different set of emissions than submitted by the facility. As stated earlier, this generates a "disconnect" in the train of data legally provided by facilities. The resulting modeling version of the inventory is then utilized to analyze ozone development in the atmosphere.

Mass of Emissions

Mass of emissions of groups of compounds or substances is often a confusing issue and thus likely to be reported incorrectly. The list in the Act defines chromium compounds (and others). The mass of these compounds is to be reported. That is to say if the emissions to be reported are zinc chromate, for example, the reported quantity should be the entire mass. However, many risk assessment exercises depend upon risk information that is based on effects of the chromium ion. If you know the weight or mass of each individual compound, and what the compounds are, one can readily determine the mass attributable to the chromium ion. However, in many real world cases, there may be a mixture with several compounds, for which the specific identity of all the cat ions and anions may be unknown. Also, the Act says that in this example, the chromium metal, which is un-reacted should be included in the total. This is not likely to be a problem in many practical situations. Yet, if the emissions were significantly composed of un-reacted metal, the risk assessment would be additionally in error as metallic chromium is very un-reactive and less likely to be risk causal than a compound. In manufacturing operations where a single or a number of known compounds are being manufactured, it may be easy for the company to determine the exact compounds emitted. For others, such as combustion or for complex reactions, it may be unknown as to what those exact quantities are. Even testing and analysis, if there is a method, may be somewhat crude due to uncertainties. Fortunately, the chromium ion, in such an example, will normally be a large portion of the atomic weight of the compound such that such an introduction of error may not be of much consequence.

Risk Determinations

Each of the pollutants defined as HAPs will likely need to undergo a risk analysis of some level at some time. Those that are carcinogens are most likely to result in a numerical risk determinations facilitated by their having mathematically expressive unit risk factors. Risk evaluations, whether they are made for cumulative risk development or a more simplistic determination of whether they will cause immediate death or permanent injury, are all based upon an accepted ability to quantify pollutants. This is needed to determine what is the <u>cause</u>, and what is the <u>effect</u> of a certain substance on a living organism. This is ultimately equated to measures of human health, or to sustenance of life itself.

A pollutant may be analyzed with an expectation determined that it will cause risk in an animal or patient by sampling and analysis of body tissue, excretions or other fluids/parts. These concentrations may often be correlated with other data to be able to speculate upon the probability that another animal/patient will actually get a particular condition or disease. In this process, the researchers will use some procedure to make measurements. 'Such procedures may be accepted in that community, though this is not guaranteed. Most likely the method, which may be valid for the purpose developed and for the use to which it is put in this situation, will not be the same method used in the field to determine ambient levels. The ambient levels are often determined by separately developed methods which are intended to provide the best measure of the pollutant to which a target is being exposed. There may be little resemblance in the measurement and analysis methods. The averaging times may be significantly different. The capture mechanisms/principles of the samplers may be different. The collection media may differ. The analysis method will often vary.

Many of the differences will be a result of different ambient conditions from laboratory or clinical conditions. Concentrations are often a frequent determinant of methods to be used. In some cases, the relationships between the measurements in the clinical situation and the ambient measurements may be little more than coincidental. This is not to say that the relationships determined are erroneous or fraudulent, but there is sufficient uncertainty to warrant additional studies and documentation to provide assurance that scientific conclusions are valid and well supported by the appropriate data

Chemical Details, Methods and Terminology

How can you properly regulate what you can not properly measure? Health researchers traditionally use methods and instrumentation developed for hospitals, health research applications and pathogenic laboratories. Ambient monitors look at many of the same pollutants, but in a different manner using different sample collection techniques and analysis methods that provide regulatory capabilities. Source (stack) measurements are specified and defined by yet another set of constraints and instrumentation, methods and concentrations /[14]. When the people involved in these narrow specialties get together to talk about seemingly common problems and objectives, they often part company thinking they have communicated, but in reality, they may have totally misunderstood each other. To further aggravate these situations, the terms defined in the Act are loose and very vague in many cases. As indicated earlier, 188 compounds are listed in the Act. However, often the citations appear to refer to one compound (or group) or another but the terms leave substantial information gaps to the imagination and individual interpretation. Some examples are discussed below with conventions adopted by North Carolina's Department of Air Quality that have evolved from practical experience and common practices.

Mercury provides an example of potential miscommunication and misunderstanding. Mercury exists in the environment in many forms, each with different levels of risk. These forms range from metallic/elemental (liquid at ambient conditions) mercury to inorganic compounds that exist widely in the natural environment, to organic compounds of mercury, either formed naturally or with human design and assistance. Elemental mercury (vapor) is not hazard-free. However, it is found in measurable quantities all over the world. As much as one half of this "background" is attributable to open deposits of the element in the natural environment with the other half being traced to human activity, primarily related to mining and purification of gold. For years, metallic mercury has been readily available in circulation and commonly accessible with relatively little reason for grave concerns compared to other forms. Inorganic compounds on the other hand are often acute poisons and are definitely worthy of severe concerns for risk. Organic mercury compounds are also toxic, but more commonly associated with serious long-term cumulative effects. If one reports all of these on the same basis or as a combined mass it becomes a rather useless and meaningless statistic with no compatibility with other seemingly similar data.

On the list in the Act, Mercury is listed as “mercury and compounds.” Mercury is frequently measured and reported as concentration of mercury ions in the patient’s blood, by the health/clinical community. Ambient air concentrations are measured in the clinical community also, but will often be sampled by a different method than is used in the non-clinical community. For example, a small personal sampler consisting of a pump and filter of some sort may constitute part of the methodology to characterize individual exposure for relating ambient concentrations to blood levels. The sampling and analytical results from such devices will obviously be intended to equate to the ambient conditions, but the methods chosen as practical measures for quantifying continuous ambient conditions will likely be different in one or more important aspects. Good science will be suspicious of any change in methods no matter how subtle, and require extensive validation that there is no difference in results and equivalency. The point here is that assumptions are made and perhaps reasonable relations are made and conclusions drawn, but on a regulatory and legal implementation, there are variations that may be reasonably challenged as not being congruent with reality.

Chromium is, of course, another metal with some of the same problems as mercury. It is also very resistant to oxidation and chemical activity. This is why it is often used as a decorative and/or protective coating. Its compounds have many uses ranging from plating to paints to pharmaceuticals and a plethora of other products. The chemical valance of chromium compounds has been found as extremely important with regard to toxicity and cancer risk. “Chromium compounds” is the listing in the Act with no specification of valance. However, a footnote to the list indicates that any listed substance containing the word “compounds” includes “any unique chemical substance that contains the named chemical. This includes the element/metal chromium itself. Therefore, the legal requirement again seems to become a rather useless term for any risk or health-impact evaluation purposes.

Other metals are identified in the HAP list that fit essentially the same pattern. For example, Antimony, Arsenic, Beryllium, Cadmium, Cobalt, Manganese, Nickel and Selenium “compounds” are listed and again the footnote in the Act applies that makes the metal itself part of the compounds. These metals cover a range of elemental toxicity, but most of them are recognized as having negative health effects at the elemental level. The health effects of the compounds are likely to be even more variable. Therefore the North Carolina DAQ’s scheme is still to list these separately at the elemental level, as a total for compounds, and as individual compounds which may or may not be specifically listed on the HAP list in the Act.

Glycol Ethers Ii an entry on the list of 188 with a footnote that few if any legislators likely understood when they passed the Act. Even many chemists not dealing daily in this area may have a hard time understanding the definition and determining what specific glycol ethers, out of hundreds of potential possibilities, are included. Since many of these compounds are used in the furniture industry in North Carolina, this has often a perplexing problem for plant operators and Division of Air Quality (DAQ) staff. The DAQ Toxics Protection Branch chemists have developed a specific searchable list that is now on a web page for use by interested parties (http://daq.state.nc.us/Offices/Technical/Toxics/tri/glycolethers.html). A paper copy of the complete list of all common compounds that fit the HAP definition is also available. EPA more recently has put further guidance and listings on their web page also.

Lead Compounds are both a criteria pollutant and on the list of HAPS. Again, this is a potentially confusing double-barreled approach. The major result of this listing situation for NC is that lead is included in the inventory in pounds instead of as tons. It is not usually emitted in large quantities, given that North Carolina has no primary lead facilities. Being a metal, elemental lead and lead compounds are separately listed and available for combination to meet the definition in the Act. Also, individual compounds are to be listed separately to presumably add up to the total of the compounds.

"Phosphorus" is one of those substances on the list that just doesn't make uch sense the way it is listed! Certainly, many phosphorus compounds are toxic (phosphine, which is separately listed is a clear example), but the Act lists the element separately without specifying compounds. Elemental phosphorus can not actually exist in an ambient air situation for long as it combines with moisture in the air and can auto-ignite (emissions of hot hydrogen gas). If one were to inhale particles of elemental phosphorous, there would be an immediate vigorous reaction with the moisture in the body. This would perhaps result in rather dire consequences, but this sort of hazard is also provided by many other substances that are not on the list. If/when the Act is revisited, this is definitely a high candidate for reconsideration and a separate treatment!

These are but just a few examples but show a pattern that needs to be addressed and fixed. The discussions that follow are intended to get that discussion rolling.

Desirable Templates for Stack Testing and Emission Factor Developments

We contend that there are problems defining and difficulties communicating what is being emitted from a stack. What is the solution to this problem? A start would be to develop a template or set of rules to invoke whenever testing is done, whether for compliance or another purpose. Of course, the problem of funding may tend to interfere with such activities, but the identification and quantification of what is being emitted from a facility is well established as the responsibility of the emitter and is generally a condition of that facility being allowed to operate and eject pollutants into the public air.

A 'starter list' of such rules, or template, is initiated below:

- ✓ The person in charge of the test should be required to conduct a careful and thorough analysis of the chemistry of the process(es) involved to establish what pollutants are likely and even possible to be emitted. Available test data may help with this process, but such existing data should not limit the analysis of what pollutants might likely be emitted to exclude substances that have never been analyzed for before.
- ✓ A screening analysis of substances emitted should be undertaken before a final list of pollutants is determined. Things on this list may not be limited to the current list of

pollutants in AP-42 or the CAA, but take into account what substances are present that may be suspect of interactions or potentially forming other toxic compounds.

- ✓ Design the analysis plan to determine the species, including the isomers that are part of total groups, etc.
  - For inorganic compounds, the test plan should include attempt to quantify the cations and anions and provide the association of the two from the best science based assumptions possible – with full disclosure of the assumptions made.
  - Establish a list of de minimus emission rates at the state, local or federal level and determine what the corresponding emission rate required to maintain a rate below that level is required (i.e., below what level does it become "unimportant?" Establish detection levels based on or below this minimum target.
  - If an element or compound is below detection, be sure to say so and define the level of minimum detection estimated existed during the test.
  - For organic compounds, some screening and surveillance analyses (e.g., gas chromatograph - mass spectrometer) should be included that will provide identification and speciation of all expected or potential HAPs and no less than 90% of the mass of the total emissions. Use these screens to determine the analytical plan for the main analyses to perform on a more routine basis.
  - Provide output of such analyses in the reports that clearly allows users of the data to determine what the various methods of reporting are used. For example, is the weight of the metal ion reported or the entire compound?
- ✓ Carefully monitor the process/production variables and rates during the test. Determine those that most effect the emissions and carefully relate the two when possible. The emissions from the stack represent only a portion of the solution and the detailed internal relationships to the process <u>must</u> be defined.
  - Report on the basis of raw material/input.
  - Report on the basis of product/output.
  - If energy related, the emissions should also be reported on the basis of the heat input/output.
  - Report operation rate before, and during the test.
  - Report design parameters and conditions relative to those parameters during the test.
  - Provide detailed information on the control devices and operating parameters.
  - If at all possible, provide 'before-and-after-controls' test results.
- ✓ EPA should consider establishing a fund to assist in paying for supplemental tests beyond that which might normally have been required for compliance purposes with state or local regulations.
  - These funds could be considered as a 'bounty' and would be provided in excess of the cost to complete the specific added tests as an incentive for more good testing to be done.
  - The submittal of the data/results to EPA would be required.
  - States would be allowed to administer these as a grant with authority to make decisions on what the priorities were for administering the funding to the facilities or their testing consultants.

- EPA should design a reporting template for the data to be reported and allow provision of such data via paper, disk or other electronic means into a central archival database that could be accessed and searched by states, facilities, consultants and others for use in generalized emission factor development or developing a basis for a facility-specific emission estimate.

✓ EPA should consider establishing a "user group" of federal, state and local agency representatives to
  - further develop and refine a list of requirements to be considered in testing situations and to
  - further define a process for grants and bounties to enable the collection and reporting of these data, and
  - to establish a means of notification and opportunity enhancement for communities to be able to work together to get better information on an industry together that will be better and less expensive than with them working alone in a vacuum.

Conclusions

This author has presented several related evolving but related treatises[15 16 17] on topics similar or related to this one at emission inventory conferences in the past few years. They have been intended to stimulate original and innovative thought and to encourage the reader to evaluate the practical aspects of the related issues. This discussion and suggestions provided for conduct and reporting of future testing for emission factor development are intended to begin the process of integrating the emission factor development process more closely with the emission testing processes. The net result should be more complete and consistent data to use to try to reach more advanced goals in the processes of air quality management.

The paper also suggests some basic tenants of a proposed template to be used universally for testing by private, state, local and federal testing to assure the maximum usefulness of the data, a panel to help refine the process for such a change in testing protocols and a means to motivate and reimburse some of the expenses that might be required due to additional requirements and testing needs. Further, such a panel should be charged with further evaluation of methods and procedures which would further evaluate specific methods in the ambient, health effects and stack arenas to assure that they are generally measuring the same things within an acceptable (to be determined) range.

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