



Appendix C

R&D Laboratories Position Paper

Department of Risk Management

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July 9, 1997

Air and Radiation Docket and Information Center (6102)
Attention: Docket No. A-97-11, U.S.
Environmental Protection Agency
401 M. Street, SW
Washington, D.C. 20460

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RE: Comments on Advance Notice of Proposed Rulemaking (ANPR) for Section 112(c)(7), Clean Air Act

Ladies and Gentlemen:

The University of Arizona (UofA) is pleased to offer comments to the EPA regarding the regulation of research and development (R&D) laboratories as a source category under Section 112 of the Act. On the basis of three years of research on this issue, we respectfully submit that no source category should be listed and no MACT standard should be developed for university R&D laboratories because these laboratories are not a significant source of regulated air pollutants.¹

Since 1994, the UofA has carefully evaluated the issue of university laboratory emissions by compiling data for an operating permit application under Title V. The UofA developed a statistical survey approach to quantify potential emissions based on chemical usage, waste information, laboratory square footage, and the number of research laboratories on campus. Teaching laboratories were exempted from the study. The approach and the survey form were reviewed and approved by the Pima County Department of Environmental Quality.

The UofA conducted its survey in 55 randomly selected laboratories. A site-specific emission factor was developed after data were compiled in a relational database and assessed for consistency and quality. Following these quality control activities, the emission factor was applied to over 700 laboratories on campus to estimate potential emissions. In addition, the UofA identified and applied emission factors from studies conducted at two other universities in order to compare the results and evaluate the broader context of potential emissions from laboratory sources. At the same time, the UofA also conducted a thorough review of existing regulatory guidance and policy documents on the subject of R&D laboratories.

¹ Our comments are specifically targeted to university laboratories although we strongly suspect that our research and findings may be applicable to other types of laboratories as well.

The following findings and assessments are the basis for the UofA's comment:

1. The federal potential-to-emit (PTE) criterion was designed to address full capacities of production and manufacturing operations.
2. Actual chemical usage in university R&D laboratories is de minimis, diverse and somewhat random in response to varying research activities. Production scenarios and their associated "capacities" do not apply to R&D facilities.
3. The EPA acknowledges this distinction in the ANPR.
4. When applied to university R&D laboratories, the use of the PTE criterion far overstates the true potential of such laboratories to emit regulated air pollutants.
5. Publicly funded universities with R&D laboratories are financially constrained from ever operating at PTE levels by limited budget appropriations and federal research grants.
6. R&D laboratories at universities are not expected to be major sources of regulated air pollutants despite the estimates that are generated when the PTE criterion is applied.
7. These laboratories are already subject to best management practices that reduce potential emissions through OSHA requirements in 29 Code of Federal Regulations 1910.1450, Occupational Exposures to Hazardous Chemicals in Laboratories. This regulation requires facilities to prepare and maintain a written Chemical Hygiene Plan which governs appropriate handling of chemicals to control airborne releases and protect employees from exposure.
8. The level of effort and expense required to estimate emissions from university R&D laboratories is significant and is not cost-effective on an annual basis, given the relatively small amount of emissions generated. The UofA statistical survey directly involved less than 10% of its total number of laboratories yet required four months to administer.

The UofA presents its position paper in support of these comments as Attachment 1, entitled, "University of Arizona Position Paper on the Regulation and Calculation of Actual and Potential Emissions from University Laboratories to Determine Source Status under the Clean Air Act", July 1997.

We appreciate the opportunity to provide these comments to the EPA and invite you to contact us at (520) 621-1790 or sholland@u.arizona.edu with any questions.

EPA Docket No. A-97-11, U.S.
July 7, 1997

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Best wishes on your efforts to assess this critical issue.

Sincerely,



Steven C. Holland, M.S., ARM
Director of Risk Management and Safety

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**University of Arizona Position Paper
on the Regulation and Calculation of Actual and Potential Emissions
from University Laboratories to Determine Source Status under the
Clean Air Act**

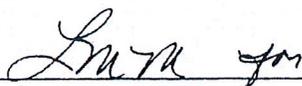
TUCSON, ARIZONA

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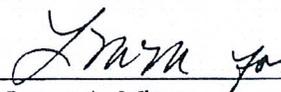
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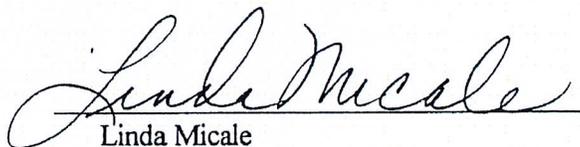


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1 OVERVIEW AND PURPOSE OF DOCUMENT

Beginning in 1994, the University of Arizona (UofA) initiated a major undertaking to estimate laboratory emissions and collect related information in support of its Part 70 permit application under the Clean Air Act Amendments and the Pima County Code, Title 17. The University of Arizona contracted with EMCON, formerly Micalc Regulatory, Inc., to develop a laboratory emissions estimate based on a statistical survey approach. It was approved by the Pima County Department of Environmental Quality (PDEQ) for the purpose of compiling data for the permit application in 1995. The statistical survey included only research laboratories and exempted teaching laboratories since chemical use was assumed to be insubstantial and lower than emissions from research laboratories.

The survey was developed to estimate the laboratories' potential to emit (PTE) for regulated air pollutants in accordance with the current federal definition. The term "PTE", strictly applied, requires that actual emissions be extrapolated for seven days per week and 24 hours per day unless there is a physical design constraint or federally enforceable control to limit this full potential. In the course of this survey, It was determined that the amount of chemicals used in each laboratory is minuscule in comparison to an industrial-scale operation. Chemical use in research laboratories may vary by types of experiment, day of the week, class hour, and semester. Other Universities were contacted to learn how they developed emission factors to address the same issue. The results of these efforts underscored that the purpose of the laboratories is academic research, and as such, they are not designed for 24-hour, seven days per week production activities. Moreover, due to the nature and diversity of laboratory experiments, it may be impossible to estimate emissions for laboratories over the course of a month, one year, and , certainly, the five-year life of the air permit. Based on our field experience and information from

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the surveys, we concluded that it is inherently inaccurate to apply a manufacturing style "capacity" to the activities of these laboratories.

Following the survey, policy documents and proposals were reviewed by the Environmental Protection Agency (EPA) to gain perspective on that agency's intent to regulate an academic research and development (R&D) laboratory. The EPA documents pointed out that R&D facilities and, specifically, laboratories should not be treated like a manufacturing facility. Just as the UofA laboratory survey process confirmed, these documents acknowledged that laboratories do not function at the level or capacity of manufacturing equipment, which is designed to function at production levels. To date, no final rule on this issue has been promulgated.

Lacking a final rule, a formally published emission factor associated with "laboratories", "research and development" or other associated term that could be directly applied to the laboratories at the UofA. In addition, to date, there are no known applicable Pima County State Implementation Plan (SIP) requirements for R&D activities and therefore, the UofA suspects that most of its laboratories fall within the intent of the EPA for reduced regulations of minor or trivial R&D facilities. Further, there is no Maximum Achievable Control Technology (MACT) for laboratories to establish what practices or controls are likely to become permit conditions.

On the basis of these efforts, the UofA proposes that University laboratories should not be required to estimate potential emissions in the same manner as a manufacturing facility. The intent of this paper is:

- To examine the different EPA documents that indicate EPA's intent to regulate laboratories in an R&D setting.
- To describe efforts to develop an emission factor that reflects emissions at the UofA's laboratories.

- To demonstrate that laboratories at a University could not emit at a manufacturer's potential to emit level.
- To propose that the Arizona Revised Statutes be amended so that laboratory emissions from educational institutions are regulated as insignificant activities so long as "good laboratory practices" are documented and implemented for these laboratories.

2 REGULATORY REVIEW

2.1 Definition of a University Laboratory

The following text is the UofA's written description defining a laboratory from the University of Arizona's Chemical Hygiene Plan and from OSHA regulations in 29 CFR 1910.1450. The plan is a procedural manual pertaining to chemical hygiene and safety at the University of Arizona and outlines those procedures to be followed for operations performed in a laboratory. The following definitions help to clarify how chemical usage in a laboratory research and development facility differs from a production-based facility.

Definition of a "Laboratory": "Laboratory" means a facility where the "laboratory use of hazardous chemicals" occurs. It is a workplace where relatively small quantities of "hazardous chemicals" are used on a non-production basis.

"Laboratory use of hazardous chemicals" means handling or use of such chemicals in which all of the following conditions are met: chemical manipulations are carried out on a "laboratory scale;" multiple chemical procedures or chemicals are used; the procedures involved are not part of a production process; and protective laboratory practices and equipment are available and in common use to minimize the potential for employee exposure to "hazardous chemicals."

"Hazardous chemicals" refers to any element, compound or mixture of elements and/or compounds which are a physical or health hazard .

"Laboratory scale" means work weight substances in which the containers used for reactions, transfers, and other handling of substances are designed to be easily and safely manipulated by one person. "Laboratory scale" excludes those workplaces whose function is to produce commercial quantities of materials.

2.2 Regulations Relating to Research and Development

Under Section 112 (c) (7) of the Clean Air Act, the EPA is mandated to establish a separate regulation covering research or laboratory facilities, "as necessary to assure the equitable treatment of such facilities". The EPA has recently addressed this mandate in an Advance Notice of Proposed Rulemaking dated May 12, 1997.¹ This notice provided advance notice that the EPA intends to list R&D facilities. In addition, several other EPA documents were examined to present the evolving policy considerations on laboratories. For example, a July 21, 1992 Federal Register Final Rule on Operating Permit Programs contains two sections entitled "Operational Flexibility" and "Definition of Major Stationary Source" where the Synthetic Organic Chemical Manufacturer's Association (SOCMA) raised concerns about operational flexibility under Title V.² Other commentators including batch processors, such as pharmaceutical or specialty chemical producers, raised concerns about the need for permit flexibility in relation to research and development (R&D) operations. Although the EPA did not exempt R&D operations from Title V requirements at that time, it stated that in many cases States will have the flexibility to treat an R&D facility as separate from the manufacturing facility with which it is co-located. Under this approach, the facility would be treated as though it were a separate source and would then be required to have a Title V permit only if the R&D facility itself would be a major source. No examples of actual facilities were given.

¹ USEPA, Vol. 62, No. 91, Federal Register 25877, May 12, 1997, Advance notice of Proposed Rulemaking - National Emission Standards for Hazardous Air Pollutants: Source Category List.

² USEPA, Vol. 57, No. 140, Federal Register 32250, July 21, 1992, Operating Permit Program, pages 32264-69.

In an August 31, 1995 Federal Register Proposed Rule on Streamlined Procedures for Federal and State Operating Permits Programs³, Title I and V permitting requirements are clarified for non-major R&D facilities that are located with sources that are major. This proposed rule is specifically addressing industrial R&D sources. The EPA states that "non-major R&D activities located with a source that is major under Section 112 or 302(j) of the Clean Air Act (Act) or parts C or D of Title I of the Act need not be considered part of that major source. Depending on the extent to which a non-major R&D facility contributes to the activity of the major source, the R&D facility need not be subject to permitting."

The EPA also states that R&D operations typically entail the use of small quantities of chemicals manipulated and released in a highly variable manner, and that these attributes are present at R&D operations to a degree that distinguishes them from other source categories. The EPA gives an example:

A relatively very large R&D facility employing 3,000 people in a 2 million square foot complex was comprehensively tested for its air emissions. Approximately 40 stacks fed by 600 laboratories involving potentially over a thousand operations were sampled for a 6 to 8 hour duration over a 2 day period. Results of subsequent analyses showed that even if this level of operation as tested were maintained day and night for an entire year the predicted actual emissions of all VOC compounds would be less than 12 tpy.⁴

The EPA further recognizes that, because of these unique combinations of attributes, bringing co-located, non-major R&D facilities into Part 70 permitting⁵ could potentially lead to difficult exercises in emissions estimating and tracking and impose additional monitoring and recordkeeping requirements.

³USEPA, Vol. 60, No. 169, Federal Register 45530, August 31, 1995, Operating Permits Program and Federal Operating Permits Program, page 45530.

⁴Ibid, page 45557.

⁵Part 70 refers to 40 CFR Part 70 for federal permit regulations that implements Title V of the Clean Air Act.

Also, mentioned in this Federal Register is the R&D operations' difficulty in calculating PTE. A source must calculate PTE from an R&D operation to determine whether it is major.

In light of the difficulty of performing emission calculations and the data gathered by the EPA to date, which indicates that even large R&D facilities tend to have very low actual emissions, EPA considers it of little benefit to require R&D facilities to go through extensive efforts in calculating PTE. Permitting authorities will bear primary responsibility for requiring determination of the PTE of individual R&D facilities and EPA intends to generally defer to these judgments. Given the small likelihood that any R&D operation will be major, EPA believes permitting authorities should accept methods of calculating PTE from R&D operations that are not unduly burdensome on the source.⁶

According to this Federal Register, some have commented that

deriving a numerical PTE calculation from an R&D activity is simply not possible, because experiments are typically performed only once or a few times, meaning that past emissions are at best a poor indicator of the future. The EPA is unsure whether this renders PTE calculations strictly impossible, but acknowledges a high degree of difficulty. The EPA believes R&D may present a case suitable for a de minimis exception from the statutory requirement to calculate PTE, because emissions are so low as to yield a gain of trivial or no value compared to the difficulty associated with their measurement. Additional comment is solicited in whether such an exception would be appropriate, and more generally on the availability of cost-effective means of calculating PTE from R&D activities.⁷

⁶USEPA, Vol. 60, No. 169, Federal Register 45530, August 31, 1995, Operating Permits Program and Federal Operating Permits Program, page 45558.

⁷ *ibid*

The UofA commented on this proposed rule in the fall of 1995.⁸ The UofA supports the EPA's opinions on R&D activities and suggested that they include educational laboratories devoted to teaching, research grants, and clinical studies to the R&D activities already discussed. The UofA also characterized its R&D activities.

As of this date, only an Advance Notice of Proposed Rulemaking has appeared in the Federal Register. It is unclear how long it will take to promulgate a final rule and whether or not the EPA will choose to include educational laboratories as an R&D activity.

A December 27, 1996 Federal Register Final Rule on "Hazardous Air Pollutants: Regulations Governing Constructed or Reconstructed Major Sources" also contains a section regarding R&D facilities.⁹ This Federal Register promulgates certain provisions of Section 112(g) of the Clean Air Act or 40 CFR Part 63. It states that Section 112 (g) "applies to the owner or operator of a constructed, reconstructed, or modified major source". To date, Section 112(g) does not apply to the UofA. However, this rule provides an exclusion for sources in source categories which have been deleted by the EPA from the source category list for standards (57 FR 31576, July 16, 1992). These sources are excluded because for any such category the EPA will have determined that Maximum Achievable Control Technology (MACT) should not apply. R&D facilities that meet the following definition are one of the source categories that are exempted. The definition from 40 CFR Part 63.41 is:

Research and development activities means activities conducted at a research or laboratory facility whose primary purpose is to conduct research and development into new processes and products, where such source is operated under the close supervision of technically trained personnel and is not engaged in the manufacture of products for sale or exchange for commercial profit, except in a de minimis manner.

⁸University of Arizona letter from Steven Holland, Department of Risk Management, to Michael Trutna, USEPA, October 26, 1995, RE: Comments on Proposed Rule: Clean Air Act: Federal and State Operating Permits

⁹USEPA, Vol. 61, No. 250, Federal Register 68383, December 27, 1996, pp. 68383-88.

The proposed Section 112(g) rule requested comment on whether to provide this exclusion, and the EPA received significant comment in favor of providing it, based on the potential resource burden of reviewing operations which by design change frequently and do not produce a product for commercial use. According to this Federal Register, the Title V operating permit program has issued a policy memorandum aimed at reducing the permit requirements for R&D facilities. No references were provided to indicate the title or date of the policy memorandum.¹⁰ Numerous attempts were made to contact the EPA by phone and e-mail to identify the title or date of this policy memorandum, as well as discuss the topic of laboratory emissions at universities. No response was received.

2.3 The EPA's White Paper for Streamlined Development of Part 70 Permit Applications

On July 10, 1995, the EPA issued a guidance entitled, "EPA White Paper for Streamlined Development of Part 70 Permit Applications" (White Paper).¹¹ The purpose of the White Paper was to enable States to take immediate steps to reduce the costs of preparing and reviewing initial Part 70 permit applications by clarifying the requirements. In relation to the UofA's air permit and laboratories in particular, the White Paper encourages the use of:

1. *Tons per year (tpy) estimates for emission units and pollutant combinations subject to applicable requirements, and only where meaningful to do so; such estimates can be based on generally-available information rather than new studies or testing.*¹²

Wherever emission estimates are needed (unless the source independently decides to more accurately estimate emissions), use of available information should suffice. Any information that is sufficient to support a reasonable belief as to compliance or the

¹⁰ Ibid, p. 68388.

¹¹ USEPA, "EPA White Paper for Streamlined Development of Part 70 Permit Applications", Office of Air Quality Planning and Standards, July 10, 1995.

¹² Ibid, page 2.

applicability or non-applicability of requirements will be acceptable for these purposes. That could include AP-42 emission factors, emission factors in other EPA documents, or reasonable engineering projections, as well as test data.¹³

EMCON and the UofA exercised extreme due diligence in compiling data from laboratories for its emissions factors. Refer to the Section titled "Emission Estimation Procedures" of this document for a detailed description of the data compilation methods. The statement that "any information that is sufficient to support a reasonable belief as to compliance" supports the UofA in its attempt to define its own emission parameters for laboratories. Note again that the UofA's emissions estimating approach was approved by PDEQ.¹⁴

2. *Exclusions for certain trivial activities from permit applications.*¹⁵

40 CFR Part 70.5(c) allows the Administrator to approve as part of a State program a list of insignificant activities which need not be included in permit applications. For activities on the list, applicants may exclude from Part 70 permit applications information that is not needed to determine (1) which applicable requirements apply, (2) whether the source is in compliance with applicable requirements, or (3) whether the source is major. The application, however, must describe any such activities at the source in a list.¹⁶

In the White Paper, the EPA also provides a list of activities that may be treated as "trivial" that may include certain activities that are not already listed as "insignificant", but

¹³Ibid, page 6.

¹⁴Pima County Department of Environmental Quality, Letter from Richard Grimaldi to Steve Holland, March 30, 1995 Re: University Laboratory Emission Estimating Approach.

¹⁵USEPA, "EPA White Paper for Streamlined Development of Part 70 Permit Applications", Office of Air Quality Planning and Standards, July 10, 1995, page 2.

¹⁶Ibid, page 7.

that are emission units and activities without specific applicable requirements and with extremely small emissions¹⁷. Three "trivial" activities from this list that could be applied to the UofA's laboratories include:¹⁸

- Bench-scale laboratory equipment used for physical or chemical analysis, but not laboratory fume hood or vents.¹⁹
- Routine calibration and maintenance of laboratory equipment or other analytical instruments.
- Equipment used for quality control/assurance or inspection purposes, including sampling equipment used to withdraw materials for analysis.

The concept of laboratory equipment being classified as a trivial activity can be applied at least in part, to the UofA's laboratories. It would benefit the air permit application if this type of equipment could be grouped and listed. However, there are additional activities other than these three trivial activities that occur at the UofA's laboratories.

3. *Research and Development Activities*

The White Paper²⁰ states that the EPA expects that many R&D activities will generally be exempt from Part 70 and not be involved in the Part 70 application process since they are typically independent, non-major sources. However, some R&D activities can still be

¹⁷Ibid

¹⁸Ibid, Pages 23-25.

¹⁹According to the White Paper, many laboratory fume hoods or vents might qualify for treatment as insignificant (depending on the applicable State Implementation Plan) or be grouped together for purposes of description. According to Dick Lemon, PDEQ, fume hoods are not permitted, it is the activity that occurs under the fume hood that is permitted. The fume hood is an equipment reference point.

²⁰USEPA, "EPA White Paper for Streamlined Development of Part 70 Permit Applications", Office of Air Quality Planning and Standards, July 10, 1995, page 13.

subject to Part 70 because they are either individually major or a support facility making significant contributions to the product of a co-located major manufacturing facility. Based on a discussion with PDEQ on December 20, 1995, if a source is major or near a major source threshold, PDEQ is interested in reviewing potential emission from units or activities that would otherwise be insignificant. The concern is whether or not other applicable requirements are triggered for the facility as a whole. However, if the source is not major then some activities can be considered insignificant per Pima County Code Title 17.12.160 (E)(8):

Activities which are insignificant shall be listed in the application. The application need not provide emissions data regarding insignificant activities. If the control officer determines that an activity listed as insignificant is not insignificant, the control officer shall notify the applicant in writing and specify additional information required.

The White Paper also states that laboratory activities which involve environmental and quality assurance/quality control sample analysis, as well as R&D, present similar permitting problems. Such activities should be eligible for classification as an insignificant activity if there are no applicable State Implementation Plan (SIP) requirements. Where applicable SIP requirements do apply, they typically consist of "work practice" (e.g. good laboratory practice) requirements. In this situation, permit applications would need to contain only statements acknowledging the applicability of, and certifying compliance with, these work practice requirements. There is no need for an extensive inventory of chemicals and activities or a detailed description of emissions from the R&D or laboratory activity. Similarly, there would be no need to monitor emissions as a Part 70 permit responsibility.

The UofA has spent a considerable amount of time and resources to collect laboratory emissions and activities information, as described in Section 3 of this paper. As a result,

the UofA believes that the above statement concerning R&D activities to be true of its laboratories. The amount of chemicals used in the laboratories in comparison to an industrial-scale operation is minuscule. The purpose of those laboratories is academic research and teaching, and as such, they are not designed for 24-hours, seven days per week applications. It is inherently inaccurate to apply a "capacity " to the activities of these laboratories. In addition, there are no known applicable Pima County SIP requirements for R&D activities and therefore, the UofA suspects that most of its laboratories fall within the intent of the EPA for reduced regulation of minor or trivial R&D facilities.

2.4 Regulatory Guidance Relating to Potential to Emit and Batch Chemical Production Operations

The Synthetic Organic Chemical Manufacturer's Association (SOCMA) provided the EPA with what it determined to be an appropriate methodology for estimating PTE for batch chemical production operations. Although the UofA is not a "batch chemical production operator", this memorandum provides the UofA with some important concepts in regards to its laboratory emissions. Calculating the PTE for a batch chemical production facility is difficult due to variations in equipment usage process sequence, the amount of time the equipment is in operation, and the products produced. Batch chemical production operations are those in which raw materials are charged into the system at the beginning of the process, and the products are removed all at once at the end of the process. The production occurs in discrete batches, rather than as a continuous process in which raw materials are continuously being fed, and products continuously being removed. Moreover, the addition of raw material and withdrawal of product do not occur simultaneously in a batch operation. Systems in batch chemical operations consist of a variety of equipment arranged in a series. The series and the time each piece of equipment is in operation may change with each different product produced or production cycle.

The EPA agrees with the SOCMA that in calculating the PTE for batch chemical operations, it is not necessary to determine the maximum emissions for a worst-case hour of operation, and to

multiply that value times 8,760.²¹ It is stated in the guidance memorandum that it is physically impossible for the process to sustain the worst-case hourly emission rate over the entire batch and so the EPA deems it appropriate to take into account variations in the emissions rate over the course of each production cycle. Worst-case emissions may be determined by deriving an average rate over an entire production cycle and emissions may be calculated based on the greatest number of batches that could occur in a year's time. The EPA accepted this methodology as long as it incorporates an appropriate list of products and raw materials.

Batch chemical production operations and the UofA's laboratories are similar primarily in that the laboratories cannot physically sustain the worst-case hourly emission rate. The laboratories cannot sustain this rate because:²²

1. Chemical use varies substantially by discipline and the type of sponsored research and teaching being conducted.
2. Sponsored research does not correspond to the 5-year term of the Title V air permit and the nature of the future research grants and their associated laboratory activities are impossible to accurately predict.
3. Experiments and procedures in research laboratories are not necessarily repetitive nor are these part of production processes that may be subject to identifiable limiting factors. For example, the equipment used in experiments are not typically developed for manufacturing production and do not typically have an associated design capacity that can be applied to PTE calculations.

²¹USEPA, August 29, 1996. Memorandum: Clarification of Methodology for Calculating Potential to Emit (PTE) for Batch Chemical Production Operations. John S. Seitz, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards. Page 2.

²²University of Arizona letter from Steven Holland, Department of Risk Management, to Michael Trutna, USEPA, October 26, 1995, RE: Comments on Proposed Rule: Clean Air Act: Federal and State Operating Permits Programs; Streamlined Procedures, Federal Register Vol. 60, No. 169, p. 45530.

4. Laboratory work involving chemical use may be concentrated during short periods of time corresponding to University class breaks (winter, spring, summer) because of the availability of students to conduct work.
5. Chemical use in these laboratories is estimated to be insubstantial and most used materials are disposed under applicable wastewater and solid and hazardous waste rules.

By providing the EPA with a methodology for estimating PTE that is based on representative information and assumptions, the SOCMA facilitated the EPA's efforts to provide alternative methodologies for calculating PTE based on assumptions that would reflect actual, rather than theoretical, conditions.

2.5 Exemptions for Research and Development and Test Marketing under TSCA

According to a 1986 EPA document²³ Section 5(h)(3) of the Toxic Substance Control Act (TSCA), 15 USC 2604(h) exempts manufacturers and processors of chemical substances subject to TSCA from the notice requirements of section 5(a) if they manufacture or process the substances "only in small quantities solely for the purposes of scientific experimentation or analysis, or chemical research on, or analysis of such substance, or another substance, including such research or analysis for the development of a product."

To qualify for the R&D exemption the substance must be manufactured or processed only in "small quantities," i.e., in quantities "that are not greater than "reasonably necessary" for R&D purposes (40 CFR 720.3 (cc)). EPA has not attempted to define "small quantities" quantitatively. The Agency's definition of "small quantities" recognizes that the quantity of a chemical substance needed for legitimate R&D activities varies considerably with the category of substance, the use of the substance, and the nature and stage of R&D (e.g. 80,000 barrels of crude shale oil produced in a pilot plant operation, 500 pounds of a resin produced for performance testing, and

²³ USEPA, Office of Toxic Substances, New Chemical Information Bulletin: Exemptions for Research and Development and Test Marketing, November 1986.

1 pound of a dye additive developed at the laboratory stage may all qualify as small quantities relative to the respective commercial activity²⁴.

In addition, this document provides a description of R&D activities. Activities are considered R&D if they are intended solely as scientific experimentation, research, or analysis. R&D includes: synthesis of new chemical substances and analysis, experimentation or research on new or existing chemical substances²⁵.

2.6 Bay Area Air Quality Management District

Based on a record of conversation from November 11, 1994 with Brian Bateman of the Bay Area Air Quality Management District university laboratories are conditionally exempt from permitting.²⁶ At that time the district was negotiating the following:

- a) Laboratories less than 25,000 square feet are exempt from all permitting
- b) Laboratories above 25,000 square feet must provide
 - records of chemical usage
 - list of chemicals used most frequently
 - identify chemicals with greater toxicity concerns
 - encourage a way of relating usage with emissions; there is more interest on direct evaporation rather than just usage

In addition, Mr. Bateman stated that laboratories over 25,000 square feet would not be required to submit emissions data. Rather, a permit-by-rule has been proposed to identify best laboratory practices (BLP) that would apply to each laboratory to promote emissions control and reduction:

- a) Keep lids on containers.
- b) Use wiping methods, rather than dipping, when cleaning with solvents

²⁴ Ibid, page 5.

²⁵ Ibid, page 2.

²⁶ Record of Conversation with Bateman, Brian, Bay Area Air Quality Management District, November 4, 1994

- c) Use non-HAP solvents.
- d) Make sure fume hoods operate properly. An area with unusual or highly toxic emission may require an absorber.
- e) Take other precautions that minimize emissions.

The Bay Area Air Quality district had proposed to categorically exempt any teaching laboratories at that time.

A copy of the Bay Area Air Quality Management District Air Quality Rules, dated June 7, 1995, were reviewed. In section 2-1-113, these rules exempt:

- Teaching laboratories used exclusively for classroom experimentation and/or demonstration. Laboratories located in a building where the total laboratory floor space within the building is less than 25,000 square feet, or the total number of fume hoods within the building is less than 50, provided that Responsible Laboratory Management Practices, as defined in Section 2-1-224, are used. Buildings connected by passageways and/or corridors shall be considered as separate buildings, provided that structural integrity could be maintained in the absence of the passageways and/or corridors and the buildings have their own separate and independently operating HVAC and fire suppression systems. For the purposes of this subsection, teaching laboratories that are exempt per Section 2-1-113.2.11 are not included in the floor space or fume hood totals. In addition, laboratory units for which the owner or operator of the source can demonstrate that toxic air contaminant emissions would not occur, except under accidental or upset conditions, are not included in the floor space or fume hood totals. In addition to the exemptions the rules also define the best (responsible) management practices for laboratories.
- **2-1-224. Responsible Laboratory Management Practices:** For the purpose of meeting the laboratory exemption of Section 2-1-113.2.12, Responsible Laboratory Management Practices include all of the following measures for minimizing the emissions of toxic air contaminants:

224.1 Open container procedures involving materials that contain volatile toxic air contaminants (TACs) shall be avoided where feasible.

224.2 Open container storage of volatile hazardous chemical wastes shall be avoided.

224.3 Training for laboratory employees handling hazardous materials shall include information about minimizing the emissions of volatile TACs. These employees shall be directed to avoid open container storage of hazardous chemical waste.

224.4 Fume hoods shall be posted with notices reminding employees to avoid open container procedures using volatile TACs where feasible. Laboratories shall be inspected periodically, but not less than annually, to confirm that these notices are present.

224.5 Laboratory fume hoods shall be monitored periodically to assure proper face velocity.

224.6 Evaporation of any hazardous chemical waste containing TCAs as a means of disposal shall be expressly forbidden.²⁷

2.7 Summary of Regulatory Review

EMCON reviewed the following regulations and guidances:

Regulations Relating to Research and Development

Section 112(c)(7) of the Clean Air Act - EPA mandated to establish a separate regulation covering research or laboratory facilities.

July 21, 1992 Federal Register final Rule on Operating Permit Programs

- Need for permit flexibility in relation to R&D facilities
- R&D facilities treated as separate from the manufacturing facility with which it is co-located.

August 31, 1995 Federal Register Proposed Rule on Streamlined Procedures for Federal and State Operating Permits Programs

²⁷ Bay Area Air Quality Management District, June 7, 1995

- “Depending on the extent to which a non-major R&D facility contributes to the activity of the major source, the R&D facility need not be subject to permitting.”
- R&D operations typically entail the use of small quantities of chemicals manipulated and released in a highly variable manner.
- Bringing co-located, non-major R&D facilities into Part 70 permitting could potentially lead to difficult exercises in emissions estimating and tracking and impose additional monitoring and recordkeeping requirements.
- Extreme difficulty in calculating PTE.
- R&D facilities tend to have low actual emissions.
- EPA stated that permitting authorities should accept methods of calculating PTE from R&D operations that are not unduly burdensome on the source.
- Commentator stated that deriving a numerical PTE calculation from an R&D activity is simply not possible, because experiments are typically performed only once or a few times.

December 27, 1996 Federal Register on Hazardous Air Pollutants: Regulations Governing Constructed or Reconstructed Major Sources

- The EPA has excluded R&D operations from source categories. Therefore, there is no MACT for R&D activities.

The EPA White Paper for Streamlined Development of Part 70 Permit Applications

- Exclusion for certain trivial activities from permit applications. Three types of activities pertain to the UofA’s laboratories. They include:
 - a) Bench-scale laboratory equipment used for physical or chemical analysis, but not laboratory fume hood or vents.
 - b) Routine calibration and maintenance of laboratory equipment or other analytical instruments.
 - c) Equipment used for quality control/assurance or inspection purposes, including sampling equipment used to withdraw materials for analysis.
- EPA expects that many R&D activities will generally be exempt from Part 70 and not be involved in Part 70 application processes since they are typically independent, non-major sources.

- Laboratory activities should be eligible for classification as insignificant activities if there are no applicable SIP requirements.
- Where SIP requirements do apply, they typically consist of “work practice” requirements.
- Permit applications would need to contain only a statement acknowledging the applicability of, and certifying compliance with these work practice requirements.
- No need for an extensive inventory of chemicals and activities or a detailed description of emissions from the R&D or laboratory activity.

Regulatory Guidance Relating to PTE and Batch Chemical Production Operations

- EPA agrees with the Synthetic Organic Chemical Manufacturer’s Association (SOCMA) that in calculating the PTE for batch chemical operations, it is not necessary to determine the maximum emissions for a worst-case hour of operation, and to multiply that value times 8.760.
- It is physically impossible for the process to sustain the worst-case hourly emissions rate over the entire batch and so the EPA deems it appropriate to take into account variations in the emissions rate over the course of each production cycle.
- Worst-case emissions may be determined by deriving an average rate over an entire production cycle and emissions may be calculated based on the greatest number of batches that could occur in a year’s time.
- The EPA accepted this methodology as long as it incorporates an appropriate list of products and raw materials.
- R&D laboratories and Batch Chemical Production Operations are similar in that the laboratories are also unable to physically sustain the worst-case hourly emission rate.

Exemptions for Research and Development and Test Marketing under the Toxic Substance Control Act (TSCA)

- Manufacturers and processors of chemical substances subject to TSCA are exempt if they manufacture or process the substances in “small quantities” solely for the purposes of scientific experimentation or analysis, or chemical research on, or analysis of such substance, or another substance, including such research and analysis for the development of a product.

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- EPA's definition of "small quantities" recognizes that the quantity of a chemical substance, and the nature and stage of R&D may all qualify as small quantities relative to the respective commercial activity.

3 EMISSION ESTIMATION PROCEDURES

3.1 Introduction

Estimating emissions from laboratories presents a distinct challenge. As shown by the regulatory review of proposed and promulgated regulations, there is not a clear definition or guidance on calculating emissions from a University setting which includes laboratory-based teaching and research and development activities. The reason for this lack of regulation and/or guidance may include some of the following factors; the degree of change in a university setting, the limited quantity but large variety of chemicals used at a University , and the lack of confidence in applying an emission factor or other emission estimating technique. A thorough review was conducted to identify methods used by other universities. These methods as well as a unique approach were applied to the UofA emission factor development.

Methodologies reviewed for calculating an emission factor include a questionnaire/statistical approach, stack testing developed into a square footage emission factor, and a comparative stack testing and mass balance approach. The results of each of the methods were applied to the UofA to estimate air emissions from research and development laboratories. This comparison does not prove one method to be more effective than another. Instead it shows the inherent errors in calculating emissions from university laboratories. In addition, the advantages and disadvantages of each method were assessed and a recommended procedure proposed.

3.1.1 Defining the Laboratories with Air Emissions

One inherent error in applying an emission factor is defining the area to be included in the application of the factor. The UofA's Space Management Inventory was reviewed to define those areas which could be considered as a "laboratory" for the purpose of estimating emissions from those areas. The problem with using the Space Management data was that it identified many

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rooms as laboratories, such as a music laboratory or preparatory laboratory, which do not have any chemical usage associated with them. Therefore, several different sources of information were used to define the number of laboratories at the UofA which would contribute to air emissions. They included the following:

1. UofA Main campus fume hood inventory
2. Arizona Health Sciences Center (AHSC) fume hood inventory
3. Information from "sweeps", air permit screening activities
4. UofA waste generation information
5. Off-campus research facilities and farms

The following rationale was applied to evaluate these sources. If a laboratory had a fume hood, it was assumed that the laboratory either needed to vent fumes of chemicals or conduct a process which required venting. Therefore, all laboratories listed on the fume hood inventories were included. Sweeps involved internal forms developed for this study to assess if an area had any activities with associated air emissions. If the sweep identified laboratory activities (research involving chemical usage) they were included. In using the waste generation information, it was assumed that if a laboratory produced waste, the waste had to be coming from a product and there is the potential for air emissions during product usage, even if the laboratory did not have a vent. The last area was farm or research facilities non-contiguous to the UofA main campus with potential air emissions. Laboratory activities at the farm or research facility were identified during "sweeps" of these areas.

3.2 UofA Lab Approach - Questionnaire and Statistical Approach

The UofA developed a laboratory questionnaire and a statistical sampling approach to calculate an emission factor that could be used to estimate laboratory air emissions at the UofA^{28 29}. The

²⁸ Letter from University of Arizona, Department of Risk Management, "Request for Approval of University Laboratory Emissions Estimating Approach", March, 1995

laboratory questionnaire appears as Exhibit A to this paper. The emission factor can be applied to UofA laboratories on main campus, north campus and off-campus locations. As shown in Table 1.0, the approach used to develop the emission factor evolved over 18 months through research of existing laboratory programs across the country, evaluation of published emission factors, discussions with PDEQ and meetings with UofA staff. A questionnaire was developed to evaluate the types of equipment in the laboratory, the amount and type of chemicals used, and the amount of waste generated from the laboratory process. Simultaneous to the development of the laboratory questionnaire, a statistical sampling approach targeted the number of laboratories for sampling that would be representative of the characteristics of the entire laboratory population.

Table 1.0
Chronology of Development of UofA Laboratory Emission Factor

Activity	Dates
Research of Laboratory Approaches in other areas	November 1994 to February 1995
Letter to PDEQ requesting approval of Laboratory Emissions Estimating Approach	March 8, 1995
Letter from PDEQ stating agreement with the Laboratory Emissions Estimating Approach	March 30, 1995
Compilation of Laboratory Database	April, 1995
Development of Laboratory Questionnaire	April through May, 1995
Statistical sample size determination	April 17, 1995
Random Number Generation to target laboratories for questionnaire distribution	May, 1995
Contact, Addresses, and phone number of targeted laboratories	May, 1995
Distribution of Laboratory Questionnaires	June 14, 1995
Return of Questionnaires	June through September, 1995
QA/QC of Questionnaires/Phone Follow-up	October through November, 1995
Development and Application of Emission Factor	February through April, 1996

²⁹ Letter from Richard Grimaldi, Technical Service Manager, Department of Environmental Quality, "University Laboratory Emissions Estimating Approach", March, 1995

3.2.1 Database Compilation

The procedure for this approach included compiling an initial database of laboratories to be included in the survey population. The compiled database contained a list of 942 laboratories derived from the sources previously identified.

To test the validity of this approach, a subset of "worst-case" laboratories based on chemical usage, hazardous waste generated, and wastewater parameters was also targeted. The worst case subset consisted of 420 laboratories located in these buildings:

1. Building 37 - Chemistry, Marvel Laboratories
2. Building 38 - Shantz Building
3. Building 77 - Gould - Simpson
4. Building 88 - Bio Sciences West
5. Building 106 - Life Sciences Building S.
6. Building 201 - Arizona Health Sciences Center
7. Building 207 - College of Pharmacy
8. Building 222 - Leon Levy, Cancer Center

3.2.2 Defining Statistical Analysis

Statistical analysis constitutes a body of techniques for deriving and organizing statistics and for determining their essential significance. Statistical analysis can be applied to either variable or attribute data to:

1. test a given hypothesis concerning some observed characteristic
2. determine a reliable estimate of some factual value
3. represent a physical situation functionally

Since no experimentally determined value is absolute, it is frequently necessary to determine by statistical methods the reliability of scientific determination. As a means of testing a hypothesis or

determining the reliability of some factual value, a statistically designed experiment should be used. These designed experiments enable the analyst to determine, with a pre-designed degree of confidence, the degree of variation in the experimental determinations which is due to chance and which is the result of some possibly known or unknown influence. In addition, a statistical experiment is designed from the standpoint of being able to make a given number of reliable generalizations from a minimum number of experiments.

3.2.3 UofA Statistical Analysis³⁰

To perform the analysis, each record of the database contained at least one variable related to possible air releases. The variables were number of hoods, square footage of the permitted area, and gallons of waste generated. The standard deviation for each of the variables was normalized between 0 and 1, and a pooled standard deviation was calculated for each case, using the following equation.

$$S_p = \frac{(n_1 - 1) * s_1^2 + (n_2 - 1) * s_2^2 + (n_3 - 1) * s_3^2}{n_1 + n_2 + n_3 - 3}$$

The sample size was calculated based on a 95% confidence interval and 0.5% confidence band using the following equation.

$$n = \frac{1.96^2 * s^2}{0.005^2}$$

³⁰ Memorandum, "Project 95-105-006, Sample Size Determination", from K. Boomer, April, 1995.

Table 2.0
Summary of Entire Set Database Statistics

Parameter	Number of Hoods	Square Footage	Gallons of Waste Generated
minimum value	1	80	1
maximum value	16	5800	101
mean value	1.44	799.17	22.86
standard deviation	1.33	983.64	21.76
number of data points	758	56	97

Table 3.0
Summary of Worst Case Database Statistics

Parameter	Number of Hoods	Square Footage	Gallons of Waste Generated
minimum value	1	0	4
maximum value	12	0	66
mean value	1.28	0	17.24
standard deviation	0.92	0	15.66
number of data points	407	0	33

Table 4.0
Results of Statistical Sample Size Determination

	Entire Set	Worst Case
Standard deviation	0.0124	0.0096
Sample size	24	14

Table 5.0
UofA Laboratory Questionnaire and Statistical Findings

	Number of Laboratories in Survey Population	Sample Size Determination	Number of Questionnaires Submitted	Number of Questionnaires Returned
Entire Set	938	24	48	36
Worst Case	420	14	28	19

The relatively small calculated sample size reflects the small variance and large subsample size of the number of hoods. Calculations were performed based on the statistics of SW-846³¹, Chapter 9, The Sampling Plan. The Sampling Plan addresses the development and implementation of a scientifically credible sampling plan for a solid waste and the documentation of the chain of custody for such a plan. The first reference, which occurs throughout the regulations, requires that representative samples of waste be collected and defines representative samples as exhibiting average properties of the whole waste. A judgment must be made as to the degree of sampling accuracy and precision that is required to estimate reliably the chemical characteristics of a solid waste for the purpose of comparing those characteristics with applicable regulatory thresholds. Sampling accuracy is usually achieved by some form of random sampling. In random sampling, every unit in the population has a theoretically equal chance of being sampled and measured. Sampling precision is most commonly achieved by taking an appropriate number of samples from the population.

The number of questionnaires submitted to the laboratories were doubled in order ensure that the an adequate number would be returned to meet the sample size determined. A quality assurance/quality control (QA/QC) procedure was also instituted to evaluate the integrity of data returned on the questionnaires.

³¹ U.S EPA, Test Methods for Evaluating Solid Waste, SW-846, Chapter 9, The Sampling Plan, September, 1986.

3.2.4 Laboratory Emission Calculations

A computerized random number generator was used to provide the random selection of laboratories which would receive a questionnaire. After the return and QA/QC of the laboratory questionnaires, laboratory emissions were calculated from the variables provided in the "University of Arizona, Required Quantification of Regulated Air Pollutants in Laboratories Questionnaire". The formulas used in these calculations are listed as Equation 1 and Equation 2 below. The annual emission values obtained from the survey questionnaires were used to calculate an emission factor for the laboratories.

Explanation of Variables:

Usage: The weekly usage of regulated air pollutants in pounds. When usage was provided in units of measure other than pounds, a conversion was performed in the database using the values provided in a Weight Conversion Factor table.

Waste: The amount of regulated air pollutant waste product generated in pounds per week. When waste was provided in units of measure other than pounds, a conversion was performed in the database using the values provided in the Weight Conversion Factor table.

% Consumed In equation 1, the percent of the product consumed in a reaction when available or applicable. In equation 2, the percent of product emitted to ambient air.

Wks/yr Active: The number of weeks per year the activities using regulated air pollutants are conducted.

PTE Multiplier: The potential to emit multiplier is based on the assumption that the actual laboratory activities are performed 40 hours a week, 52 weeks per year. Chemical usage was requested on a weekly basis and a week was assumed to have 40 hours although findings from laboratories surveyed showed that chemical use was highly sporadic. The PTE multiplier is calculated according to the following equation.

$$\text{Multiplier} = \frac{\text{PTE Total Hours per year}}{\text{Hours of operation per year}} = \frac{8760}{2080} = 4.2$$

If the calculation of annual emissions using Equation 1 equaled zero, then the annual emissions were calculated using Equation 2.

Equation 1:

If usage is not equal to waste generated:

$$\text{Annual Emissions (tpy)} = \left(\text{Usage} \frac{\text{lbs}}{\text{week}} - \left(\text{Usage} \frac{\text{lbs}}{\text{week}} \cdot \% \text{ Consumed} \right) - \text{Waste} \frac{\text{lbs}}{\text{week}} \right) \cdot \text{Active} \frac{\text{weeks}}{\text{year}} \cdot \frac{1 \text{ ton}}{2,000 \text{ lbs}} \cdot \text{PTE Multiplier}$$

Equation 2:

If usage equals waste generated:

$$\text{Annual Emissions (tpy)} = \left(\text{Usage} \frac{\text{lbs}}{\text{week}} \cdot \% \text{ Consumed} \right) \cdot \text{Active} \frac{\text{weeks}}{\text{year}} \cdot \frac{1 \text{ ton}}{2,000 \text{ lbs}} \cdot \text{PTE Multiplier}$$

After obtaining the results of the annual emissions from the laboratories surveyed, an emission factor was calculated by calculating the mean value from various sets of data. This included calculating a separate emission factor for the main and north campus and calculating an emission factor both excluding and including teaching laboratories. A summary of these factors are provided in Table 6.0.

Table 6.0
UofA Laboratory Emission Factors Based on Questionnaire Data
Tons per year per laboratory (tpy/lab)

Area	Number of Laboratories	VOC Actual	VOC Potential	FHAP Actual	FHAP Potential
Main Campus	517	0.018	0.0756	0.0087	0.0365
North Campus	242	0.0267	0.1125	0.0142	0.0596

Next the UofA decided to assess if emission estimating techniques from other universities could be applied to evaluate laboratory air emissions from the UofA.

3.3 UCSF Parnassus Campus Emission Factor - Stack Testing³²

In 1989, Radian, an environmental consulting firm, completed a study for the University of California at San Francisco (UCSF) Parnassus Campus that quantified VOC emissions from laboratories. In the study, measurements of the emissions of select organic species were made over a one to three day period from certain fume hood vents believed to have the highest emissions based on laboratory usage questionnaires. The results of the Parnassus study were developed into

³² Bateman, Brian, "Review of Laboratory Health Risk Assessments", summary of *Laboratory Building Fume Hood Modeling Study*, Bay Area Air Quality Management District, September, 1994.

emission factors ($\mu\text{g/s/sq ft}$ of laboratory space) that have been used repeatedly in health risk assessments completed for other laboratories. This study was not conducted to assess emissions for major source status under the Clean Air Act.

A total of about 30 separate VOC species were analyzed in the Parnassus study. These compounds were selected on the basis of their usage and toxicity. The emission rates for the Parnassus study were reported separately for pharmacy and non-pharmacy fume hood vents. The pharmacy vents had higher emissions than the non-pharmacy vents. The total VOC emission factor derived from the pharmacy vent measurements was 9.71×10^{-5} lb/day/ft² on an annual average basis, and 1.35×10^{-4} lb/day/ft² on an operating day basis.

The UCSF factor was applied by obtaining an estimate of the square footage of emitting areas. The estimate was obtained from the UofA's Space Management Department which prepares an annual physical space inventory of the campus. In addition to square footage of buildings, the Department provided information on laboratory room use, and organized research. This information is updated yearly and allows for a comparison of campus square footage increases which could potentially be used for recordkeeping requirements. However, extracting the appropriate information to calculate emissions was a time consuming process.

3.4 Purdue University - Stack Testing and Mass Balance³³

Purdue University conducted a study in 1994 to provide an accurate estimate of laboratory fume hood emissions. The estimates were used to show that Purdue's largest academic/research facilities are insignificant activities, emitting less than 15 pounds per day. One of the results of the Purdue Study states "The Method 2 release factors predict that approximately 13% of VOC/HAPs purchased (0.061 pounds/hood/day) will appear as air emissions. This compares reasonably well with the measurements obtained in Part I (fume hood measurements) of this paper and is consistent with observations of typical laboratory operations."

³³ Anderson, A. and Stuart Kline, "Approaches for Quantifying Potential to Emit from Laboratory Fume Hoods, Purdue University, 1995.

"The Method 2 estimated release per laboratory fume hood value of 0.061 pounds/day can be used directly to estimate releases from typical laboratory operations without an extensive review of purchasing records. The value can also be incorporated into Title V Operating Permits where "insignificant source" justification is required. The authors recommend Method 2 as a suitable alternative to mass balance emission estimates, emissions monitoring, and emission inventories."

By applying the Method 2 factors Purdue is using an alternate approach to calculate actual emissions. This differs from the UofA in that the laboratory questionnaire used a mass balance approach to calculate actual emissions. By applying Method 2, Purdue is using their own emission factor (similar to a control efficiency) to estimate what is released to air versus what is purchased. However, the Purdue approach does not account for potential emissions, nor does it distinguish between VOCs and HAPs.

A conversation with Stuart Kline at Purdue University confirmed that this university was not required to look at potential to emit (PTE) from the laboratories. Indiana Department of Environmental Management has moved away from PTE for insignificant sources by promulgating a rule to exempt these sources. He stated that based on Purdue's purchasing records alone, they would probably be a Title V source for laboratories if they had to calculate PTE in the same manner as a manufacturing facility.

Table 7.0 below shows the release factors applied to the methods used in the Purdue Study. The factors from Method 1 were used to compare emission values to the UofA statistical approach. UofA usage in pounds per year (lb/yr) was compiled for of the constituents considered in the Purdue Study. Then the Purdue release factor from Method 1 and the UofA Laboratory Emission Factor was applied to the usage. The results were then used to calculate an estimated daily air emissions per hood which could then be extrapolated for the entire campus.

**Table 7.0
Purdue Study**

Radionuclide NESHAP		Release Factors Modified from Radionuclide NESHAP (Method 1)		Release Factors based on Purdue Univ. Chem. Dept. (Method 2)	
1.0	gases	1.0	gas, BP < 25°C	1.0	BP < 25°C
0.001	liquids, particulate solids	0.5	BP < 26-38°C	0.5	BP 25-38°C
0.000001	solids	0.05	BP < 39-100°C	0.1	BP 39-100°C
--	--	0.001	BP > 100°C	0.001	BP > 100°C
--	--	0.000001	solids	--	--

3.5 Critical Discussion of Procedures

The UofA has completed an extensive search of laboratory emissions estimating procedures for calculating actual and potential emissions. Some of the methods applied in these procedures use the following factors;

- Statistical sampling of laboratories using a questionnaire approach
- Applying an emission factor based on square footage
- Applying an emission factor based on stack testing

As shown in Table 8.0 below, A Comparison of UofA Emissions Estimates by Applying Documented Approaches, shows that applying the different approaches provides a range of values for potential and actual emissions at a University environment in a similar order of magnitude.

In addition to applying the emission factor developed by the UofA and by other Universities, the UofA also assessed limiting the potential to emit. This approach looked at the actual number of hours chemicals were being used, as opposed to assuming that usage was spread over a 40 hour

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work week and calculated potential emissions. The high value of potential emissions is directly proportional to the low hours of actual chemical usage when calculating PTE.

Table 8.0
Comparison of UofA Emissions Estimate by Applying Different Approaches

Approach		Potential Emissions (tons per year)		Actual Emissions (tons per year)	
		VOCs	FHAPs	VOCs	FHAPs
Questionnaire/Statistical Representation		66.32	33.29	15.79	7.92
Limiting the Potential to Emit		343.12	172.10	15.79	7.92
Parnassus Emission Factor		44.69	--	10.64	--
Purdue Release Factors	Mass Balance	48.67	--	11.59	--
	Stack Testing	34.90	--	8.31	--
Purdue Release Factor - Mass Balance	Main Campus	35.83	--	8.53	--
	North Campus	12.90	--	3.07	--

What are the inherent limitations in calculating emission estimates from a University?

1. Lack of a centralized purchasing system. There is no mechanism in place at the UofA to track the purchase and use of chemicals. The quantity and types of chemicals purchased varies by building, departments, grants, and time of year. Chemicals may come through a stores facility at the University or be purchased by individual departments directly from the manufacturer.
2. Degree of change - A university setting involves a higher degree of change than a manufacturing facility. The degree of change is dependent on the grants awarded to the University.
3. Difficulty in tracking the usage of chemicals from purchasing to waste.

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What are the disadvantages of applying each technique to calculating laboratory emissions from a University?

1. Questionnaire/Statistical Approach - The major limitations found were as follows:

- difficulty getting recipients to provide a timely response to the questionnaires.
- recipients interpreted questions differently, required detailed QA/QC - phone follow-up.
- provides only a statistical sampling of the University- not a complete picture.
- time consuming process to repeat for yearly recordkeeping requirements.

2. Stack Testing

- due to the degree of change of chemicals used and processes, the results from one or several stack tests may not be valid for an accurate daily, weekly or yearly emission estimate
- stack testing may be costly if necessary to meet the requirements of yearly recordkeeping and reporting requirements
- fume hoods normally operate continuously and are part of air balance.

3. Mass Balance

- difficult to implement without a strict central purchasing system and waste tracking system in place at the point of generation (laboratories).

3.6 Recommendations

This study finds that there is not a single recommended laboratory estimation procedure which can be applied with scientific validity. Due to the nature of laboratories, developing an emission factor for one university or R&D facility may not guarantee its applicability to other universities.

The work conducted to estimate actual emissions supports the position that emissions at university laboratories should not be considered a significant source of regulated air pollutants:

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1. The federal potential-to-emit (PTE) criterion was designed to address full capacities of production and manufacturing operations.
2. Actual chemical usage in university R&D laboratories is de minimis, diverse and somewhat random in response to varying research activities. Production scenarios and their associated "capacities" do not apply to R&D facilities.
3. The EPA acknowledges this distinction in the May 12, 1997 Advanced Notice of Proposed Rulemaking as well as in other policy and regulatory documents discussed in this paper.
4. When applied to university R&D laboratories, the use of the PTE criterion far overstates the true potential of such laboratories to emit regulated air pollutants.
5. Publicly funded universities with R&D laboratories are financially constrained from ever operating at PTE levels by limited budget appropriations and federal research grants.
6. R&D laboratories at universities are not expected to be major sources of regulated air pollutants despite the estimates that are generated when the PTE criterion is applied.
7. These laboratories are already subject to best management practices that reduce potential emissions through OSHA requirements in 29 Code of Federal Regulations 1910.1450, Occupational Exposures to Hazardous Chemicals in Laboratories. This regulation requires facilities to prepare and maintain a written Chemical Hygiene Plan which governs appropriate handling of chemicals to control airborne releases and protect employees from exposure.
8. The level of effort and expense required to estimate emissions from university R&D laboratories is significant and is not cost-effective on an annual basis, given the relatively small amount of emissions generated. The UofA statistical survey directly involved less than 10% of its total number of laboratories yet required four months to administer.

This study finds that implementing best laboratory practices (BLP) would be the most effective means to promote emissions control and reduction. In our opinion, no source category should be listed and no MACT standard should be developed for university R&D laboratories.